Next Wave Automation

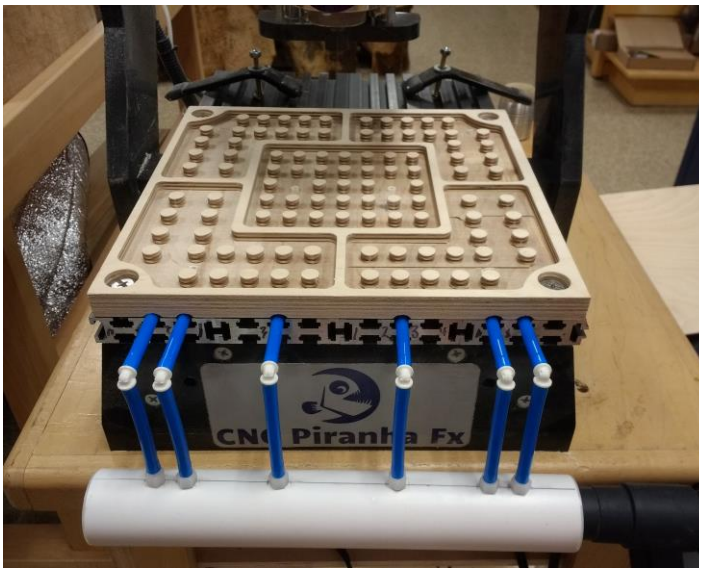
Project Tutorial

Compatible with the Current Version of VCarve Pro & Desktop

Project: T-Track Vacuum Table

By David White

There are many ways to hold down stock while engraving, cutting, carving, and lasering. One of the best ideas for holding materials is a vacuum table.



This type of material holding offers:

- Faster repeated parts
- Can pull thin warped stock flat
- Leaves no surface marring
- No tabs to be cut and sanded
- No hold downs for a tool to hit

My inspiration for this was making signage around the shop using 1/8” Baltic birch that was warped. This left the engraving text inconsistent in depth and is significantly noticeable the thinner the material.

Design Goals:

- Very low profile so thicker stock and attachments like the laser can still be used
- Should scale to different size tables
- Offer zoned areas so smaller work pieces can get a higher holding force if needed
- Reasonable in cost
- Work with a variety of vacuum sources

In testing, I found that almost all vacuums seemed to produce about a 5-pound PSI drop. That doesn’t seem like much until you start multiplying. A 6” x 6” part with 4 pounds per square inch which gives 144 pounds of holding force.

Even that force might not be enough if the idea was to keep a rogue Yeti from pulling the work piece off the table. The forces we are concerned with though are lateral. That is the tool in a material pushing stock in the X or Y plane. This is even far harder to move as friction is a force multiplier of the holding power. Thinner passes in the toolpaths can make these forces much lower and cleaner in the process if you have trouble.

One might assume that pumps specifically made for this purpose could draw much lower pressure readings but at the cost of cubic feet per minute. I am assuming that we are going to have a rather leaky system and concentrated on more cubic feet per minute than absolute drop.

Various vacuum sources can be used if the motors are independently cooled (separate fan for vacuum wet side and the motor) as in Wet Vacs and higher ended industrial vacuums (Festool). I sourced the cheapest Wet Vac that I could find at $23 on sale and it has worked well although the hose quality is poor.

Small vacuum pumps made specifically for this purpose can run $400 and higher. The ones that are used for automotive AC at $100 and under aren't designed to run continuously and tend to aerosol out lubricating oil.

Height is an issue in smaller footprint machines too. By using the T-track grooves to run the pneumatic tubing we can save important head room in the Z axis. It makes construction easier too.

Material costs should be around $40. Poorly cast aluminum vacuum tables online start in the mid-$150 range that don't even match the cutting size of a small CNC machine bed. Puck vacuum styles also can't offer the uniform flatness of a table for thin stock and you would still need a spoil board if cutting through a work piece.

All parts other than the base were sourced from Amazon except the PVC pipe and sidewalk bolts. The PVC came from the local home box store with the matching sized end caps. The bolts from the local nut and bolt house.

The first revision I used a 1-inch PVC pipe. It worked well but 1.5-inch worked better and seems to buffer a more consistent pressure difference. One could assume the bigger the better for a manifold/accumulator.

Materials selection for the base has a lot to do where I live. Many use MDF, but in Tampa we have wide swings in humidity. We will use a ¼" sheet of MDF for the spoil board. But I am loath to use anything much thicker. MDF thickness can vary 10% on the rain forecast in Florida.

We always start a project with a two thousand spoil board cutter pass. A benefit of plywood or solid surface as a base is there is no need to seal the cavities. Using MDF or solid surface as the base, you can run the spoil board cutter on it if you intend to have the work piece directly on the vacuum table.

After several prototypes and testing, I landed on solid surface. It was free in the dumpsters of all the remodeling places around my area. It's incredibly uniform in thickness and it works well with standard woodworking tools.

Sink cutouts littered the dumpsters and a local fabricator now leaves off cuts for me to pick up every few weeks. The only downside is that if you drop solid surface countertop material it can shatter.

MDF is like Swiss cheese and we can use that property for a spoil board. A vacuum can pull right through it as if it's not hardly there. You will need to seal the edges though as it can suck air in the X and Y planes easily. A skim pass is also necessary on both sides to get the surface glue off for maximum vacuum penetration. This of course is if you are going to cut through the material and into a spoil board.

You can use paint, shellac, or 50% diluted wood glue and water for sealing MDF to prevent vacuum leaking through anywhere that isn't contacting the work piece. On a spoil board, you will at a minimum want to seal the edges. If you use MDF in the base, you will want to seal everything.

Using newsprint under smaller work pieces will act like a gasket filling any micro gaps between a spoil board and the stock to be cut.

If you ever run into a vacuum leak, incense smoke or vapor from dry ice in water are excellent ways to track down where the air is flowing.

Parts List and Pricing:

Solid Surface/MDF .7” x 12” x 12” $5.00
¼” or 6mm hose barbs (10) - $7.51
90-degree elbow 1/4” barb (20) - $16.00
Pneumatic Hose 8mm x 6mm x 1m $12.00
12” 1.5” OD PVC pipe - $2.00
1.5” Knock out PVC caps (2) $1
Sidewalk or Hurricane bolts 1/4x20 (4) $2.00
Nylon sealing washers 1/4x3/4 (4) $2.00

You will need a .25” upcut spiral bit and a .25” bull nose bit.

Hurricane or sidewalk bolts

Optionally you can order ball valves in place of the ¼” hose barbs, if you want to control the zoned sections.

Assembly is straight forward and hack saw, drill and bits, razor knife, sandpaper, CA glue, and a heat gun is all that is necessary. I did tap the holes for the hose barbs but could have just glued them in. The heat gun makes the pneumatic hose go over the barbs a bit easier.

The 90-degree elbows were cut off at the barbs to expose just the ¼” OD shafts. The tube stops at the round base of the elbows were sanded off for clearance in the t-track slots.

Open the project CNC files in V-Carve and carefully review all the toolpaths and make necessary changes to suit your tools and machine. The toolpaths are currently set with tool, feeds and speeds that were used in designing the original project. In this project it used a .8 horsepower router and they are set accordingly.

If using a different model, you will need to verify the track spacing and adjust. In V-Carve, the guides are your friends.

Don’t use them directly until you review them for your machine. Edit the tools and change the settings to fit you own machine and requirements. It is very important to recalculate all toolpaths after making any changes.

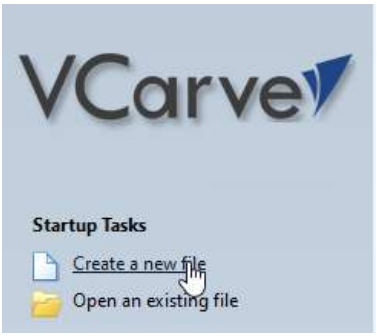
Once having recalculated for your own machine and tools, reset the preview, and then preview all toolpaths again to visually verify the project outcome. Then create the tap file for your machine using the correct post processor.

Once satisfied with your settings, save the tool paths using the appropriate Post Processor for your machine. Check tool paths by air cutting the project or use rigid foam board to run a sample tool path. If satisfied with the outcome, now you’re ready to make your own vacuum table!

Step by Step In V-Carve

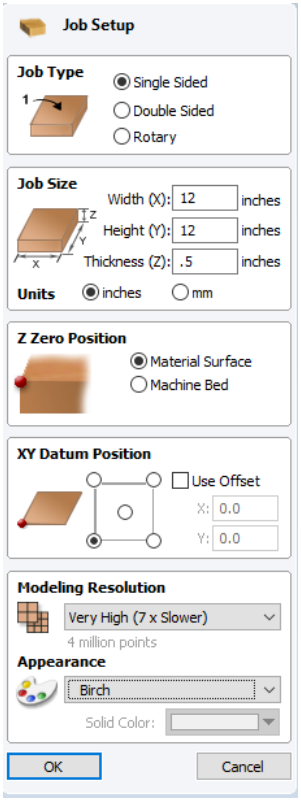
This tutorial highlights the process we took in creating the CAD files for this project. Different sized tables can be easily adapted using the same techniques.

Remember to set your speeds and feeds for your specific router and CNC machine.



Of course, the first thing to do is create a new file.

Then set up the size. This one is for a Piranha and is 12” x 12”. For the solid surface its .5” in the Z.



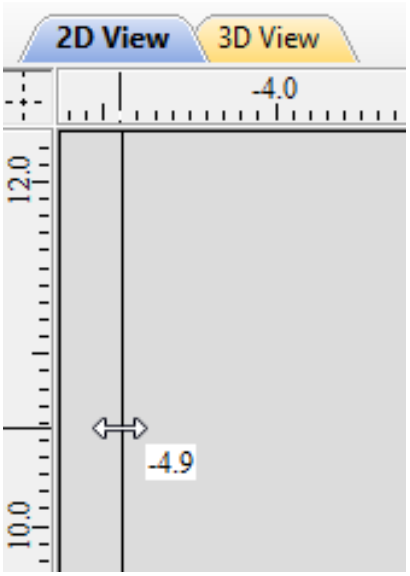
We will use a single sided design so that all V-Carve versions can use these files. Since the design is symmetrical. There isn’t a lot of need for the complexity of a two-sided design anyway.

We will separate the toolpaths and use the through holes to align the top and bottom cuts.

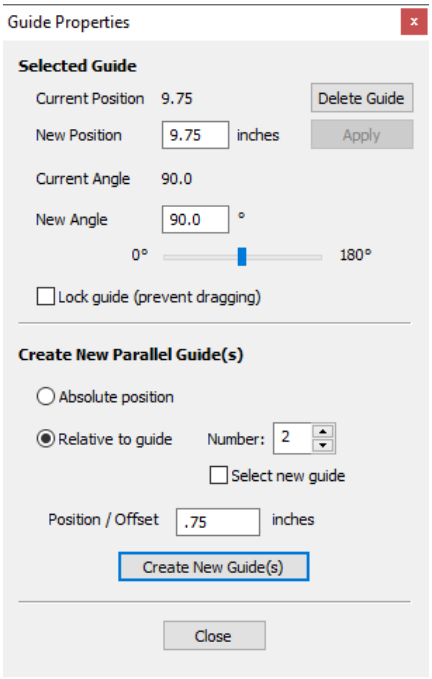
On the Piranha, the T-Track is spaced .75” for three tracks and then a 1.5” gap before the pattern continues.

Remember to change the guides to match your T-Track spacing. This shows the new [HD5 spacing].

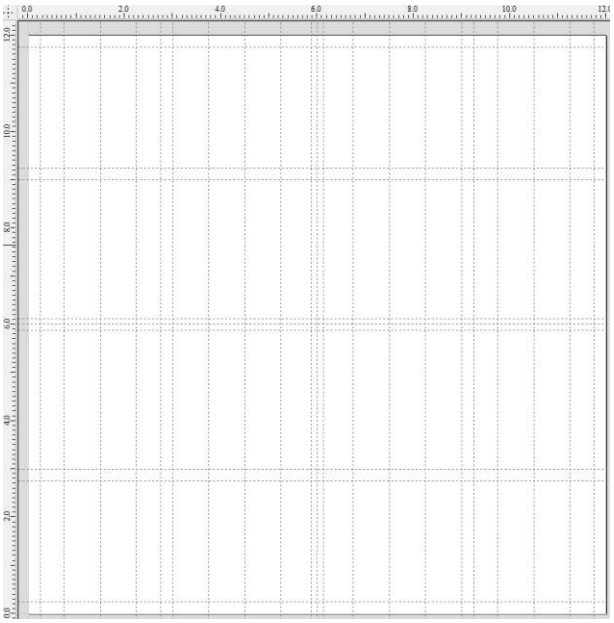
Also, if you are reading this as a PDF, remember that holding the control key down as you move the mouse scroll wheel will let you zoom in for more detail.



I start by dragging out the guides from the x and y rulers.

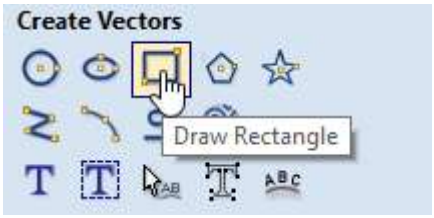


Right clicking on a guide will bring up the properties and make sure that they are on the exact number you want. These seem to not always snap to the position wanted. Trust but verify using the properties dialog.

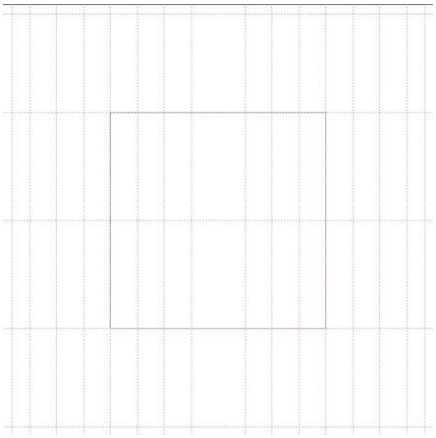


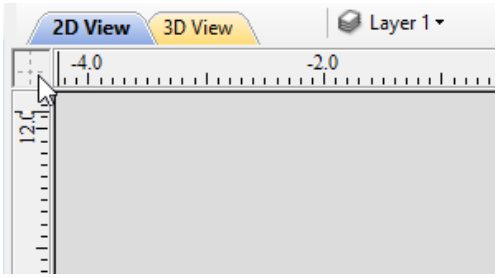
Set up guides for each T-Track slot so we know where they go. ¼” margins around the edges and each zone on the table.

We will start in the center zone. For the most part the center is where you want the most vacuum as that is where warp will be in the thin stock.



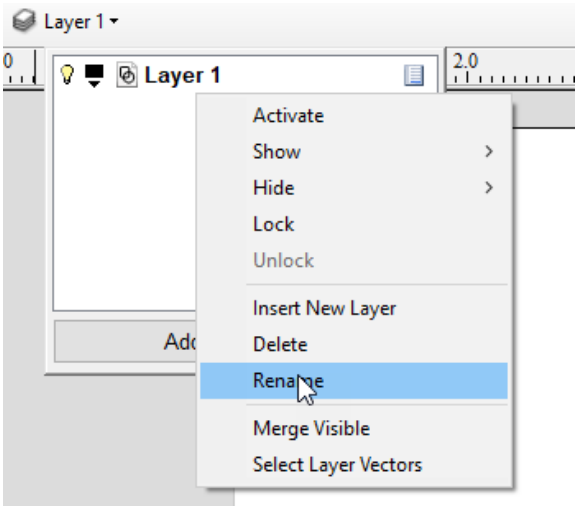
Select the Rectangle vector tool and draw out a 6” x 6” square using the guides.



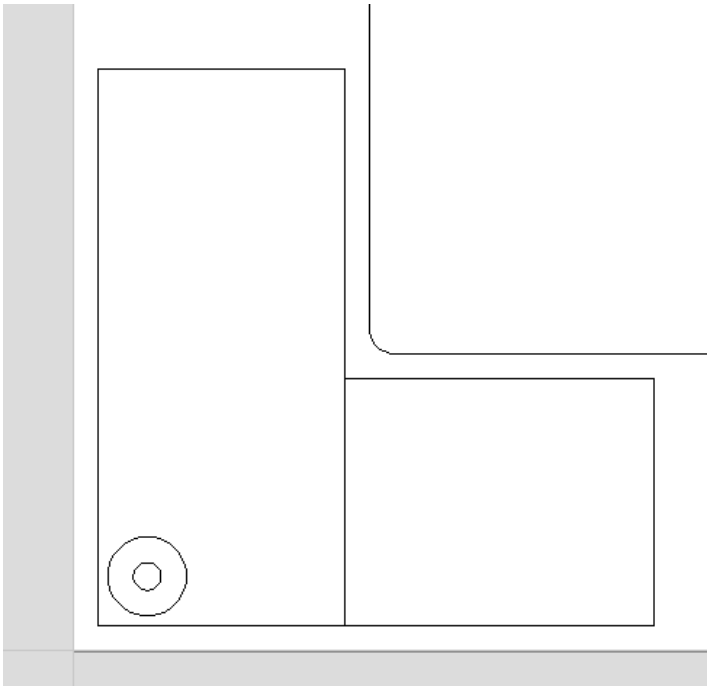


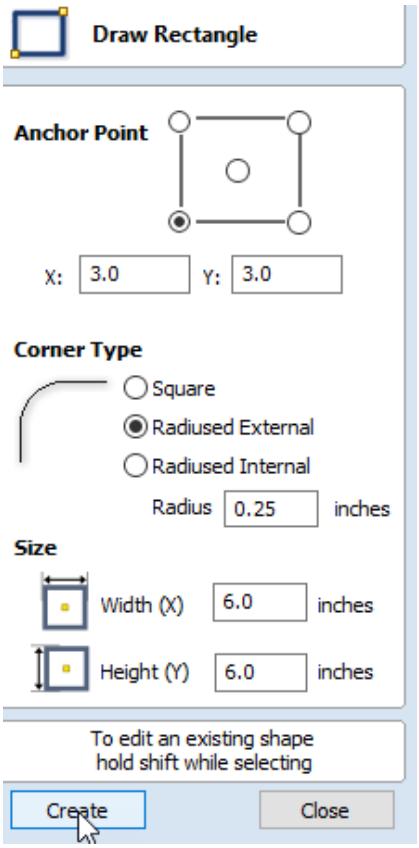
Remember that you can turn the guides off and on in the upper left-hand corner of the design window.

At this time, we should start using layers to make this process a lot easier down the road.



With the square selected, lets rename the first layer to something meaningful. How about “Supports” for the internal pocket. [Layers help]





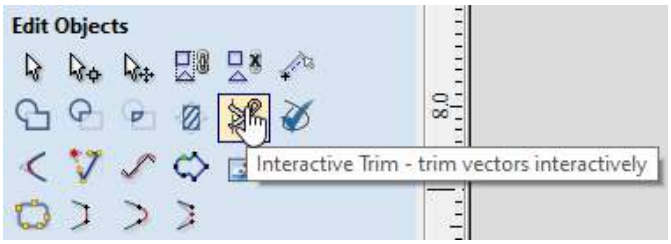
With the square still selected click on the Rectangle vector tool icon to get the dialog properties for the center square. Let’s have a ¼” outside radius.

As a side note, some of the earlier prototypes we made from clear plastic to test with smoke to see how the air flowed. Rounded edges seem be a big factor in how well the vacuum flows through the zones.

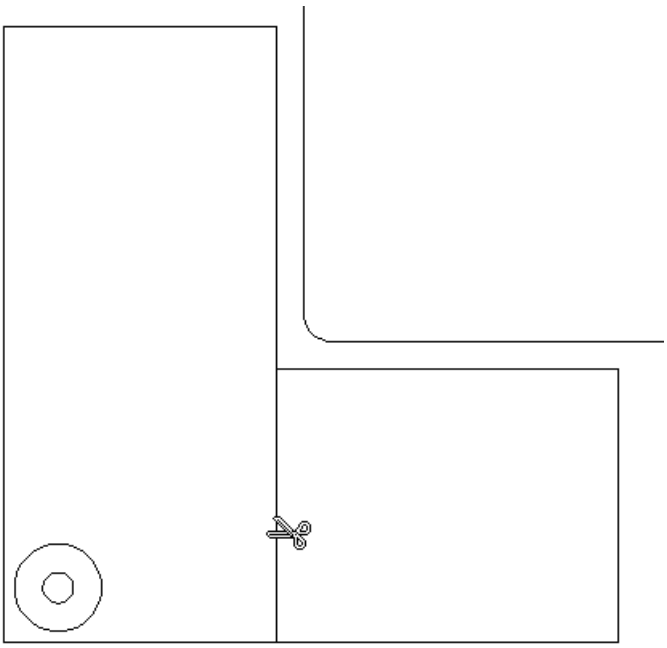
Next we want to add two circles at .75 X and .75 Y. The first one is .28 diameter and the second .8 for the hurricane bolts to hold the table to the T-Track.

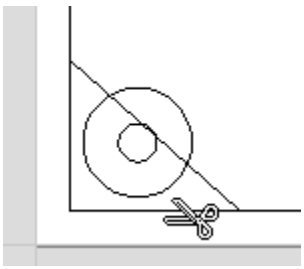
Select the two circles and move them to another layer to make selection easier in coming steps.

Next we add two squares around the guides to form another zone.

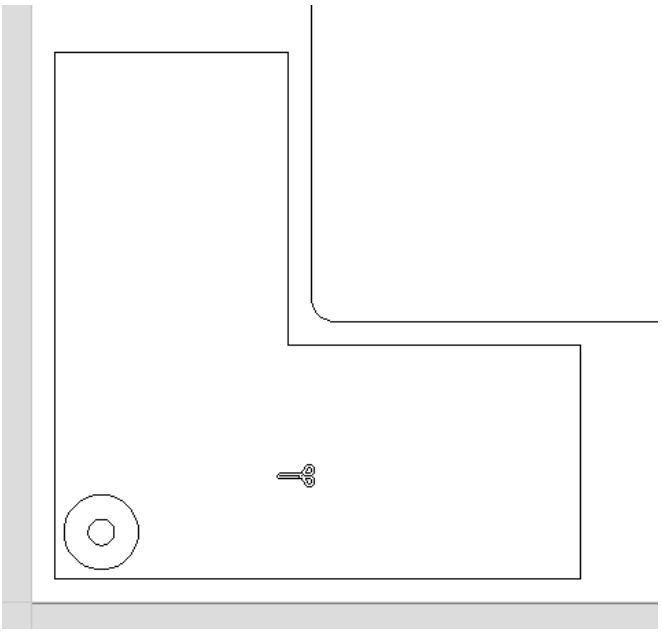


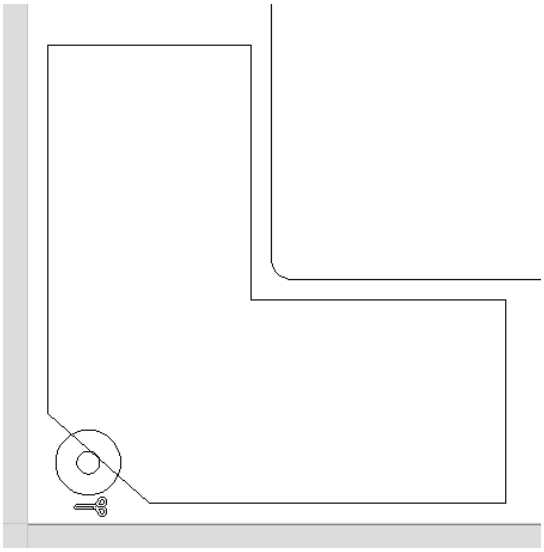
[Interactive Trim help]



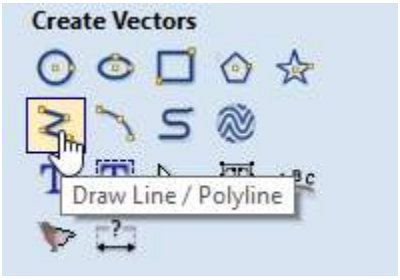


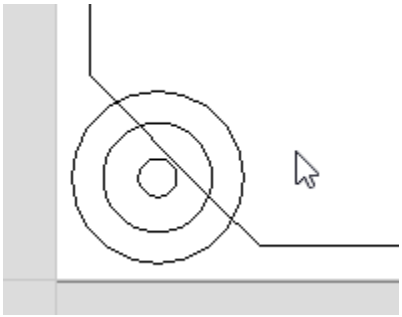
Add a corner using the poly line tool. Then cut the corner off using the Trim Tool. [Polyline help]



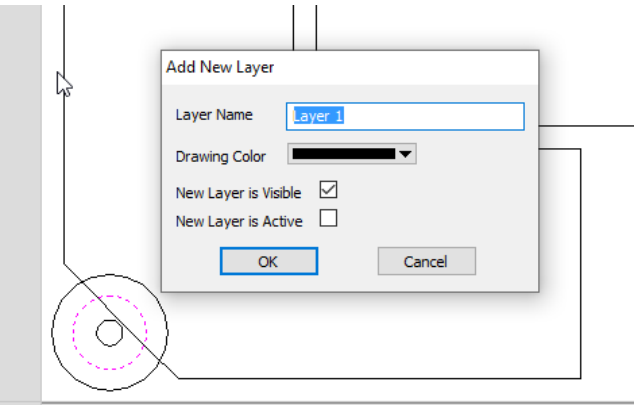


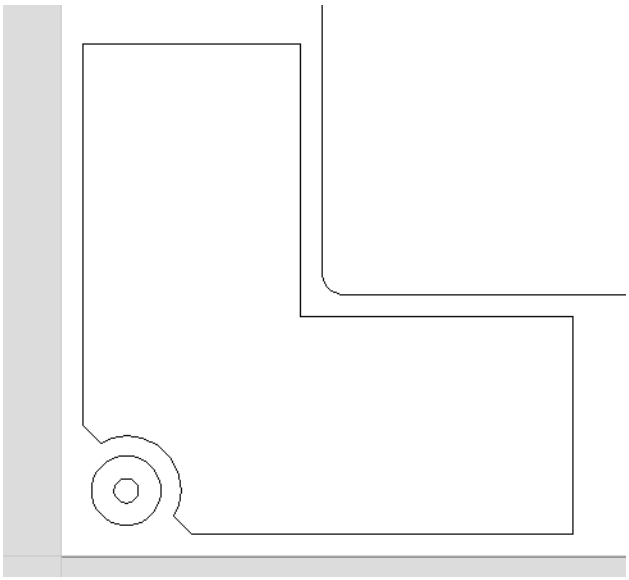
Add a larger 1.25” circle at the .75 X and .75 Y positions.

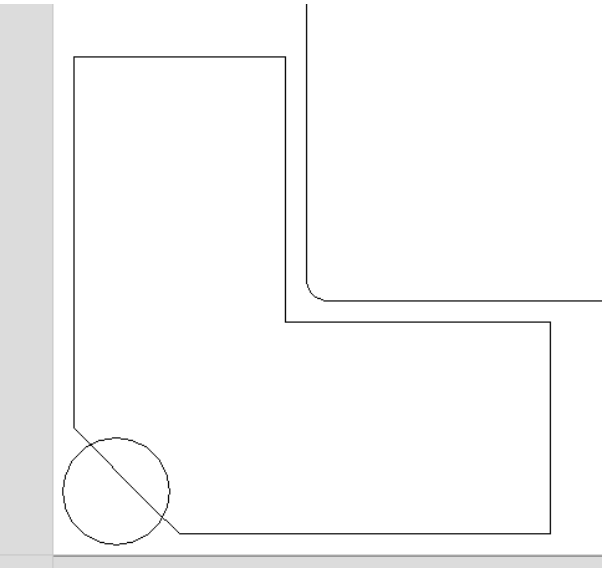




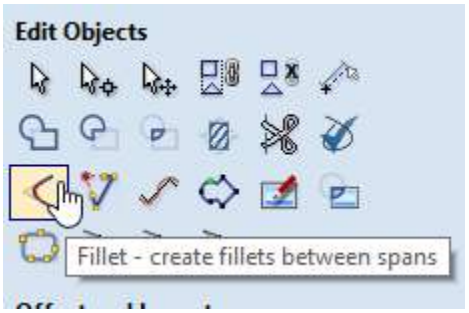
Using layers, you now just want visible the largest circle and the zone trapezoid. You can move the objects to the same layer or create a new one.



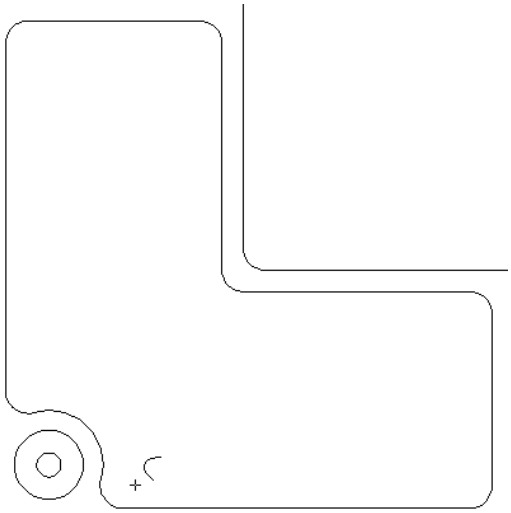


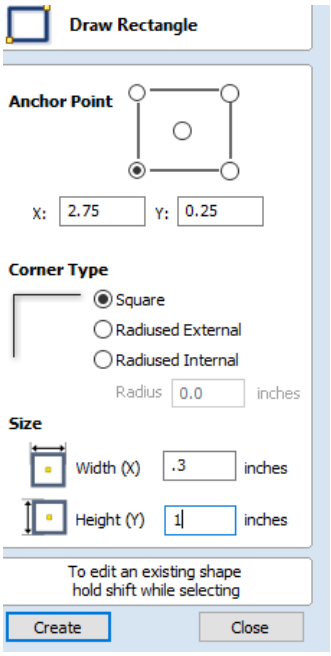


Using the Fillet Tool, outside radius the corners.

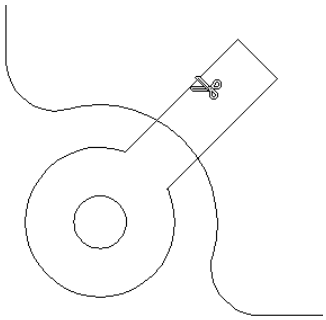


Using the Trim Tool, cut the extra sections out to reveal the inside radius. Move the bolt holes and the bolt head circles back to the Supports layer and make the Supports layer visible.

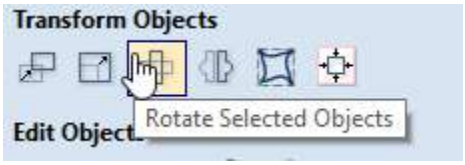


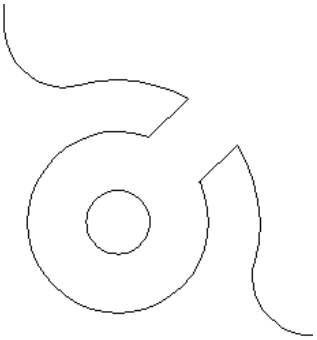


Use the Rectangle Tool to create a small rectangle. The length is not so important as the width at .3 inches.

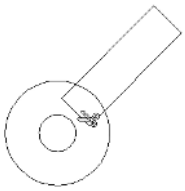


Yet more Trim Tool fun as you need to have the corner rectangle and the bolt hole visible in the same layer to make them one object.



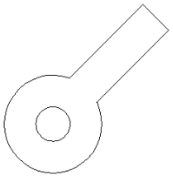


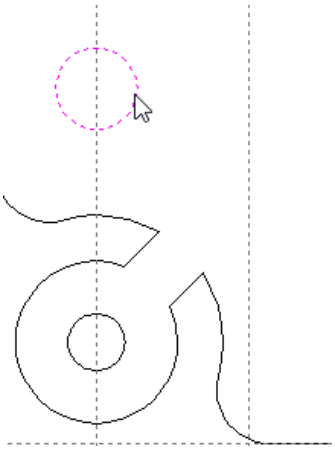
The first versions of the table I had the bolt head pockets dammed and there was no vacuum in the corners. This works better as a corner can easily start delaminating and have the whole piece come off if cutting something the same size as the table.



Use the Rotate Transform to turn the rectangle to a 45-degree orientation to the bolt head and through hole for the mounting bolts. Move or create a new layer if need be.

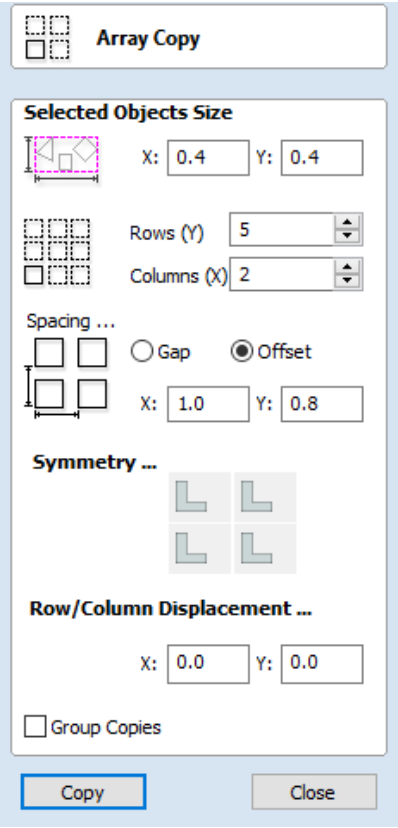
Using the Trim Tool cut out the intersection to get a solid object like this.





Next we start adding the internal zone supports that will hold the work or a spoil board flat without warping.

Add a.4” diameter circle along the guidelines on the bolt holes.

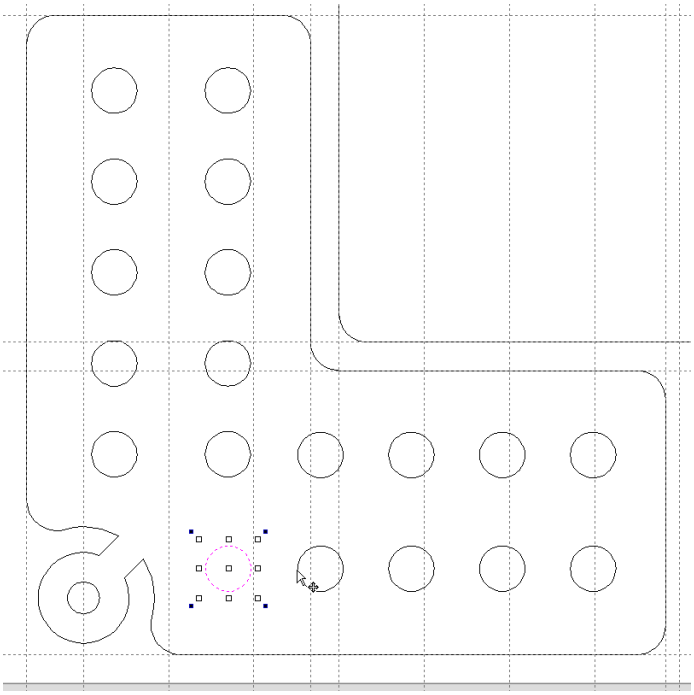


Using the Array copy tool, fill the upper left side of the vacuum zone with circles.

You can array copy just like you did the first time but change the rows and columns to fill out the other side of the zone.

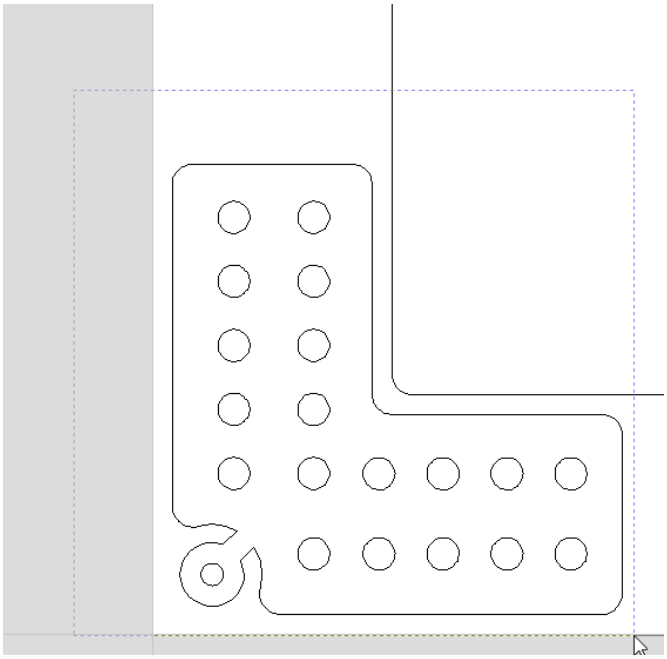
Array Copy help

It should look something like this.

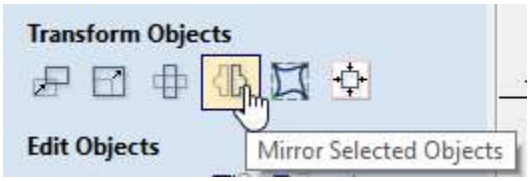


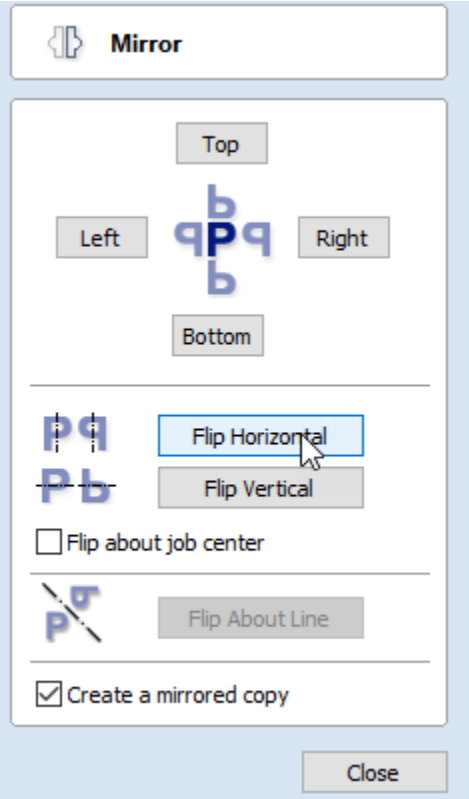
Select all the objects in the zone by either clicking on them while holding the shift key or moving them all to a common layer and left mouse hold lasso select.

Note: You can select objects by either starting in the upper left corner or the lower right. One will select anything it touches, the other will only select what is in the bounding box. Object Selection help

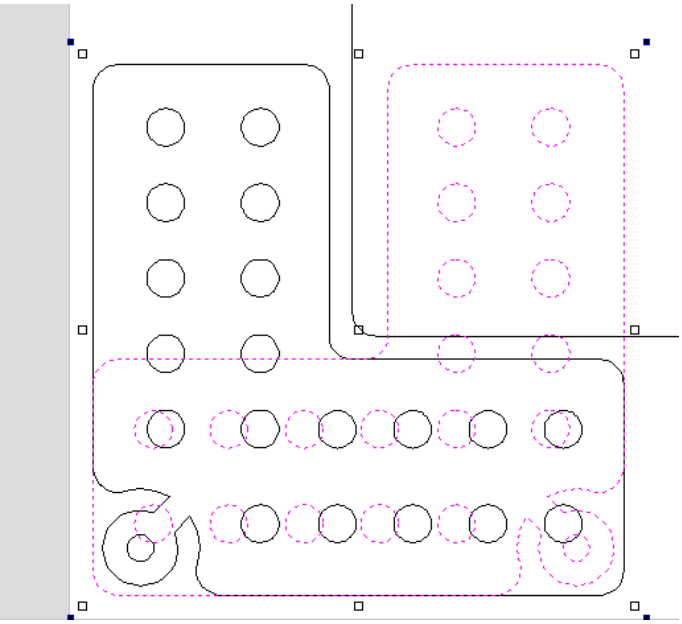


Once selected, we want to use the Mirror Objects Tool. Mirror Transform help

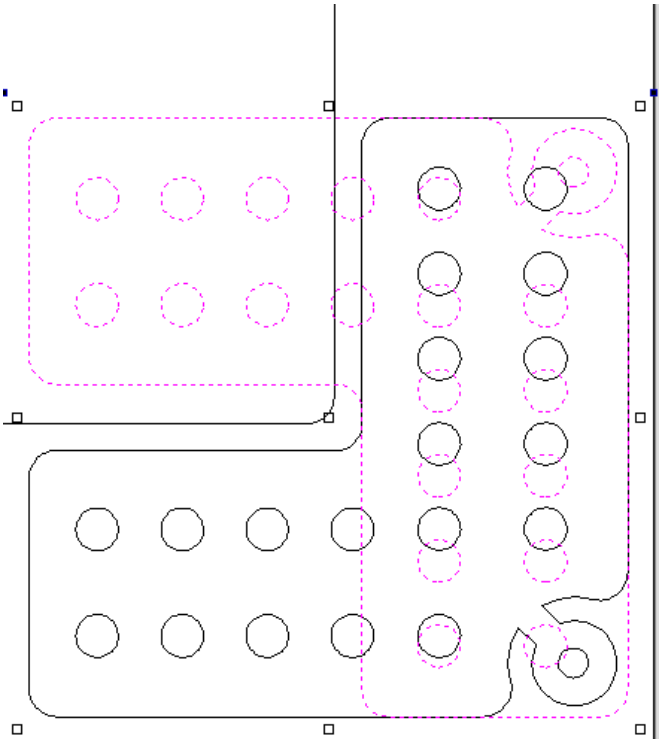




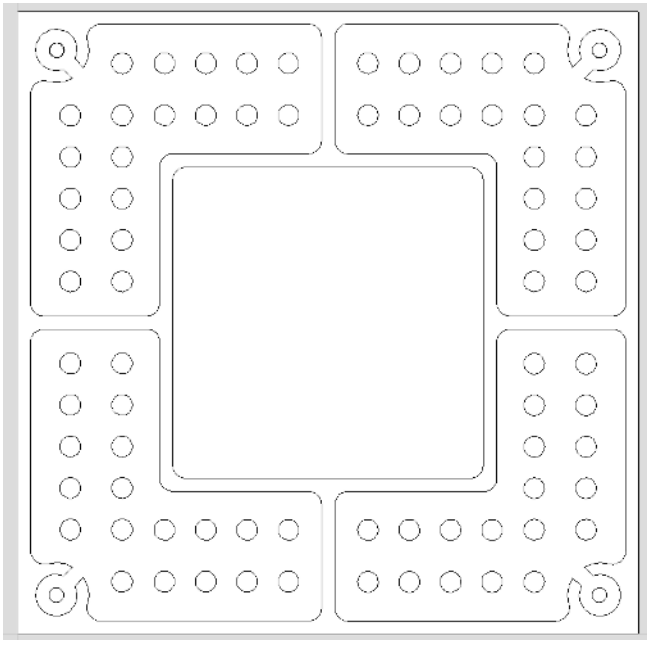
It will make a copy of the zone and then use the keyboard arrow keys to move it to the right side and position.



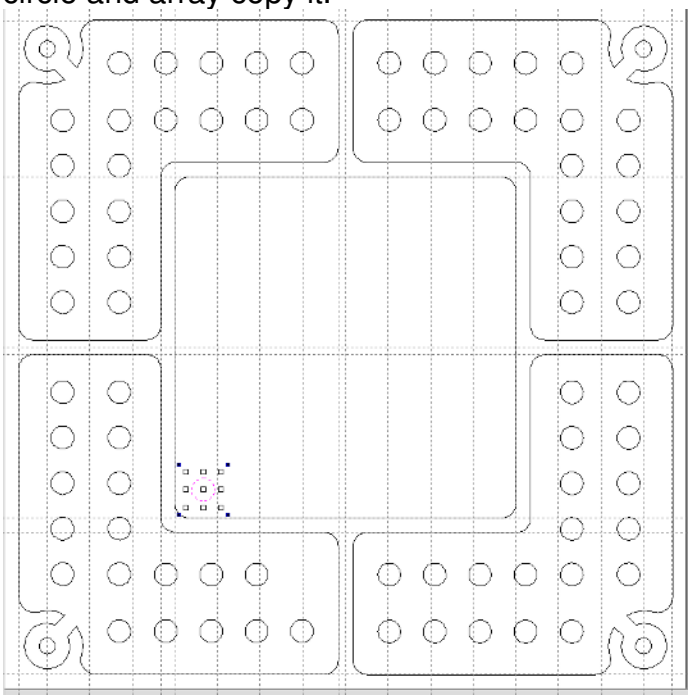
Continue mirroring and flipping for each corner.

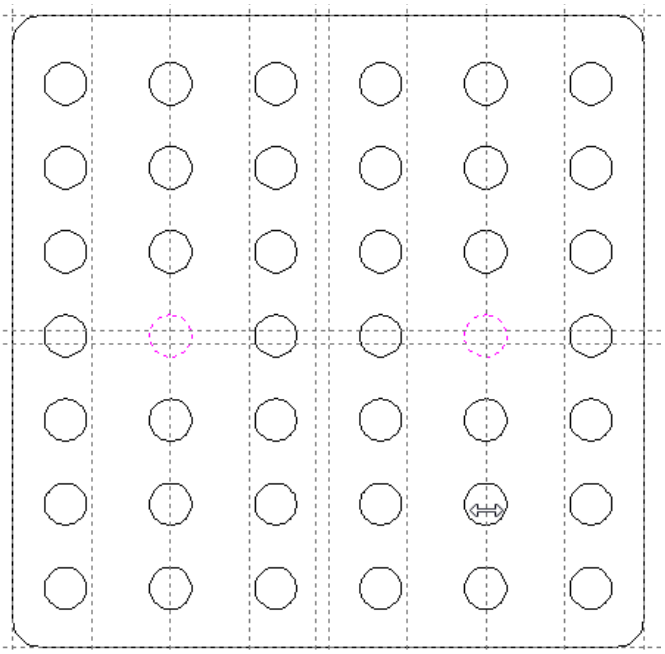


Now we have something that looks close to what we want.

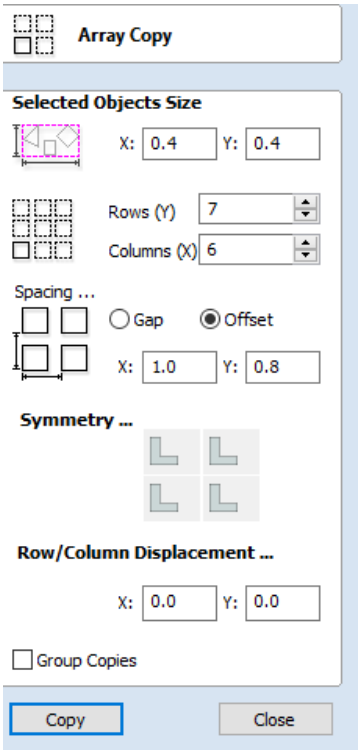


Completing the center zone is very much like we have done before create or copy a .4” diameter circle and array copy it.

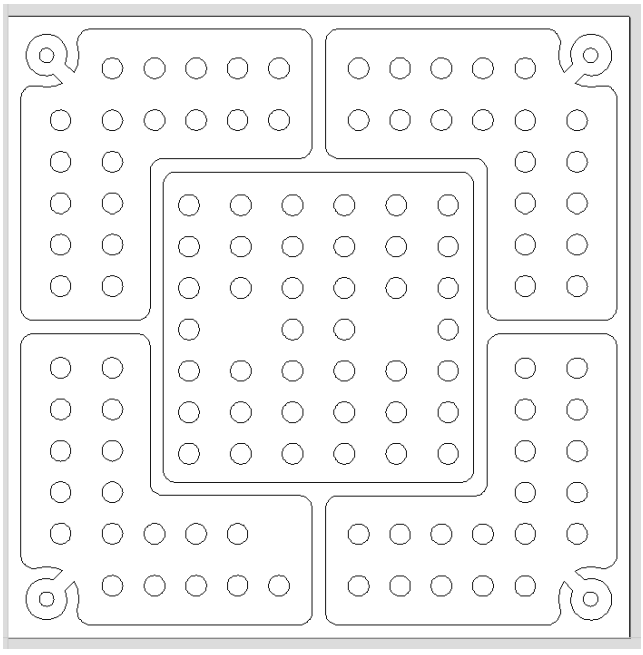




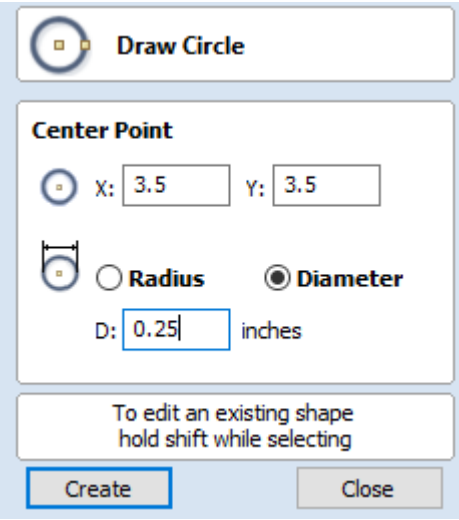
For the center zone we just delete two of the circles that will use for the vacuum ports. The image below is what it should look like.



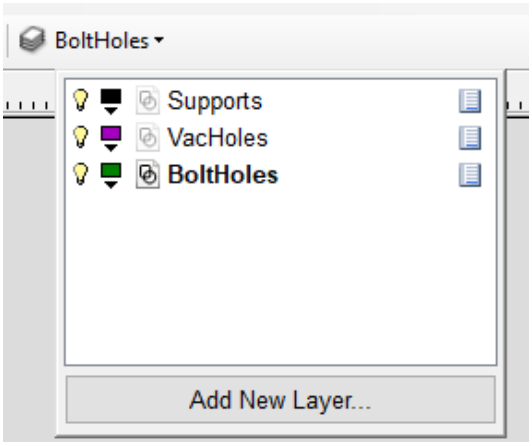
The only difference to what we did in the lower left zone are the parameters in the array copy.



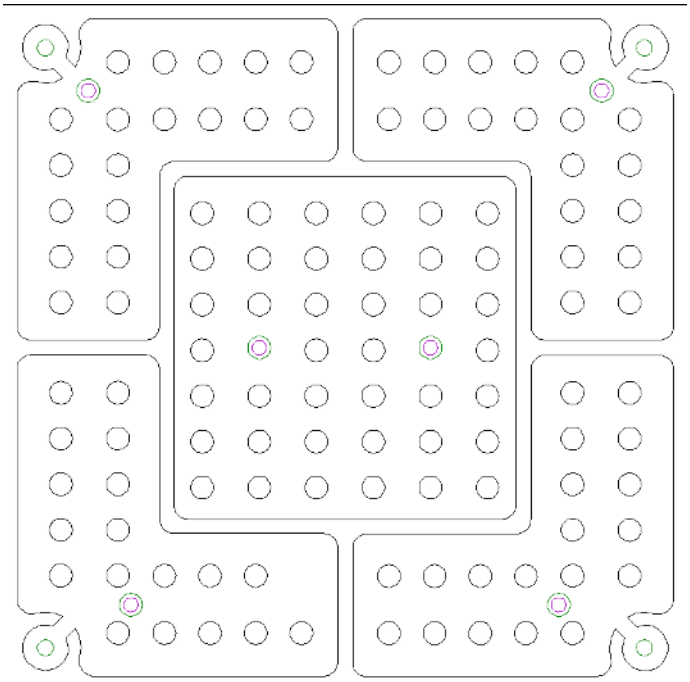
Next we need to add the vacuum ports that will be fed from the pneumatic tubes riding in the T-Track.

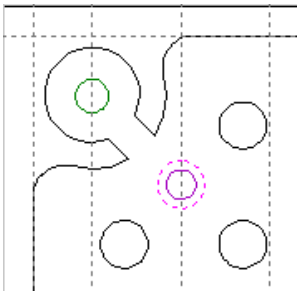


Add a circle of ¼" size to each zone and place it along the guides that are the center of the T-Track.



We want to add two cuts for the bottom of the table to add relief tunnels for the pneumatic tubes and for the elbows to fit.

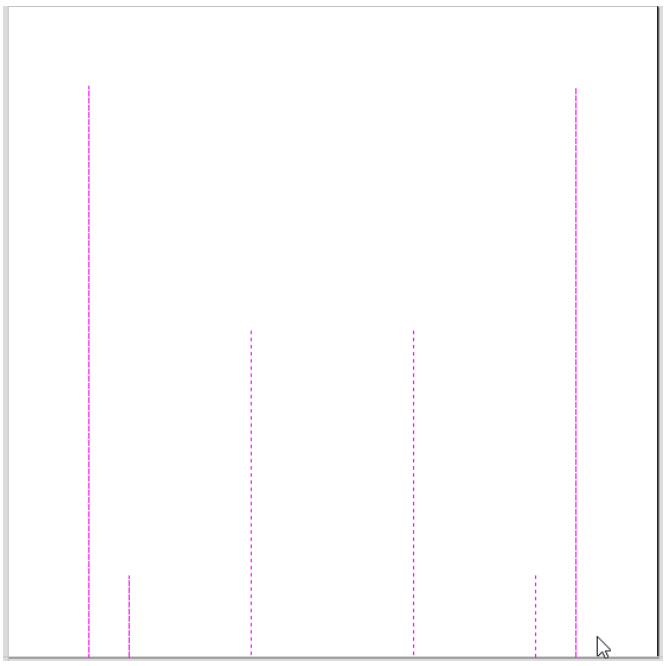




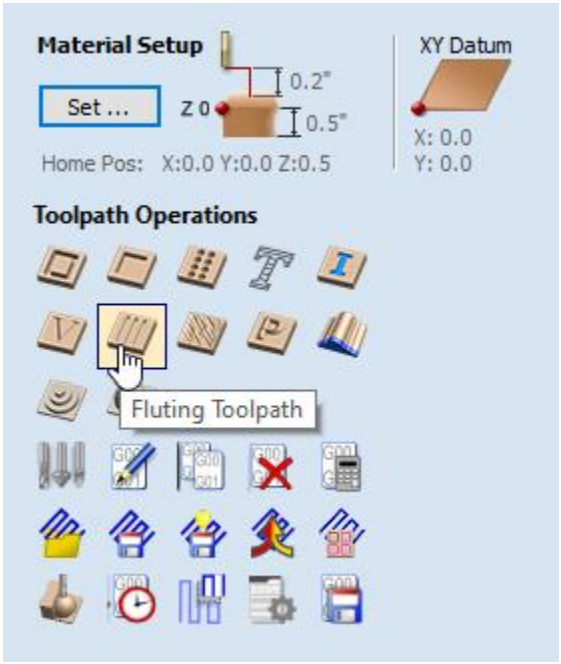
First we will add the elbow reliefs by adding .5" diameter holes around the vacuum port holes that will be drilled from the top.

We will want to have all the vacuum holes and the bolt holes on a layer by themselves as they will be on a toolpath of their own. Doing this now will make it a lot easier to create independent tool paths for drilling and pocketing since there will cutting on both side of the part.

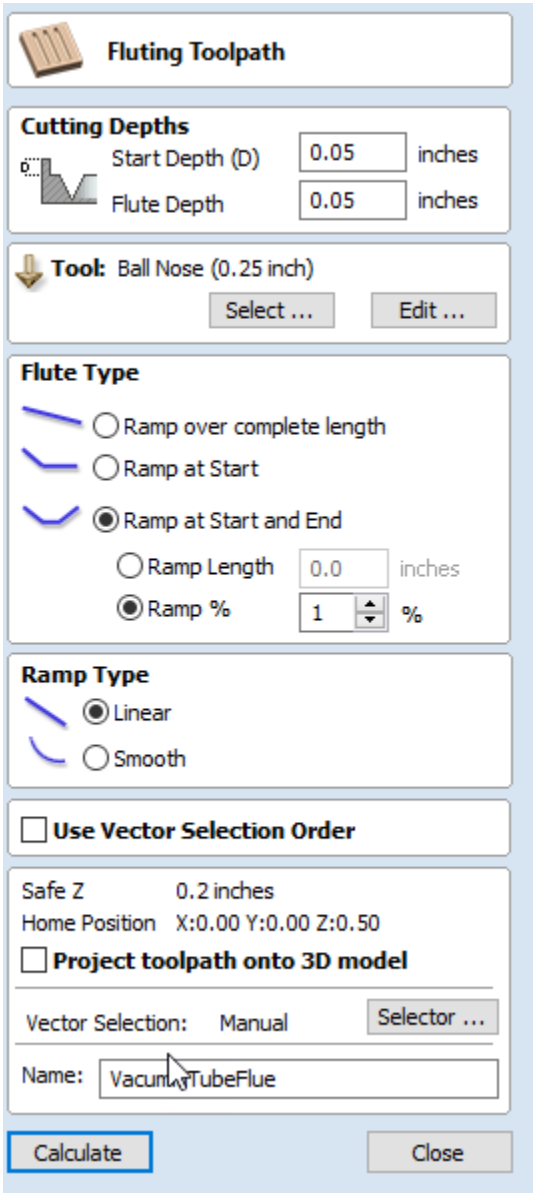
Now its time to add lines where we will run a flute to match the T-Track channels to the elbows. I used the Polyline Vector Tool. Draw the lines along the guides. The direction that you draw is the direction the flutes will be cut. You can select the ends of the line and change where the starting point is.



Its now time to start creating Toolpaths. We can start with flutes. Select the lines and then click on the Toolpaths tab on the upper right margin of the V-Carve program window.



[Fluting Toolpath help]



Set the depth and start depth.

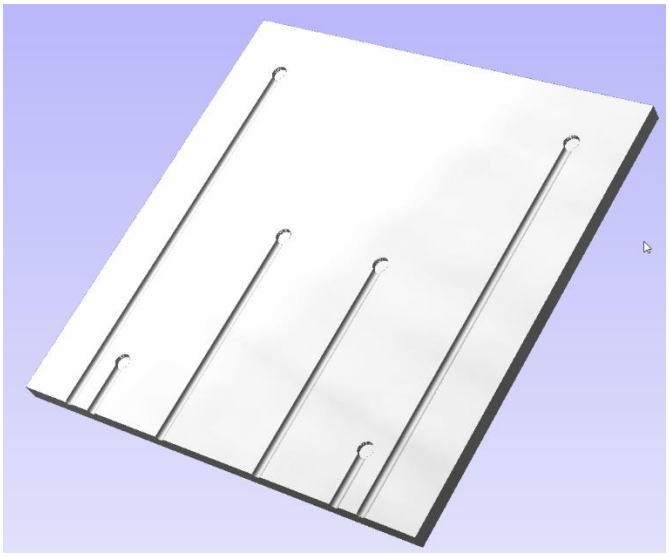
Click the Tool/Select button and select a ball nose bit.

Set Ramp at start and end and to 1%. Select ok when you have set the parameters to your liking. We are just using the flute toolpath to create a non-ramping flute.

Create another Tool Path using the Pocketing Tool Path after you have selected the reliefs for the elbows. Set the depth the same as the depth of the flutes. Name it something like Elbows.

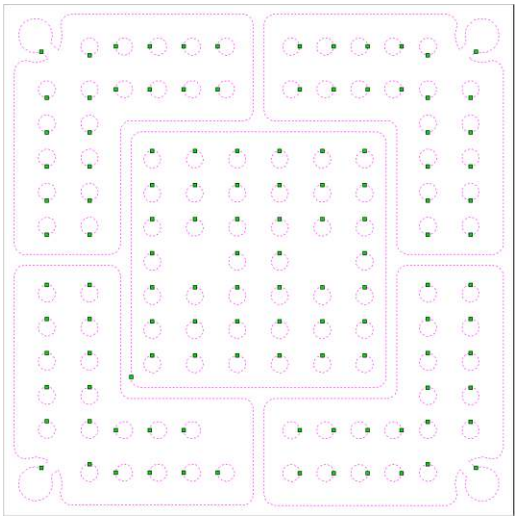
Pocket Toolpath help

Click Calculate on both Flute and Elbow Tool Paths and preview the bottom side of the vacuum table.



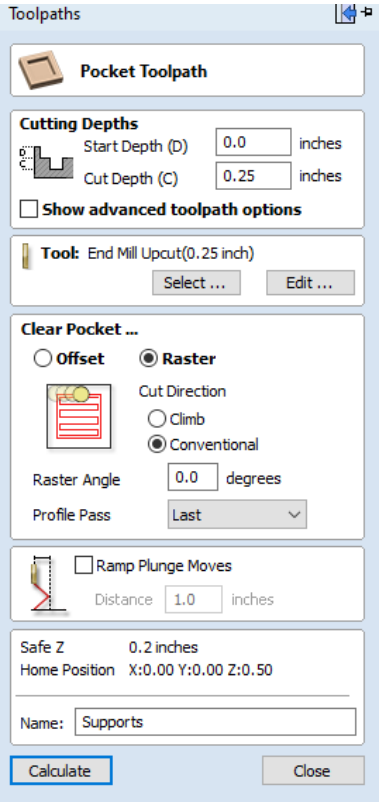
It should look like the above.

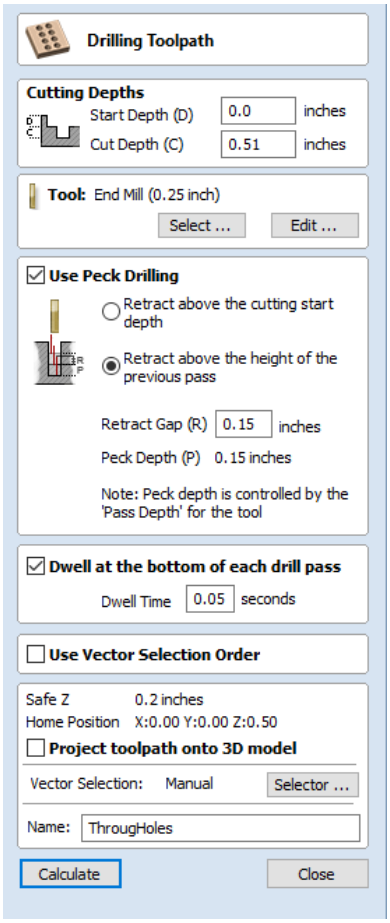
Use the layer control and turn on the Supports layer and turn off the rest.



You should be able to left click and hold the mouse, drag and select all the zones and interior supports shown above.

Select the pocketing Tool Path icon and create a new tool path.



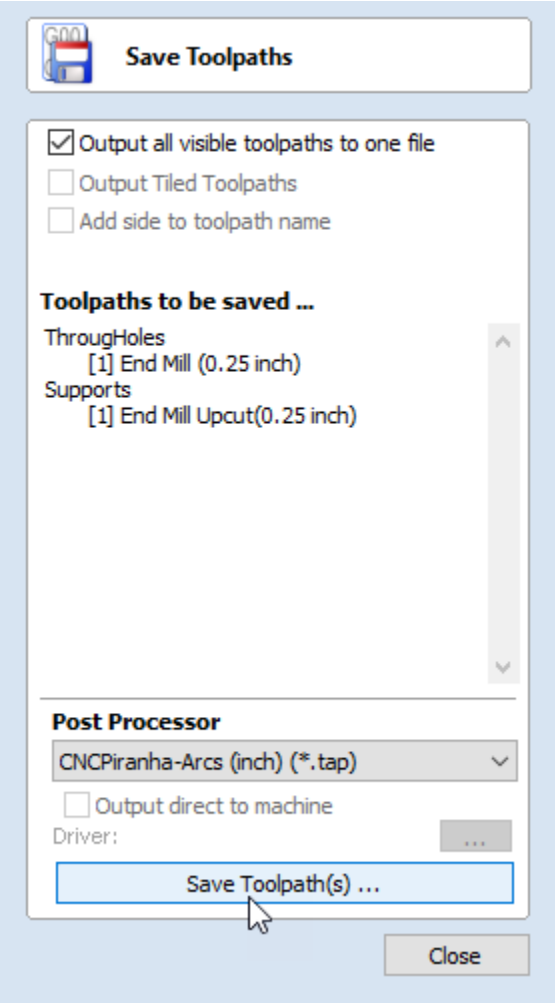


The last tool path will be to drill the holes that penetrate the thickness of the table.

Select the bolt holes and the vacuum holes and then the Drilling Toolpath.

The last thing to do is save the toolpaths with the correct post processor. The tool paths for the top of the table can be all cut with one bit so those can be combined into one file.

The two on the bottom will be run separately for the ball nose bit and the straight upcut bit.

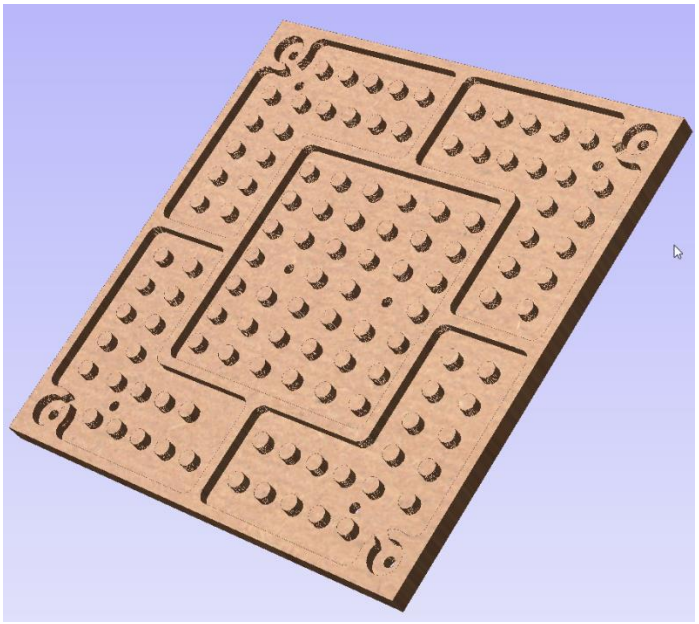


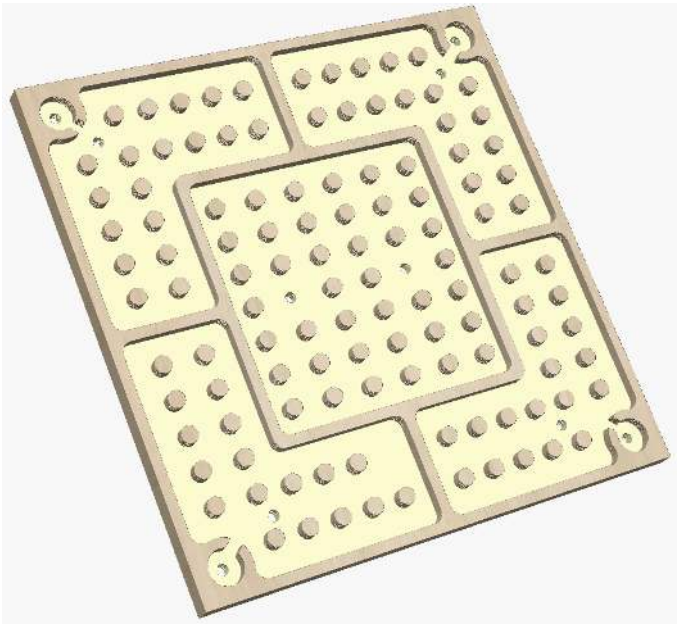
Aligning the cuts is the last thing to think about. Since all the corner holes to screw the table to the T-Track are .75” in the X and Y from the corners of the work piece, you can use the pendant or remote to make sure that the top and bottom are synchronized using those holes.

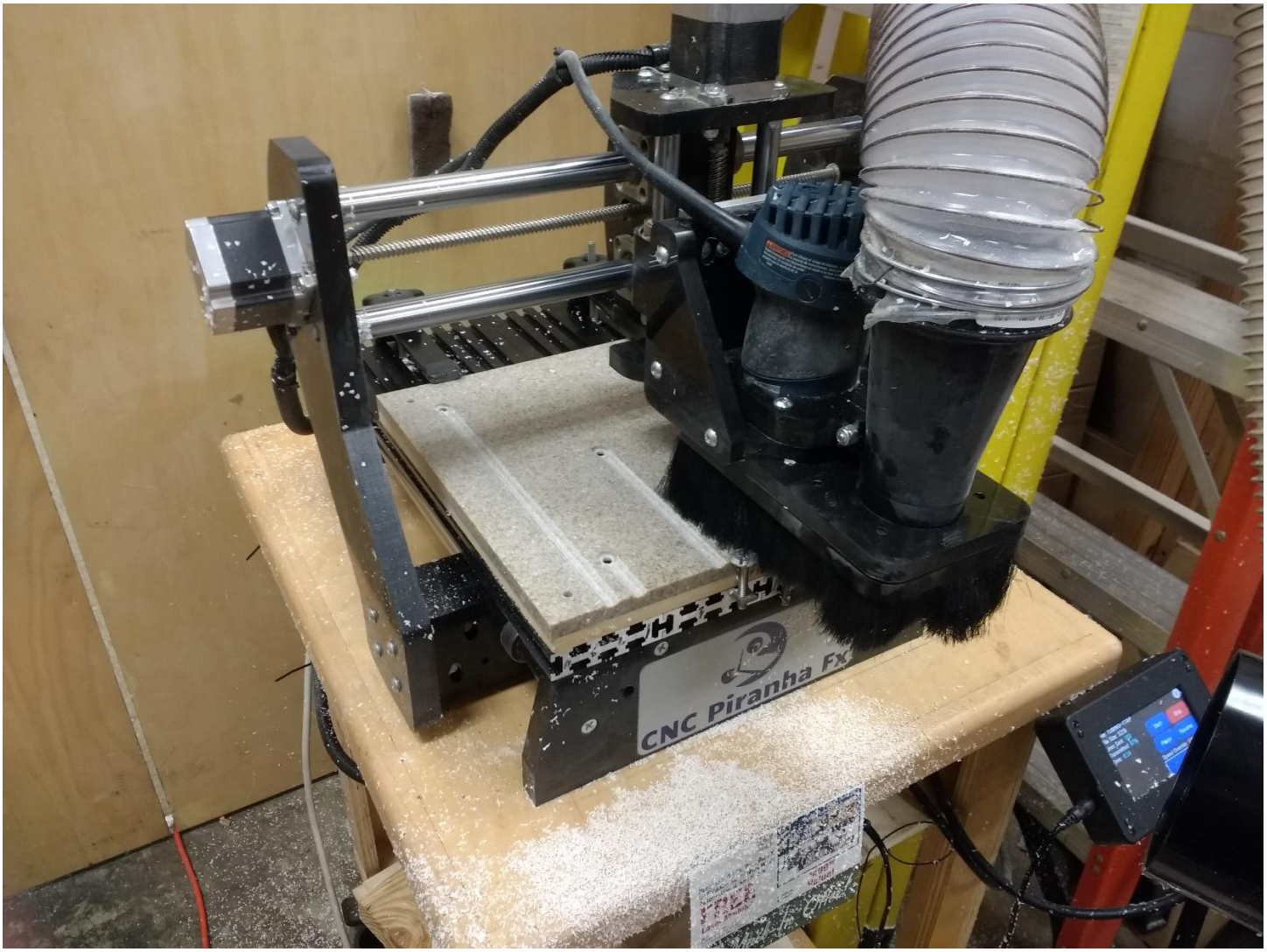
About the Contributor:

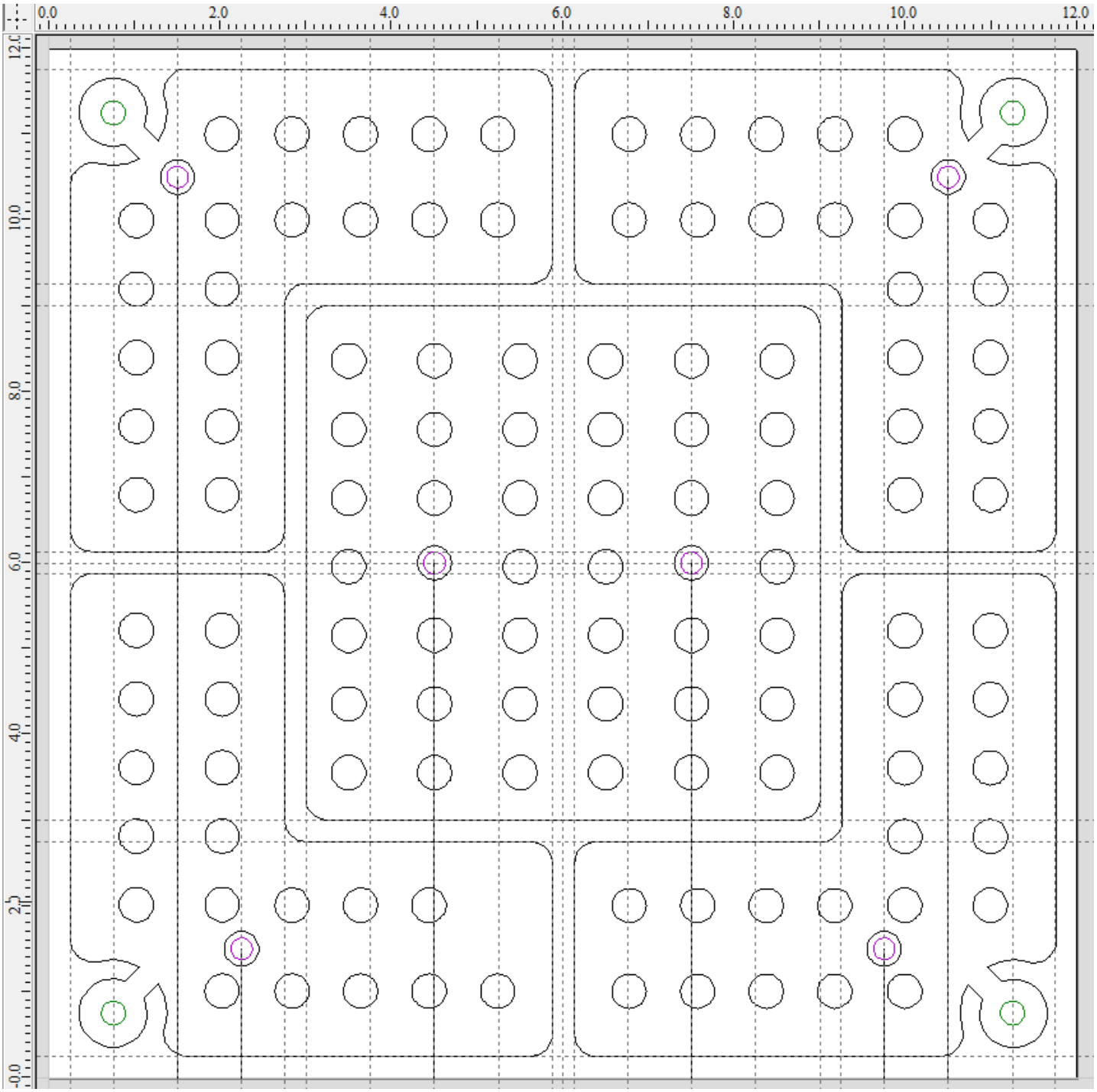
David White is a CNC enthusiast by night and a computer programmer/financial technology analysist by day. You can find him hanging out around the Woodcraft store in Clearwater Fl occasionally. The best way to contact him is through his email at:

superdavewhite@outlook.com.






CNC Piranha Fx


0.0
2.0
4.0
6.0
8.0
10.0
12.0
12.0
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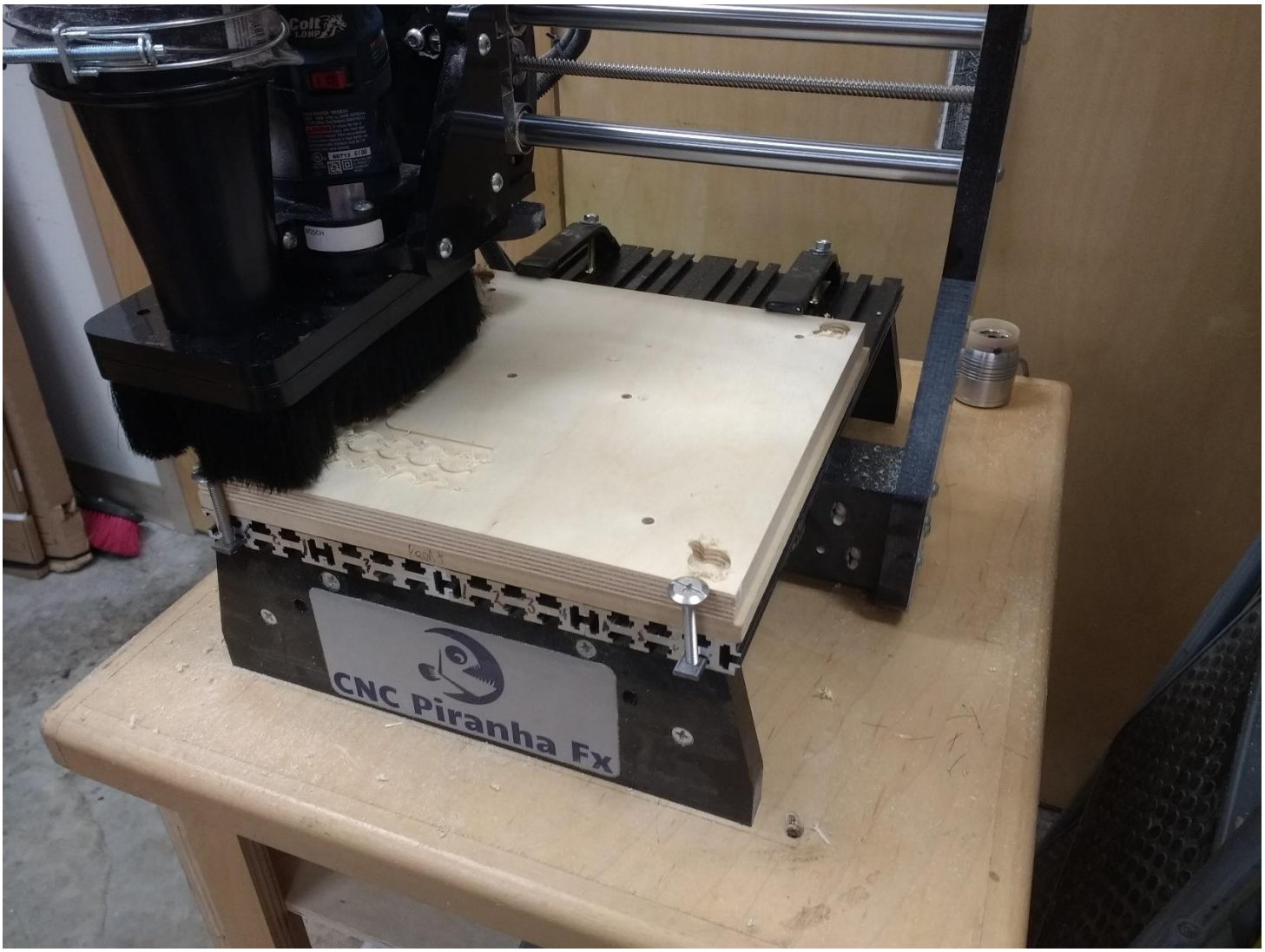
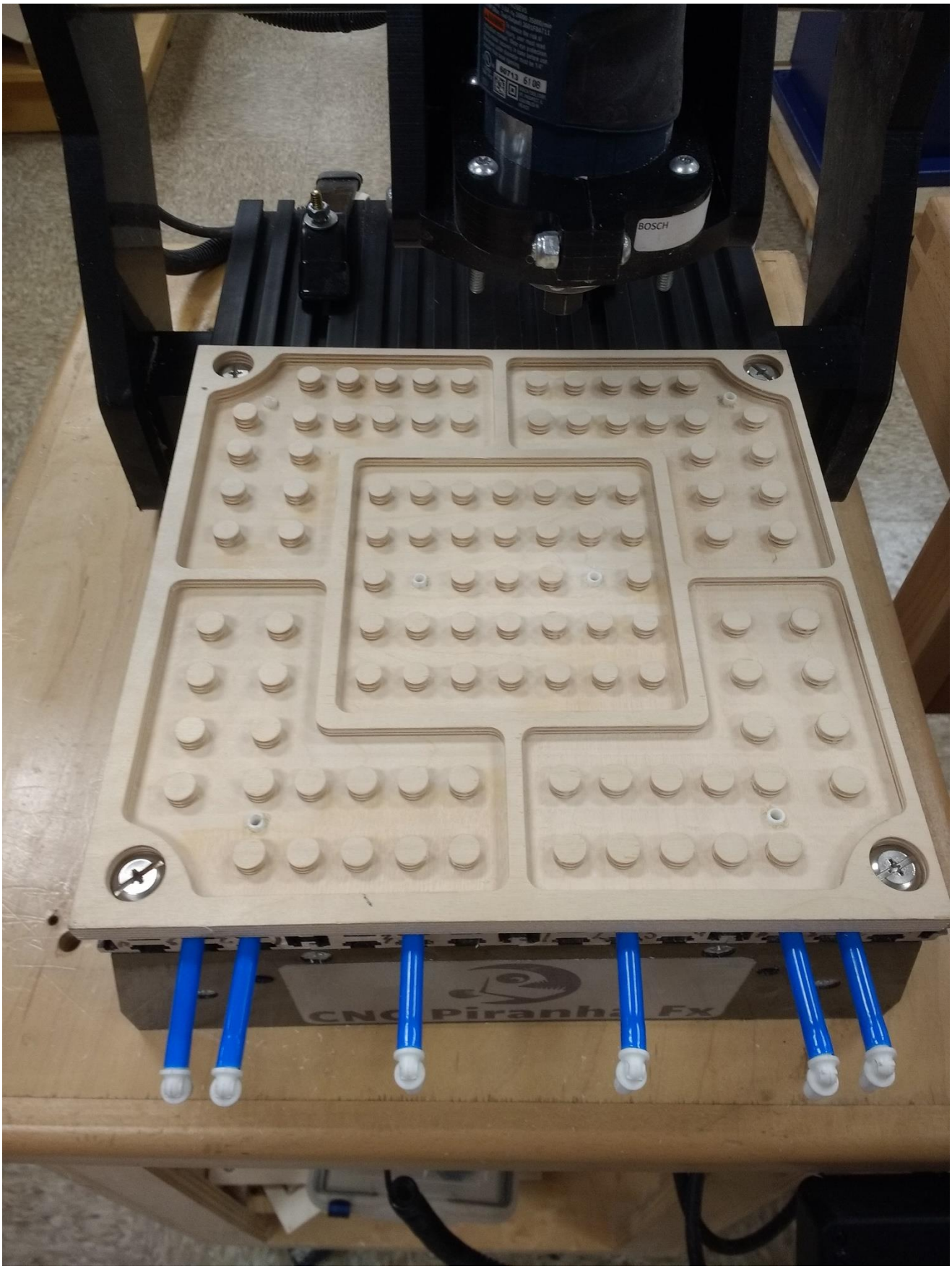
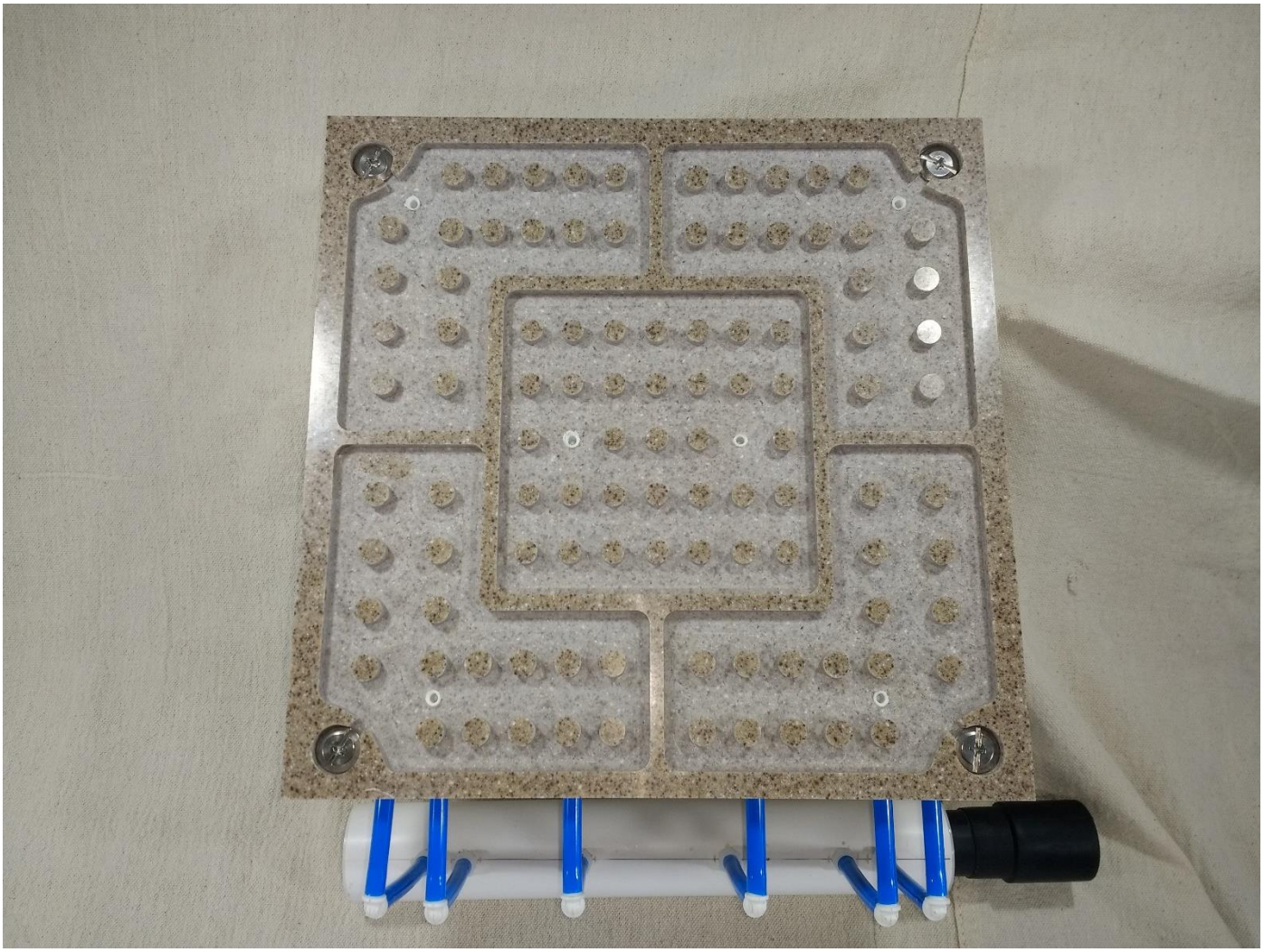
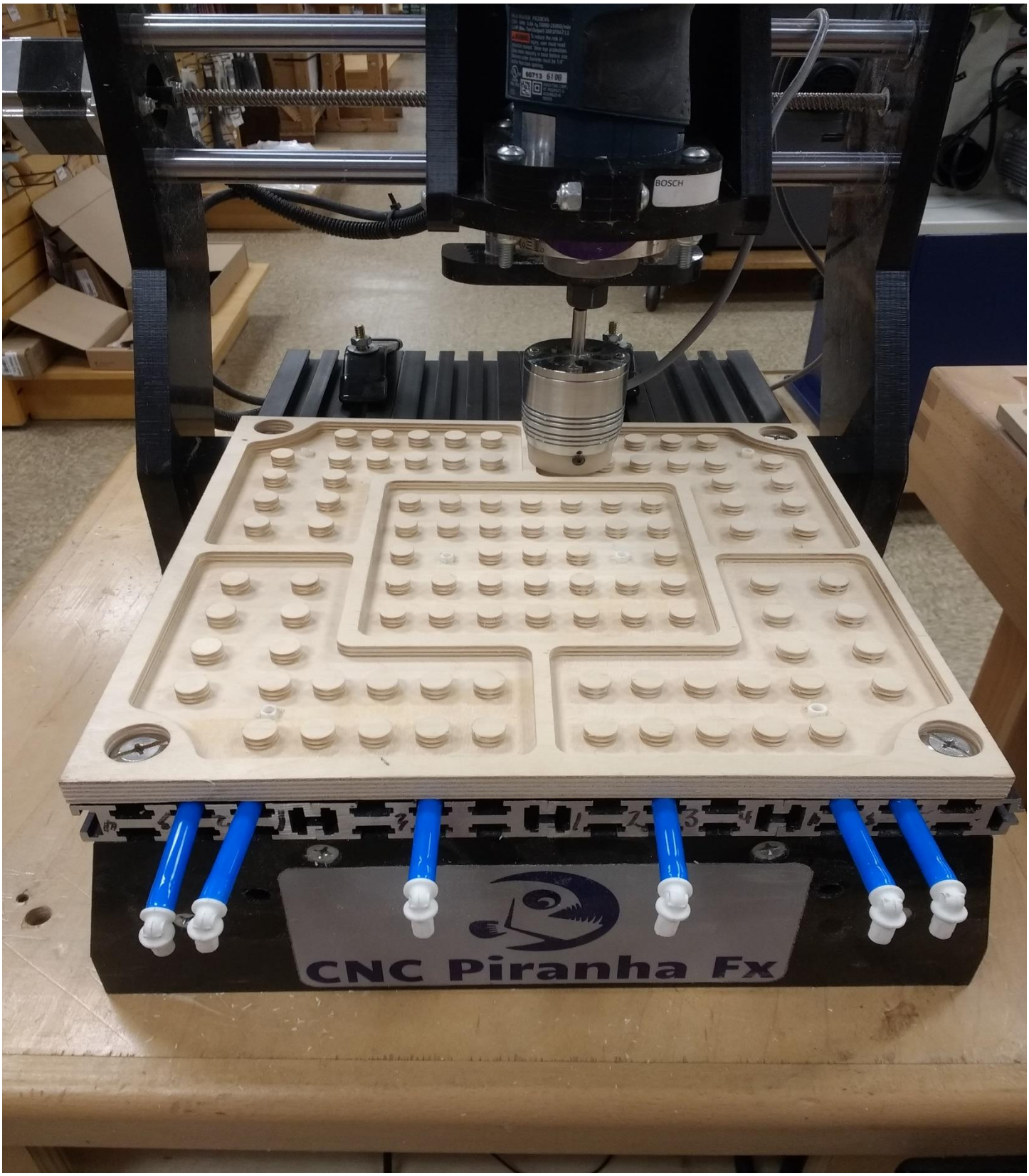

CNC Piranha Fx


BOSCH



Solid surface is the bomb for vacuum tables. This is the production rev for me.



At ½” thick, there is plenty of room for the laser. This is before the flutes on the back and you can see how the pneumatic tubes are just slightly proud of the T slots.

If trying to glue the vacuum pneumatic tubes to anything, the right glue is key.

This stuff will stick the plastic tubing I used to just about anything and it won't ever come off. I suspect there is something in the activators not in other activators for CA glue. Available in the big box homes stores.