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Home John's Workshop

My Perpetual Safety Disclaimer: You'll burn your eye out, kid! I am not a pro by any stretch of my imagination, so please exercise sufficient caution to avoid equipment damage, wasting materials, or injury to yourself or others.

And then there's this Blue Light Hazard article.

For My Metric Friends: God forbid, but somewhere in this article I think I might have referenced that most-abhorred, illogical unit of measurement known as "inches." If so, I beg your forgiveness and pray you will be appeased by the conversion widget which I have included just for you at the very bottom of this page. :-)

Acclaim Air Assist Nozzle for Laser Cutting

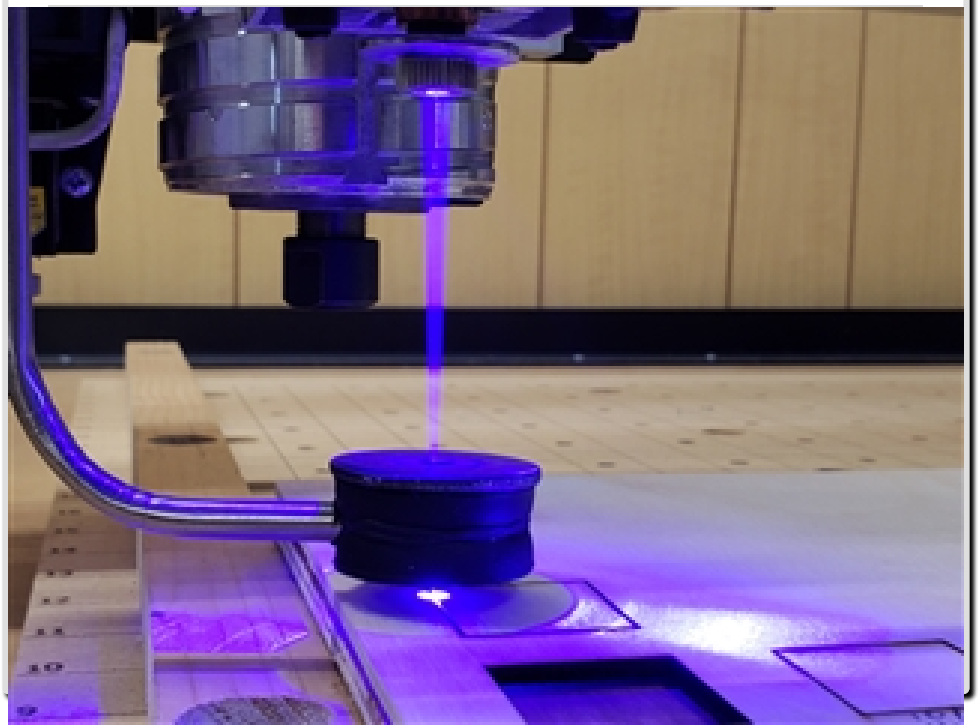
by John Walker

Those of you who have been kind enough to endure my articles to this point know that I have recently installed an Endurance 10 watt diode laser onto my Shapeoko 3 XXL, which I covered in my first article. However, as I have already embarrassingly demonstrated, I'm still kind of new to this. So, if you think I'm all wet on my thinking, here, I'd be grateful if you would seek me out in the Endurance Lasers forum on Facebook and set me straight.

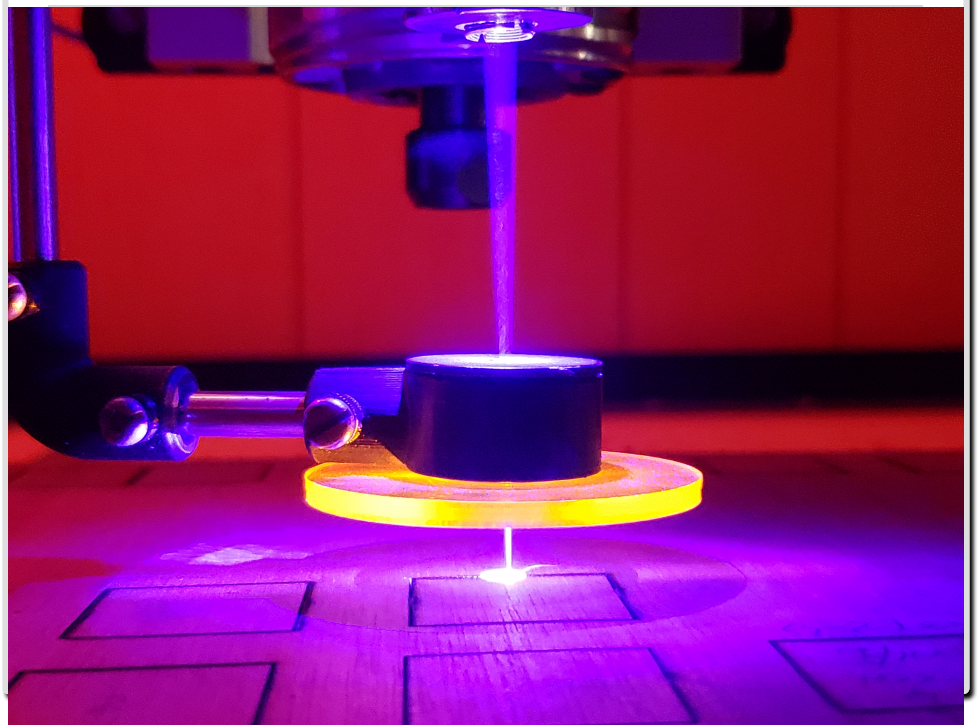
This article covers my Air Assist journey using an aquarium air pump with various delivery methods/nozzles. These include a simple metal drinking straw to which I later added a sports ball inflation needle, a hand crafted prototype of a nozzle made from caster wheels, and finally the carefully designed and 3D-modeled version which I hope some of you will want to print and try for yourselves.

Please know that you DO NOT need a 3D printer to realize this design for yourself. I have very deliberately dedicated my first section of photos and instructions to those who do not yet have one - in whose company I was only a short few weeks ago.

Homemade



3D Printed



Three Part Article on One Page

Introduction: In the first section that follows, I cover my what led me to wonder whether we (you and I) might not benefit from yet another Air Assist nozzle. (Acronym = YAAAN.) Maybe give it a quick glance even if you'll not be considering the homemade or 3D printed versions. You never know - there may be something useful in here, professionals excepted, of course.

Homemade Version: If you want to give the nozzle a try but don't have a 3D printer or don't want to have someone print the nozzle for you, this section is for you. Even if you are going to go with the 3D printed version, you might find a laugh in here as this was my first prototype.

3D Printed Version: Here's the easiest way to go, complete with pictures and (hopefully) helpful suggestions on how you can get the best out of the thing.

Introduction, or "Why Another Air Assist?"

Just prior to writing my second article on through-cutting, I learned that this is a difficult thing to do, if not impossible in some cases, without Air Assist - a phrase that was brand spankin' new to me at the time. For those who don't know, Air Assist simply refers a variety of means of concentrating pressurized air to a laser's focal point with a

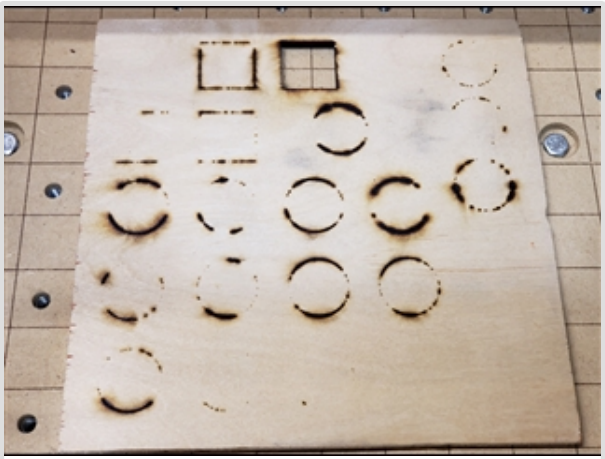
velocity sufficient to remove the already fried pieces to expose fresh material for cutting. Or something like that.

I first gave Air Assist a try by using my construction air compressor to blast 120 psi into the laser's kerf and, oh yeah, it worked great! Cleared out all the burned bits AND sent the stock flying. Just a smidgen of overkill. I then thought back to what I had seen in the Facebook groups where a couple of guys achieved good results with aquarium air pumps, so I went onto Amazon and bought this one. (Note, this is NOT an affiliate link.) But what was I going to put onto the other end of the air hose?

I wish I could give credit where it's due, but back when I first saw all of this, article-writing was the furthest thing from my mind, so I didn't note the originators' names. Sorry, guys. But "someone" had posted about mounting a stainless steel drinking straw near the laser to deliver the air, so this is what I tried first. At the time, I only had a 3.8 watt JTech laser, but this made an astonishing difference in its ability to cut!

Shortly thereafter, I saw a post about someone who was using a sports ball inflation needle to deliver a more directed air stream, so I tried this. I hope I don't hurt that guy's feelings, but I don't think this worked quite as well as the open straw. I felt that the volume of air leaving the needle, though more pinpointed, was too constricted by the needle's smaller diameter to deliver the most air. Air Pumps seem to work differently than piston compressors. On the latter, as the airway gets smaller, the velocity seems to go up. The air pump, on the other hand, just seems to peter out. This is the same reason I stayed with quarter inch I.D., smooth tubing all the way from the air pump to the nozzle. But, I could be wrong.

Still, I had a problem that persisted regardless of the amount of air delivered by pipe alone or with needle. I think this will be obvious here:

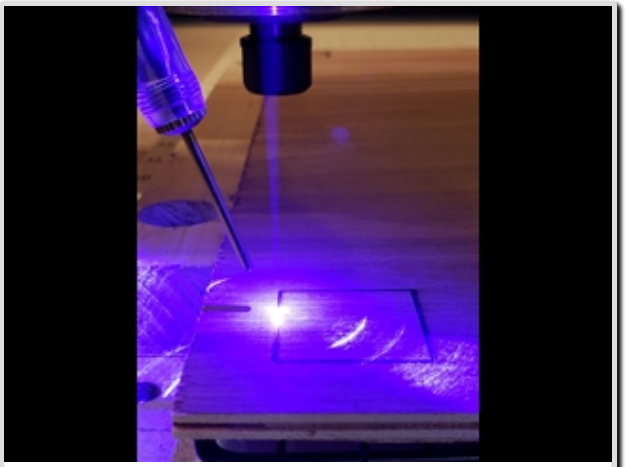


Uneven Through-Cutting

The Suspected Cause

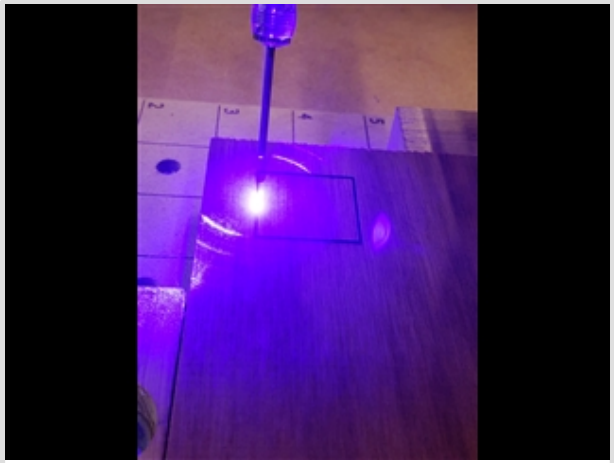
As you look at the 1/4" Luan ply in the picture above, think of an analog clock. Note how the majority of the partially cut circles are only cutting through from about 10 to 2 o'clock, and from 4 to 8 - basically at the tops and bottoms, but not at the sides. Is it the wood? No, I tried a similar experiment on another piece that I had rotated 90 degrees, but got the same results. What I've concluded is that it's the angle of attack of the air.

Consider the following photos where I'm using the inflation needle:



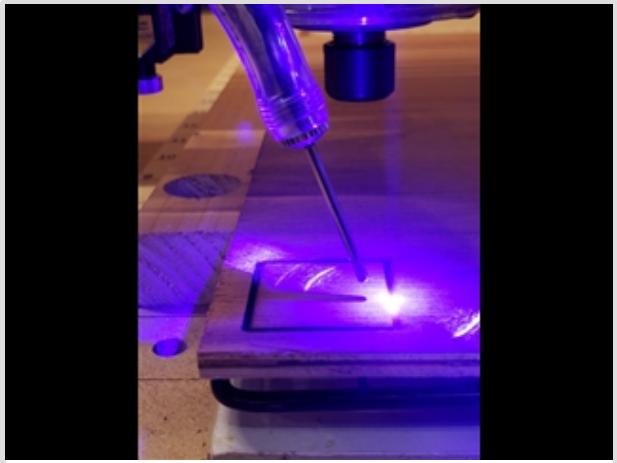
Air and Laser's Focal Point Converge

When the cut is near the top of the material, the air and beam converge. You've painstakingly set it up this way because you want the air to be directed precisely at the laser's focal point so it can best rid the kerf of the burned bits.



Air and Beam in Deep Kerf on X Axis

As you can see in this side shot along the X, there is no problem with convergence in a deep cut because the needle is on the same travel plane with the laser, and the air is blasting directly into the kerf.



Air and Beam Diverge on Lower Z

However (seen from the front again), when traveling along the Y, and as the Z descends with each successive cutting circuit, the air is no longer directly in the kerf, so can't clean as efficiently. The air is hitting the surface of the material a good distance away from the cut. Additionally, the material is now acting as a wall, preventing the air from reaching the laser's focal point deep within that cut. And the deeper the cut, the more exaggerated the problem. I assume this is why I've seen some folks using two nozzles set 90 degrees apart.

So, I Got to Thinking...

What if I could surround the beam with the air stream? Hey... Maybe that's why someone designed those conically-shaped nozzles. But, shoot, I didn't have a 3D printer (yet), and the nozzles that existed might not be designed for my particular lasers or lenses, anyway. Now what?

Before I go on, please trust that I didn't create my nozzle to make anyone else's efforts appear inferior in any way - most are downright ingenious, if not elegant. But what I had tried so far wasn't working to solve my problem, so I had to get creative with whatever I had on hand.

Because I already had a JTech 3.8 with two lenses which focus between 1 and 3", and an Endurance 10 with one lens at around 3" - and more on the way - my mission was obvious: Whatever I did, I didn't want to have to design something for every laser and each lens focal length I wound up getting. I needed something *universal*. C'mon brain, work!

Are You for Wheel?

I hope I don't offend the cone guys, 'cause I've never tried one of their designs, but I was thinking that, because it seems to be open at the top (where the ice cream would go), such a design might lose air pressure, and some might work against a laser's downdraft cooling fan. I'm no scientist, so maybe there's some venturi or cyclonic thing going on there. I dunno.

My thinking, then, was that I wanted a way to surround the laser's beam and direct ALL of the air downward and into the kerf. After a bit of head scratching, I decided that what I needed was a center column to isolate said beam, and a surrounding chamber to hold the pressurized air to deliver. Hm... What do I have in my parts inventory (junk boxes) that might work?

Air Assist Wannabees

That's right, folks. As you'll soon see, those two, stupid little caster wheels might just evolve into what you're looking for in Air Assist.

I will attempt to be concise from here out so you can get to building and burning! As I mentioned earlier, whether you'll be opting to try either the DIY or 3D printed versions, you may find something useful in one section that you won't in the other, so maybe give 'em both a gander.

First, The Homemade Jobbie

Okay, Makers, here you go. Before you get to digging for your wheels, I'd like to make a couple of points:

1. Size might matter. If you'll be using a lens with a focal length of an inch, the total height of your wheel assembly must obviously not exceed this. And, don't forget to take into account the descent of the Z, or you'll bottom out.

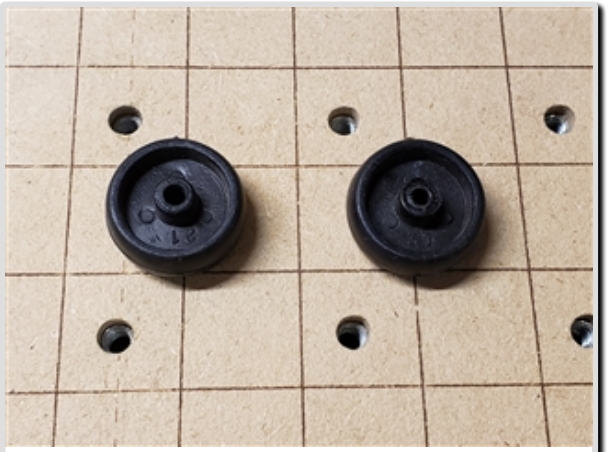
2. The plastic used in my wheels wasn't very hard, so collapsed slightly to fill the void when I removed the drill. You may need to use one slightly larger than your pipe.

3. I used E6000 glue, which is basically (and chemically) Shoe Goo. Great stuff. You'll need just enough to fill any potential gaps while not blocking the air holes. I applied it to all four mating surfaces, i.e., the perimeters of both pieces and the areas surrounding the axle, then clamped them.

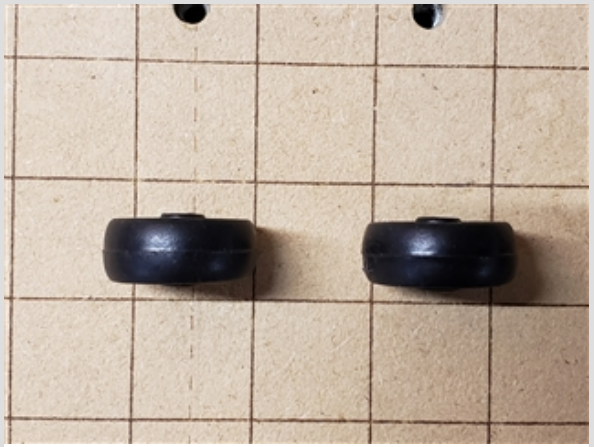
4. To get a 90 degree pipe, you'll either need a tubing bender or some sort of elbow. The smoother the bend, the better the air flow. I have a picture of the stainless steel straws I used in the 3D Printed Version section under "Piping," below, and on my Endurance laser installation page, here.

5. Lastly, and very importantly, when drilling the hole for the pipe into the side of the assembly, be sure to *only* drill through the exterior wall and not into the central, axle part.

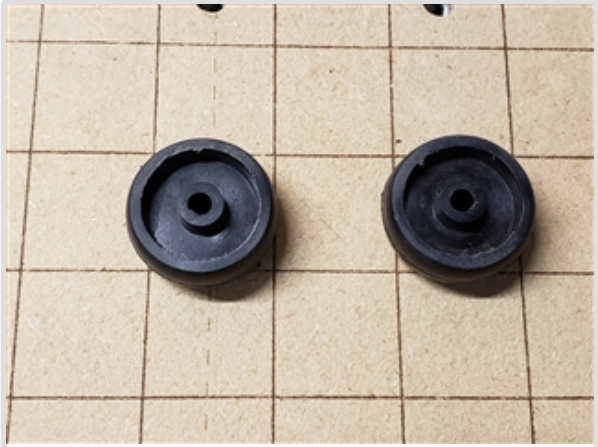
I hope the pictures and captions speak for themselves, and that I won't lose you. If I do, just reach out to me in the Endurance Lasers Facebook group and I'll help as I can.



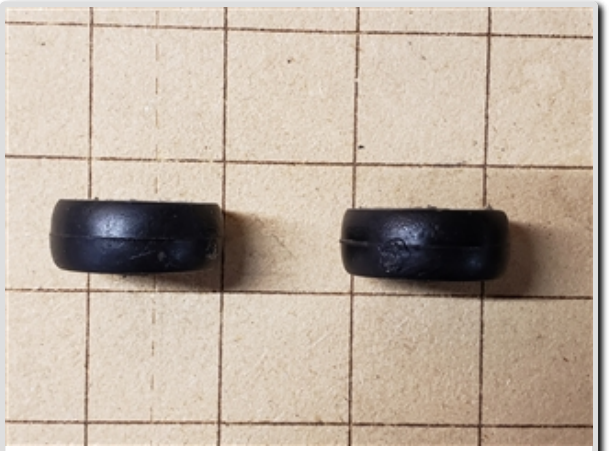
Remove the wheels from the casters.



This shows the protruding axles that need to be sanded flush with perimeter.



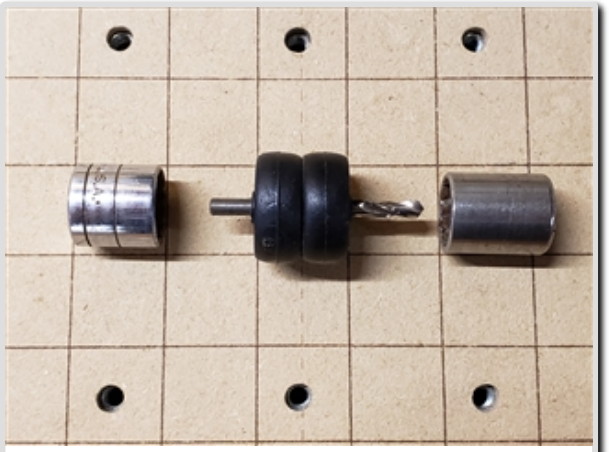
Sand the mating surfaces, i.e., one side of each wheel.



Here is a view after the mating surfaces were sanded.

Drill eight-ish, 1/16" air holes into ONE wheel.

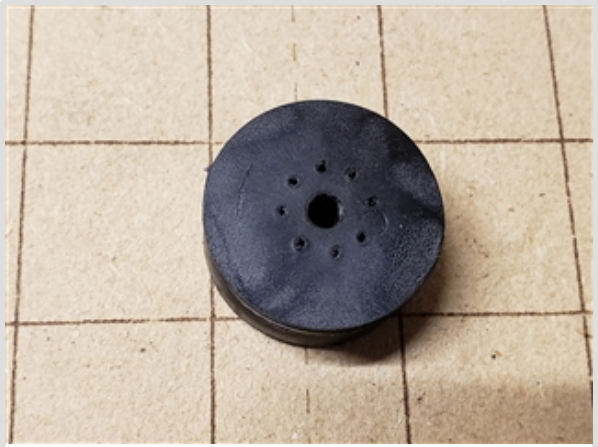
Close-up of Drilled Air Hole Array



Sockets and Drill Contraption to Align and Clamp Wheels During Gluing

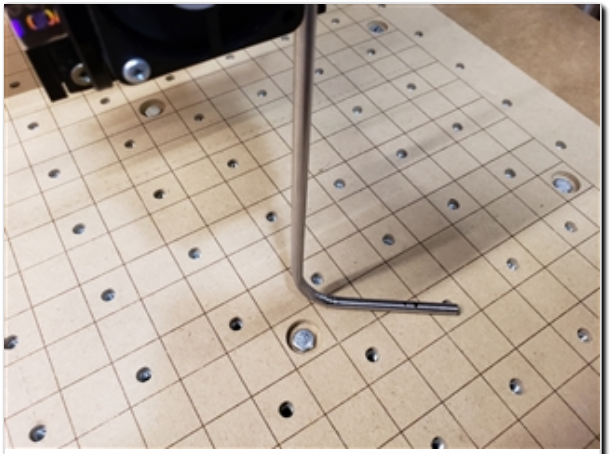
Now, glue and clamp da wheels. I used a small bench vise.

Sand the glued wheel assembly to remove excess material. Mine is about 1/2" thick.



View of the Air Holes Side After Sanding

Drill a .25"-ish hole in the side to accept the pipe.

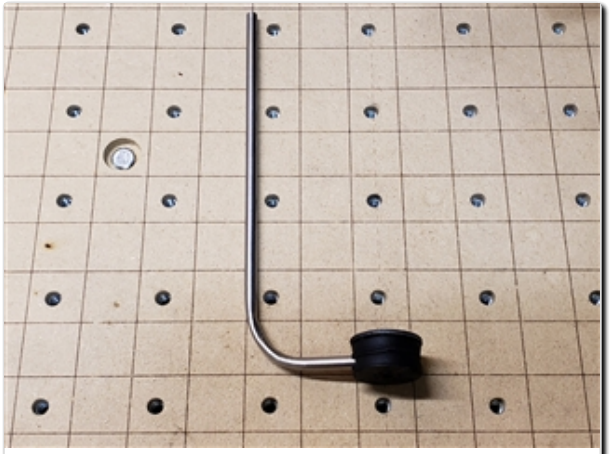


Carefully bend pipe 90 degrees.

PENETRATE ONLY THE OUTER WALL.

Affix protective washer(s) to avoid cutting plastic with laser.

Paint the washers flat black to (hopefully) reduce glare, a.k.a., eye damage.



Mount the pipe to your machine, then cut the lateral leg so the nozzle will center around the laser beam. Attach the nozzle and air hose to the pipe. Done.

Congratulations!

You now have another Air Assist nozzle to toss into the drawer with all of the others. Or not.

Another really cool thing I gained from this was, if I kept it as low as possible above the material, it served as somewhat of a shield to block the bright flashing. (Not that I'm EVER without my protective eyewear. Cough.) Maybe we could attach a disc of that laser viewing acrylic to it, too.

If you'd like to see how I attached the pipe to my Shapeoko before I got my 3d printer, please visit my first article here. After you hook this baby up, take her for a test drive, and then please let me know what you think, be it good or bad.

Now, what about that printed version I promised you?

3D Printed Version

Here's the coup de grâce of my through-cutting miseries! This is gen one, people, so I'm anticipating lots of feedback and modifications. I'm entirely new to the whole 3D printing thing, so I'm sure these prints aren't as pretty as some of you can make. It works fine for me, but I'd love to hear your suggestions. Be kindly constructive, but don't be shy.

Just FYI, I drew this in FreeCAD, which I also just learned. All of this is really taxing this old guy's brain! I used both Cura (v4.2.1) and Simplify3D (v4.1.2), mostly with their default settings for my Ender 3. I did bump up the infill to 40%, used a pretty little skirt, and a layer height of .2 mm. (Take that, my metric friends!) Also, I used the stock build surface. (The Creality glass plate I bought stuck TOO well!)

Design Evolution

I'm including this section just in case any of you are wondering what transpired between my making the prototype and posting the files online, and why I designed everything the way I did. It was a work in progress over a couple of weeks, but here's what I remember:

I thought the prototype worked well enough to share with others, but wanted something a bit more professional looking.

Me: "Hey, Honey. I need a 3D printer."
She: "What do you need that for?"
Me: "I'm gonna make us rich!"

She didn't buy that, but did buy me a printer for my 64th birthday. (Cringe!) So off to the workshop I went.

At first, I drew and printed the nozzle itself, with 8 holes, just like the prototype. I thought the stainless drinking straws I had were 1/4" O.D., so initially designed for that. No such luck. They're apparently made in one of "those" countries who use still use metric. (I'm trying to be funny, here, so please don't get offended.) Anyway, they mic'd at roughly 6 mm, so that's what I changed my design to and stuck with. If you have something slightly larger, use a drill. If a tad smaller, fill with glue, epoxy, or whatever.

I then added an elbow so we could use straight pipe instead of needing a tubing bender, and opted for a nice radius, versus a sharp 90, to help with air flow. This simultaneously added a desirable bit of adjustment length to the lateral pipe, which is also why there is a neck on this nozzle.

I then added a bracket for my Shapeoko 3, followed by two more versions, one each in both horizontal and vertical orientations, in an attempt to meet others' needs. I added countersunk mounting holes to these, just in case you need to drill and tap.

To help lock everything in place, if desired, I added collars for set screws to all of the pieces. On the fittings (the nozzle and the elbow), I attempted to situate the collars near to the pipe's entrance to allow sufficient length adjustment without introducing a leak at the collar. The collars' holes are 1/8" and unthreaded, leaving open the possibility of using nearly any screw that diameter. If you don't need a set screw on the fittings, simply fill the hole. I expect the set screws might come in handiest on the mounting brackets to mitigate any undesirable dropping or spinning.

The last thing I can think of that I did was to design another nozzle with offset slots. Even though I wasn't having any problem with the holey version, I was thinking that this design might get more air into the kerf for those who have ample air pressure to provide sufficient velocity. My pump seems a bit too wimpy for this 2nd version.

Here It Is

I think I've said all that needs saying, so here's to wishing you happiness and success!

The Whole Famn Damily

Air Assist Nozzle with Air Focused .5" Beneath Nozzle

First, a shout out to Mouss Arena in the Endurance Lasers Facebook group for getting me to revisit an idea that I had abandoned.

Of the three nozzles in this set, this one (monogrammed with an F) seems to clear the kerf best. Also, there is significantly less charring on the top, making for a much sharper looking cut.

Thanks, Mouss!

Air Assist Nozzle with Holes

The nozzle is 1" across, .5" high, and 1.5" long. Bore is ~6mm. Walls are .125" thick.

Air Assist Nozzle with Slots

Offset slots ensure maximum air delivery to the kerf, but might need a pretty beefy air pump for good velocity.

90 Degree Elbow

Horizontal Mounting Bracket

The mounting plate itself is 1.25" long by .5" high. Front to back thickness, including the collar for the set screw, is .625".

Vertical Mounting Bracket

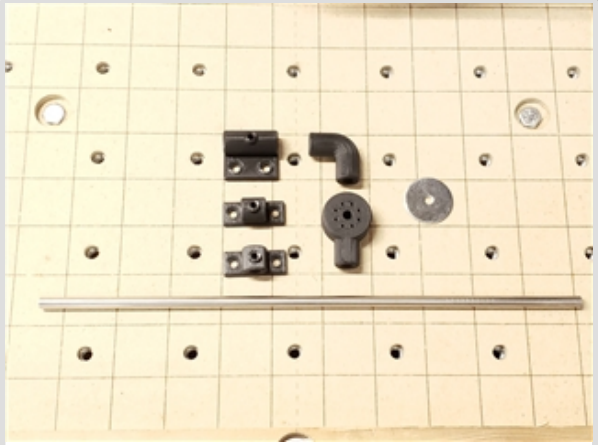
Same dimensions as the horizontal bracket.

Square Mounting Bracket

This one is sized at 1.25", the rough height of the Shapeoko 3 spindle mount. Being square-ish provides more surface area for double-sided tape.

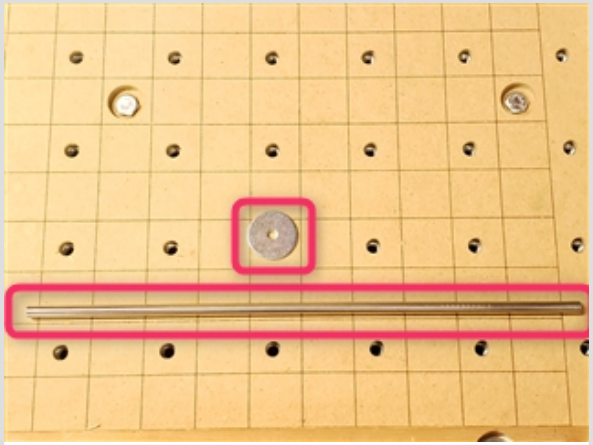
Bracket Mounted on Shapeoko 3

Click the pic to learn more about the aluminum part of this mount in the Air Assist section of my first article.



The Whole Kit and Kaboodle

Here's all there is to it - the printed pieces, a washer, and a length of small (~6 mm) diameter pipe. You may only need one of the mounting brackets.

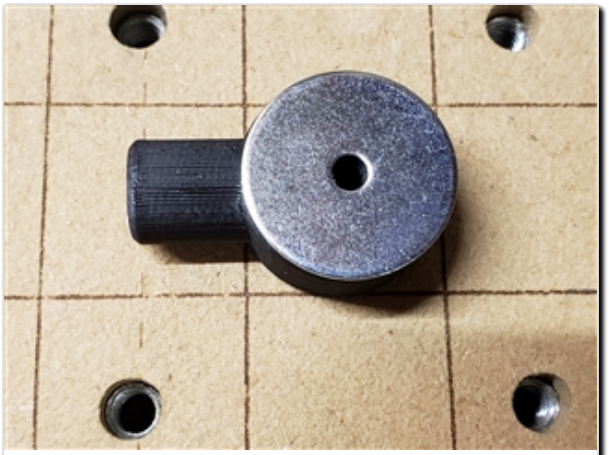


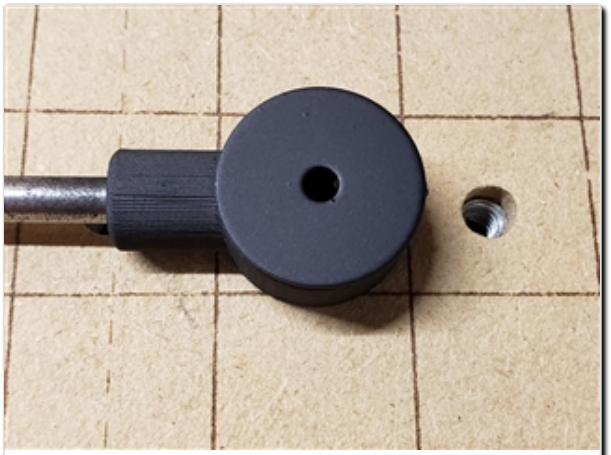
You're going to need a washer and a length of small diameter pipe.

I show the washers I used in the next picture, and the pipe in the one thereafter.

Fender Washers from Home Depot

To keep the laser from cutting into the nozzle, I attached one of these to the top. I used a double-sided tape called ATG, but I'm pretty sure any adhesive will do. They're an inch in diameter, with a 3/16" hole (even though it says 1/8").





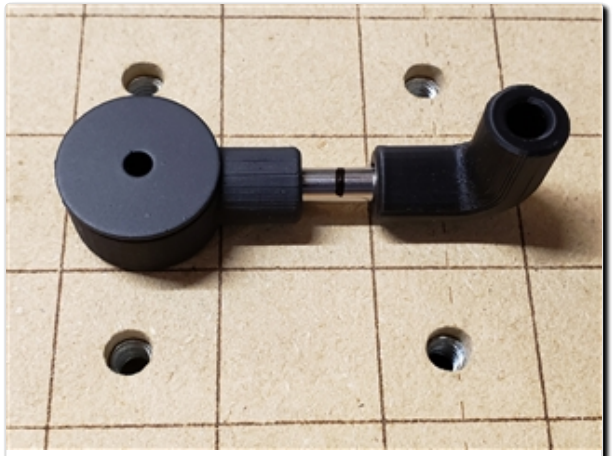
"Piping"

Got these at Walmart. They're roughly 6 mm O.D. and cheap!

Nozzle with Washer Attached

Nozzle with Washer Painted Flat Black

Paint that washer, and keep it painted, so as to avoid laser reflection and a fried retina or two. (I held it with the pipe while spraying, which kept my fingers purdy.)



Nozzle and Elbow with Connecting Pipe

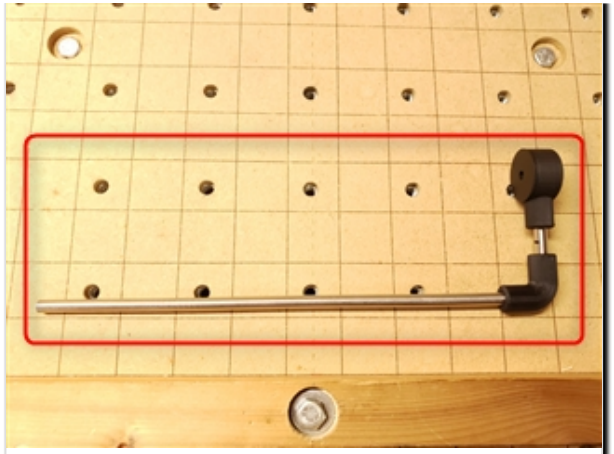
Note the line midway on the pipe. I drew that there to ensure that it remained centered as I adjusted the length to center on the laser beam.

How I Measured for the Lateral Pipe

I centered the nozzle atop the laser, and put an elbow onto the pipe, then measured about half an inch into them to get my length. I went with 1.75" for mine.

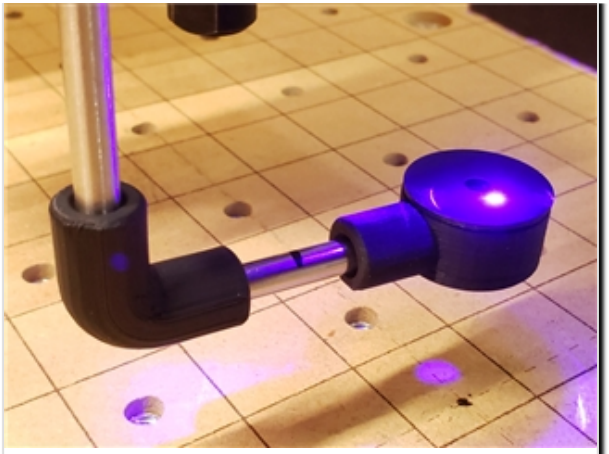
Spare Elbow for Height Adjustment

That pipe is sharp, and the fit within the bracket tight, so I used an elbow to assist with vertical adjustments to the pipe.



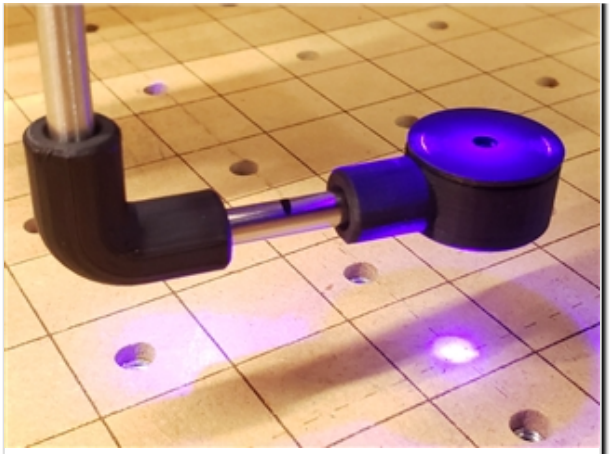
The Entire Assembly

Not much to show for two weeks' work, eh?



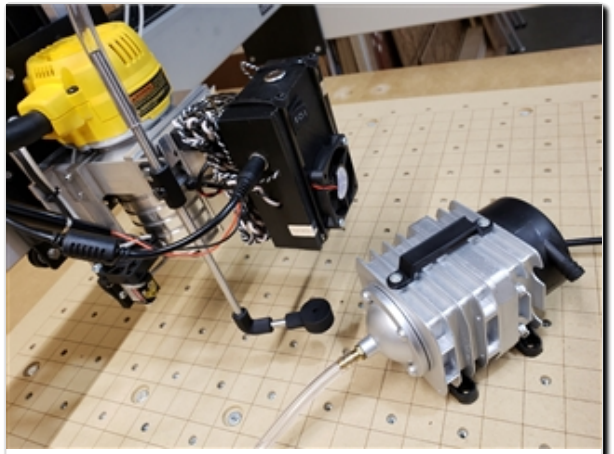
Preliminary Alignment

All that remains to do is get that pretty, violet light into the center. I start by letting the laser cast a spot on top of the washer as I visually adjust the lateral pipe's length. Note again the mid-line on the pipe to keep it somewhat centered between fittings.



Perfect!

Now, just swing it into place 'til the beam is centered in the hole, and tighten/glue the pipe and fittings if desired. Of course, you would make any needed height adjustments before tightening the bracket's set screw, if necessary.



All Set

Now connect your air and cut something!

Final Observations

Quality control on my "piping" wasn't great as some were loose in the brackets and fittings, while others were almost impossibly tight in the same. Please proceed with caution if you're forcibly trying to budge a sharp pipe, lest you punch a hole in yourself. (Not the voice of experience, but could've been.) Maybe just drill the hole a skosh larger, or print a spare elbow for this purpose, or use a leather glove and block of wood to help with your pushing, or...

After reading all of this, I have no doubt that some of you have already thought of improvements, or maybe an entirely new creation of your own brainstorming. Great! I was hoping this would be helpful/useful to someone, somewhere, somehow.

Update: August 24, 2019

Because I run the nozzle 1/2" from the top of the material, it was already acting to somewhat shield the bright light, but not enough for my comfort. So I redesigned the nozzle by adding a 1/8" high by 3/4" diameter flange to the bottom, onto which we can attach any size shield we desire! I made mine 2" across and used transparent acrylic laser shielding from JTech because I like to see what the laser is doing (with safety glasses on, of course). But I imagine you can attach a disk of anything opaque that won't burn. Also, mine was a nice press-fit, so no adhesive, making it easy to remove and replace for cleaning.

Doing this also made it necessary to modify the air holes' angle of attach. It's much "pointier" at its 1/2" focal point, now. Hope you like it!

Acclaim Air Assist Nozzle with Flange for Shield

Acclaim Air Assist Nozzle with Shield Beside

Acclaim Air Assist Nozzle with Shield Attached

The Files!

All of the STLs for the nozzle can be freely had on Thingiverse and Cults, whether for personal or commercial use.

Best wishes, and a very sincere "thanks" for visiting and reading!

Length Conversion

1	Meter
3.28084	Foot

Conversion Widget Compliments of:
UnitConverters.net

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