



Shakuhachi (in 2 or 4 parts with tapered bore)



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Summary

Or - how to unmake bamboo filament. Suitable for playing, displaying, learning how to do woodworking on plastic.

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Tags: [flute](#) [bamboo](#) [japaneseculture](#) [bamboocreate](#)
[shakuhachi](#)

I'd call it medium difficulty because despite being a very simple model there are some things you need to do to convert it to a playable musical instrument, the same as pretty much anything you would print out with the goal of making music. The following writeup is exhaustive, and probably exhausting, but if you want to skip through it the two most important parts of building this involve sealing the pieces together and making the top sharp enough to make a note when you blow down into it at an angle. Please upload any builds you do, as well as any tips you've found and corrections where I've made mistakes :-)

Some things to know about this model

- It is a few mm longer than the measured drawing in the main photo indicates, as printing to the specified size and tuning the embouchure

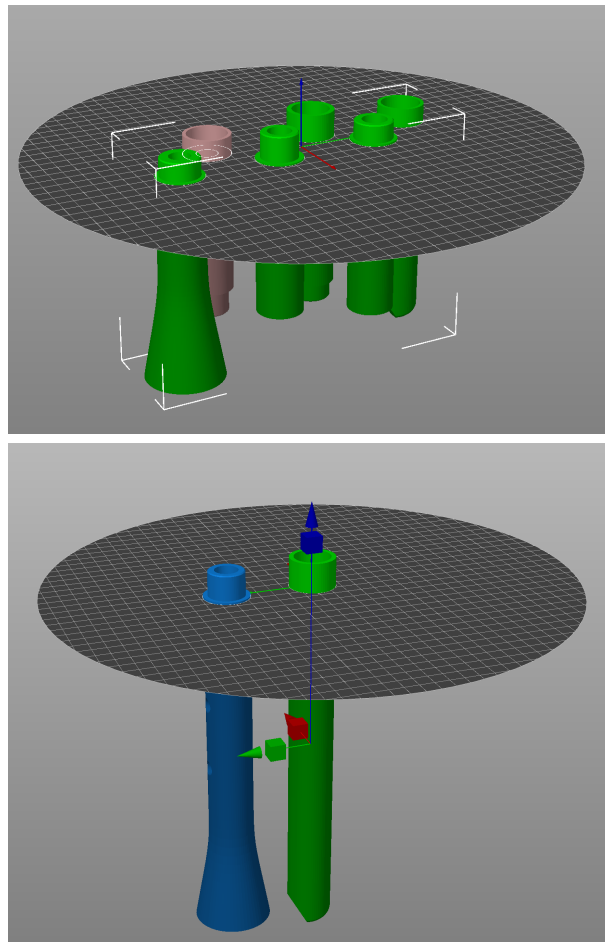
from the drawing results in an instrument that is a few to several “cents” sharp from concert D.

- Likewise, the angle of the embouchure is 30 degrees based on other guides I've found to building these rather than what the drawing indicates. You may wish to modify this to be closer to the drawing however I have not tested this to see if it plays any easier, or at all.
- both 2 and 4 part models will be uploaded. The 4 part model max z is ~165mm or so, and the 2 part should top out at a bit less than 295.
- I used bamboo filament here- wood filament would be a good choice not only due to (hopefully) sounding more like the instrument this is modeled off of, but because it will look much more like a serious musical instrument.
 - With wood filament some additional prep work will be needed to make a complete and playable instrument.
- The measured drawing was found here, and is not included in the blend files as I am unsure the license and would not want to redistribute it myself:
<http://www.shakuhachiforum.com/viewtopic.php?id=5987>
- Build log will be added once photos/models are uploaded, as well as some additional links which may be help

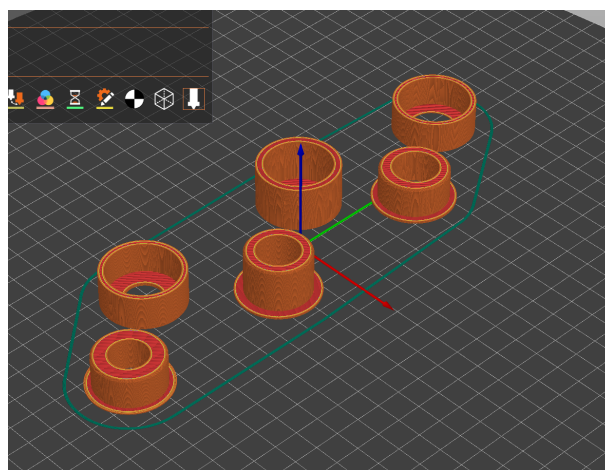
Testing Fit

My first upload wound up being too loose fitting, as it turns out my delta printer had worn tie-rod ends and was in need of a tune up in general. After fixing that I've resized the connections on both the 2 and 4 part model using [3D Printing Tolerances & Fits - 3DChimera](#) as a guide, with slightly smaller than “tight” fit which should require a slight bit of work but nowhere near as much as what is illustrated below. The same techniques should apply though.

Prior to printing the full model it would be a good idea to do a test print of just the joints by plating the model and slicing like shown:



Basically you are burying most of the model below the build plate and when sliced should only have the top/bottom sections of each piece to test, like so:



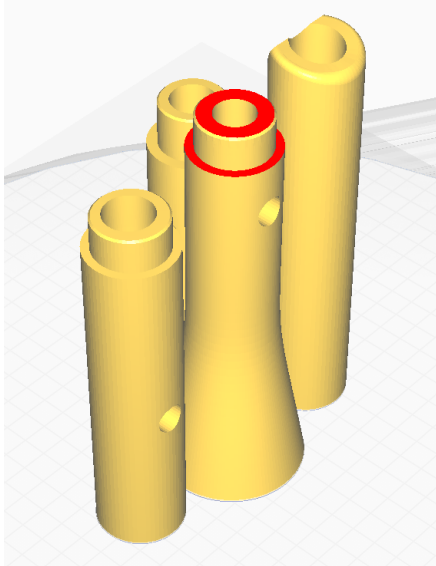
The fit can be adjusted somewhat in Cura using the “Slicing Tolerance” setting, I’m not aware of the equivalent for PrusaSlicer.

Printing

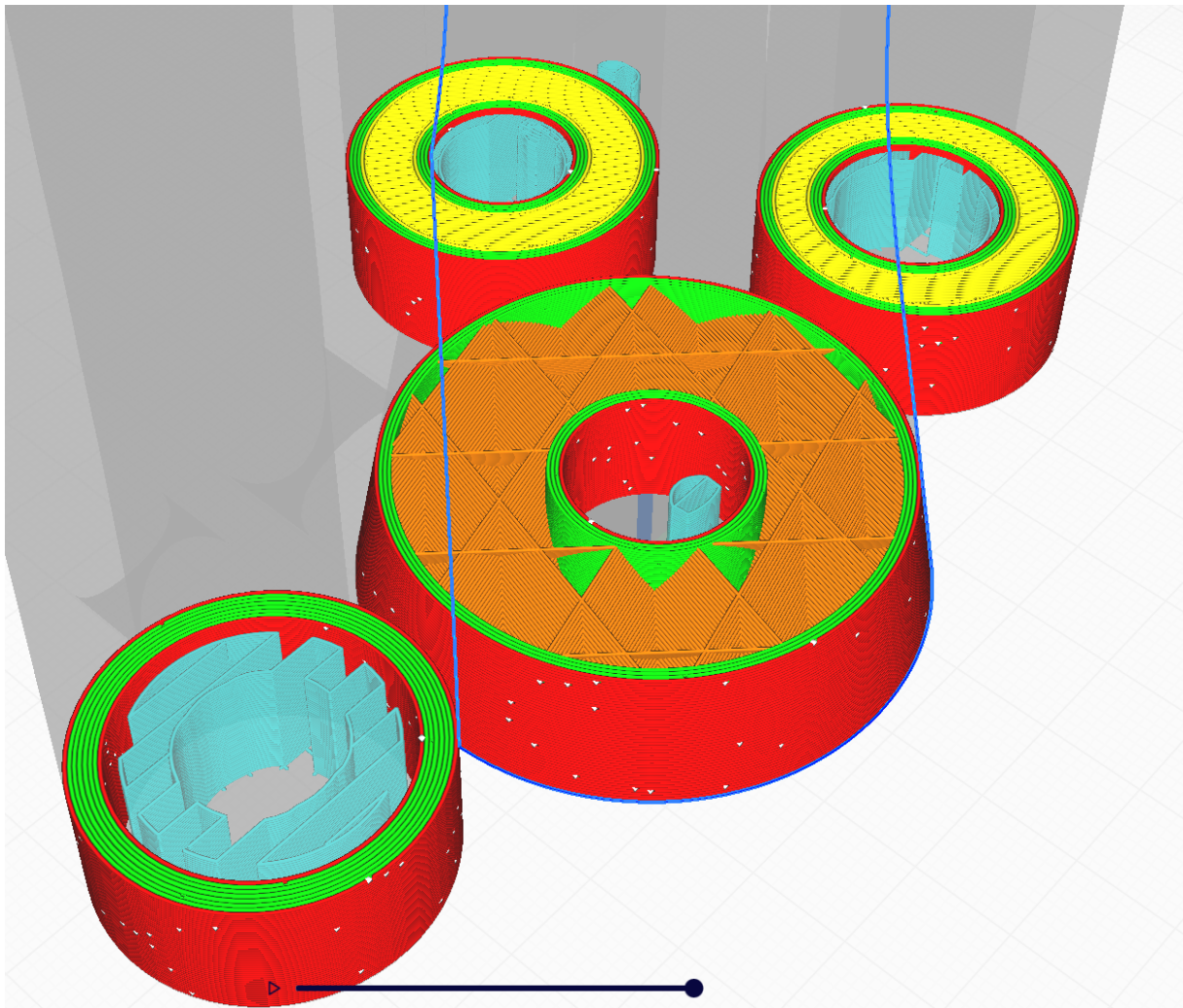
For mine I used Amolen Bamboo PLA filament, and a profile in Cura for a different brand as they have apparently not heard of this brand- IT turned

out with a lot of stringing and some voids where the stringy bits of filament would have gone. In general it's going to take a little more heat to print than normal PLA and your area may start to smell like smoldering wood. Ventilation or a chamber with air filtration is key here if you use something like this.

I plated mine like so:



with the “tenon” areas facing upward. This makes for a bit of work later but looks better once the parts are glued together. Infill isn't so important here as the model is mostly self supporting but you want to make sure the parts are well supported. Mine was set to 15% for supports in Cura, with no interface as we'll need to scrape the inside “cheeks” of the part clean for a perfect fit. Example below:



Two of the 4 part models first layer on top of support, the top-middle section is still printing support and the bottom is into infill already. I used like 10% cubic infill just to have something kind of holding the walls altogether and in case I broke through the walls while sanding it, something to make backfilling easier.

I used 4 walls at .4mm line width but I would recommend 4 walls at .5mm or even 5 walls at that width. It will take longer to print but result in a much more solid feeling part. Also at least 5 top/bottom layers as adjusting/sharpening the embouchure later will risk breaking through into the infill area otherwise. Another important thing is to check if your slicer has an “exclusivity” setting and select “exclusive”. This means that the printed part itself sits within the confines of the STL which will help joining the parts together later.

Recap:

- If you're using wood filament for the first time maybe make some test prints first to avoid a lot of work later
 - Wood filament looks kind of terrible until it's scraped/sanded.

- "more walls = better than" for cases like this where additional work on the model will be needed later
- Supports are going to be in an awkward place to clean. Interface layers may make this more difficult.

Post Printing:

Joining the parts

I've left a small gap in the joins for the parts in order to make up for printing, however even this and setting my print for "exclusivity" I wound up needing to manually fit the parts together. Honestly this is probably a good thing as it allowed me to generate an air tight seal with no gaps on the inside. I chamfered the INSIDE edge of the receiving ends like so:



There is already a chamfer designed into the "tenon" portions however you might want to scrape, sand or file this a little larger. Do not add a chamfer to other edges or we may wind up with a gap in the parts when joined, which may negatively impact the sound. Only file or scrape the very top parts of the tenon to complete flatness. In the picture to the left the inside cheek/shelf area where the tenon connects at the top is visible, you want to use

a chisel or some other scraping implement to remove all support strands and make the surface as flat as possible.

The sides inside should be scraped mostly flat. After this if there is still an issue getting the tenons into it you can go around the outsides of the tenons with a file like this:



Take care not to file any material off the "outer" shelf portion or else there will be a visible gap when joining that cannot be gotten rid of easily.

Once everything fits together without too much effort line all the parts up and if you are printing the 4 part model, it might be a good idea to also download the 2 part to make sure all the holes are in the correct

orientation and order.



Use CA or super glue to join the parts, a small amount on the shelf areas, making sure not to leave any gap and a few lines on the tenon. Double check orientation to make certain you are in the correct place as it will set very quickly before joining the parts. If you are using 2 part epoxy or similar it would be helpful to clamp the parts together as above to prevent any misalignment while the glue is setting up.

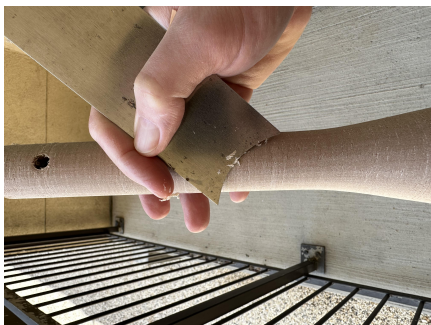
Don't use white or yellow carpenter's glue (at least on Amolen wood blend). I tried it, and it just doesn't set up without access to air even after a full day.

Smoothing:

I was able to use a card scraper to even the finish out, which made the material look a lot more wood-like.

(A quick primer on using card scrapers with pla, which also works wonders here)

<https://www.youtube.com/watch?v=a4e9JJkinvk>



I'm using a cheap set that I think I picked up at Harbor Freight. If you don't already have a set I highly recommend them. Obviously if you have your print settings dialed in for this filament it makes for a lot less work. I wound up scraping the outside of the print 3x and sanded in between with some 80 grit sandpaper to vice my hands a rest. One tip they won't tell you in class is as soon as you start to feel your hand hurting a little bit put

some medical tape (or duct tape or similar) over the tender spot to keep it from turning into a blister or scrape.

The card scraper pictured is part of a set of various shapes and sizes. The concave face doesn't match the outside of the flute at any point, however by angling it as pictured it can be made to scrap a wider area. Watch out

for the corners while holding the workpiece with your other hand as they are sharp! Overlapping the areas scraped will give better results. You can sand with 80 and then 220 grit sandpaper with wood based filament to smooth out the final marks left behind with the scraper or leave the scraper marks for a “rough hewn” look.

If you have a rifle cleaner, or even a stick you can super glue some sandpaper to- it makes sense to start smoothing out the inside bore prior to assembly. Avoid the edges where we are going to be gluing the parts together for now, They should already print more or less even with each other and we'll need to sand away any squeeze out from the glue joint later anyway.

Tuning the embouchure:

I used a rolled up 220 grit sanding disk to smooth out the inside bore (this is fairly important as we need the angled part at the top where the semicircular cutout is to be both smooth but also fairly sharp, at least as sharp as a sharp fingernail in order to produce sound:



Following this I used a mill file (photo below) to gradually widen the sharp semi-circle cutout from the top part until it was able to play the fundamental note of the instrument (Low D.) You could also use a nail file, sanding block or anything similar so long as it is flat and leaves a flat

surface as shown below. If you need to use abrasives you'll want to follow through to a fine grit where there is no rough surface left behind. The semi-circular opening should be a bit sharper than a fingernail, without any “burr” or rough edges.



Not pictured: Smoothing the insides of the finger holes. Some sandpaper wrapped around a pencil or dowel rod and sanded gently to remove layer lines and other print artifacts. See also the above-linked pages for tuning and otherwise adjusting the sound on the flute after completing to this stage.

Model files



shak-4-part-fitted-1.stl

☐ Four Part model



shak-4-part-fitted-2.stl

☐ Four Part model



shak-4-part-fitted-3.stl

☐ Four Part model



shak-4-part-fitted-4.stl

☐ Four Part model



shak-2-part-fitted-1.stl

☐ Two Part model



shak-2-part-fitted-2.stl

☐ Two Part model



booleans-used-for-cuts.stl

☐ Boolean shape used for all hollows/holes, can be used to create new design easily.



shak-2-part-final-fitted.blend

☐ blender source file for exported 2 part model



shak-4-part-final-fitted.blend

☐ blender source file for exported 4 part model

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