

N95 RE-USABLE MASK

3D PRINTING AND POST-CRAFTING INSTRUCTIONS



With a neighbor serving as head ICU nurse at one of the largest, local hospitals here in Washington State (Peace Health in SW Washington), I've been hearing daily reports about the PPE equipment that is fast running out (or has already run out). Being an industrial designer, and in possession of two Ultimaker 3D printers, I've jumped in to print and craft as many as I can crank out. Meanwhile...even more parts are needed (beyond masks), so there will be more to come. But for now, here are the details on what I've been printing, crafting and delivering.

SPECIAL NOTE: These 3D-printed masks **ARE NOT *NIOSH-certified for health care***. These masks are for the last resort, when there is no supply of NIOSH-rated masks. In other words, it's either one of these or nothing. **DO NOT** use these masks when other, NIOSH-rated masks are available. We take no responsibility for your download, printing and/or use of this mask. Use at your own risk, and only as a last resort.

Step 1: Secure the .STL files (there are 2 files) - If anyone has an issue getting the file, e-mail me direct at: Dan@DM3.Consulting (and I'll get it straight to you!).

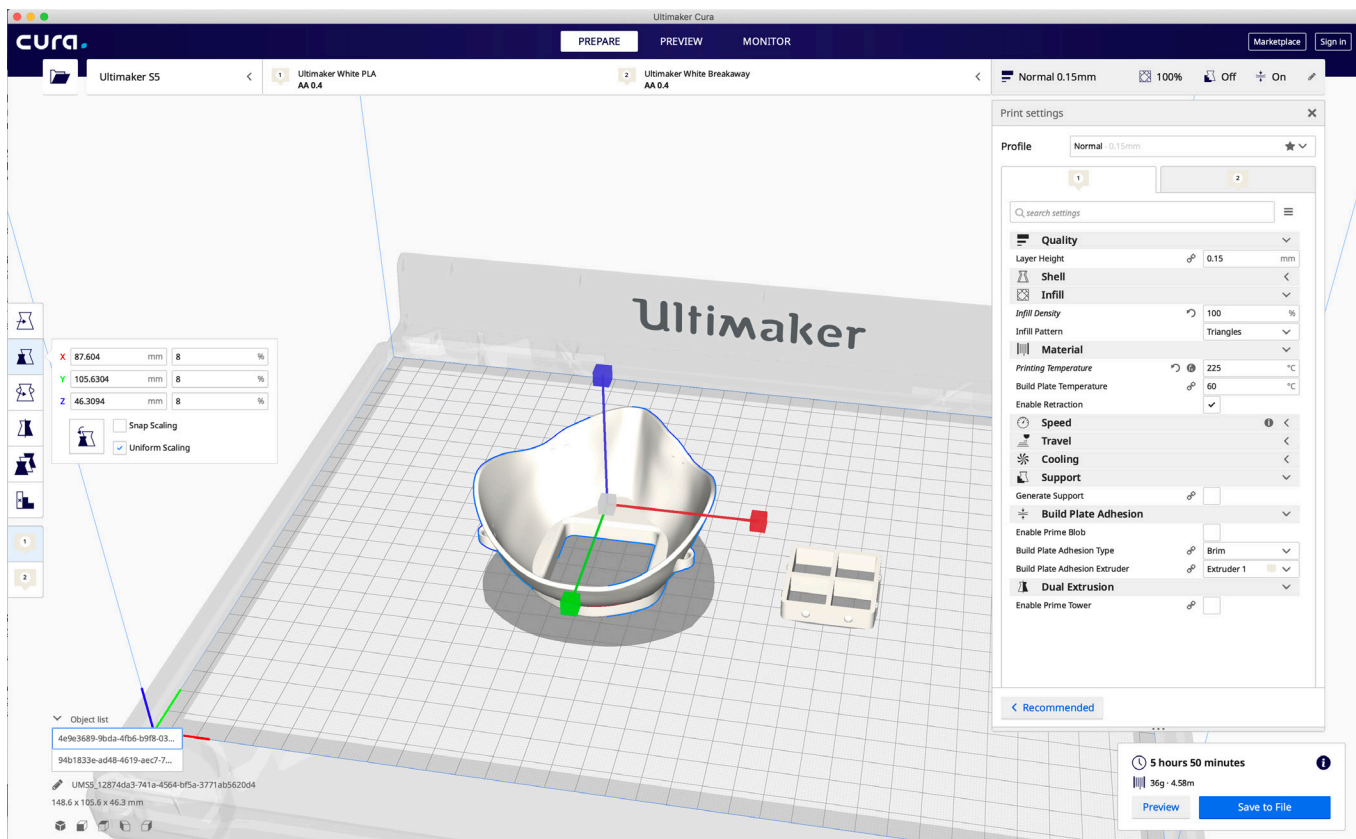
Step 2: Open the files in your CAD program (Solidworks, Fusion 360, etc.) and view. You will see there are two parts to be printed: Part (1) is the main mask, Part (2) is the small "window" that serves to secure a small portion of N95 filter material (or other hacked filter material*).

Step 3: I've been printing these masks in (3) different sizes, based on the following plan:

Export the model for 3D printing to your slicer of choice (I'm using Cura).

Printing a Size 8 Mask

Scale the main mask (large part) to 8%...and we call that a "size 8" and it fits many, smaller women's faces. The matching "window" part for this size 8 mask should be exported and then scaled to 7.75%. I've found that with my additive printers a slightly-scaled down version of the window portion makes it fit easier when placing in the N95 fabric (or otherwise*).



Here are the settings I'm using in Cura to prep a "size 8" mask and window for printing.

Printing a Size 9 Mask

Scale the main mask (large part) to 9%...and we call that a "size 8" and it fits many, smaller women's faces. The matching "window" part for this size 9 mask should be exported and then scaled to 8.85%.

Printing a Size 10 Mask

Scale the main mask (large part) to 10%...and we call that a "size 10" and it fits most mens faces. The matching "window" part for this size 10 mask should be exported and then scaled to 9.8%.

Masks Larger and Smaller

Masks of smaller size (size 7, 6, 5) and larger (size 11, 12, 13) can be made as well, although I haven't yet seen the need as so far one of the 3 sizes above are fitting people. It helps that the face seal part is soft and squishy, making it conform pretty easily. However, if a child needs a mask, the smaller sizes will be needed. Same for extra large people...size 11, 12, etc. In general, the window part can be around .15 to .2% smaller in scale vs. the main mask part. However, if you're using an SLA printer, such as a Form Labs (nice!), then my guess is you can stay 1 to 1 as there shouldn't be any of the usual ".3mm off" issues seen with additive printers ;).

Material Needs:

I've experimented with different materials and have found the best combo to be:

- PLA (nozzle 1, keeper material)
- Breakaway Support Material (nozzle 2, support only) - PVA will work here just fine as well, but this slows things down due to the need to soak off the PVA (and the breakaway stuff just "breaks away" and gets dialed fast with a tiny bit of sanding).

Crafting the Masks (Post-printing)

After printing a mask, and removing all support material, I've been doing the following:

1. Light sanding on all face-touch edges - not more than a minute or two is needed here, depending on the quality of your print. My printer makes really nice stuff, but is slow...so it's a trade-off. As noted, an SLA machine would likely require no efforts here!

2. Placement of the face seal gasket - This is a simple but somewhat time-consuming step. Using the below Rubber Window Seal [MD Rubber Window Seal](#), peel and stick the seal around the open face edge of the main mask. Do this firmly and carefully, making sure not to stretch the seal, which causes it to come off of other, previously adheded areas.





Use an exacto knife to cut the face seal so both ends abut to form as much of a seal as possible. Glue will fill the rest (see below).

3. Glue the face seal gasket - This is the time-consuming part. Starting at the location where the two ends of the seal meet, begin applying [CYANOCRYLATE glue](#) (the only glue I've found to work well with PLA), around the outer edge. This must be done somewhat slowly, taking the time to press the seal to the mask, allowing the glue to work. This glue sets up pretty fast if there isn't stress on the two surfaces being glued....AND....you don't use too much glue. It takes forever to set if it's a big glob ;) . See pic below:



CRITICAL GLUE POINT!!!

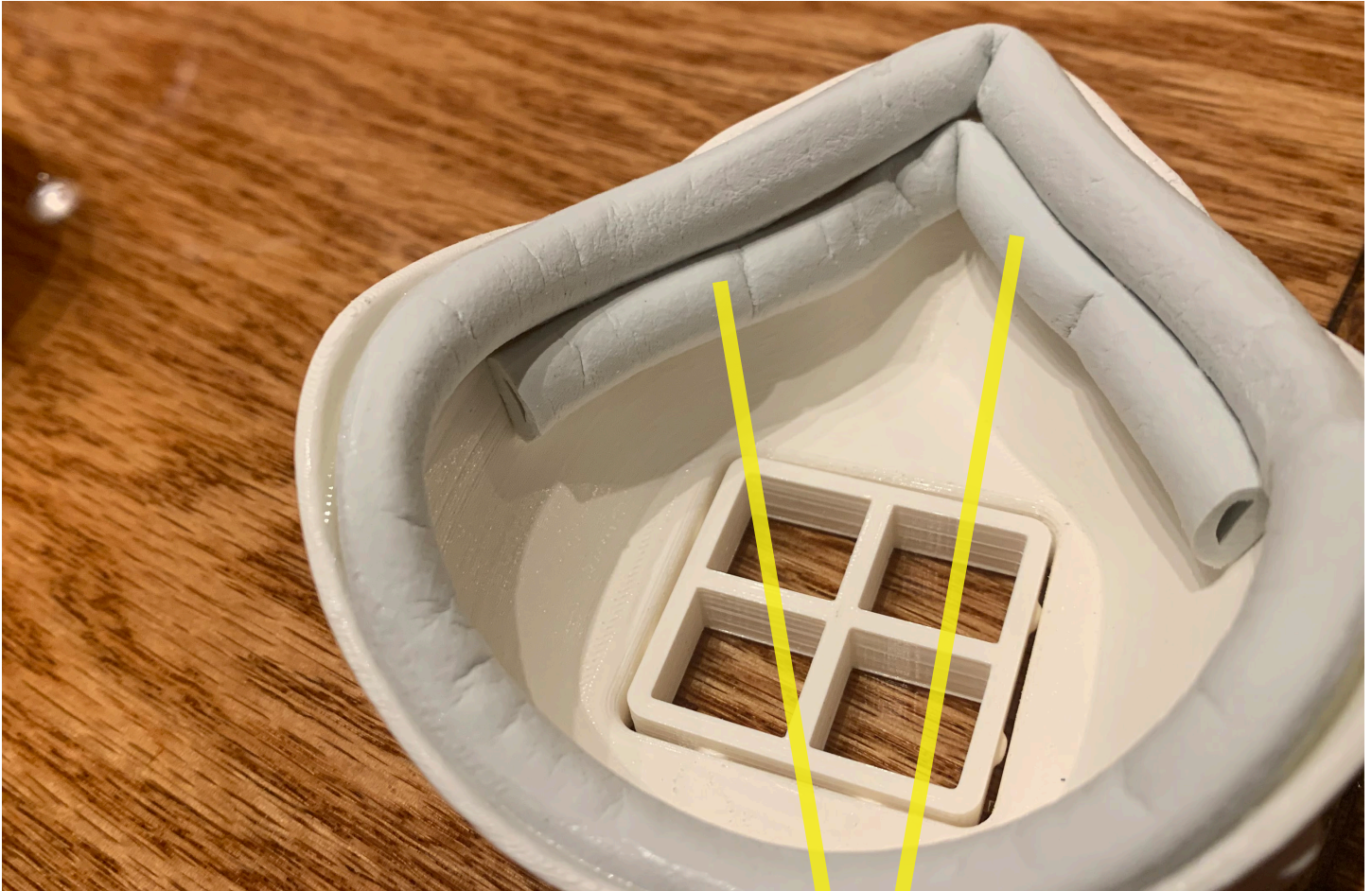


Glue at the junction point at both ends of the face seal first. This THE MOST CRITICAL GLUE POINT as there is a natural break in the seal. Glue this very well, very carefully. Put glue inside the seal, around it, etc. Squish out any air bubbles.

Next, glue at the points that are not stressed and trying to peel off. Keep in mind, the glue can make the seal adhesive not work, so you may need to hold things in place while they get tacky enough to let go. Don't use too much glue or it takes forever to set. Add glue to more stressed areas after the non-stressed areas are set. Found this to work the best. After gluing, put yet another bead of glue around the ENTIRE SEAL to ensure the seal is air tight.

3B. Glue the INNER Face Seal Gasket: Now that you have the outer ring face seal gasket glued on it's time to glue into the place the inner face seal gasket. This extra seal gives, well, more seal ;). The same gluing procedures apply in that you glue a little at a time, ensuring to A. Get a solid glue line under the seal and B. ensure the seal isn't being pulled or stressed off out of its position.

KEEP IN MIND this [CYANOCRYLATE glue](#) is EXTREMELY STICKY! Be very, very careful not to glue your fingers together (literally). I've done this too many times...and it hurts!



INNER FACE SEAL GASKET

4. Putting in the Filter - Once your glue is dry, the mask is generally “done.” That said, it isn’t in any way functional yet as it still needs a square of N95 (or otherwise*) filter material sandwiched in-between the Main Mask and the Mask Window (as shown below).

To get the N95 material (for cutting into squares), people have been using existing N95 masks...and cutting them into smaller pieces. The larger N95s can be cut into (6) different window portions for a size 8 mask. You can get around (4) squares of material out of a large, N95 to fit the size 9 mask, and (3) for the size 10. This allows medical staff to stretch their supply of N95s on-hand.

***ALTERNATIVES to N95 Material:**

We are researching alternatives to N95 filter material if such material is not available. In the end, these masks, not being [NIOSH-certified](#) are not ideal for use...but rather, a last resort. Yet many are already seeing this “last resort” arrive...and thus these masks are of critical use and need. So, when no N95 material is available to plug the hole in this re-usable mask, alternatives must be considered (when otherwise you have nothing). It states on the Montana Mask website that they do use cut up squares of surgical masks if no N95 material is available, but that this is not as effective as N95. Yet if your alternative is nothing at all? Well, you get the picture.

Leave this filter element to the health professional. Ideally they can cut up existing N95s and use small portions to make things stretch. I will update with any and all I find out about the alternative materials as I learn more.



Two finished masks (although I haven’t put in the INNER FACE SEAL GASKET yet on these two) with small squares of N95 material “sandwiched” in-between the main mask part and the window part. NOTE: This can create a very tight fitting...whcih may require you to sand the outside edges of the window part (all four sides) to get it to go in easier (to sandwich). Just depends on your printer, material, etc.

Putting on the Straps:

The strap material (elastic) is very hard to find. 1/8" elastic material fits best, but can't be found easily. Hospital folks are also taking these straps off of existing N95s and using them. Folks have to fit these individually as it is, depending on head size, comfort, etc. Then...they must do what is called "fit testing," at the hospital, where a spray is emitted of a certain odor...and as the mask wearer can/cannot smell the odor...they know if they do or don't have a good seal.

Cleaning the Mask:

Here is a link to the protocol for [cleaning and disinfecting the mask](#) between uses. With my masks being 3D printed in PLA plastic, they CANNOT be taken up to or above 70 degrees celcius for any length of time (or they will begin melting). Thus, please follow the directions in the cleaning link above for disinfecting/cleaning using a method that does not employ these higher temps.

In general, the idea is to remove the fliter portion, discard it (safely), and then disinfect the hard mask parts and the face seal as noted. That said, I'd leave the cleaning and disinfecting element to the medical staff using the mask(s).

Details on the Original Mask Design:

The original mask design comes from two doctors (and one of their sons) out of Billings, Montana. Dubbed the "[Montana Mask](#)," this design has been [rigorously tested in clinical trials](#) to be an effective barrier against COVID-19. That said, use only as a last resort to either stretch existing N95 material and/or with an alternative filter material if you've run out of anything else. Always use a NIOSH-certified PPE solution if it is available.

Disclaimer:

Use at your own risk. As noted on the [MakeTheMasks.com](#) website, these mask design is NOT NIOSH-certified and should only be considered for use as a last resort when nothing else is available. We do not take responsibility for the creation of these masks and are only disseminating this information in an effort to help the medical community that is running out of PPE equipment at certain locations.

Contact:

If you have any questions, please feel free to e-mail me at Dan@DM3.consulting, or call me direct (anytime) at 503-550-6110. My website is [DM3.consulting](#) and I plan to put these files up on there soon too.

Thanks for jumping in!!

-Dan Meyers