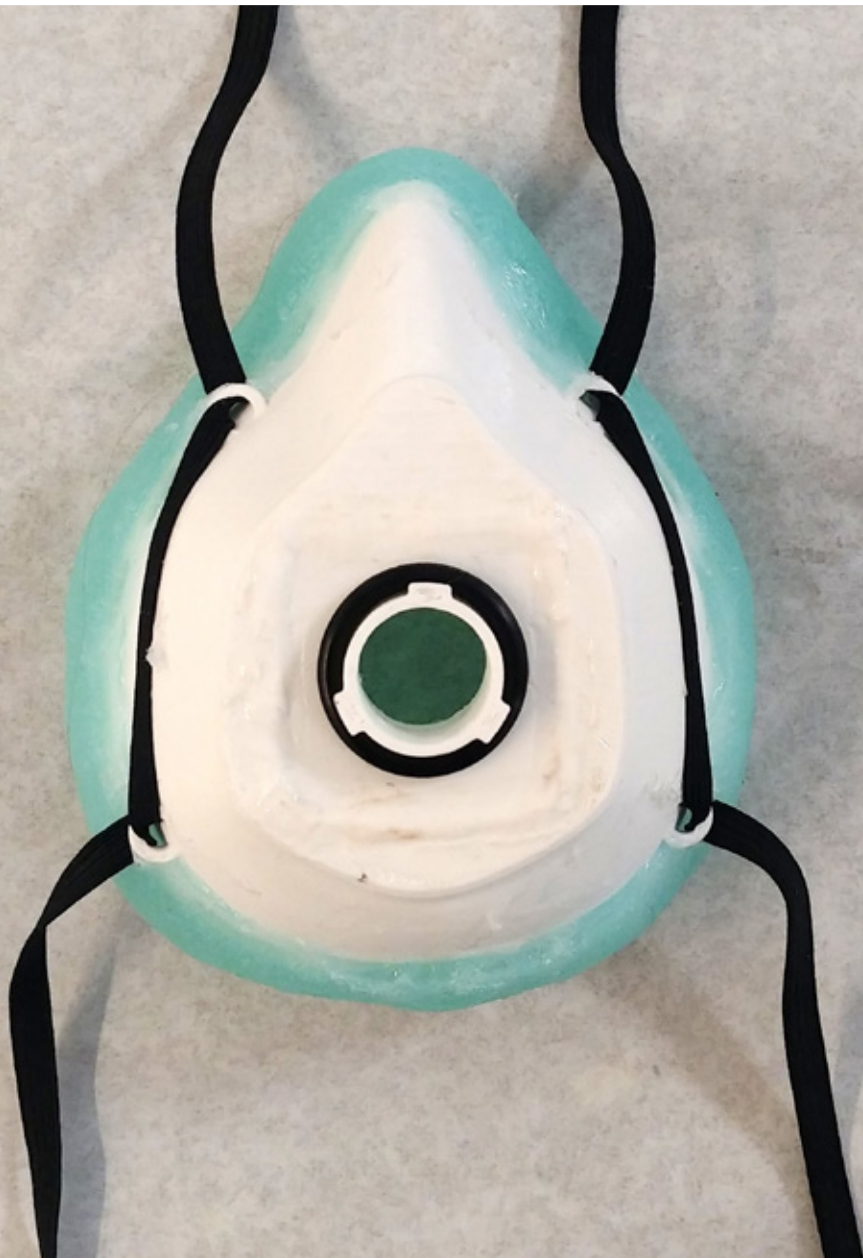


3D Printed N95 Replacement Mask



3D Printed N95 Replacement Mask

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Legal Disclosure

The products and claims made herein have not been evaluated by the United States Food and Drug Administration and may not provide the same level of protection as FDA-cleared surgical masks, N95 masks, and equivalents.

Acknowledgements

The designs in this booklet were created by the team at the Barrow Innovation Center, a rapid prototyping laboratory within Barrow Neurological Institute, in collaboration with SurgiSTUD LLC. The team made many adjustments to existing designs and files freely available online at makethemasks.com.

What follows are the published improvements to the mask design.

Bill of Materials

N95 Replacement				Updated:	3/31/2020
Item	Name	Description	Manufacturer	Supplier	Quantity
1	PLA	3d Printing Filament	Hatchbox	Amazon	.044kg
2	Dragon Skin 10 Very Fast	Silicone	Smooth-On	Reynolds Advanced materials	.053 gal
3	Sil-Poxy	Silicon Rubber Adhesive	Smooth-On	Reynolds Advanced materials	2 mL
4	Ease Release 200	Silicone Mold Release	Mann Release Technologies	Reynolds Advanced materials	1/10 can
5	Silc-Pig	Silicone Colorant	Smooth-On	Reynolds Advanced materials	1/400 unit
6	Elastic Band				48 in
7	#212 O Ring	O Ring		Arizona Sealing Devices Inc	1
8	Gloop!	PLA Adhesive	Gloop!	Gloop!	1/50 bottle
9	Silicone Mold		BNI	BNI	1

Printing Parts

All 3D printing files can be found in our [github repository here](#).

These files can be downloaded to work with any 3D printer. At the Barrow Innovation Center we've been using FDM printers as they've proven to be fast and reliable.

Recommended print settings:

- Material: PLA
- Infill: >20%
- Shells: >4 (1.6mm)

Scale mask 90% if making a mask for a person with a smaller face and print the corresponding filter.

Preparing Mask For Silicone Mold Creation

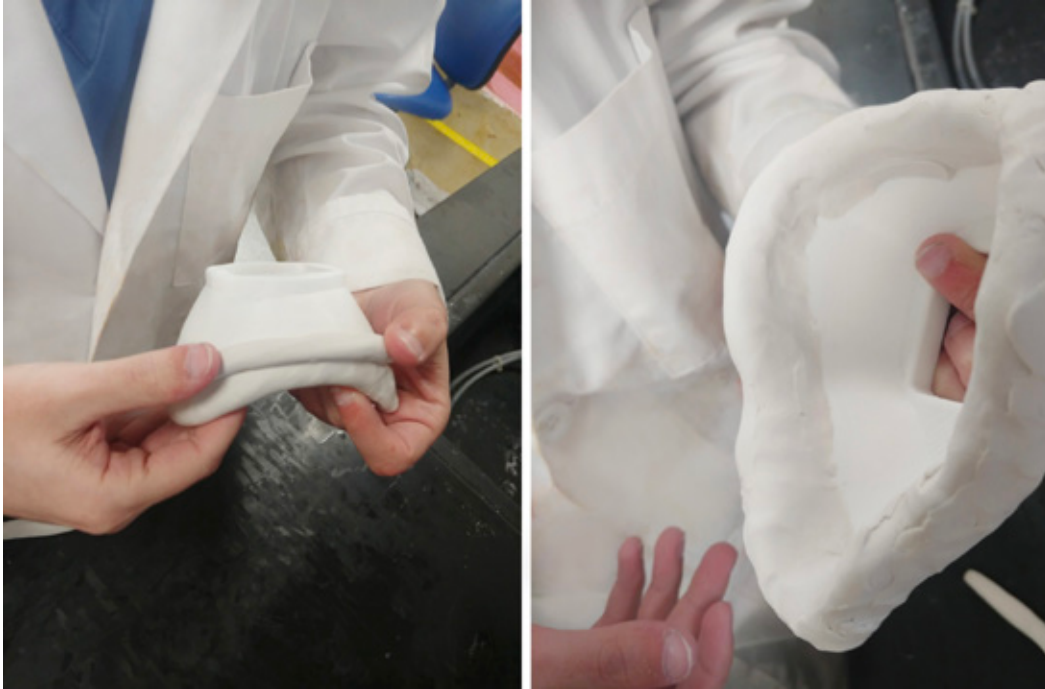
A. Roll out one 1/2 inch clay strand and two 3/8 inch clay strands



B. Place the 1/2 inch clay strand along the edge of the mask, with more overhang on the inside compared to the outside



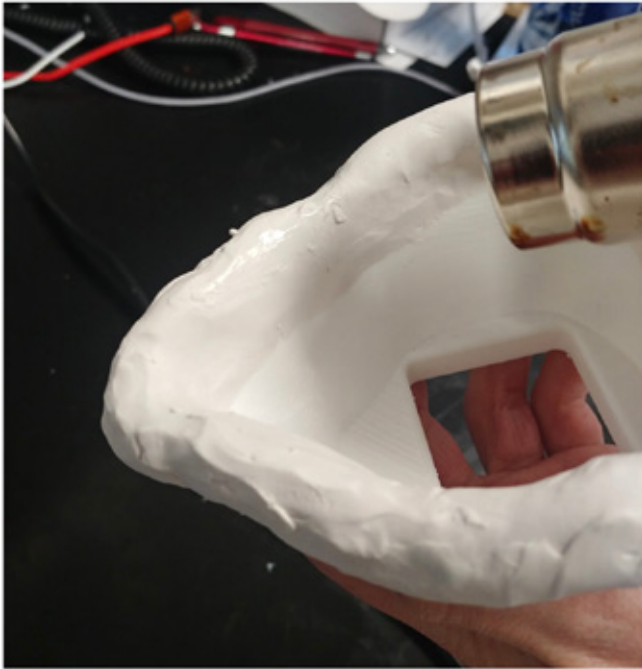
C. Place the small strands on the inside and outside and spread clay to completely cover all holes in the mask



D. Hold mask up to face and test the seal by covering the front opening. Add additional clay anywhere there are leaks.



E. Heat clay with heat gun or hair dryer until glossy

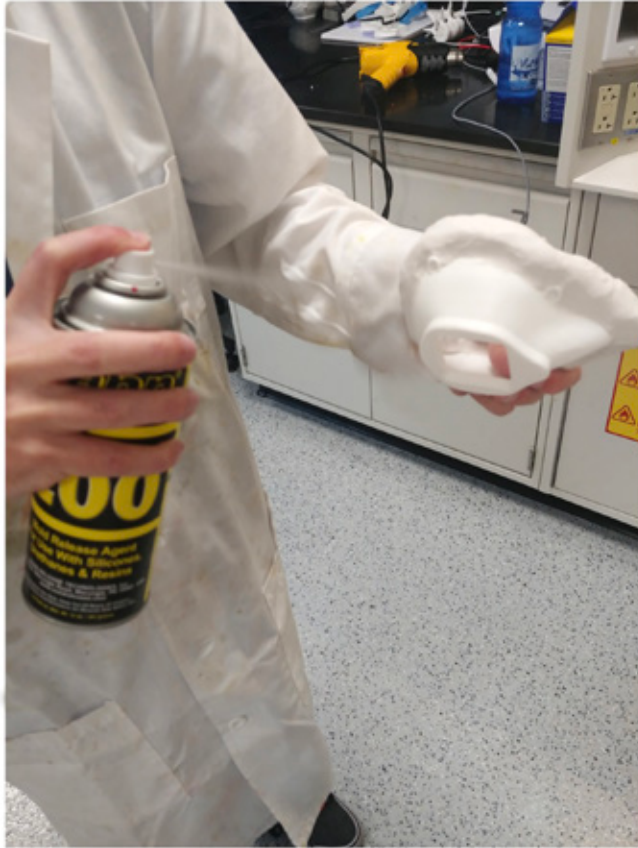


F. Smooth clay for a cleaner finished product



Creating a Silicone Mold

A. Spray prepared mask with mold release



B. Find a tupper ware container that fits the mask

C. Mix enough silicone to fill container with at least $\frac{1}{4}$ inch of silicone

D. Pour silicone in container and allow to cure

E. Mix enough silicone to fill container enough to cover all clay parts of mask

F. Place mask in container and pour silicone around mask until all clay is covered

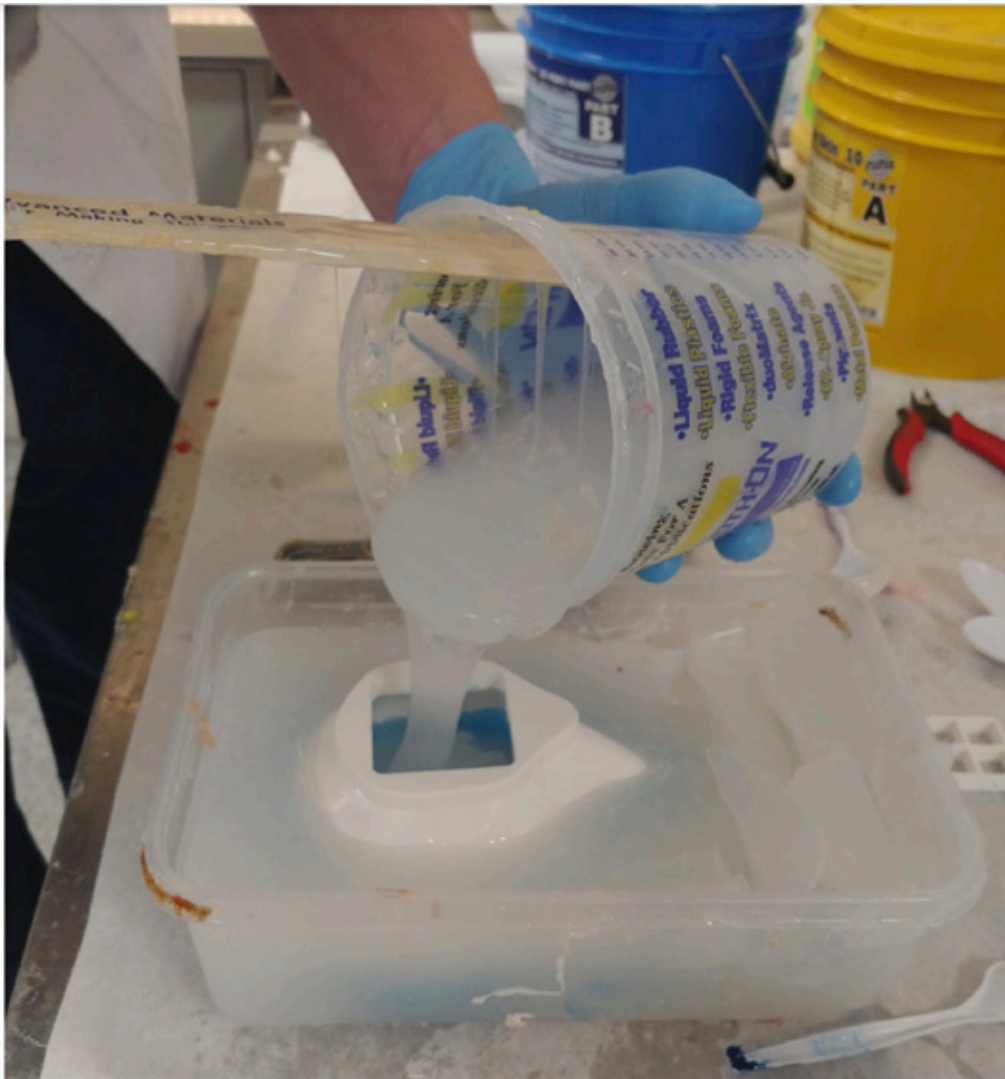


Optionally: add pegs on all four corners to make following steps easier and fill gaps with filler to save silicone

G. Allow silicone to cure

H. Mix enough silicone to fill the inside of the mask

I. Pour silicone through the square hole of the mask until the mask is filled, avoid silicone spilling over sides of mask



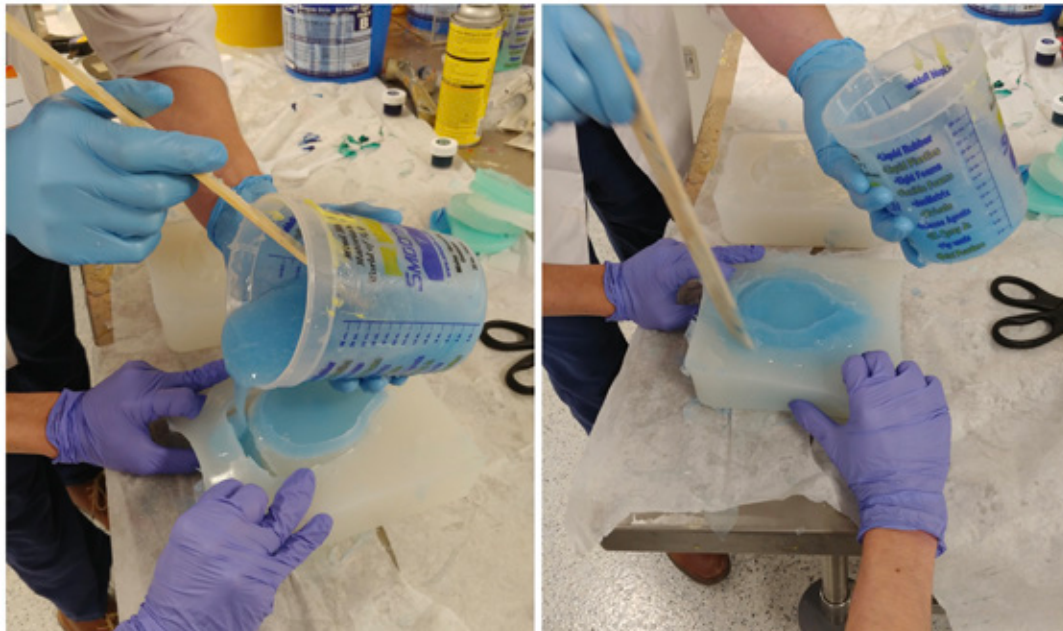
J. Allow silicone to cure

K. Carefully remove mask from silicone mold, ensuring that all clay has been removed



Casting Silicone Seal

- A. Use a newly printed mask or a mask cleaned of all clay, visually inspect for print imperfections that might impair mask performance
- B. Spray the inside and top of the silicone mold with wax mold release, pulling back edges of mold to spray inside of mold to ensure a good coating on the interior
 - ii. Avoid touching interior surfaces coated with mold release as it can be wiped off
- C. Mix enough silicone to fill mold:
 - Approximately 200ml total for Montana Mask printed at 100% Scale
 - Approximately 150ml total for Montana Mask printed at 90% Scale
 - Optionally add colorant to personalize masks or identify different sizes
- D. Pull back edges of mold and pour in silicone until interior is full



- E. Place mask in mold



F. Allow silicone to cure

G. Carefully remove mask from mold:

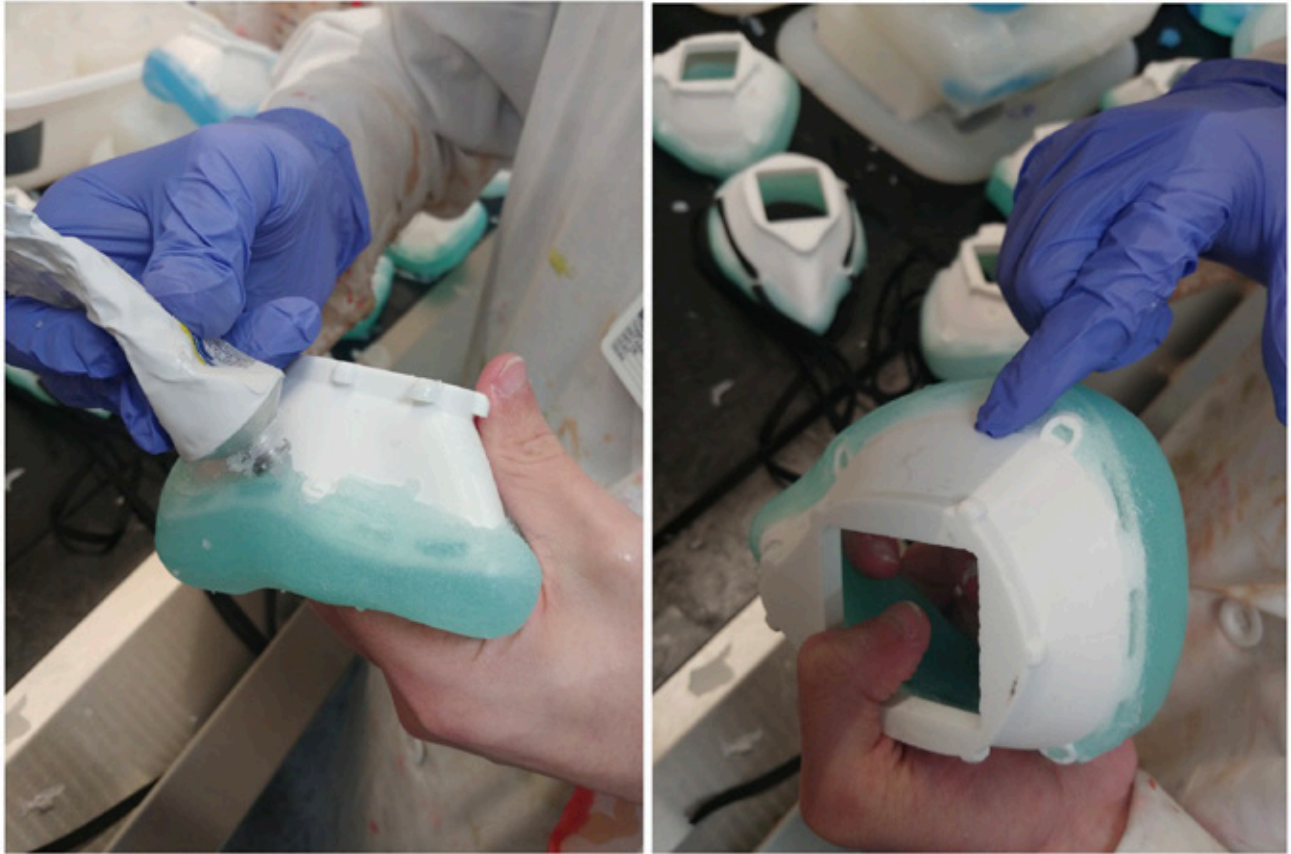
- i. Attempt to get one finger in and underneath the silicone seal of the mask
- ii. Run finger around mask entire mask underneath the silicone seal, detethering any point where silicone seal adhered to silicone mold
- iii. Once finger can be run freely around entire mask, get multiple fingers underneath nose of mask and carefully pull out mask, detethering any interior adhesions as necessary

Mask Post Processing

H. Remove any excess material from mask with a sharp blade



- I. If silicone does not fill all slits around edge of mask:
- J. Mix a small batch of silicone and apply to sites where desired, filling holes completely
 - ii. It may be necessary to allow silicone to become more viscous before applying
 - iii. A heat gun (or blow dryer) can also be used to accelerate the curing and prevent running of silicone
 - iv. Allow silicone to cure
- K. Use silicone glue to seal down edges of silicone seal on the outside of the mask



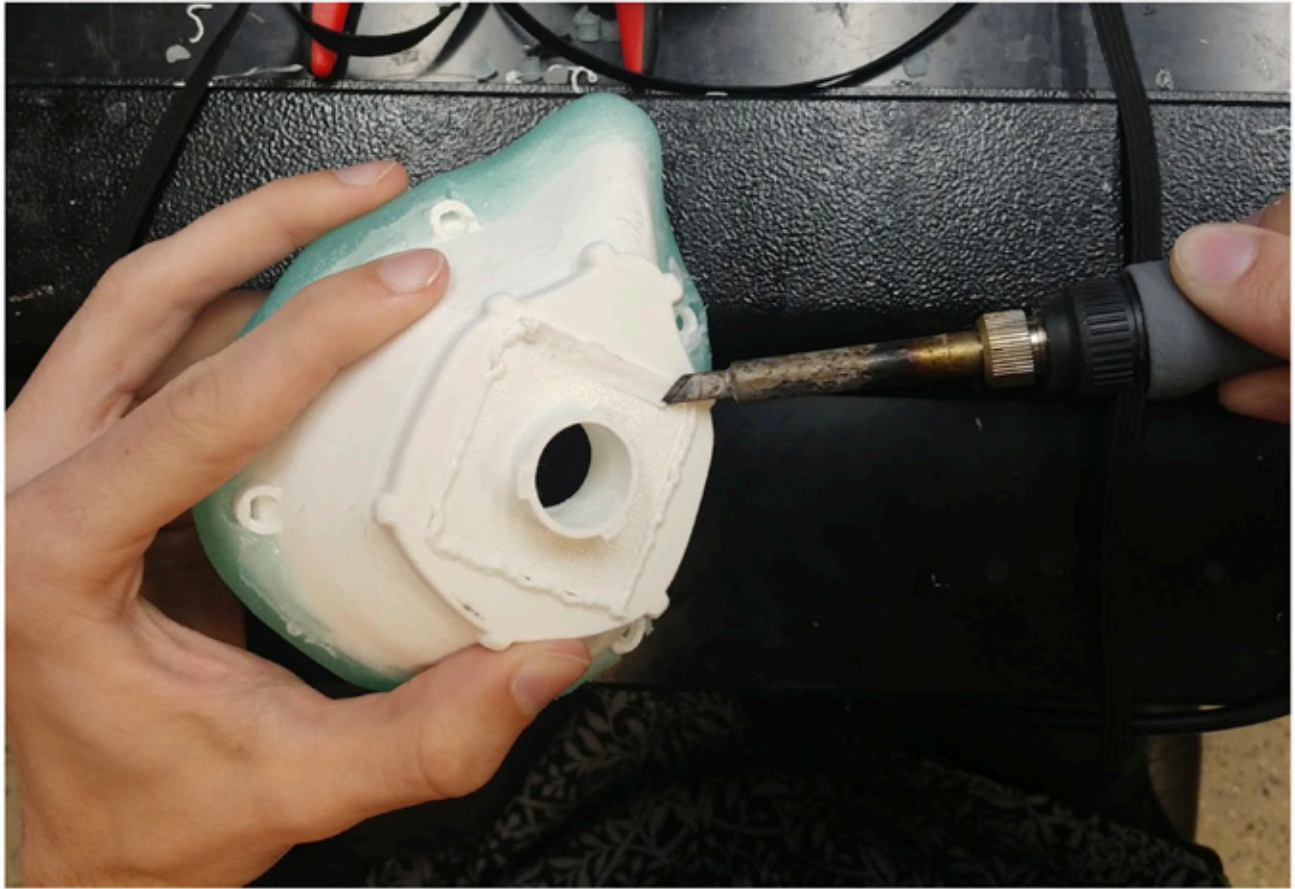
- i. This will make the mask easier to clean
- ii. Allow silicone glue to cure

Attaching Filter Coupler

- A. Insert coupler into mask, ensuring that the filter will be oriented correctly when installed, press in until flush with mask



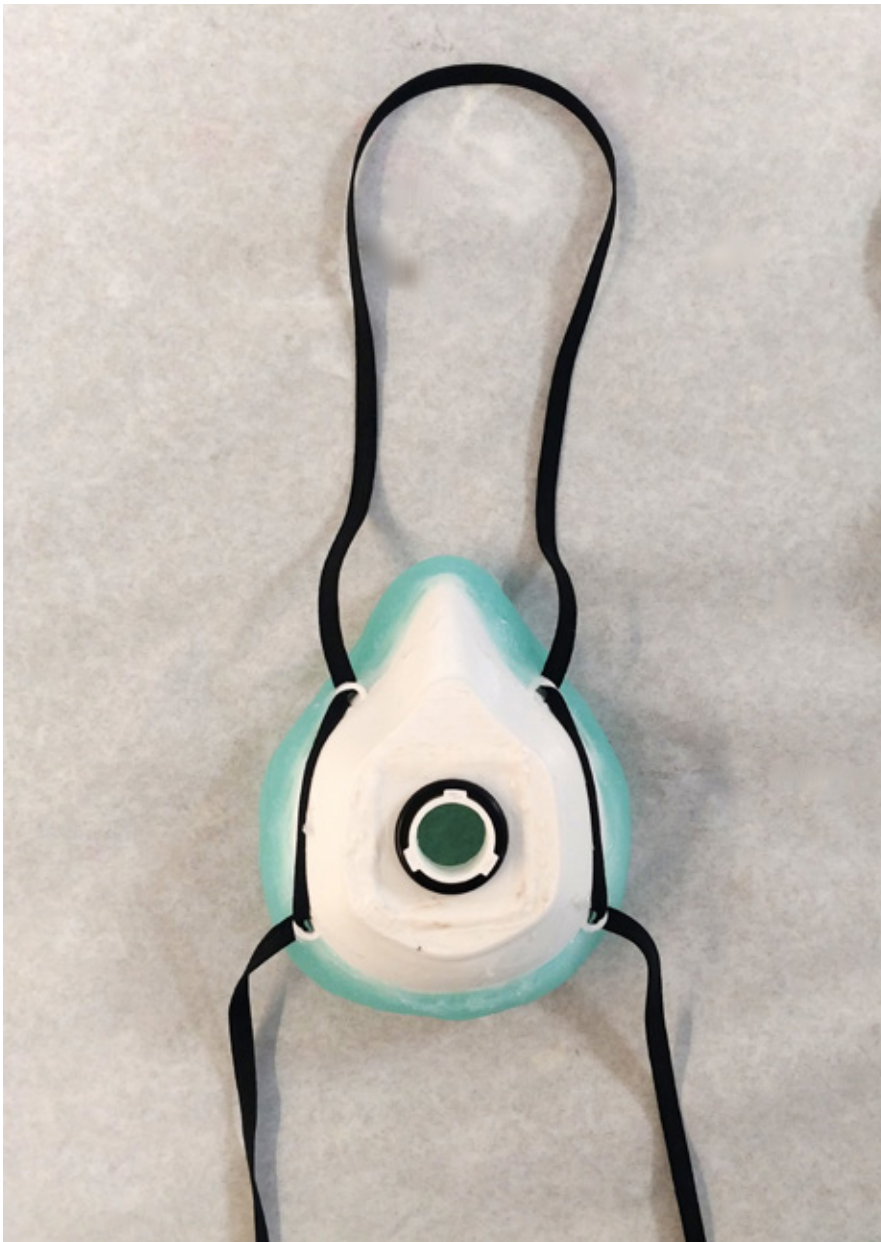
- B. Use a 3-D printing pen to add a thin line of PLA across seam between mask and coupler



C. Install O-Ring over coupler

Attaching Straps

- A. Use sharp blade to cut through silicone covering strap connectors and remove any silicone inside of connectors
- B. Measure and cut 48" of elastic material
- C. Burn ends of elastic material to avoid fraying
- D. Feed elastic through connectors in the following order:
 - i. Bottom left > upper left > upper right > bottom right



Fitting and Testing

Testing of these masks can be done in two steps: suction and saccharin (standard fit test).

For suction, fit the finished mask to your face. Cover the coupler hole with your palm and inhale lightly. If there is a complete seal, you will not be able to inhale.

The mask can undergo the same routine fit test as the standard FDA approved N95 surgical mask. This involves the standard saccharin nebulizers and testing hoods. This test and its details can be found on the OSHA website.

Guidelines for Fit Testing

This test and its details can be found on the [OSHA website here](#).



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