Vandal Mask V10 R1.0 Information

“The University of Idaho, in accordance with Governor Brad Little’s March 13, 2020 emergency declaration related to the COVID-19 pandemic and his March 25, 2020 declaration of Extreme Emergency, is doing what it can to help the State of Idaho respond to the COVID-19 pandemic. As such, the University of Idaho is happy to utilize its expertise and resources to provide this emergency equipment. While we are building this equipment from designs intended to comply with relevant standards related to the equipment, this equipment has not been tested or approved by the American National Standards Institute (ANSI) or International Safety Equipment Association (ISEA).”

1) Description:
The Vandal Mask V10 is a 2-piece 3D-printed face mask design adapted from the Montana Mask [1,2]. Design adaptation have been made by researchers of the University of Idaho’s Rehabilitation Robotics research group with input from regional health care providers. Some of the key revisions include: 1) a larger filtration area in order to increase breathability; 2) external filter securement to help keep contaminated fabric on the outside of the mask; 3) a flared facial edge, straightened nasal bridge, and thinner outer walls for a wider range of fit; and 4) custom securement anchor points to offer more versatility in the attachment of head straps.

2) Components (see Appendix A for individual component photos)
3) **Materials:**

**Mask base:** PETG, PLA, or ABS  
**Snap Rim:** PETG, PLA, or ABS  
**Face Seal:** Adhesive-backed EPDM rubber weather stripping  
**Head strap:** Tourniquet material and rubber bands.  
**Filter:** Approved shop towel, surgical wrap, or microfiber polypropylene.

**Print Files**

**Mask base:** VandalMaskV10_Mask_2 mm Thick_Large Size.stl  
**Snap Rim:** VandalMaskV10_Rim_2 mm Thick_Large Size.stl

STL files can be downloaded at [https://www.uidaho.edu/engr/covid-19/downloads](https://www.uidaho.edu/engr/covid-19/downloads)

4) **Printing Instructions:**

The 3D printed Mask and Snap Rim use roughly 45g of filament per Large set and can be printed in PETG, PLA, or ABS. The STL file is provided in a Large size, but other print sizes can be achieved by scaling the file in your printers slicing software.

Size recommendations:
- Small: 85% scale  
- Med: 90% scale  
- Large: 100% scale

Each print can be further scaled in height, width, or depth for a customized fit to individual face shape. To ensure appropriate wall thicknesses, select the size closest to the user before applying customized scaling.

Preferred print settings to ensure structural integrity:
- Nozzle diameter: 0.4mm  
- Layer height: 0.3-0.4mm (0.4mm will print 20% faster with adequate smoothness)  
- Wall thickness: 0.8-1mm  
- Bottom/Top Thickness: 0.8-0.9mm  
- Infill Density: 0% (the wall is thick enough that infill adds very little strength and may decrease print smoothness. If you do use infill, we have found the concentric infill pattern helps improve smoothness along the mask wall.)  
- Bed Adhesion: None -- the design should print without additional adhesion. If needed, a brim with 5 lines can be used with the Mask. The Snap Rim will print cleaner without the brim or other adhesion tools.  
- Supports: None

These preferred settings have proven to produce a good, structurally sound part. If your printer cannot match these values, the recommendation is to get as close as possible and perform a test print to verify structural integrity, wall smoothness, and minimal presence of other printing defects.

**Contact Information:**
Any further questions can be addressed by email to Joel Perry at jperry@uidaho.edu.
5) **Installation Instructions:**
The Vandal Mask R1.0 requires minimal assembly. The print is made in two parts. When printed without supports and no bed adhesion, no post-print cleanup is required.

**Pre-assembly Notes:**
- A clean Snap Rim and pen can serve as a stencil from which to mark the shape of the filters.
- A piece of paper can assist in cutting the strap to length and placing holes for size/tightness adjustability.
- Additional rubber bands can be used to ensure the snap rim stays in place during mask donning and doffing.
- Using two or more rubber bands in parallel at the attachment of the strap to the mask is recommended for redundancy in case of band failure.

**Fabrication/Assembly Procedure:**
- Wear gloves.
- Remove from 3D print bed carefully.
- Don’t bend, twist, or pry the mask parts to prevent damage.
- Trace and cut the filter in your desired material.
- Position the filter and snap the snap rim in place making sure the filter fabric is visible from the back side of the snap rim all the way around.
- If the snap rim feels loosely held, rubber bands can be used to secure the T-shaped anchor points on the snap rim to the Y-shaped anchor point on the mask.
- Punch a hole at one end of the head strap and a second hole about 8.5 inches away at the other end.
- Add remaining 5 holes to the head strap for size adjustability.
- Secure rubber bands to holes in strap (one at each end)
- Secure two rubber bands to each of the previous rubber bands.
- On each side of the mask, secure the two rubber bands around the T-shaped anchor points of the snap rim and stretch the rest of the bands behind the Y-shaped hook on the mask.
- Clean the mask with alcohol or other approved cleaning agent.
- Bag the cleaned mask in a new zip-lock bag and zip it closed.

More detailed description and photos of the assembly process can be found in Appendix B.

**Mask Fitting Instructions:**
- Always clean the mask with alcohol or other approved cleaning agent prior to use.
- Always inspect integrity of the bands (rubber bands, and head strap) for cracks or tears prior to use. Replace any bands that show signs of wear or damage.
- Place the mask over the nose and mouth and the strap around the back of the head with the strap placed high on the head.
- Breathe in and out and check for signs of air leaks around the seal.
- Adjust the mask so it seats well over the bridge of the nose and under the chin.
- Tighten the strap if there are signs of air leaks.
- Repeat the process to check for proper fit.
• If signs of air leak continue, request a different size and recheck the fit.

6) Cleaning instructions:
All components can be cleaned with alcohol. Other cleaning options can be explored by users at their own risk.

Acknowledgement:
The Vandal Mask design has been adapted from the Montana Mask design with feedback from clinical collaborators in an effort to improve mask breathability. Details of the original Montana Mask can be found in references [1] and [2]. Most of the design revisions were conducted in SolidWorks 2019 by UI PhD candidate Christopher Bitikofer.

Contact Information
Any further questions can be addressed by email to Joel Perry at jperry@uidaho.edu.

References
Appendix A: Component photos.

A1. Face mask components disassembled

A2. Face mask components assembled
A3. Snap rim

A4. Filtration fabric

A5. Head strap
A6. Face seal
Appendix B: Assembly photos.

B1. Assembling the Filter

**Making the filter:** Place a filter material over the mask and secure the snap rim down over the fabric. Using a pen to mark the inner shape of the snap rim on the fabric. Remove the fabric and cut around the egg-shaped profile, leaving about 1/2 inch of extra material outside the profile.

![Assembly photos](image)

**Securing the filter:** Place the filter back over the mask base and place the snap rim over the filter, pressing and holding the parts together first at the bridge of the nose. With the bridge side in place, adjust the lower end of the filter and press the snap ring down over the mask to secure the filter. You should be able to see a small amount of filter visible all the way around the edge of the snap rim to confirm the filter is appropriately sized and placed.
B2. Assembling the Head Strap

Making the head strap: The head strap is composed of an 11-inch length of 1-inch wide rubber strap (phlebotomy band works well). Using a leather punch or sharp hole punch, make a hole at one end and a series of 6 holes at the other end of the rubber strap. Make the single hole at least ½” from the end and a second hole 8.5 inches away from the first hole (the width of a piece of paper works well for marking the strap length and hole spacing). This second hole will be the 4th hole of the 6-hole sequence. Make two more holes in the direction away from the first hole and 3 more holes in the direction toward the first hole, each spaced about 5/8” apart center-to-center. Secure a rubber band (recommend non-latex antimicrobial #33) to the single hole at one end of the head strap by pushing a small loop through the hole and lacing the other end through the loop and pulling it tight little by little, being careful not to over-stretch the hole. Do the same at the other end pushing a small loop of rubber band through the two middle holes (in one and out the other) and threading the other end of the rubber band through and pulling tight, little by little, again ensuring not to over-stretch the holes. Secure two rubber bands to each of the previously attached rubber bands using the same method. The strap is now complete.

Securing the head strap: The two bands of the head strap are placed around the two t-shaped anchor points on each side of the snap rim. The portion of rubber band in between can go behind the anchor point on the mask. If using shorter rubber bands that shouldn’t be stretched that far, the side with the strap can be placed behind the mask anchor point and the other side of the rubber band can be placed under the “I” logo tab. Repeat on the other side of the mask.
**B3. Assembling the Face Seal:**

**Making the Face Seal:** Using a 1/4” EPDM D-profile weather stripping, cut a single strip to a length of 13.75 inches for a Medium, or 15.25 inches for a Large.

[Image of weather stripping]

**Securing the Face Seal:** Using a 16-inch length of adhesive-backed EPDM weather stripping, expose about 2 inches of the adhesive at one end. Starting in the middle of the base of the mask, stick the weather stripping to the mask with the outer edge of the weather stripping even or slightly (up to 1mm) outside the outer edge of the mask ensuring the adhesive remains against the mask. Work your way around the mask, exposing 1-2 inches of adhesive at a time and securing the weather stripping around the inside edge of the mask all the way to the bridge of the nose. At the bridge of the nose, fold the stripping back on itself and push it up into the bridge before continuing to adhere down the other side of the mask. When you get within 2-3 inches of completing the perimeter, check for adequate length on the strip and cut about 1/16” longer than needed. Remove the rest of the adhesive and press the end against the starting end and then adhere it to the mask ensuring continuous contact between the ends of the weather stripping. Now go back and secure the last 2-3 inches of stripping to the mask following the contour as best as possible without undue strain on the seal.

[Images of face seal installation process]