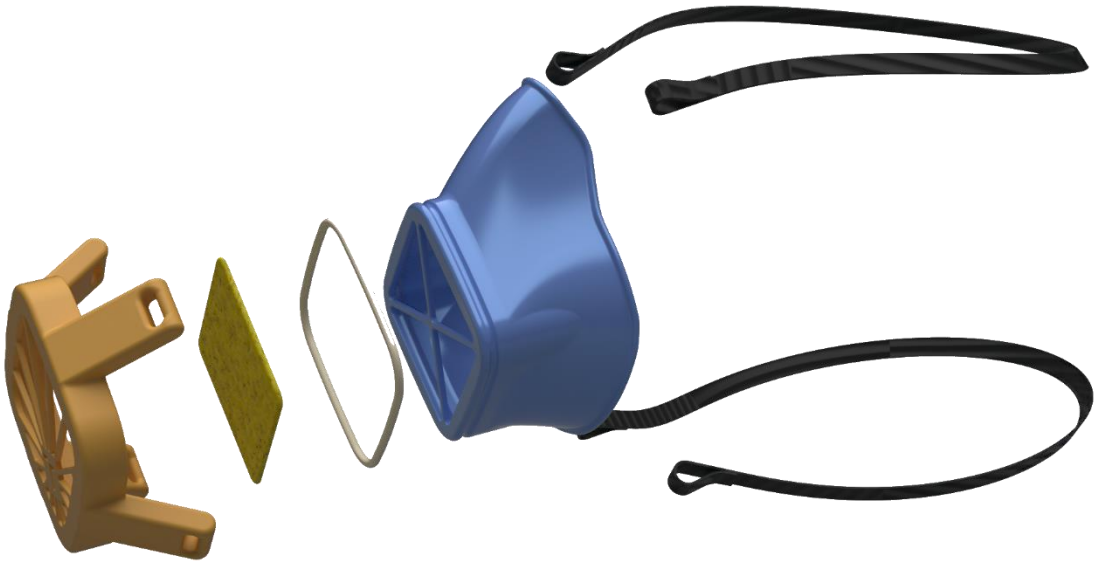
VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ



BUTMask H1

User and Assembly Manual

3rd version of the document

BUTMask H1

The original protection halfmask for non-professional use is mainly intended to replace regular surgical masks and respirators when these are unavailable or do not fit on tightly due to improper design or heavy everyday duty. The halfmask can be assembled from common, commercially distributed materials, and its basic parts are 3D-printable (via FDM and other standard technologies). A tight touch on the face and full sealing of the walls are ensured by a sleeve that, for practical and easy usage, is made of a disposable glove.

Main benefits

Compared to a simple 3D-printed product, the VUTMask H1 brings the following advantages:

- Full sealing thanks to a convenient sleeve
- Good face shape adaptability
- Face skin contact only with the actual material of the disposable glove (Nitril or Latex)
- Sleeve-protected structure eliminating external contamination completely
- A material quick and cheap to change and disinfect.

Caution:

The protection provided by a halfmask, surgical mask, or respirator depends mainly on a tight face fit; the filtering capability of the applied medium is a secondary parameter. Even improvised filtering instruments substantially reduce the virus contraction risk, although their protective performance cannot match that of a classic tool.

The halfmask does not comprise an expiratory valve, and the humidity aggregates in the filtering medium; similarly to surgical masks, there then forms a potentially bacterial environment, meaning that the filter must be dried and disinfected or replaced.

Using the Product

When or before using the halfmask, proceed as follows:

- **If allergic to latex, always put on a nitril glove!**
- Check the integrity of the product and/or its components, the sleeve in particular. **Never use a damaged halfmask.**
- When handling the product, do not touch the inner parts and components that directly fit on the face.
- Ensure tight skin touch.
- Adjust the wearing time to the applied filtering material.
- Disinfect after use.

Tightness Testing

After putting the halfmask on, cover the filter with your palm and breathe in slightly to create a vacuum. In an optimal case, there should be no air sucked in over the edge. If you feel air leaking inside, reposition the mask on the face to find a better fit. The actual shape of the PLA-based product can be altered mildly in hot water (60 °C) and then adjusted when put on.

Size

In most adults (about 70%), the distance between the bottom of the chin and the nasal bridge ranges circa 12 cm, where the **M or L** size is sufficient. Your personal measure is easy to determine: just use a caliper.

Table of sizes:

Size	Distance between the bottom of the chin and the nasal bridge
S	less than 10 cm
M	11 – 12 cm
L	more than 13 cm

Disinfecting the Surfaces

The product must be disinfected before further use; the individual steps and alternatives are described below.

Filter

Ideally, the filter should be heat-treated (by using tools such as a flatiron) or replaced with a new one; the procedure has to be chosen according to the printing material used.

Filter Holder

Immerse the holder in a disinfecting solution (for example, ethanol, isopropylalcohol, or Savo Original diluted at the rate of 1:6); the applicability of a solution depends on the printing material used.

Sleeve

The glove has to be either treated with a disinfecting solution or replaced with a new one.

Structural Parts

The body of the halfmask can be immersed in a suitable solution (such as ethanol, isopropylalcohol, or Savo Original diluted at the rate of 1:6); surface-wiped with a disinfectant; or washed in soap water. Under normal conditions and standard use, contamination by the external environment is not assumed, and soap water washing thus appears to be fully sufficient.

Manufacturing Components

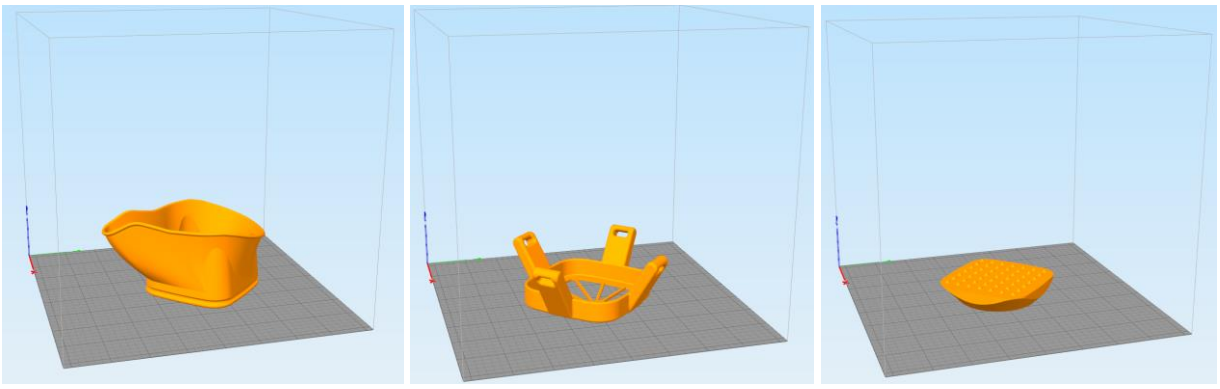
To fabricate the halfmask, the following items are necessary:

- A 3D printer having an area of at least 130 x 130 x 70 mm
- Printing material (filament); generally, the requirements are very minimal, and the user can employ PLA, ABS, PET, PETG, ASA, CPE, or any alternative item (however, PLA is recommended, as after the printing and possible re-heating in hot water (60 °C) the product's shape can be finalized and adjusted to better fit the face)
- An elastic, disposable, L- or M-sized glove. Nitril gloves are recommended thanks to their durability and overall strength; a latex sleeve is also convenient but offers less reliability and must not be used by persons allergic to latex
- Improvised filtering inserts having a minimal size of 70 x 70 mm.
- Strings, wider elastic rubber bands, or other material applicable for the head straps
- Thin kitchen rubber bands (40 mm in circumference)
- A pair of scissors.

3D printing settings

Important 3D printing parameters are as follows:

Nozzle	Layer height	Top solid layers	Bottom solid layers	Outline shells	Infill	Support	Raft
0,4 mm	0,2 mm	3	3	2	40 %	no	no



Manufacturing Procedures

The individual assembly steps are indicated below.

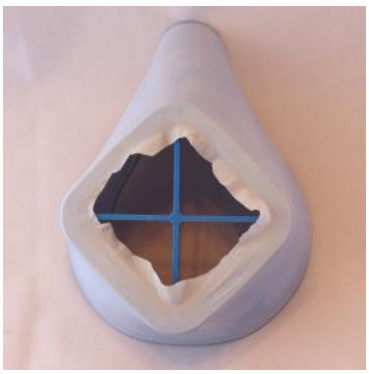
1. On a 3D printer, print out:
    a. half mask frame of desired size (BUTMask_H1_Frame S, M, L, XL),
    b. filter cover, two sizes available for filter thicknesses of 1 to 6 mm and 6 to 11 mm (BUTMask_H1_FIlterCover nebo BUTMask_H1_FIlterCoverExtended),
    c. and filter template, that makes it easier to manufacture the filter (BUTMask_H1_FilterShaper).

2. Lay the frame (BUTMask_H1_Frame.stl) on a desk, with the face-fitting side down.

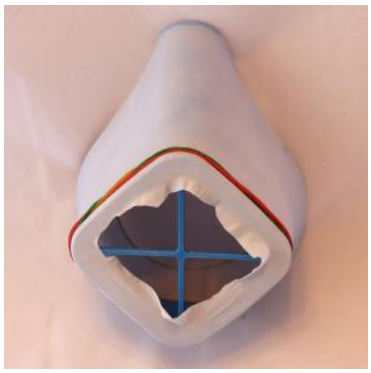
3. Take a glove, stretch its mouth with both hands, and put it over the frame of the halfmask.

4. Adjust the position of the glove, letting its hem to run (at least approximately) along the edge of the halfmask‘s edge, at a distance of about 1 cm.

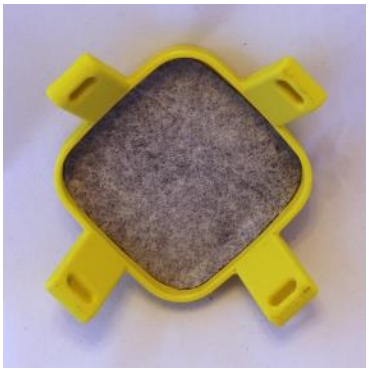

5. Use the scissors to cut off the glove fingers in the area of the halfmask’s vent, approximately 1 cm from the outer edge.

6. Fix the glove by inserting the kitchen rubber bands in the groove below the edge of the halfmask's vent. Adding some more rubber bands at a later time will improve the locking ability of the filter cover.

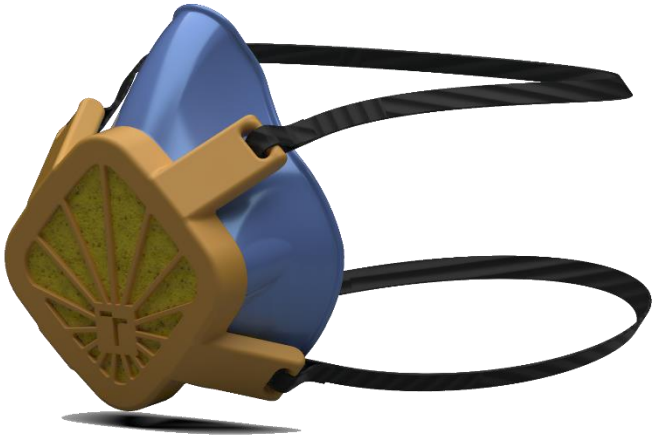


7. Use the printed filter guide to mark on the filtering material (cotton tissues, a vehicle cabin filter, a vacuum cleaner HEPA filter or bag, or another convenient item) the shape of the halfmask' filter, then cut the filter out. Filter properties can be improved by composing a filter of several layers of different materials. Depending on the resulting filter thickness, select the correct filter cover size. Finally, insert the filter into the filter cover.



8. Make the headstraps by utilizing a string, wider elastic rubber bands, or another suitable type of material, and fasten them to the filter cover. The straps should be long enough to fit and hold.

9. Attach the filter cover to the headmask's frame. The product is now ready for use.



Designed by:

Brno University of Technology

Faculty of Electrical Engineering and Communication

Department of Control and Measurement

Industrial Automation Group

- Michal Husák - Ondřej Baštán - Václav Kaczmarczyk - Petr Fiedler - Zdeněk Bradáč -

Contact person:

Václav Kaczmarczyk, PhD.

+420 54114 6395,

kaczmarczyk@feec.vutbr.cz

http://www.vut.cz/maska

Acknowledgement

The research team thank in particular

the **Siemens** corporation for its long-term collaborative efforts and assistance within 3D modeling and software application, and

the company **Speltronic** for the information.