

MANUFACTURING INSTRUCTIONS:

ENSTA BRETAGNE FACE SHIELD

BACKGROUND AND GENERAL ADVICE

This face shield with transparent screen was developed at ENSTA Bretagne in close collaboration with the CHRU of Brest. It has been designed and distributed to help in the fight against the COVID-19 pandemic. It does not dispense with wearing a nose-to-mouth mask, but its role is to provide a secondary airway barrier as well as a barrier against possible ocular contamination.

It is intended for people who need to work with affected populations. Foremost among these people are hospital emergency and resuscitation personnel. But this tool may have other domains of application: medical services and private clinics, nursing home staff, independent medical practitioners (doctors, dentists, nurses, physiotherapists etc.) and any other professionals who closely encounter a large scope of the population (personal care specialists etc.).

Thanks to a project carried out by PRUSA in the Czech Republic, a community of 3D printer owners printed a first model, three hundred copies of which were distributed to the CHRU Brest. The ENSTA team wishes to express its deep gratitude to those who contributed with printers. This model is an update by ENSTA Bretagne which is now available to download. It is the product of design work carried out by the team at ENSTA, and it is offered up free of rights claims and as open source to permit others to further develop the technology. This final concept corresponds as closely as possible to the specifications expressed by Professor L'Her of the Medical Intensive Care Unit of CHRU Brest.

These instructions and the visor model, which is the subject hereof, are protected by intellectual property law and in particular by copyright.



The main design efforts were dedicated to the optimization of the print parameters to the best model in terms of reliability, weight and short print process.

The text « MERCI » is written inside the screen support. This small message is our way to thank all the makers who print models for us. We have a special regard for all the staff in health departments who risk their lives every day to save so many people. The “MERCI” message is obviously for them too.

PRODUCTION

NECESSARY MATERIAL

- Any 3D printer (see printing specifications below).
- Wire for 3D printer (the most used model is 1.75 mm PLA).
- A4 transparent plastic sheets. Several thicknesses can be used. The thicker the better. Stationery shops offer PVC report covers of 20 microns thickness.
- A 4-hole punch for binder sheets.
- Elastic bands. The proposed model is suitable for rubber straps 20cm long, 10mm wide and 1mm thick. The builder must cut the strap in order to create à band.
- Standard tools for 3D printing.



MAKING THE PRINTED HEADBAND

The model was developed so that printing is possible even on a very basic printer. The model enters a print area of less than 20cmx20cm. The resolution does not require a very precise machine, but the printing device must be calibrated to make sure of a precise pin spacing of 80mm. The model is available on [“https://www.ensta-bretagne.fr/fr/creer-des-pieces-avec-une-imprimante-3d-pour-lutter-contre-le-covid-19”](https://www.ensta-bretagne.fr/fr/creer-des-pieces-avec-une-imprimante-3d-pour-lutter-contre-le-covid-19) under the name “ENSTA_Bretagne_face_shield_vxx.stl”. Where xx stands for the ultimate version number.

The optimal settings for printing are:

- The model has been designed and tested for a 0.4mm nozzle.
- Layer height: 0.3mm for the given nozzle.
- Wall thickness: 0.8mm.
- Printing speed: Depends on the materials but 60mm / s is generally quite good.
- Ideal nozzle diameter: .0.4mm
- Ideal nozzle temperature: Between 190°C and 210 °C for PLA.
- Heart filling: 15% generally gives good results.



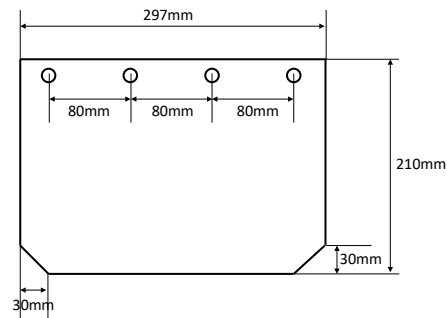
The builder must make sure that no defects exist on the printed part. Particular attention must be paid to the band in contact with the user’s forehead.

It is useful to sterilize the parts. But in general, health professionals prefer to take care of it themselves. A hot process must not be used as PLA is very sensitive to high temperatures. The French ANSES recommends the use of alcohol (>70°) or bleach to disinfect the surfaces

MAKING THE TRANSPARENT SCREEN

The sheets are ideally made of PVC, Polyamide or equivalent. The ideal thickness is 0.5mm. They should be prepared as follows:

- The sheets are worked horizontally.
- The sheets must be beveled at the bottom on both sides by cutting a 3cm chamfer on both sides with scissors.
- The sheets must be punched in the upper part using the 4-hole punch. The hole spacing is 80mm.



MAKING THE RETAINING RUBBER BAND

Bevel the ends of the rubber band and simply thread them into the holes at the ends of the arms of the front support. Normally they must be forced through. The adjustment around the user's head will then be made by simply pulling the elastic through the hole. It is important to make sure there is enough friction at this point.



ASSEMBLY

The final assembly is carried out thru two processes:

- The media pegs are introduced into the holes of the transparent screen.
- The elastic is applied in the support holes.

The user simply adjusts the mask to his/her morphology by pulling on the elastics. A knot may be required.



CONCLUSION

This model is easy and quick to manufacture (less than an hour and a half including 3D printing and assembly). It should be accessible to many people even with basic equipment.

It cannot be sterilized in an oven (it will be distorted). It is therefore necessary to employ cold-sterilization methods: Bleach, 70° minimum alcohol, etc. Each country has its own sanitary rules, please check.

ENSTA Bretagne thanks you for choosing this model and we hope it will help you contribute to the fight against the COVID-19 pandemic. The designers would appreciate if you could send us some feedback of your finished products. Happy manufacturing!

Special acknowledgement is due to Pr. L'Her and his team for the support and advice they extended during this development.



Pr L'HER from Medical Intensive Care Unit of CHRU Brest

RESERVE

This device, although developed in partnership with the Brest University Hospital, could not be certified mainly for emergency reasons. It is therefore made available free of charge.

These instructions are provided "as is" without warranty of any kind, either express or implied, including but not limited to any warranty that these instructions are complete, accurate, free of defects, and fit for the purpose for which they are intended.

All users waive the right to claim compensation from ENSTA Bretagne for any damages that may arise in connection with the printing of a visor pursuant hereto.

ENSTA Bretagne disclaims all liability for any consequences that may result from the use of this device. ENSTA Bretagne cannot be held liable for any damage arising from the use of a visor designed in accordance with these instructions, whether or not these instructions have been strictly observed.

APPENDIX

RELEASE NOTES OF THE FINAL VERSION

The final version is the result of some iterations made during the last ten days of March 2020. The changes arose from both internal and external ideas. They include mainly the following improvements:

- Best side protection by making the screen edges closer to the user's face, its size increase to accept an A4 sheet without any size modification and a new blocking system at the edges to maintain the screen in place.
- Smaller diameter of the headband to accommodate smaller heads.
- Decrease in height of screen support to minimize the weight.
- Turning rubber band hooks into holes to minimize use of material and for ease of assembly. The rubber band + hole solution allows an easier set up for the user. The design has been made to be used with standard rubber straps (200mm, 10mm & 1mm).
- Screen hole spacing is based on standard 4-hole punches to be applied to transparent sheets of report cover type.
- Removal of the hexagons of the previous version leading to misprinting on given devices.