



# OPEN MEDICAL SHIELD V4

## A COVID-19 Quick-Turn Manufacturing Plan

### Operation: Bull Shield

DESIGN FOR X LABORATORY

Mini-Circuits

Scope: Presented here is a ultra-low cost face shield to assist with medical shortages. In quantities greater than 1000 units, production costs can be reduced to below \$1 USD and below \$0.70 at quantities greater than 5000.

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A low-cost, disposable face shield that can be built in less than 1 minute for less than \$1 USD



## Should you make PPE

The question of whether you should make PPE (Personal Protective Equipment) seems obvious at first glance but surprisingly, it's not always yes. There is an unfortunate effect of everyone trying to perform small, uncoordinated efforts which can actually reduce the availability of resources to manufacture PPE, decrease the sterility or reliability of these items, and ultimately reduce the availability of PPE for front-line medical professionals. It is strongly recommend that you coordinate with your local community and find or organize a unified effort with strict cleanliness and sterility standards. Check with your local hospitals and medical offices to determine if there is a need for the specific items you are hoping to make. There's nothing worse than 10,000 spoons when all you need is a knife. 8^)

# Supplies and Setup

**Critical:** Scissors, stapler, ruler/tape measure, utility razor, raw materials\*, gloves for packing, and gloves for volunteers to perform assembly.

**Desired:** Guillotine style paper trimmer, laser cutter, electric stapler, heat sealer.

**Raw Materials:** Besides the Plastic Film, Foam, and Elastic bands, you will need ample supplies of Staples, possibly double-stick tape if you plan on purchasing non-adhesive backed foam, and packaging bags. Consider tissue paper as well for easier transport and cleanliness.

**Cleanliness - Wear gloves** and find an area you can keep segregated and kept clean. All volunteers should wash hands before entering work area, never touch body or face. Where possible, use IR thermometer. Area can be sanitized with 10% bleach solution prior to each production run. The shields don't need to be sterile, but good manufacturing practices are important. We recommend using the first off the production line as PPE for the volunteers or assemblers.

**Procurement -** Rather than immediately jumping into purchase extreme quantities of material, consider buying a "test" amount of material to test the process and ensure that you are capable of running the assembly to completion. Again, we do not want to deplete the limited supply of these precursors for groups who are actively manufacturing. Additionally, there are sometimes incompatible parts that you can come across. A case study was a near miss when we were order plastic film when we nearly ordered 500 sheets of frosted rather than clear film. This would have been a costly mistake.

## Pre-Staging

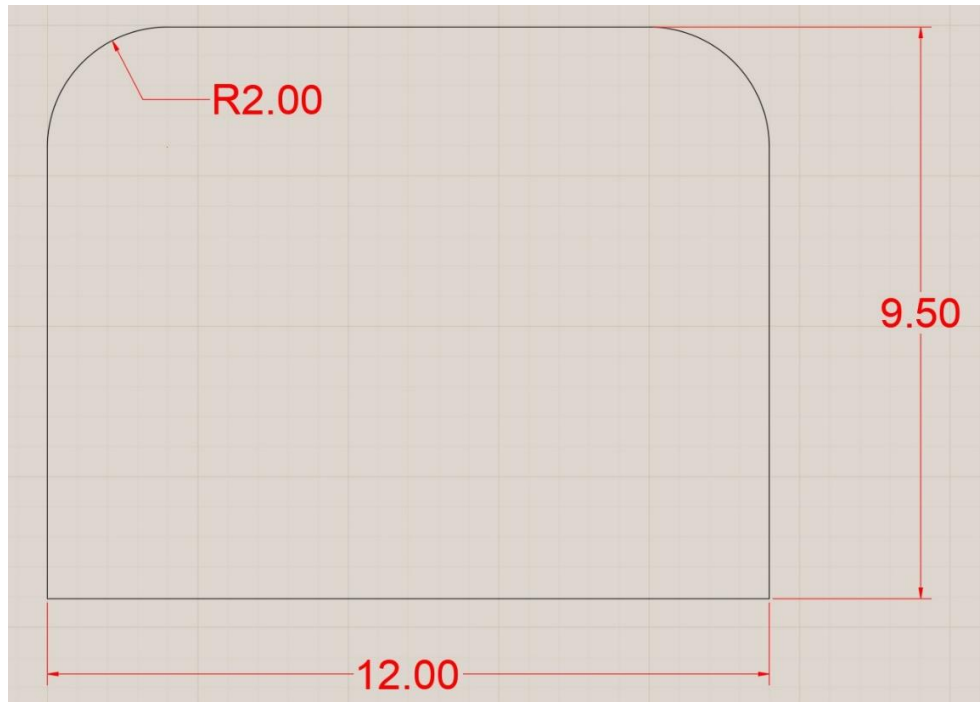
Material Acquisition can be the most frustrating part of the whole process. Film/foam, and elastic can be found at Art Stores, bulk suppliers like U-Line, Grainger, and McMaster-Carr, local Bricks-and-Mortar stores such as JoAnn Fabric, or online retailers such as Amazon. Supplies are beginning to get hard to find so it may be wise to contact local elastic/film/foam manufacturing companies and work directly with them if you can order a sufficient bulk quantity. Bear in mind that lead times can be as much as multiple weeks. **The prudent thing is to avoid having an asymmetrical supply (a massive surplus of one item and none of another). This is effectively the same thing as toilet paper hoarding and results in fewer people being able to manufacture these critical supplies!**

### **CLEAR SHIELD**

MATERIAL: CLEAR POLYETHYLENE (PET) FILM (0.007" THICK)

It is typically sold in either sheet or roll form. Sheet can be nice as a common size found in art stores is 9x12" which is very close to the desired dimensions of 12.0x9.6" (in our case optimized for our roll dimensions). Film as thin as 0.005" can work but 0.007"-

0.010" is much more stable and durable. Film can be as thick as 0.020" but this begins to get hard to work with. The goal is to make disposable units so striking a balance between plastic waste and durability is important. If you are working with a plastic film manufacturer, they can cut a roll into sheets that are sized optimally for your process. Talk to them for best results.



Film Cutting Dimensions in inches. These can be cut manually with scissors, hobby knife, utility knife, or with a laser cutter.

### **ELASTIC HEADBAND**

**MATERIAL: ELASTIC LATEX FABRIC (0.75-1" WIDE X 13-16" LONG)**

Again, local or online stores listed above can be great places to search. Bear in mind that sometimes, you can purchase 1.5 or 2" wide elastic bands and cut them lengthwise into two smaller bands. The success of this varies depending on the type of weaving and it should be noted that this is a VERY slow process. We found 3/4" wide band to be optimal and a shorter band can be used provided it is double stapled for stability. Our current production uses 13.25" long bands.

Use a jig or set length template to quickly cut from a roll to a pile. It is best to create a large stockpile of these pre-cut bands as they are very quick to produce. Fill up a bin or box and label with the length and quantity completed.



## **BROW FOAM**

**MATERIAL: ADHESIVE BACKED or CUSHION POLYURETHANE FOAM (1" THICK)**

To reduce cost, you can purchase permanent double stick tape and get traditional 1" thick foam (the high-density, upholstery-type, polyurethane foam). We found that most come in 24" wide pieces which can be cut equally into 3 strips of 8" wide. From here, we can use either scissors, a razor knife, or a paper trimmer (guillotine style) to make quick work of producing 1.25-1.5" wide blocks. Alternatively, you can procure adhesive-backed foam. We found that the adhesive sometimes gums up the cutting implements and the cleaning slows the process. Paper backed double stick tape can be torn by hand which increases throughput.

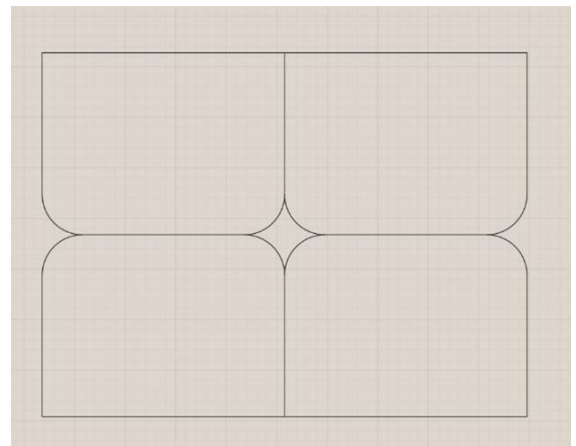


## **Final Assembly**

After neatly arranging all materials into stacks, the first assembler should adhere the foam to the center top of the shield film. The next assembler should be in charge of stapling the elastic bands. To reduce fatigue, it is recommended to get a heavy-duty automatic stapler. The final assembler will collect sets of 10, perform quality assurance, affix serial numbers (if desired for Quality Assurance and tracking), bag into sealed poly mailer, and stack into shipping boxes. Bag in 15x19" Self-Sealing Poly mailer bags available from U-Line or Amazon.

### **Optimization:**

Saving a few seconds on a process where you make thousands of items can save a considerable amount of time. You can use a t-shirt folding device to accelerate the packing process. You can use nested laser cut part. You can rotate assemblers and determine who is capable of working most efficiently at a process line. Make local instructions that are clear and don't require much explanation. A jig is better than a ruler. Remember that process optimization is something that needs to be done continuously. (see video for details)





Bag and deliver to the appropriate medical distribution center to balance supply based on need.

## Detailed Process Flow

### Line 1: Clear Film

1. Manual
  1. Volunteer puts on Kevlar cut-resistant gloves over Nitrile gloves
  2. Roll out Plastic Film and cut using Poster trimmer to appropriate size
  3. Have a volunteer manually cut with scissors or hobby knife the final curved shape
  4. Stack with Tissue paper separating sheets in bin or box and label with final number and volunteer number
2. Alternative Manufacture Method - Laser cut final Design
  1. Volunteer puts on Kevlar cut-resistant gloves over Nitrile gloves
  2. Roll out Plastic Film and cut using Poster trimmer to laser cutter size
  3. Film weights are added and Laser cutter program is used to cut parts to final shape
  4. Stack with Tissue paper separating sheets in bin or box and label with final number and volunteer number

### Line 2: Foam Process

1. Foam Sheet Processing
  1. Unroll foam from storage area onto a quad table setup
  2. Volunteer puts on Kevlar cut-resistant gloves over Nitrile gloves
  3. Put a UHMW (Ultra High Molecular Weight) cutting board down over area to cut

4. Use template or razor jig to cut Foam into 1.25 x 8" pieces (optimized for 24" wide roll)
5. Place Foam parts into Storage bin and affix final number and volunteer number

## Line 3: Elastic Bands

1. Cutting Elastic Bands
  1. Obtain either ¾" or 1" Elastic band roll from storage area and place into rolling jig
  2. Volunteer puts on Kevlar cut-resistant gloves over Nitrile gloves
  3. A pair of scissors is used to cut predetermined 13.75" strips and place directly into a bin just below work area. The length is given by a fixed bar with markings and a slot to safely cut the requisite length while protecting fingers.
  4. Affix final number of parts on bin including volunteer number

Notes on Lines 1-3. These can be completed asynchronously to the final assembly step. If you have 3 volunteers, you can run everyone on Lines 1-3 in a morning session and finish processing your material stock and then run them distributed as described below in Line 4.

## Line 4: Final Assembly

1. Affix double stick tape to foam and apply to center top of plastic sheet
2. (Optional) Hot glue elastic prior to stapling to stabilize for electronic stapler
3. Double staple band approx. 1cm from edge of plastic sheet using heavy duty staples. An automatic/electric stapler can be used for this to reduce fatigue. Be sure these go through the double stick tape located in this area as well as it helps resist staple tearout.
4. Check Strength of Finished Part by tugging gently at staples and ensure foam does not dislodge
5. Apply QA serial number sticker or lot serial number
6. Load into bags in quantity of 10 and seal



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