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Harrisburg University's Face Shield Response for Health Care Workers

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Author Note

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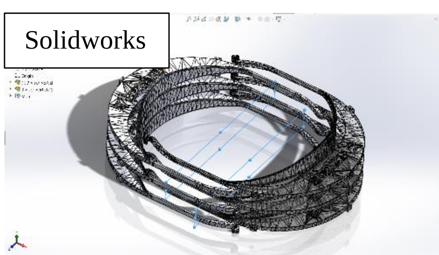
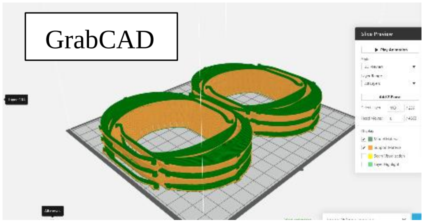
The pandemic has most definitely been a significant factor in how people operate throughout the past few years. The pandemic was first introduced at the end of 2019 and is still a current issue at the end of 2021. Close to the beginning of the pandemic, health care workers had found themselves with a shortage of protective gear to fight against the virus while working on the front lines. The quick spread of the virus was the main cause of the supply drain. During the most heavily needed time for supplies, the Advanced Manufacturing program at Harrisburg University took the time to support their local health care workers in the form of manufacturing and distributing face shields. The process for how this was achieved began with understanding what is being printed, the printers used throughout the production stage and project phase, assembling the face shields, the distribution of face shields, and any issues that have occurred throughout the timeframe. These five points have the potential to show the steps that were taken to provide the necessary supplies to health care workers as well as to show the struggles that were dealt with in providing the greatly needed supplies.

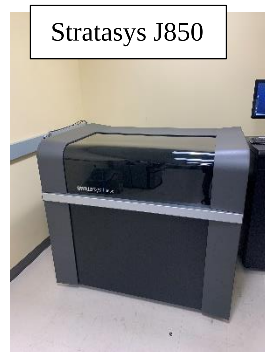
The first step in the project was to obtain the necessary file and modify the file if needed. Understanding product flow is greatly required in manufacturing, and what better way to portray that than presenting how the face shields were produced. During the main production timeframe,

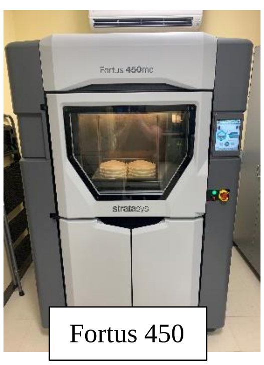


a print file was provided by Stratasys, however, as for the project, I had to try to replicate a close representation of what was used during the main production stage for that the original file was lost. To achieve this, I had to use a solid modeling computer-aided design program called Solidworks to create a part file then use the newly created part file to make an assembly. After looking at many photos of prints during the main production stage, the next step


GrabCAD

was to optimize the layout and print file. For this step, GrabCAD was used. GrabCAD offers the capability to efficiently streamline job management. The need to use GrabCAD is due to the ability to select the printer template and customize the print file features such as orientation, tray layout, infill pattern, material usage, etc. If you want to interpret GrabCAD in another way, this step is to prepare the printer and the file for how you would like the print to come out. The printers that were used during the main production phase consisted of the Fortus 450, Stratasys 370, and the Stratasys J850. For the project alone, the only printer used for this consisted of the Fortus 450. All the printers that were used for the project and during the production stage have a model and a support tip/material. The model material is the filament that is used to create the 3D model you want to be printed


Stratasys J850

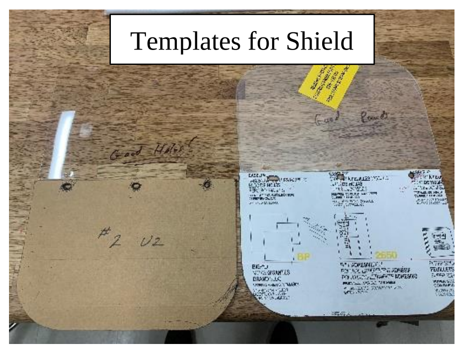

Fortus 450

physically. In this case, the stacks of visors. The support material is a removable material after the printing stage whereas, during the printing process, this material provides a necessary need when the print has overhanging features within the air, but also provides the ability to print complex shapes and increase the overall outcome of the part. The material used throughout the printers consisting of the 450 and 370 used the same material. The material used consistently within both printers is known as ASA. ASA is an acronym for Acrylonitrile-styrene-acrylate, which is a safe filament for human contact, extremely resistant to heat, chemical influences, strong, stiff, and easy to print. As for the J850 printer, there was an issue that had occurred while testing the visors that were produced from this printer, these


Stratasys 370

issues will be disused in a later section. The print time for two stacks of 8 visors within the 450 takes around an average time of 21 hours. As for the 370, this printer is a lot smaller, so this

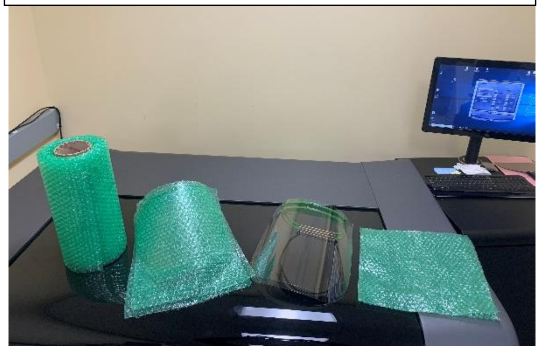
printer has the capability of printing a single stack of 8 at around 16 hours. As for the project, the modified file that was created consisted of only six visors within a stack. The time for the 450 to produce two stacks of six visors ranges around 16 hours whereas the 370 was able to produce a single stack at the rate of 12 hours. Once the visors were printed, they were then transported to the SCA3600 which is a cleaning station that removes all unnecessary materials (support material) and leaves the model material. Once done in the cleaning station, which takes roughly around 6 to 8 hours, the visors are then rinsed with clean water to remove any remaining chemicals on the prints. Once the visors are dried the next phase in the operation deals with preparing the shields. A plastic sheet that is used for a 380mc printer is used within



Templates for Shield

this process for creating the shields for the visors. A custom template was drawn and designed to fit the visors as best as possible. After many iterations of creating the most optimal template, the next goal was to trace the outline and holes. After tracing, the next step is to remove the lines by using scissors to cut the lines and punch holes by using a handheld hole puncher. When the shield is ready to be placed on the visor, you then remove the plastic covering by hand to obtain a clean and clear look. Once the plastic sheet coverings are removed (one on each side), you then line the holes up with the notches on the visor and attach the plastic sheet to the visor. Once on appropriately, you then hook the rubber band on the two hooks on the back of the visor. Once completely assembled, the second to last step is to take a single square of bubble wrap and place

Layering Bubble Wrap Between Face Shields



it over-top the shield so that you can stack the face shields in stacks of 10 to optimize packaging. The bubble wrap also protects the shields from obtaining any damage while being transported. Once a stack of 10 is made, there will be two stacks placed within a box which will then be given the green light indicating it is ready to be sent out.

Once the word got out that Harrisburg University was distributing/donating face shields to health care workers, there was a major increase in requests. By the end of the production stage, a total of 2,344 face shields were produced. As for the team that made this happen at Harrisburg University, it consisted of only four individuals, Charles (Chip) Shearrow, Matthew Walters, Charles (Casey) Shearrow, and Lynn Shearrow. Of the total amount produced at Harrisburg University and from Phoenix Contact (unknown amount), around 2,181 of the face shields were distributed to various locations. Below in the map and tables section will consist of a map portraying the various locations of distributed face shields and the various charts that apply to the map displaying data on the specific details as to how many face shields were distributed to each location.

As for if I had run into any issues while conducting the project, I can thankfully state that there were no serious problems or issues. Other than changing the canisters to replace the materials, that would probably be the most serious issue during the project. However, an issue that had occurred outside of my project during the same time frame was where another print had just finished, and the printer had run into itself. The incident left the printer's model tip and the printed part destroyed. The cause of the accident is unknown for how or what happened, but the incident had resulted in the T16 printer tip being replaced with the T12 printer tip. It doesn't seem like much however, the drastic change in tip greatly affects the finish of the print as well as the time it takes to complete the print. For the file used within the project, the T16 tip was able to complete the two stacks of six within 16 hours, whereas the T12 tip jumped up to 35 hours. Despite the major increase in time and the printer having the tips exchanged, there were no other major issues while conducting the project itself. During the main production stage, the time frame was a lot larger and the consistency of producing the visors was a lot more frequent. The printers were continuously printing for about a year whereas, for the project, the total time spent with the printers was about a total of one week. Within that year of almost constantly printing, you can assume that there are going to be countless issues. During this time, a few of these issues consist of the J850 print fail, print failures, material issues, and much more. As stated earlier, the 450 and 370 were the primary printers for both projects. The reason why the J850 was unable to be used is that the material used for this printer is a resin that once it hardens it is done. However, during testing the visors from this printer, we came to find out that the resin was not structurally sturdy enough to have constant pressure from the rubber band. This caused the visor to reshape itself but also cause the visor to become structurally weak and break. After the first batch, we deemed the J850 an unreliable printer for this task. Another problem that was encountered during this time deals with the Stratasys 370 printer. When the printer was first obtained, it was an awesome printer, however, after a week or so the printer started having a few issues with the support material. For one print in particular the printer had not laid any support material causing a complete mess of the entire print. It was unsalvageable but provides a great representation of a

Failed Print, Support Failure

failed print. In the end, the support material head had to be replaced. A common issue that was encountered throughout the entire time as well as once during my project deals with canister issues. The canisters are what hold the filaments to allow the printers to 3D print. Sometimes there is an issue with the canisters where the printer won't accept the material, or the prints will come out horrible. The cause of this can be due to a simple material issue or somehow water was able to affect the material within the canister. Nothing can fix this issue except for repackaging the canister and sending it back. That is the only thing that can be done about this issue. Despite the issues that were encountered during the main production stage and the limited issues encountered during the project, there was nothing too catastrophic that had completely halted either process.

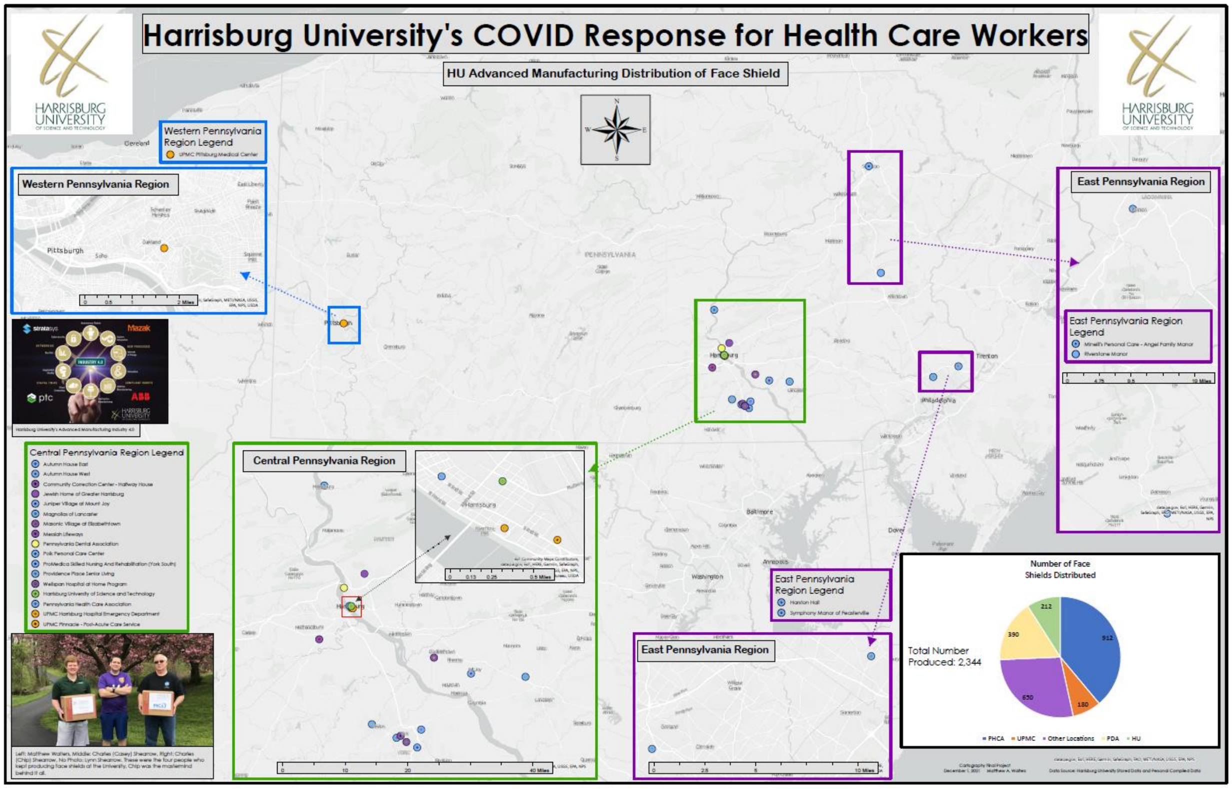
All in all, the pandemic has caused many of our lives to change either slightly or drastically. The need for supplies for health care workers is most defiantly something that was caused by the swift spreading of the pandemic. I am just pleased that Harrisburg University had allowed the opportunity to give back with its newly developing Advanced Manufacturing program by allowing the printers to be used to produce the very much requested face shields. By understanding what was being printed, which printers were used throughout the production stage and project, steps in assembling the face shields, the distribution of face shields, and any issues that have occurred throughout the timeframe of either project creates perfect representation as to how and what the process looked like to complete a batch of face shields. The distribution and production of face shields would not have been possible if it wasn't for Harrisburg University and Charles (Chip) Shearrow who


Completed Print, Fortus 450

was the mastermind behind the entire operation. This project was only possible due to the dedication and time that was provided by Harrisburg University, Phoenix Contact, Chip, Matthew, Casey, and Lynn. On top of expressing the process of producing the face shields, this project is also used as a platform to commend all the healthcare and first responders who risked their lives to help others. Thank you all who gave everything to help those in need during these dark times.

The result once fully packaged

Map, Tables, and Work Files



Click here to download or just view the map.

All tables below are associated with the map that is presented above. The tables show how many face shields were distributed to each location.

Pennsylvania Health Care Association

PHCA	Number of Face Shields Distributed
Providence Place Senior Living	12
Juniper Village at Mount Joy	20
ProMedica Skilled Nursing and Rehabilitation (York)	20
Magnolias of Lancaster	20
Polk Personal Care Center	40
Autumn House East	20
Autumn House West	20
Harston Hall	40
Symphony Manor of Feasterville	40
Riverstone Manor	40
Minelli's Personal Care - Angel Family Manor	40
Pennsylvania Health Care Association	600

University of Pittsburg Medical Center

UPMC	Number of Face Shields Distributed
UPMC Harrisburg Hospital Emergency Department	40
UPMC Pinnacle - Post-Acute Care Service	40
UPMC Pittsburg Medical Center	100

Other Locations

Other Locations	Number of Face Shields Distributed
Jewish Home of Greater Harrisburg	100
Community Correction Center - Halfway House	40
Wellspan Hospital at Home Program	150
Messiah Lifeways	160
Masonic Village at Elizabethtown	200

Pennsylvania Dental Association

PDA	Number of Face Shields Distributed
Pennsylvania Dental Association	350 (elongated)
Pennsylvania Dental Association	40 (standard)

Harrisburg University

HU	Number of Face Shields Distributed
Personal Use - Family Friend Nurses	4
Harrisburg University Labs	40
Faculty Member	5
Miscellaneous	163

Work Files, Assemblies, STL, and GrabCAD Layouts

Click here to download the files that were used, created, and modified throughout the entire duration of the operation (Onedrive).

All files consisting of work files and assemblies were made on Solidworks. The STL (Standard Triangle Language or Standard Tessellation Language) files are converted files to allow an implementation to other programs such as GrabCAD (separate files once saved as STL from assembly file). GrabCAD allows the implementation of the newly saved STL files to whatever template you require so you can set how you would like the files to be printed.

In loving memory of Charles (Chip) Shearrow (right), a man who was an outstanding leader, a man of many wonders as some would call him a jack of all trades, a friend, a teacher, professor (Advanced Manufacturing program at HU), a father, grandparent, and a truly loving husband.

You will be missed.