Creating a Vacuum Thermoformer Designed to Help Fabricate a Powered Air Purifying Respirator for Children

(Technical Paper)

School Closing's Disproportionate Effect on Low-Income Communities

(STS Research Paper)

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A death toll of 573,000, people losing their jobs, and cities shutting down, the coronavirus has caused an unbelievable amount of pain around the world (CDC COVID Tracker, 2020). None of the present solutions have fully solved the problem, cases are still on the rise, loved ones are still being lost. These problems are the reason I developed a Powered Air Purifying Respirator (PAPR) system that eliminates the chances of spreading COVID for my Technical project. I decided to create this product because I fear the effects that COVID has had on young children's education in particular. School age children are at a stage in their life where development is crucial, and the more time out of school, the less chance they have to develop. For my STS Research paper, I investigated the education, technology, and food gap that has been created as a result of at home learning.

The technical portion of my project produced a layout of how to create a fully functional PAPR system under $100 and a vacuum thermoformer. Our PAPR was modeled after an Ironman mask to make it appealing to younger children. It was composed of two fans with filters to blow fresh clean air for the person wearing the mask, while also filtering the exhalation of the person. For the PAPR system we developed assemblies, designed circuit diagrams, tested parts, and created 3-d models. During the process, we ran into a roadblock that required us to shift our focus. In order to create the PAPR at a cheap cost and create a mask that could be distributed quickly, our original idea of 3-d printing the mask was infeasible. After discussing these implications with my team, we realized creating a mask out of thermoformed plastic would be the cheapest, most effective way to accomplish our goals. However, the Mechanical Engineering department at UVA did not have a vacuum thermoformer to make this goal a reality. We had to build our own. Our vacuum thermoformer consists of a heating element, a housing for plastic sheets, and a vacuum to pull the heated plastic to the object you are forming it to. The vacuum

thermoformer we created was nearly able to shape the plastic to the Ironman mask, but it still needs slight improvements on creating an airtight seal. All of the time spent creating the vacuum thermoformer strained our schedule and we were unable to finish a full prototype of the Ironman PAPR

In my STS research, I reinforced the fact that COVID-19 has disproportionately affected the low-income and minority communities through gaps in technology and food. Through analyzing case studies and government data, it is clear that online learning from home for low income individuals is exponentially harder for them versus their wealthier counterparts. Only 56% of low income families have home broadband, while 94% of high income families have access. The trend remains the same for availability of internet ready devices. The closing of schools not only meant a lack of education, but it also led to a shortage in food for these children as well. The low income families rely on the school for feeding their children food, and when the pandemic hit, meals were missed. From my research, to solve the food shortages schools need more funding during pandemics to alleviate delivery costs associated with meal distribution and an expansion of Pandemic Electronic Benefit Transfer (P-EBT) supplements is needed across all states. The disruption of the food supply and education has hit these communities the hardest. No internet means no school. No school means no food. These communities need help and they need it now.

After completing both my Technical and STS Research paper, I realize how interconnected these issues are. How technology can have both positive and negative effects on society. For example, developing the PAPR would allow students to return to in person classes, my intended goal. However, would underfunded schools have enough money to purchase them? Probably not. I also realized that technology created this education gap while in person schooling

was cancelled. Had computers and the internet not been developed, all of the children would be on the same playing field using paper and pencil. Students without the internet would not be left behind. On the other hand we all know all the benefits that computers have brought. Through my research and my STS classes I understand technology has great power to shape the course of history. As an engineer, it is my responsibility to think about the actions and consequences of engineering products I create or that I use. It is important to take a step back, think, and discuss the possible ramifications a product will create and if the benefits outweigh the costs. That thinking has the power to save people from discrimination, maintain ethics within your company, and increase your products social benefit.

Before reading my thesis I would like to thank the people that helped me put it together over the past year. Without these people, this project would not be possible. I am so grateful for all of the time they spent helping me and making me a better engineer. First, to Professor Richard Jacques, thank you for caring so much about your class and students. If I ever had a question, I knew you had the answer. You were a crucial resource to the writing of this paper and expanding my mind in engineering ethics. I would like to also thank my team members for staying committed to our project even when it had to change course. You all were tremendous. Finally, thanks to Professor Gavin Garner for his effort and expertise. In your class you taught us how to move through the Mechatronic forest and finish on top of a mountain. To get us in person in the lab last semester took a lot of effort that I appreciate to a great extent. Thank you all again. I couldn’t do it without you.

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