Thesis Project Portfolio

Design of a Fan-Powered Face Mask with Advanced Filtration Capability

(Technical Report)

What We Can Learn from Hurricane Katrina: Applying Lessons Learned to the Response and Recovery of the United States After COVID-19

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

(Executive Summary)

Identifying Issues Surrounding the National Response to Pandemics and the Design of an Electric Fan Powered Filtration Mask

In the midst of the Covid-19 pandemic, a severe shortage of personal protective equipment (PPE) arose due to extreme increases in demand. While supply shortages made PPE, such as masks, hard to find, confusion arose in the public about whether masks were even useful or not. These two factors inhibited the containment of the virus and played a part in its rapid global spread. For these reasons, I chose to design a mask for my technical project and to research the ways in which the US failed to properly handle the virus. These related topics address the issues of PPE shortages and policy blunders.

The technical portion of my thesis produced a mask which filtered inhalation and exhalation with fan assist. A mask such as the one we produced had not been built before. This project helps prove that a cost-effective mask can be produced while offering the best levels of filtration and comfort of use. The mask we built cost us $108 in raw materials. The price could be brought down significantly if it was produced at scale. This mask is noteworthy because no other powered mask exists that can be worn on your face while filtering inhalation and exhalation. Most designs are either passive filtering devices or are powered hoods that must be worn over the user's entire head while our mask uses electric fans to assist breathing. This mask is simple in its design so we can 3D printed the product. This ability to 3D print a mask means that it could be produced rapidly at short notice. 3D printing is expensive however, so the price of manufacturing could be brought down significantly if it were produced with molds at large scale. Masks like these could help meet sudden demand surges that may be caused by future pandemics.

In my STS research, I hoped to better understand the factors that lead to poor handling of the pandemic by the US. This problem is extremely important because this is not the last pandemic the world will see. There are plenty of mistake the US made during the onset of the pandemic that, if corrected, could save lives and reduce the impact of future pandemics. These changes will not happen on their own, however. An effort must be made to better understand the factors which caused mistakes. The research focuses on the US and the blunders which politicians and the public made. The research compares the response to COVID-19 to the response to another disaster, such as the Katrina hurricane in New Orleans.

These two projects work very well hand in hand. The research portion discusses broadly the reasons why the US failed to handle the pandemic as well as it could have. These findings help to better understand the problems that we need to solve in order to respond to the next pandemic better. The technical portion is an example of how we can be more ready next time. The research attempts to isolate a few issues that amplified the effects of a pandemic while the technical portion attempts to solve one of the issues. In the future, we should have the knowledge of how to rapidly build masks like the one produced in the technical portion, so we can better protect people in the next pandemic. These two topics work great together because the technical portion offers one little solution to one of the many problems brought to light in the research portion.

Professor Kathryn Neeley helped guide me in the process of creating and crafting documented and organized records of my work this year. Professor Gavin Garner helped my team and I build a mask which could inspire the next round of wearable filtering devices. I worked closely with fellow students Nano Masters, David Barrett, Spencer Pergande, and Matthew Ziegelbauer to design and build the face mask.