Sociotechnical Synthesis

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Ryan Gibiser
Mechanical Engineering

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Ryan Gibiser

Approved: _____ Date_____

Richard D. Jacques

The Coronavirus pandemic has introduced unforeseen changes to society. It has not only changed the way people interact with each other, but it has also shifted research attention toward fighting the virus. It has therefore prompted innovation from engineers of all backgrounds to help alleviate the problems that society is still facing as we continuously adapt to new and difficult situations. From ventilators and respirators to vaccine production, scientists and engineers are coming together to tackle today's most difficult problems. This pandemic has impacted the lives of everyone, including myself, my peers, and professors at the University of Virginia. Because of this, my technical research group and I set out to use our engineering skills and knowledge to design a fan-powered mask that could be cheaply fabricated and worn to successfully prevent the spread of COVID-19. For my STS research, I decided to explore the social effects of wearable devices such as powered masks, and the social construction of wearable technology in general. Although our technical research efforts were ultimately shifted toward building a device that would have been used to fabricate our powered mask, the idea of incorporating smart technology into wearable devices influenced me to research more into the ethics of implementing wearable technology into society. Pairing STS research with technical research is imperative for ethical engineering practice, so it was important for me to link my technical project with related STS research.

The technical portion of my project focused on researching and designing a respiration system that would bring air through filtration material with powered intake and exhaust fans. As the semester went on, however, professor Gavin Garner and my capstone group realized that we did not have the necessary materials or resources to plastically mold the desired shape of our design. 3D-printing would be too costly and would take too long to produce, so we needed a way to easily mold plastic to pre-defined shapes. This is when our team shifted focus to building a

vacuum thermoformer. This device is comprised of a vacuum pump combined with a heating lamp and a vertically translating stage, which clamps the plastic sheet being used. The lamp melts the plastic hot enough to be able to bend to the shape of whatever object is placed beneath in the vacuum chamber. When the vertical stage is clamped shut, the vacuum pump sucks the air from underneath the sheet, forcing the hot plastic to conform to the shape of the mold. For an even distribution of heating the plastic sheet, a linear actuator was used to translate the heating lamp back and forth with programmed motion. Design and assembly of this machine was performed using the computer-aided-design software SOLIDWORKS, and the final system incorporated embedded software on a Parallax microcontroller. The technical report of this thesis discusses the process of designing and building this device, and how it would eventually be used to fabricate the mold of a powered respiration mask, if given more time. The end result of this technical project was the completion and a successful test-run of our vacuum thermoformer.

In my STS research, I explored the ethical dimensions of advancing wearable technology. Originally inspired by current developments in smart mask technology, I decided to more generally research the ethical development of current and future wearable technology. In many cases, wearable technology has been used appropriately to identify and solve problems in society without the devices becoming too obtrusive. However, I argue that now is the most important time to recognize the dangers of allowing technologies in such close proximity to our bodies. If engineers are designing the technology to record our and use our personal data, it should be for a socially driven purpose. I also connected my use of STS frameworks, most notably the Social Construction of Technology, to actionable response in the form of ethical considerations. The final STS research paper analyzes current opinion on wearable technology with current and future innovations. In my argument, I emphasize the importance of not only acknowledging

social constructivism of technology, but actively designing wearable technology ethically with society driving development.

Through my technical project and STS research, I learned the importance of setting goals early and making sure your design aligns with the goals of a problem that society is facing. With the pandemic providing societal pressure on engineers to develop solutions, I learned from my technical and STS research that it is important to recognize the entire scope of the problem so that any possible oversights can be avoided. This way, engineers would not be creating any more problems and the benefits would be returned to society. Although a tedious process, engineers must not rush through the crucial steps of the design process where you take into account all ethical considerations and how the technology will impact relevant social groups. While working on researching and designing components for the powered mask as well as the vacuum thermoformer, we had to be mindful of how it would affect individuals. Functionality, adaptability, and accessibility all have to be addressed and correctly implemented when designing new technology. When designing a better world, engineers need to maintain a socially driven approach to engineering so that society collectively benefits from innovation, rather than being negatively impacted by it.