Thesis Portfolio

Design of a Fan-Powered Face Mask with Advanced Filtration Capability
(Technical Report)

An Analysis of Nuclear Energy and the Possible Solution to the Consequences of Burning Fossil Fuels
(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

In the last year, the COVID-19 pandemic has, in some way, affected the lives of everyone in the world. Scientists and other experts have continued to learn more about this virus, including how it is transmitted, how long individuals remain contagious, and the best ways to slow down its spread. That being said, some ambiguous discoveries, including the extent of airborne transmission and the high number of asymptomatic cases, have instilled levels of fear and risk in society, ultimately leading to an emphasis on advanced personal protection equipment (PPE). In the energy industry, fossil fuel-burning plants made great advancements that also came with significant costs, being the negative effects of greenhouse gases, such as carbon dioxide, methane, and other pollutants, on the environment. As a result, the search for effective means of energy production that eliminate carbon emissions has become a worldwide initiative. Nuclear energy, a process that can produce energy at great capacities without producing greenhouse gases, is a plausible solution to this environmental crisis.

The technical portion of my thesis designed a fan powered mask system that effectively filtered both the inhalation and exhalation of COVID-19 virus particles, as well as one that assisted breathing and looked aesthetically pleasing. The design process of the mask heavily depended on the SolidWorks modeling software, which was used to iterate early mask concepts and create tangible prototypes via 3D printers. In addition to the ABS plastic molding that came from the printers, the product was comprised of two centrifugal blower fans, a battery unit, and a clear CPAP mask. Our group made additional alterations to the existing CPAP mask in order to create a transparent view of the user's face. The front of the original CPAP mask, a surface designed to attach to an air supply apparatus, was cut and replaced with a flat sheet of acrylic. Moreover, the fans that assist in the filtration and inhalation of air were positioned in such a way

that the view of the user's mouth was not obstructed. The final design was tested using a flow simulation within SolidWorks, a mask leak indicator known as Bitrex, and a fit comparison to other well-known respirators.

In my STS research, I investigated the risk of nuclear energy and the political nature of the energy industry as a whole, and how these factors influence its implementation into future society. Past nuclear disasters have shown the potent nature of the fuel itself, and the safety measures that must be taken should it be uncontrollably released into the surrounding environment. While the public has shown general support of nuclear energy, uncertainties regarding the safety and security of its implementation still exist. As a result, this industry has become significantly regulated, from the design of the nuclear reactor to waste mitigation of spent radioactive fuel. The existing fossil fuel industry was also analyzed, specifically the fact that certain communities in America depend on coal, oil, and natural gas to support their local economies.

Environmental reform is a subject that has recently become a great focus in society. However, large-scale actions are difficult, as they are intertwined with political and social factors. Risk analysis was the primary framework used to analyze how the public's attitude towards nuclear energy affects its replacement of existing energy forms. Despite research and innovation by experts, the general public's response is a significant factor in this technology developing on a large scale. Just like the potential transition to nuclear energy, developments in personal protection equipment (PPE) heavily depend on perceived risk from the public. In the case of the COVID-19 pandemic, fear and uncertainty led engineers to search for solutions in personal protection gear that would be acceptable. Our technical deliverable is an example of an

engineering design that considers social factors in addition to technical and health aspects, all in the interest of a community's safety.

I would like to thank Prof. Gavin Garner for his assistance and supervision in the technical portion of my thesis. His course was designed to be a six credit, hands-on lab that revolved around working in small teams. I honestly believed that the COVID-19 pandemic would dissolve this in-person capstone, but the time and effort he put in allowed us to experience the intended design of his course while also taking great safety measures. I would also like to thank my teammates, Nano Masters, Spencer Pergande, Wheeler Gibson, and David Barret, from this same project, for it would not have been possible nor rewarding without them.