Thesis Project Portfolio

Design of a Pembrolizumab Manufacturing Plant Utilizing a Perfusion Bioreactor and Precipitation Chromatography

(Technical Report)

Assigning Moral Responsibility in the 1987 Grangemouth Explosion

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2023

Department of Chemical Engineering

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Sociotechnical Synthesis

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The technical work and STS research are closely connected through the idea of responsibility of engineers, and the possible outcomes of engineering mistakes that can happen many years into the future. My technical work focuses on designing a pharmaceutical plant to produce pembrolizumab, a cancer drug, whereas my STS research examines a chemical plant explosion and assigns moral responsibility to the plant designers. While these projects focused on different fields within the chemical engineering industry, they centralized around plant design and the responsibility of plant designers to construct safe chemical plants.

My technical project focused on constructing a biochemical plant using two currently unlicensed technologies—continuous production using perfusion bioreactors and continuous capture of proteins using precipitation chromatography. With my capstone team, we researched the new technologies and designed a processing plant that will grow the pembrolizumab protein in Chinese Hamster Ovary cells, then purify and collect it through a series of downstream steps in order to help meet the future demand from pembrolizumab (Keytruda) by 2028. The goal of this project was to reduce production and purification costs in order to reduce costs of life-saving medications to patients, and as such required using new technologies within the plant.

My STS research explores a chemical plant explosion from the 1980s, looking at plant design from the other end of the lifecycle—failure. My research focused on assigning the moral responsibility of a plant explosion to the plant designers for their negligence in including an additional relief valve. The paper explores the conditions of moral responsibility, and explores how the plant designers, even decades later, can be held morally responsible for the loss of life, calling attention to the importance of their role in the chemical plant network.

Working on these two projects simultaneously adds significant value to both. The research I conducted for my STS project allowed me to consider the importance of thoughtful plant design, as well as the decay of plants over time, which is vital for the safety of the operators. Additionally, it emphasized the importance of good engineering plant design to me, which directly related to my technical process. Similarly, the technical project gave me better understanding of the numerous considerations plant designers have to take into account, which helped me understand the significance of the role of engineers in building our society. Together, these projects helped me understand the close relationship between the technical and ethical responsibilities of an engineer, and working on both over the course of the past year has allowed me to explore chemical plant design from multiple angles.