Production of a Recombinant Spike Protein-Based SARS-CoV-2 Vaccine Using the Baculovirus Expression Vector System
(Technical Report)

An Analysis of the Piper Alpha Oil Platform Disaster Using Actor-Network Theory
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Table of Contents

Socio-technical Synthesis

The SARS-CoV-2 disease has been an ongoing global problem that has taken the lives of many people; thus, producing vaccines is crucial to the fight of this disease. The technical project seeks to solve the issues around the limited supply of vaccines. This is addressed through developing the technical specifications for a chemical engineering pharmaceutical plant to produce COVID-19 vaccines. Additionally, it is imperative that our pharmaceutical plant maintains current good manufacturing practices in order to not only produce sterile vaccines, but also to maintain a safe production environment. The STS project will seek to provide more insight on the importance of maintaining a positive safety culture. This is done by studying the 1988 Piper Alpha oil platform explosion to identify the main contributing factors to the disaster. Together, the technical project and the STS project will provide a greater understanding on how to create an effective vaccine while maintaining process safety in order to end the COVID-19 pandemic. In what follows, I will expand on both the technical and STS project and reflect on the benefits of working on these two projects simultaneously.

The ultimate goal of the technical project is to design a rapid, safe, and cost-effective production process for a recombinant spike protein-based SARS-CoV-2 vaccine using the baculovirus expression vector system (BEVS). BEVS uses insect cells to produce the vaccine antigen, enabling the vaccines to be stored at normal refrigeration temperatures. The manufacturing process encompasses upstream, downstream, and formulation and filling. The upstream process involves growing the insect cells, and infecting them with a baculovirus to produce our desired antigen. Downstream processing will include a series of unit operations to recover and purify the protein. In formulation and filling, we will combine the protein in an aqueous solution with excipients, and fill the final vaccine into multi-dose vials. In order to

supply vaccines for the remaining unvaccinated global population, this process will produce 400 million vaccine doses per year.

In the STS project, I analyze the 1988 Piper Alpha oil platform explosion using Actor-Network theory in order to identify the contributing factors to the disaster that killed 167 people. I argue that a poor safety culture exacerbated by oil production economic pressures led to the destabilization of the Piper Alpha actor-network ultimately resulting in the 1988 disaster. Two rogue actors, safety culture and economic pressure, destabilized Occidental's goal of producing profitable oil. To support my argument, I analyze evidence from the Cullen Investigation report. This analysis provides a better understanding of what led to the Piper Alpha disaster, in order to effectively balance profit and safety on an offshore oil platform.

While the technical project, creating the vaccines, is certainly the best way to prevent the spread of coronavirus, the manufacturing process raises many environmental, health, and safety (EHS) concerns. That is why it is important to additionally study and be aware off all safety and environmental hazards for this manufacturing plant. The STS research highlights the importance of process safety, which has influenced the EHS portion of my technical design. Additionally, designing the pharmaceutical manufacturing plant has shown many of the safety improvements that have been made since the 1988 Piper Alpha disaster. Overall, working on both projects simultaneously I can produce a sterile and effective SARS-CoV-2 vaccine, while maintaining a safe manufacturing environment, in order to end the COVID-19 pandemic.