

Thesis Project Portfolio

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

(Technical Report)

The Politics Fueling Global Vaccine Distribution Inequality

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Since humans first began using vaccines in the late 18th century to prevent the spread of infectious diseases, a principal challenge has been ensuring equitable access to these vaccines. Over the last two centuries, a standard response to disease outbreak has emerged: the powerful economies of the world are the first to produce and administer vaccines, while developing countries must wait and hope vaccine imports eventually reach their most vulnerable populations. The COVID-19 pandemic has adhered to this historical narrative. The global scale of this pandemic along with the increasing political power of vaccines have given urgency to the issue of vaccine equity. In the following thesis portfolio, the technical project and the STS research paper grapple with equity within the sociotechnical context of mass vaccination.

The technical project completed by my undergraduate chemical engineering team involves the design of an industrial-scale process to manufacture a COVID-19 vaccine on the African continent. Specifically, the scale of our process is 400 million vaccine doses per year. Our process is unique in its use of a viral expression vector to produce the protein subunit used by the vaccine to induce a protective immune response in recipients. We designed the upstream and downstream unit operations along with the ancillary equipment needed to achieve a fully formulated vaccine product, filled in vials for distribution without the cold chain requirements of other widely-used COVID-19 vaccines. The proposed manufacturing process is shown to be economically viable.

The STS research paper explores the role of international politics in perpetuating a historical pattern of inequity in global vaccine distribution. An analytical framework of vaccine diplomacy facilitates a comparison of how vaccines have been exploited to realize foreign policy objectives at different points in history, from the 20th century smallpox and polio eradication

efforts to the ongoing COVID-19 pandemic. China is used as a case study to characterize COVID-19 vaccine diplomacy. I propose that a return to the multilateral international cooperation of the late 20th century is necessary to reduce the present inequalities in vaccine access.

Vaccinating the global population against a highly contagious disease is an exceedingly difficult task. My thesis only scratches the surface of the complexity of ensuring equality in mass immunization. Nevertheless, completing this technical and STS work simultaneously has reinforced a central theme of my undergraduate engineering experience: in order to make ethical decisions and to co-create innovations within the networks of communities that currently exist and are shaped by their actions, engineers must be flexible and attentive in responding to the needs, expectations, values, and other conditions of these communities they serve. Increasing vaccine production capacity in unvaccinated areas seems like an appropriate response to the issue of vaccine inequity, but entrenched social, cultural, and political hurdles must be surmounted for this solution to succeed. In the future, as the world becomes increasingly interconnected, an international dialogue will be imperative to determine how we can equitably manufacture, regulate, distribute, and administer vaccines among other essential medical technologies.