

THESIS PROJECT PORTFOLIO

**PRODUCTION OF A RECOMBINANT SPIKE PROTEIN-BASED SARS-COV-2
VACCINE USING THE BACULOVIRUS EXPRESSION VECTOR SYSTEM**

(Technical Report)

**A UTILITARIAN ETHICAL FRAMEWORK FOR THE ANALYSIS OF PUBLIC
POLICIES TOWARDS VACCINE DISTRIBUTION**

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Department of Chemical Engineering

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SOCIOTECHNICAL SYNTHESIS

**PRODUCTION OF A RECOMBINANT SPIKE PROTEIN-BASED SARS-COV-2
VACCINE USING THE BACULOVIRUS EXPRESSION VECTOR SYSTEM**

with Derek Wu, Victoria Atkinson, Gordon Lee, and Grant

Technical advisor: Eric Anderson, Department of Chemical Engineering

**A UTILITARIAN ETHICAL FRAMEWORK FOR THE ANALYSIS OF PUBLIC
POLICIES TOWARDS VACCINE DISTRIBUTION**

STS advisor: Kent Wayland, Department of Engineering and Society

PROSPECTUS

Technical Advisor: Eric Anderson, Department of Chemical Engineering

STS advisor: Rider Foley Department of Engineering and Society

Vaccine inequity is an important issue in low and low-middle income countries. The African continent and the SARS-CoV-2 pandemic perfectly exemplifies this issue. In the initial stages of vaccination, many high-income nations were able to achieve over 50% vaccination rates while low-income countries were struggling to vaccinate even 10% of the population. The World Health Organization's goal is to have a worldwide 70% vaccination rate. Organizations such as COVAX are aiming to vaccinate 20% of low and low-middle income countries. This 20% is suggested to protect healthcare workers and at-risk populations such as the elderly and immunocompromised. However, COVAX has fallen short of this goal. Vaccine doses were in short supply as many well-developed countries were securing them for their own populations leaving the less developed nations behind. To better understand the relationship between these well-developed countries and the lesser developed countries, I explored the policies pursued by the United States, Russia, and China with vaccine donations. To find a solution to produce more vaccine doses, my group designed a Covid-19 vaccine manufacturing plant in South Africa to serve as a hub for vaccine doses on the African continent.

The goal of the vaccine manufacturing plant we designed was to output 400 million doses of a SARS-CoV-2 vaccine per year. The plant would be sited in Cape Town, South Africa. The vaccine would be using the Baculovirus expression vector system to create a recombinant subunit protein vaccine with the spike protein for coronavirus as the antigen in our vaccine. The vaccine uses GSK's AS03 adjuvant to increase efficacy. Our vaccine does not require the cold storage that other vaccines that are mRNA based require. This makes distribution of the vaccine in countries that lack cold chain infrastructure easier. My group designed the upstream, downstream, formulation, and filling processes to successfully produce 400 million doses in 1

year. An economic analysis was performed to determine that the project was economically favorable and that the design should proceed forward.

The research question proposed in the policy analysis was to understand which of the approaches used by Russia, China, and the United States in donating vaccine doses led to the most utilitarian outcome abroad. I applied a utilitarian framework and used the idea of reducing the most deaths abroad as leading to the most well-being. I used tertiary sources such as newspapers and articles to provide a detailed account of each of the countries approaches. I then used information provided by UNICEF to calculate how many doses each of these countries donated. I broke down the number of doses donated into the type of deals and which countries these doses went to. I heavily weighed which countries these doses went to by subdividing the income of these countries. In conclusion, I suggested that both China and the United States have implemented Utilitarian policies as they each had a focus on providing vaccines to low-income countries.

I do believe this work, coupled together, is valuable. I target both a physical solution by suggesting a design to produce more vaccine doses for countries in Africa. I also seemed to better understand the actions that led to many of these countries having minimal vaccination rates. I do believe both projects were fruitful. Further work could be accomplished in designing a distribution plan for these vaccines as there are many remote areas in the African continent that are not easily reached. Further work could also be accomplished in designing a policy that maximizes the doses that go to low-income countries to help with vaccination rates.