

**NOVEL DESIGN OF THE RTS,S MALARIA VACCINE PROCESS TRAIN  
EMPLOYING SINGLE USE SYSTEMS**

**TECHNOLOGICAL HOMEOSTASIS OF CHILDHOOD VACCINATION IN THE  
UNITED STATES**

An Undergraduate Thesis Portfolio  
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By

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## **SOCIOTECHNICAL SYNTHESIS**

In the last century, significant forward progress has been made in the fields of immunology and vaccinology. The development of vaccine technology has helped eradicate many fatal diseases, but is unfortunately also associated with serious drawbacks. In developed countries, the spread of vaccine technology has led to feelings of concern and distrust as part of what is known as the Antivax Movement. Contrarily, populations of underdeveloped countries have a desire for vaccines but find them nonexistent or inaccessible. These juxtaposed limitations to vaccine diffusivity gave rise to both the technical topic and the science, technology, and society (STS) topic: to design a manufacturing plant for an antimalarial vaccine and to describe the rationale behind the antivax movement and how it can be combatted to improve public health.

Malaria is a complex and serious disease that, until recently, lacked an efficacious cure. In the last decade, the pharmaceutical company GlaxoSmithKline conducted clinical trials for a vaccine containing an antimalarial protein called RTS,S. However, because their vaccine is produced on a small scale, it has a high cost per dose, which is detrimental to the impoverished target population of sub-Saharan Africa. This technical project details the redesign of GlaxoSmithKline's RTS,S manufacturing process at an industrial scale to decrease the cost per dose. In addition to scaleup, the cost per dose is also decreased through the incorporation of single-use systems, which replace stainless steel components with disposable plastic and eliminate the need for caustic cleaning chemicals.

The final plant design demonstrated that 392 grams of purified RTS,S protein can be produced annually. Based on the RTS,S dosage quantity specified by EudraLex, a collection of medicinal regulations in the European Union, and annual production scale of 14 million vaccines

can be achieved. Via a four-dose regimen, 3.5 million children can receive their antimalarial vaccines every year. Economic analysis of the proposed process indicated that initial capital costs amount to \$39.3 million and annual operating costs are \$17 million. Fortunately, with an annual revenue of \$70 million, the process is profitable and yields an annual net profit of \$35.3 million after taxes.

The aim of the STS paper was to determine the reasons for technological homeostasis of childhood vaccination in the United States. Using various STS methodologies, including Roger's theory of Diffusion of Innovations and Law and Callon's Actor-Network Theory, the antivax movement was framed in a sociotechnical context. An initial analysis of the antivax movement suggested that the stagnation of vaccine adoption is a regression in modern medicine and has detrimental effects on public health. However, the goal of the STS paper was not to justify this claim, but instead to analyze the antivax movement from an ethical and psychological perspective and provide a solution to motivate change. This was accomplished using published medical data, doctoral testimonials, and responses to legislation conveyed in national newspapers.

The STS paper discusses the concept of herd immunity and its extreme importance in maintaining public health. However, because people often act in their own self-interest and are influenced by omission bias, they may develop a resistance to vaccination, which contributes to ineffective herd immunity. Since members of society cannot be trusted to contribute to herd immunity without coercion, legislators use utilitarian and duty ethics to justify their passage of laws to end nonmedical exemptions. This thereby enforces vaccination but disregards the rights of religious groups, leading to a considerable ethical dilemma.

Vaccine hesitancy, delay, and refusal are growing global health concerns. To enhance vaccine uptake, and therefore public health, public health officials and legislators must make a coordinated effort to shift perceptions of vaccines to the positive. Officials can accomplish this by improving awareness of the threats of disease, avoiding overstatements of the risks of vaccines, and by improving availability, accessibility, and affordability of vaccines.

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#### **TECHNOLOGICAL HOMEOSTASIS OF CHILDHOOD VACCINATION IN THE UNITED STATES**

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### **PROSPECTUS**

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