**Thesis Project Portfolio**

**Leveraging Enzyme Excretion Systems for the Cell-Free Synthesis of Lactic Acid**

(Technical Report)

**An Analysis of LEGO's Promotion of Sustainability and Impact on Consumer Ideals**

(STS Research Paper)

An Undergraduate Thesis

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

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Bachelor of Science, School of Engineering

**Gavin Estrella**

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Department of Chemical Engineering

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## Sociotechnical Synthesis

Plastic waste is an ever-growing problem for the world. It continues to accumulate and cause problems for the environment. Because of this, it is essential to find solutions to reduce plastic waste. There are several approaches to the plastic waste problem. The first approach is to find a more profitable, sustainable alternative to traditional plastic. The main reason plastic is such a problem is because it is usually made from fossil fuels, and it does not decompose. Sustainable alternatives, such as bioplastics, do not have these traits. However, one of the reasons they are not adopted over traditional plastics is their expensive manufacturing processes. As a result, a cheaper production method is needed to make sustainable alternatives more competitive in the plastics market. This method will be discussed in my technical paper. The second approach is to analyze how major plastic companies approach sustainability. Plastic companies are responsible for most of the plastic waste currently being produced. Because of this, they have started to adopt policies that aim to reduce their waste. By understanding what solutions these companies adopt, we can determine the most effective ways to reduce corporate plastic waste. This is the method that will be discussed in my STS research paper.

Polylactic acid (PLA) is a common bioplastic alternative. The raw material that is needed to make PLA is lactic acid. Lactic acid is usually produced through fermentation. Fermentation utilizes biological cells to produce the target product. This process is very resource-intensive and results in a complex manufacturing process. Because of this, using lactic acid as a raw material is more unfavorable than using fossil fuels, meaning PLA is less likely to be used. One solution to make the price of lactic acid more competitive is to utilize cell-free synthesis. Cell-free synthesis uses enzymes, which are catalysts within cells, to create the target product. Using this process will result in fewer resources and process steps needed, which will cause lactic acid to be cheaper. My technical paper aims to show how this process can be implemented to make lactic acid.

LEGO, a prominent manufacturer known for its toy building blocks, generates substantial plastic waste due to its global distribution efforts. However, LEGO has taken steps to reduce this waste by incorporating sustainability into its mission statement. This commitment is shown by its sustainability framework, which organizes its policies into three overarching concepts: circularity, sustainable materials and packaging, and climate action. My STS research paper aims to analyze LEGO's policies and advertising under this framework. This analysis will show how effective this framework is and its potential to inspire other companies to adopt similar strategies.

My technical and STS research papers aim to provide solutions to reduce plastic waste. My technical paper focuses on a future solution that can be implemented to make plastic alternatives more popular. My STS research paper focuses on sustainability methods that major plastic corporations can use to reduce waste. These two approaches combined to show that there are ways to reduce plastic waste worldwide and multiple benefits to adopting these solutions.