Thesis Project Portfolio

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

(Technical Report)

Corporate Producer Dominance in the FPCN: How a Moral Shift Led to the Modern American Health Crisis

(STS Research Paper)

An Undergraduate Thesis

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Ethan Paul Coleman

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Department of Chemical Engineering

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Prospectus

Executive Summary (Sociotechnical Synthesis)

It seems that any given topic oscillates between two extremes, either undeniably progressive or eternally ebbing toward horror. In many ways, that is the story of these two projects, how the triumphs of a journey to the cutting edge are undermined by the realizations that elsewhere society stands off-balanced at the edge of a cliff. The technical portion, the empowering cutting edge, is an acellular lactic acid production process that showed the potential to lower cost introducing a cheap, consumable, and environmentally friendly substitute to the food, medicine, and plastic markets. The social portion, a reminder that engineering has a limit to the problems it can solve, is a study aiming to understand how shifting moral priorities created a power imbalance in the food production-consumption network that has cyclically caused worsening health outcomes for Americans. While the two topics are not directly related, the potential of the lactic acid project sharply contrasts the despondence in the food production-consumption network. I chose to study the moral and network-based causes of negative health outcomes because I felt lost in the nutritional system and wanted to find a root cause. These causes also show that engineering alone cannot solve non-technical problems. This serves as a reminder that engineering does not reduce the number of problems, it only introduces a new set of tradeoffs to ethically weigh.

My technical project is an acellular process that creates lactic acid. The process feeds glucose to bacillus subtilis which manufactures the enzymes needed for production in a bioreactor. The enzymes are then separated from the cells and sent to the cell-free reactor along with some condition stabilizing chemicals to convert glucose into lactic acid as efficiently as possible. The lactic acid is then separated from various intermediary chemicals using a plethora of downstream processes including nanofiltration, sedimentation, liquid-liquid extraction, and

distillation to produce the final purified product. An economic analysis is added to assess the market potential of the process before multiple obstacles and risk factors are considered to determine that the generated income is not high enough to outweigh the negative possibilities and that the project is not viable.

My social research project studies the American health crisis through the lens of shifting moral priorities and a power imbalance within the food production-consumption network. My research paper argues that shifted moral priorities resulted in ceding control within the network to major food production corporations. The moral priority shift is understood using Jonathan Haidt's Moral Foundations Theory (MFT) to understand different moral priorities. The power dynamics within the food industry are viewed through Stewart Lockie's food production-consumption network (FPCN) construct. The paper begins by establishing the correlation between declining health due to diet and the moral shift as understood by MFT. It then outlines that major corporations control the FPCN and outlines why that is so problematic. I conclude the paper by offering a three step solution to regain agency from major corporations. The paper both demonstrates the root of the United States's arguably worst problem and offers one method of alleviating the issue.

Engineering is a profession and an activity primarily concerned with solving problems. It is to thank for almost every part of modern life, iterating and modifying niches of weakness until they become niches of opportunity. But that is what engineering progress manufactures: opportunities. Not solutions, not answers, but opportunities. The introduction of food processing has prevented the starvation of billions; it also introduced a new crop of ailments and diseases to be cured. It is important to integrate aspects beyond the technical when solving problems because within these aspects are intended consequences that could drastically improve the impact

of new technologies or make them an absolutely horrifying proposition. By incorporating knowledge of the social, cultural, and ethical implications of a technology into the responsibility of the designer, there is greater potential to mitigate adverse effects often without scraping the benefits. That is the importance of understanding ethics and multi-order effects as an engineer. It allows the builders of tomorrow to steward a better future.