Biofuels are arguably one of the most defining inventions of our species. It allowed for early homo-sapiens for the first time to create warmth, cook food, and see at night. So why is an invention that has been iterated and employed for so long still a point of contention in today's society? Biofuel's now have an even more enticing value proposition: they can act as a carbon-neutral source of energy to power a world who is failing to understand the scale and importance of environmental responsibility. There is no longer any debate that we can power all of the activities of the world with fossil fuel energy sources. In contrast, this world also cannot simply run on renewable energy; there must be a diverse energy infrastructure that balances our emission of carbon-dioxide with energy demands.

Biofuels, a potential part of this new era of energy, have struggled to be adopted as a scaled energy source and provide a relatively miniscule amount of energy in comparison to the dominant fossil-fuel industry. This solution cannot be solved by itself, it will take key players to promote the adoption and prove the technological feasibility of the industry. This thesis will work to understand the major and minor actors, how they have or have not influenced adoption, and their potential for improvement. Additionally, the capstone project will evaluate a viable systematic approach to developing algal biofuel production. As the world grows in energy consumption, this thesis and capstone will work together to understand how to optimize resources for biofuel energy generation.

Holistically, this thesis works to understand the impact of the relationships between organizations, society, and technology and how these groups can influence the successful integration or feasibility of biofuels. The impact of these relationships are not exclusive of one another but they are helpful to note when grasping the trends of the industry. Certain trends in biofuels' economic implications, like incentivization or social and environmental responsibility

are imperative to understanding the rate of adoption. In synthesis, the relationships and themes laid out in the sociotechnical triangle are enlightening to major decision makers and industry leaders to make an informed impact on biofuel adoption. Collectively, implementation is a factor of economic incentives and social awareness; while feasibility is a product of compatibility and convenience. Moving forward the incorporation of biofuel as an energy source will be a consequence of intentional action within the major themes prevalent in our infrastructure surrounding feasibility and implementation.

The technical portion of this synthesis concerns the recommended design and economic analysis of an algae farm and biodiesel refinery. Using kinetic data, Aspen Plus modeling, and general chemical engineering considerations, a full scale plant was modeled to yield fully refined biodiesel and a glycerol byproduct. The motivation for this project stemmed from creating a carbon-neutral energy source that would compete with fossil fuel alternatives as well as sourcing energy and recycling waste from poultry litter as nutrients. The upstream system employed the cultivation of *Chlorella Vulgaris* in open raceway ponds and dissolved air flotation(DAF) to extract algae as a feedstock. Additionally lipids were extracted from a high pressure homogenization system(HPH). As they entered the downstream, the lipids were converted into fatty acid methyl esters(FAME) through a series of esterification and trans-esterfiicaiton reactions. The downstream yielded both crude biodiesel and crude glycerol which was refined through a series of washing and drying or vacuum distillation respectively. The economic considerations evaluated equipment costs, labor benefits, utility costs, raw material costs, and taxes and determined an unfavorable return on investment. The raw material cost and land use were determined to be detrimental in breaking even economically and the project was not recommended for future use.

The synthesis of both the thesis and capstone were very effective in continuing the conversation on how biofuels will fit into the global infrastructure. Seeing the lens of adoption through both socio-technical factors and a systematic modeling approach shed a light on where inefficiencies lie for the industry and technology alike. There was some disappointment on the economic outlook of the modeled system but it should serve as a motivator to create more efficient technology and approaches to biofuel feedstock. The growth of biofuels can benefit the world in its approach to capture carbon, create alternatives to fossil fuels, create jobs, and waste treatment and recycling, so it's important to be aware of major obstacles so they can be overcome. As the industry progresses, future research should work to understand inefficiencies in land use, energy loss, economic margins, and infrastructural convenience for new biofuel systems. The potential for the biofuels industry is massive for the growing energy market but only after significant strides in biofuel production and integration can be accomplished.