

**Thesis Portfolio**

**Low Power Wireless Networks in Vineyards**  
(Technical Report)

**Analyzing the Prospects of the Nest Power Project Through Actor Network Theory**  
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree  
Bachelor of Science, School of Engineering

Anna Haikl  
Spring, 2020

Department of Engineering Systems and Environment

## **Table of Contents**

Sociotechnical Synthesis

Low Power Wireless Networks in Vineyards

Analyzing the Prospects of the Nest Power Project Through Actor Network Theory

Thesis Prospectus

## **Sociotechnical Synthesis**

In order to address the greater sociotechnical problem of extending Internet of Things (IoT) connectivity (IoT technology is used to collect and store data, ultimately allowing the user to make data-driven decisions), it is necessary to understand both the technical and social factors influencing it. To expand my knowledge of this problem, my work has focused on exploring the impacts of expanding IoT technology beyond typical smart home applications. Specifically, my technical work focused on atypical applications outside of the home while my STS research focused on atypical users of smart home technology. Though these projects consider expansion of IoT differently, they both ultimately focus on broadening its applications.

In particular, my technical work focused on the use and impact of IoT technology in vineyards. My capstone team developed the concept for a three-part solution that enhances the decision making process for vineyard managers. Before developing the solution, we did extensive research, allowing us to identify particular requirements of the system. With these requirements identified, we were able to develop a prototype that consisted of hardware, industrial design, and user interface elements. Each part of this solution was shown to vineyard managers to obtain feedback and was then iterated upon. The project resulted in an in-depth understanding of the needs of vineyard managers and how to address them with IoT technology. We hope that our research and initial prototype will drive the development of a commercial product in the coming years. Additionally, we hope that this research will lead others to question future applications of IoT technology.

On the other hand, my STS research focused on evaluating the success of expanding the use of IoT technology to atypical users, low-income individuals, namely through the Nest Power Project. The Nest Power Project is an initiative by Google Nest to distribute smart thermostats to

low-income households to mitigate disproportionately expensive energy bills. While the Nest Power Project has been around since 2018, it is very new compared to more established programs such as the Department of Energy's Weatherization Assistance Program and Pacific Gas and Electric's Energy Savings and Assistance program. These programs have seen varying levels of success and the purpose of my work is to explore the similarities and differences between them and the Nest Power Project to identify how the Nest Power Project will likely be affected in the near future. By exploring the prospects of the Nest Power Project, I hope to bring about a greater conversation regarding inequalities in low-income communities. More specifically, inequalities regarding the use of IoT technology in low-income communities and what impact that has regarding factors such as physical and mental health, safety, and security.

Working on both of these projects concurrently allowed me to understand that it is necessary to consider inequalities when developing our technical prototype. Though the target customer for the technical project is a vineyard manager who may not be as restricted by income inequality, there are many other reasons why certain vineyards may or may not have access to such a product. My team needed to ensure that our technical project did not inherently ostracize certain vineyards from using it due to factors such as cost, vineyard topography, growing styles, etc. This concurrent research also allowed me to realize that there will likely be external factors that may impact the success of our prototype that we do not have influence over. Understanding this prevented us from seeing our prototype as a technological fix to a number of greater issues. Additionally, seeing how a lack of insightful decision making can have significant impact during the technical project showed me that it is necessary to track and record data and decisions. As the Nest Power Project continues to grow, I hope that they will accurately measure and record data that will allow them to better quantify impact. Overall, working on the technical and STS

portions concurrently has brought to light several factors that would not been analyzed otherwise. This allowed me to gain a greater understanding of how IoT technology can be used and applied across a variety of use cases in a way that I previously had not considered.