Thesis Project Portfolio

Shake Power Bank

(Technical Report)

Understanding the Failures of Albemarle County's Stormwater Initiatives

(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

Samuel Tipton Varrieur

Spring, 2020

Department of Mechanical and Aerospace Engineering

Table of Contents

Sociotechnical Synthesis

When designing a new product or system, engineers must be cognizant of the values held by their target recipients. Balancing features like effectiveness, cost, sustainability, and appeal is challenging, yet is essential to a successful product launch or system integration. For my STS thesis, I studied the value mismatching and developmental inflexibility that led to the failure of Albemarle County's stormwater utility fee initiative. For the technical capstone, our group created a handheld mechanical generator designed to be a manufacturable consumer product. These projects required an in-depth analysis of the values of relevant social groups and their importance when introducing new technologies.

Stormwater management in Albemarle County is hindered by a lack of funding and public support. In 2016, Albemarle County attempted to pass a stormwater utility fee, charging property owners on land covered in impermeable surfaces and putting the additional funds towards modernizing and maintaining stormwater infrastructure. A significant resistance from community members led to the failure of the measure and a decision to stop all future discussion of a stormwater utility fee. I chose to research the process of the measure's creation and the subsequent community backlash to determine why Albemarle was unable to progress their stormwater management into the modern age. This was accomplished by performing a discourse analysis on the relevant social groups' reaction to the measure. By tracking the system's development from conception and the subsequent changes to attempt to balance the values of the environmental committee, local government, and citizen groups, a clearer understanding of the shortfalls of the implementation of this innovation can be ascertained.

Mechanical power generation is an underutilized technology in consumer-grade portable generators. As renewable energy solutions continue to increase their market share and more people move off-the-grid, handheld low-power generators have increased commercial potential. For the technical capstone, our group attempted to create a mechanical generator with multipurpose charging functionality. Power was generated through induction, by shaking the generator to move a magnet through a coil of wire. This current was used to charge a battery powering a USB port. Optimizing this design meant making changes to the outer shell to improve ergonomics, reducing weight, and increasing lifetime. Ultimately, although the technology was feasible, bringing the product up to the standards expected by consumers in a competitive market revealed how difficult it can be to market innovative solutions.

In my STS thesis, I studied the challenges a past group had in selling their innovation to social groups with complex and conflicting values. In my technical capstone, I involved myself in such a group, and became intimately familiar with the challenges of building an innovation up to a commercially marketable state. While the handheld power generator will never see store shelves, I still consider my thesis work to be fruitful. I have gained a new level of understanding for successful technological implementation. My group worked well together, but still faced significant design challenges. Both projects, with additional research, could inform future implementations of environmental innovations.