Thesis Project Portfolio

Design and Construction of Modern University of Virginia Themed Pinball Machine

(Technical Report)

The Foreign Human Rights Abuses of the Modern Electronics Industry

(STS Research Paper)

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Executive Summary

The future of mechanical engineering is here, and it is its implementation with electrical engineering is the driving factor that allows for automation. The technical research report highlights the project that was undertaken by myself and 18 others to design and construct a University of Virginia themed pinball machine. We took this project on because it sounded like a lot of fun, and it is a direct implementation of the field of mechatronics, one that is the emerging future of mechanical engineering. The STS research paper addresses the topic of labor abuses when it comes to the manufacturing of rechargeable lithium-ion batteries whose contents require certain materials of which labor is currently cheap and exploiting in foreign countries. I took this on because I have an appreciation for the application of electrical engineering used with mechanical engineering, and electric rechargeable batteries are used in some mechanical applications for power. I knew that labor abuses were happening in foreign lands, and I wanted to do some research to understand what is happening and why I do not hear about it often. Both topics are relevant to my field because, as mentioned before, mechanical engineering is using a lot more electrical applications in modern times, so it is necessary to understand the manufacturing processes of certain electrical applications, and also understand and be competent with regard to its design process and implementation in these mechanical systems.

For my capstone project, I worked collaboratively with a team of 19 people (including myself) to construct a University of Virginia-themed pinball machine from scratch. Now what problem is this project addressing/how does it connect to the STS research? It is not addressing a specific problem per se, rather, the integration of electronics, which includes many semiconductors and cheap electrical parts made in China, points to the awareness of the overlooked problem that plagues the electronics industry of where do these parts come from?

How are they made? Who made them? Rather than overlooking these things, I believe they can be brought to light in the context of a pinball machine that is being made in a fast manner because, in the context of modern-day electronics, demand and speed is the common driver of human rights abuses. However, the main driving factor that led to our 19 members taking on this project is that it is fundamentally tied to the field of mechatronics, where electrical engineering, mechanical engineering, and software engineering synergistically collide to work in a system where there are sensors, controllers, and actuators present. These systems are the backbone of automation today, as all robots and automatic systems employ this blueprint of technology. Therefore, the task at hand to construct a pinball machine is relevant to pushing the members to become more aware of the design process surrounding these machines.

From our team's technical report: "Over the course of the semester, our group accomplished a great deal. We designed and redesigned many mechanisms until they operated smoothly, consistently, and dependably. We brought many of them into reality through prototyping and eventually finalizing them in sturdy, polished metal forms. With only about two months, we made significant progress on the upper playfield and more, but were unable to finalize an entire, working machine. We did not get to very much of the coding. Physically, we have mounted many of our devices onto a prototype playfield… Therefore, this machine will not be installed in the 1515 study space yet. Future Work We believe in this project. Our hope is that a future Capstone group will discover the relevance and wonder of pinball and see how UVA could benefit from a UVA-themed Pinball machine of our own design. This (technical) report would serve as a starting point for this group so that they may push beyond our accomplishments and eventually see the completion of the project."

While the above two paragraphs describe the technical side of the summary, the next two shed light on the STS research portion of it. The sociotechnical topic that I addressed with my STS research is the question of how the development of modern, smaller, and more powerful electronics has led to a rise in slave and child labor in foreign countries because I wanted to find out why the media and general public are silent on or indifferent to this tragedy. Just as the electronic devices have a global scope, so too does labor abuses. The DRC produced about 74 percent of the world's cobalt (used in rechargeable batteries) in the year 2021, and "Some 20,000 people work at Shabara artisanal mine in the DRC, in shifts of 5,000 at a time," to put it into context (Gross, 2023). One can see the global scale that this problem has, and therefore its significance. With regard to methodology, as there are a lot of actors within the question, the evidence was analyzed using an approach that considers human actors and parties as both subjects and objects that considers both their perspective as subjects but also the rights due to each as objects with dignity. Considering the source of the evidence, it came from online resources (particularly mainstream media outlets and also smaller study-based outlets) and articles (those that address this issue head on).

The first part of the research question (rise of slave labor in foreign countries) is answered in the contextualization of the situation, and the rationale behind its still existing nature, especially in the discussion of supply and demand and sustainability goals. In the answering of the second part, however (claims of indifference and ignorance), I have found conflicting evidence to my initial assumptions of indifference and ignorance. Are there probably people of the general public out there that choose to push this tragedy to the side? Most likely, but are they significantly represented by the evidence (evidence being a lot of coverage and outspoken people and groups on the issue)? No. Perhaps I should have asked the question why

there hasn't been a swift end to the problem on the part of the larger actors. To conclude, I will note that the exploited laborers find themselves at the central role of the story, and even with all of the other actors' looming circumstances, ideas, or roles in the situation, they deserve to be the center of attention not to be lost in the forest of complexity. After this entire analysis of the contextualization of the problem, the fact still remains that there are miners and minors in the DRC being taken advantage of and suffering due to this labor injustice imposed upon them by the electronics industry. Therefore, the media and public must continue to provide the pressure that was started in 2016 to those actors in this ongoing story that have reasonable influence. Similarly, with the issue of sustainability and clean energy looming over our heads, the cobalt industry must be reformed in the DRC. If not, the emissions may be carbon free, but not completely blood-free.