Prospectus

Self-Sufficient, Light-Up Running Vest Design
(Technical Topic)

Sexual Assault at The University of Chicago
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Sociotechnical Problem

The University of Chicago has a troubled history with sexual assault that continues to haunt it to this day, with new occurrences opening up wounds of old. The university is situated in Hyde Park, an area of Chicago that has seen considerable crime both with university members and the surrounding communities. The number of violent crimes, which includes criminal sexual assault, in Hyde Park has grown from 169 incidents in 2013 to 266 incidents in 2018. Under a narrower lens, there were 65 student reports against sexual violence in 2017 alone ("Crime Trends," n.d.). Many of these incidents occur under low-visibility circumstances, as 67% of sexual assaults take place between 6:00PM and 6:00AM ("Sexual Assault Statistics," n.d.).

In response to this, our team is developing a high-visibility (hi-vis) running vest designed to harvest the physical energy expended by a runner and utilize it to power fixated lights. Unlike other hi-vis vests available today, this design is self-sustaining in its light-powering capabilities. This allows the runner to be constantly illuminated, ensuring a higher level of safety when exercising in dark environments. It also eliminates the need to charge the batteries beforehand along with the risk of the batteries dying while on a run.

However, within the framework of actor-network theory, it is important to note that there are other actors within this network of the University of Chicago. A hi-vis running vest benefits actors seeking increased safety while exercising in low-visibility environments, but a plethora of actors are seeking increased safety assurances outside the scope of exercise. The vest is simply one step toward the broader goal of reducing/eliminating sexual assault at the university.
The system in place to address sexual assault at the university, backed by both University officials and the University of Chicago Police Department (UCPD), is creating a false narrative

of safety and security and the true nature of this network is being exposed by statistics and student groups within the university.

By addressing the issue of sexual assault both technically and socially, the actors in this network can gain a greater understanding of the flaws in the current alert, prevention, and support systems and, subsequently, the means of addressing said flaws. The technical solution lies in the hi-vis running vest, which gives the runner peace of mind in that the hi-vis feature of the vest will always function due to its self-sustainable power system. The social solution begins with a better understanding how and why the current system in place is not performing as well as University officials believe. In pairing these two, the extremely pressing issue of sexual assault at the University of Chicago can be approached holistically and successfully.

Technical Problem

Electrical energy can be harnessed from the vibrations caused by the running motion of a human. One of five key running dynamic variables is vertical oscillation, which varies greatly from runner to runner. It is characterized by the amplitude of the oscillation of a runner's center of mass and is measured in centimeters (Folland, 2017). An important factor of vertical oscillation is that it is both repetitive and predictable for one runner, allowing it to be manipulated for energy-harvesting purposes. This can be done through the use of an electromagnetic Faraday generator to create electrical energy. In a typical linear Faraday generator, a magnet is placed in an ideally-frictionless, cylindrical chamber wrapped in a coiled wire. The magnet is allowed oscillate between the two to ends where it bounces off springs to conserve its residual momentum (Mah, 2008). The movement of this magnet generates electricity through Faraday's law of induction: electromotive force is directly proportional to the number of turns of wire and the change in magnetic field, and inversely proportional to change in time (The

The technical problem frame was written with Jacob Fishman.

Editors of *Encyclopaedia Britannica*, 2013). A common way of storing electrical energy is through supercapacitors, which are a type of electrochemical energy storage device. When a voltage isapplied to a supercapacitor, opposite charges accumulate on either side of the device. An electrolyte solution between the two sides balances the overall charge of the electrodes. The generated charge can then be released quickly for a number of uses.

The given technical design problem of converting physical energy to electrical energy through exercise is not addressed directly in today's market. An existing product that partially addresses this problem is a Faraday flashlight, which houses a linear Faraday generator in the body of a flashlight acting as the light's power source ("Shake Light 40 Rechargeable Flashlight," n.d.). Because the use of this product is predicated upon deliberate, isolated movement of the flashlight through a shaking movement of the arm, it does not meet the requirements of the technical design problem at hand. A product on the market that supplements the given problem is a hi-vis running vest, but no versions are mechanically rechargeable as they rely on conventional batteries or capacitors that need to be charged through a power outlet ("Safety Depot Mesh Safety Vest with Hooke & Loop Closure and Pockets Hi Viz 2" Reflective Tape Lime Yellow," n.d.).

With the introduction of a new technology that clearly meets the requirements of this technical design problem, users can gain the ability to capture energy from exercise. Within the context of running, this ability has not yet been experienced and there is a great deal of mechanical energy that can be harvested and re-used for practical purposes.

Our team is designing a high-visibility running vest that can translate the energy from human exercise to provide light. Through the use of four Faraday generators fixated to the vest (two on the front and back each), the mechanical energy from the vertical oscillation of human

running will be translated into electrical energy. This energy will charge supercapacitors which will then be stored and released to power strips of LED lights. The vest will also be equipped with strips of reflective material like those on current hi-vis vests. Runners wearing the vest will be seen much more easily and have safer runs in low-visibility conditions such as late nights, early mornings, or fog.

Existing products will be modified to create the projected design: a shake flashlight, LED light strips, and a hi-vis vest. In the prototyping phase, the shake flashlight will be deconstructed in order to isolate the desired part: the linear generator. Modifications to the linear generator will be made if necessary and its period will be adjusted to match that of the runner's vertical oscillation. The hi-vis vest will be made more form-fitting, if not-so already, to increase isolation of the runner's vertical oscillation, and compartments/Velcro strips will be added to house the linear generators and attach the LED strips. Once developed, a user will wear the vest while running to test the product.

STS Problem

On Monday, August 19th, 2019, a University of Chicago student was a victim of an attempted sexual assault. The 21-year old woman was walking alone at 12:10am on the sidewalk of South Drexel Avenue, in the heart of the campus, when an unknown man "placed his arm around her torso, pushed her to the ground and attempted to place his hand up her skirt." To defend herself, she bit the man and broke free of his grasp, leading him to flee the scene. The University of Chicago Police Department (UCPD) issued a campus-wide alert and "increased police presence in the area" ("University of Chicago student escapes attempted sexual assault, bites offender," 2019).

In spite of such an event, the University of Chicago prides itself as a "safe and secure" environment for students to pursue a higher education (Santhanam, 2018). The UCPD actively contributes to this positive image, beginning its annual crime trends report by stating there has been "considerable success" in reducing crime in the university community ("Crime trends," n.d.). Addressing sexual assault incidents that threaten this aura of safety and security, Provost Daniel Diermeier reassured all those affiliated with the school that "the university makes substantial efforts to address allegations of sexual misconduct… in a manner that best serves our community (Diermeier, 2018)." These efforts include climate surveys, institutional support, compulsory sexual misconduct awareness and prevention training, and campus-wide incident alerts. Evidently, the university has a strong desire to shed a positive light on safety, and more specifically sexual assault, concerns and believes the current system in place adequately addresses the issues faced.

However, the UCPD's message is contradicted by the numbers that directly proceed it; crime trend statistics actually point toward a severe lack of progress in recent years. Violent crime, of which criminal sexual assault is a large component, on and surrounding the campus has increased by 8 percent from 2009 to 2018 and by 41 percent from 2014 to 2018 ("Crime trends," n.d.). Additionally, the UCPD reported that the number of forcible sexual offenses on campus per year has increased from 17 to 25 from 2016 to 2018 (The University of Chicago, 2019). To supplement these statistics, sexual assault advocacy groups have also exposed the true status of the university's efforts to curb the issue. During an interview with Provost Diermeier, Fatima Eldigair, a member of the Pheonix Survivors Alliance (PSA) and student at the university, uncovered the sentiment of University officials that the nature of deciding when or when not to send campus-wide sexual assault alerts is "complicated." His fear lies in the possibility of

desensitizing individuals to the issue by sending too many alerts. Eldigair and other members of the PSA, however, believe that "the University is compliant in propagating sexual violence through not alerting [the student body]." "If UChicago cared about the well-being of its students," Eldigair remarks," they would inform [them] about sex crimes the same way they do with robberies (Frank, 2017)." This notion conflicts heavily with Diermeier's original statement that the university wants to address the issue "in a manner that best serves [its] community" and indicates that a key technology, the sexual assault alerts, are not being used effectively in the eyes of those they are intended for (Diermeier, 2018).

If the university were to continue in this manner, it will lack an understanding of the actual status of the network it created. I argue that the efforts of University officials to address sexual assault have not been as sound as they perceive, shown by the trends in reported statistics and the viewpoints of sexual assault advocacy groups and those the university is meant to protect, the student body. Analysis of this problem will draw on the STS framework of actor-network theory (ANT), which examines the power dynamics between human and non-human actors in one network assembled by a network builder to achieve a singular goal (Cressman, 2009). With the goal of reducing sexual assault, University officials such as Diermeier have built a network intended to address the issue while, more confidentially, downplaying its prevalence. They have also employed an actor, the UCPD, to aid in perpetuating the narrative of safety and security at the university. Other actors, including the non-human actor of reported statistics and the human actors of sexual assault advocacy groups and the student body have shed light on the true status of this network.

Conclusion

The technical paper will deliver a design for a hi-vis running vest capable of harnessing physical energy expended by the runner and converting it into electrical energy used to power fixated lights. The STS paper aims to address the issue of sexual assault at the University of Chicago, where the current system in place is not performing as perceived in the eyes of University officials and a false narrative is being perpetuated that is creating a culture of complacency.

Together, the results from the technical and STS papers will provide a more effective means of approaching the sociotechnical problem of sexual assault at the University of Chicago. The hi-vis running vest can provide a safer running experience in low-visibility conditions, under which sexual assault incidents are likely to take place. In parallel, a better understanding of the true status of this network and its lack of actual success can lead the university towards its ultimate goal of reducing and, ideally, eliminating sexual assault within its community.

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