Thesis Project Portfolio

Developing An Environmental Monitoring Dashboard to Identify Construction Activities That Affect On-Site Air Quality and Noise

(Technical Report)

Examining the Benefits and Social Implications of Sensors and Wearables in Construction

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Introduction

My capstone technical project and my STS research are moderately related, as both address the topic of using sensors to improve safety in the construction industry. The motivation for the two projects is the poor level of safety that has historically existed and still persists on and around construction sites. Construction struggles with keeping their workers safe from bad environmental conditions and accidents during work projects. My technical project addresses environmental health in construction by analyzing a specific construction site On-Grounds at UVA as part of a capstone team. The team used air and noise monitors on the site to diagnose environmental problems on the site. Analyzing environmental problems motivated me to research solutions to protect construction workers, which ties into my STS topic. My STS research includes analyzing the safety, social, and ethical impacts of a possible tool for construction safety improvement: wearable devices. The benefits and privacy concerns are discovered and discussed.

Project Summaries

The technical portion of my thesis produced an environmental diagnosis of the Contemplative Commons construction site for Hourigan Construction. Poor air quality and dangerously high noise levels can lead to cardiovascular and hearing problems for many construction workers. To gather a wholistic diagnostic about the environmental health on site, my capstone team deployed six environmental monitoring sensors around the construction site. The team worked alongside Hourigan to set up temporary structures to hold the sensors, signs to alert workers, and temporary power. These air quality sensors detect carbon dioxide, humidity, dust particles, and decibel level. Data analysis was conducted on decibel and dust particle levels to

identify strengths and weaknesses of the construction site environment. The team looked at the proportion of time that air and noise quality was dangerous, determining that dust levels were unhealthy for prolonged periods on the ground near Emmet St. and that noise levels were harmful at least 33% of the time. It also found that dangerous dust levels were correlated to the amount of masonry staff on site. These findings were given to Hourigan to allow them to make adjustments to scheduling, staffing, and protective equipment selection.

In my STS research, I analyzed the possibly of using wearable technologies on construction sites, devices that can be used in counteracting environmental problems and human error. The research begins with discussing different types of wearable devices, such as smart caps, exoskeletons, smart watches, and clip-on sensors. Benefits, such as active health and stress monitoring and fall prevention, were then discovered in detail. After looking at the options and positives of these devices for construction, their negative social effects and ethical concerns that come with their use in the workplace as a whole were described in detail. Some social problems that were discovered are the blending of work time and personal life and the misuse of sensitive health data by employers. The privacy and discrimination laws HIPAA and the ADA were introduced to see how they could protect workers and quell privacy concerns, while acknowledging that they need to be amended to account for wearables. Lastly, I recommended that the construction industry widely adopt wearable devices, while pushing for federal legislation updates or creation to protect employee interests.

Conclusion

My technical project allowed me to be hands-on with new air and noise sensor technology and approach construction safety through taking action. I was able to work closely with a real construction site to analyze their specific problems in a concrete manner. On the other

hand, my STS research allowed me to gain a broader overview of wearable devices in the workplace, not only looking at their technical functions, but their impact on the workplace and society as a whole. When looking at them together, both projects gave me technical and ethical insight into the use of sensors in the construction industry. I would like to acknowledge my STS Advisor, Richard Jacques and my technical advisor Arsalan Heydarian, who have both been guided and helped throughout the capstone and STS project. Last of all, I would like to acknowledge and thank my capstone team members: Casey Calixto, Juan Chavez, Abid Hussain, and Kathryn Owens.