Thesis Project Portfolio

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

(Technical Report)

Understanding Construction Employee Responses to and Interactions with Wearable Technologies to Facilitate Their Integration in the Construction Industry

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Sustainability is an often-discussed concept in the construction world and rightly so, considering the significant impact the industry has on both the natural environment and the employees who make up the construction industry workforce. In the *2019 Global Report for Buildings and Construction*, the Global Alliance for Buildings and Construction noted that 6% of global energy consumption is due to the construction industry (Figure 2), while The Center for Construction Research and Training noted that, in 2015, more worker deaths occurred in the construction industry than in any other industry in the United States (*The Construction Chart Book*, 2018, Figure 38a.). Statistics like these show that sustainability is a pressing issue across the construction industry. My capstone projects address multiple aspects of sustainability. Specifically, my technical project addresses environmental sustainability through the development of an environmental dashboard, while my STS project addresses sustainability as it relates to the industry's impact on workers through a discussion of how wearable technologies can be effectively implemented in the construction industry.

Construction sites are well known for being significant sources of air and noise pollution, impacting both individuals who work on those sites and surrounding communities. Construction projects on the Grounds of the University of Virginia are no exception and their locations mean that any pollutants from the projects may impact a large number of people and individuals in educational, workplace, residential, and healthcare settings. While the presence of dust and other sources of pollution is clear, existing site management techniques do not provide opportunities to understand the causes or extent of various pollution events. The purpose of my technical project was to develop an environmental monitoring dashboard for an On-Grounds construction site which incorporates real-time data from air and noise quality sensors installed on-site, and link

the data to specific construction activities on a detailed schedule. Sensors were installed in high traffic locations on-site including on the first two floors of the building under construction and in the jobsite trailer to specifically track noise, CO2, VOC, PM2.5, temperature and humidity levels. Information related to on-site activities was collected through an analysis of construction documents, like a detailed schedule and daily reports. Spatial trends found included the first floor of the site having higher PM2.5 levels, PM2.5 levels decreasing from the roadside to trailer side of the site, and the second floor having higher noise levels. Time trends include lower noise and PM2.5 levels at noon and higher levels between 8AM-11AM and 1PM-3PM. Lastly, the middle first floor sensor PM2.5 levels were found to be significantly correlated with the masonry subcontractor's daily total labor hours.

My STS research paper discusses using the concept of repair as defined by Steven J. Jackson as a framework for implementing wearable technologies on construction sites. My research focused on case studies found in the trucking and Amazon warehouse industries that showed the negative impact, both on individuals and industries, of technology implementation methods that focus on fixing people and treated individual workers as the problem, as opposed to system-focused implementation strategies that align with Jackson's concept of repair. Jackson's concept of repair not only requires a focus on system-based implementation strategies, but also encourages the development of systems that utilize and rely on worker experience and expertise. My paper concludes that Jackson's concept of repair provides a framework for implementing wearable technologies that maximizes safety benefits for both individual construction workers and general contracting companies.

While these projects address very different aspects of sustainability, they inform each other in that they both demonstrate the difficulties inherent in technology implementation on

construction sites. In theory, installation of internet-enabled environmental sensors does not seem challenging, but my team encountered many obstacles including difficulty maintaining a stable internet connection and our temporary power stations which provided electricity to our sensors shorting out. Additionally, as we considered the information provided by the sensors, we developed technology concepts that would make that data more useful to workers and construction managers on-site. My STS paper specifically discusses challenges inherent in implementing technologies that are meant to directly shape the experience of workers. While the introduction of new technologies on construction sites can make construction sites more sustainable, both in regards to the human and environmental impacts of construction, my projects help to show that technologies must be implemented strategically to ensure the process is efficient and the resulting system is effective.

References

Global Alliance for Buildings and Construction. (2019). 2019 Global Status Report for Buildings and Construction. https://globalabc.org/sites/default/files/2020-03/GSR2019.pdf

The Center for Construction Research and Training. (2018). The Construction Chart Book: The U.S. Construction Industry and Its Workers. https://www.cpwr.com/wp-content/uploads/publications/The_6th_Edition_Construction_eChart_Book.pdf