

SITE DESIGN FOR A HOTEL IN PANTOPS, CHARLOTTESVILLE

**IMPACT OF AUGMENTED REALITY ON THE METHODS, PROFESSIONALS, AND
OVERALL FIELD OF CONSTRUCTION**

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Civil Engineering

By
Charlotte Gillum

November 3, 2023

Technical Team Members: Coleman Boatwright, Caroline Lystash, Henry Voter, Garrett Warren

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.

ADVISORS

Prof. Pedro Augusto P. Francisco, Department of Engineering and Society

Arsalan Heydarian, Department of Civil Engineering

Introduction

The technical problem, or Capstone project, I am working on this year is to design and develop a set of construction documents for a private developer who would like to build a hotel in the Pantops area of Charlottesville. There are many local codes and regulations that our group must adhere to in our site design, final grading, stormwater management, erosion and sediment control, and utility design that could add some unexpected complexities to our project. Land development is a crucial step in the construction process because it will provide a general contractor with all the information necessary to get a parcel of land ready to be built on.

The sociotechnical topic I am addressing in my STS research is how Augmented Reality (AR) is changing the methods, professionals, and overall field of construction. This is important because as AR technologies advance, they are becoming more and more prevalent in the construction industry, so I want to understand the effects these AR technologies are having on the industry. Noghabaei et al. (2020) conducted a series of surveys and “the results of the surveys show that industry experts foresee strong growth in the use of AR/VR technologies over the next 5 to 10 years. Furthermore, the results show a significant increase in AR/VR utilization in the AEC industry over the past year and potential opportunities.” Augmented Reality is “an interactive experience that enhances the real world with computer-generated perceptual information,” meaning AR, “overlays digital content onto real-life environments and objects” (SAP, n.d.). Considering this technology combines the real world and virtual world, it will impact how humans interact with and think about the physical world, thus shaping the methods and professionals of the construction industry. AR is being increasingly implemented in the construction industry because of its potential to improve safety, efficiency, and communication on the job site. Augmented Reality is in the future of the construction industry, whether we like it

or not, so the goal of my sociotechnical research is to understand how this technology will change the current state of the construction industry.

While AR has very limited applications in the land development field, land development is the first step in a construction project, so AR could be used to help implement the land development construction documents in the field. When the site/civil general contractor is performing their scope of work, it mainly involves moving dirt and working underground, so AR would have many benefits to help the contractor visualize where elements of the plans need to go in the field. Following the completion of the site/civil work, the general contractor comes in to begin construction of the building, and that is where AR has numerous possibilities to make an impact. While AR in the construction industry is not directly related to land development/site design, buildings would not be being built without land development, as it is the first step in preparing a site to be built on. Therefore, AR being used in the construction industry would not be possible without the process of land development.

Site Design For a Hotel in Pantops, Charlottesville

The Capstone project I am working on consists of developing a 2.397 acre parcel of land for a new 14,000 square foot hotel located in the Pantops region of Charlottesville, VA. The site is located just off Richmond Road (US Route 250) and is surrounded by Town and Country Lane, Olympia Drive, and Jalisco Way. My team is working with mentors from Timmons Group and is tasked with designing and developing a set of construction documents for a private developer, Pantops Hotel LLC. The site design will require determining the best location and orientation of the building that complies with the Code of Albemarle County, designing a parking lot that meets county requirements, developing final grading of the site, a stormwater

management design that complies with DEQ requirements, utility design, and erosion and sediment control (ESC) plans. Becoming familiar with the local codes that will guide all aspects of this project is of utmost importance because “they are the framework that regulates where and what type of development can occur” (US EPA, 2023).

Included in the final set of construction documents will be a general notes page, the existing conditions, site layout, grading plans, stormwater management plans, utility connection plans, and ESC plans. However, many of these items included in the final construction documents cannot be completed without coordination with the other disciplines involved in this project, such as the architect, plumbing engineer, electrical engineer, etc., to make sure all plans are coordinated before submission. It is important to have the drawings of each discipline aligned with one another because “if such errors make it onto the construction drawings, there is a chance that the building will end up with a deficiency, or a change order will be needed to resolve the issue” (Stonemark Construction Management, n.d.).

Site development is a crucial step in the design process for a construction project because a building cannot be built without the piece of land being ready to be built on. Therefore, for this Capstone project, it is our job to make sure the construction documents we create are proper instructions for a contractor to follow in order for them to properly prepare this site for the hotel. It is inevitable that the contractor will run into issues when following our documents in the field, so in the real world, we would have to be prepared to collaborate with the contractor to help solve the problems. However, this Capstone project is completed with the submission of the construction documents because Timmons Group already has a design that is currently being brought to life, so we will not have to work with the contractor to resolve any issues with our design being implemented in the field.

Impact of AR on the Methods, Professionals, and Overall Field of Construction

The sociotechnical topic I am addressing in my STS research is how AR is changing the methods, professionals, and overall field of construction. This is important because as AR technologies advance, they are becoming more and more prevalent in the construction industry, so I want to understand the effects these AR technologies are having on the industry. AR enhances a user's perception of the real world by overlaying computer generated content with what the user is looking at in the physical world, thus allowing for endless possibilities within the construction industry. Improvement in safety, communication, and efficiency are three important areas of construction where AR could make a big impact on the industry, especially considering the interconnectedness of these aspects of construction: “One key factor that significantly impacts both productivity and safety is effective communication. By facilitating clear and efficient information exchange among all stakeholders, communication plays a vital role in enhancing productivity and ensuring safety in construction projects” (First Compliance, 2023).

From reading and analyzing different journal articles, I will provide examples of AR technologies that improve one or more of these areas of construction, thus affecting the methods and professionals of the industry. Wu et al. (2023) proposed that the Cognitive Ergonomics Theory is reasonable and can be utilized when designing and developing wearable AR devices for improving the kinaesthetic performance of construction workers performing assembly tasks. The results of their experiment showed that “the developed AR application had significant advantages in improving kinaesthetic performance and understanding assembly workmanship” and “the application allowed the participants to complete the task more independently” (Wu et al., 2023). Zollmann et al. (2014) “introduced an approach for using AR for on-site construction

site monitoring and documentation” and by combining different components in this approach, they were able to show that “AR can support the documentation and monitoring of construction sites.” Kim et al. (2012) proposed an AR visualization system that can simulate equipment operation during different phases of a construction project, with an emphasis on spatial constraints, and it was determined that the “use of the interactive modeler in the planning or design phase would ensure cost and time efficiency of design and project specifications.” Hajirasouli et al. (2022) conducted a systematic literature review and identified the stages in the project lifecycle that were found to benefit the most from AR. It was found that the application of AR in these stages results in “increased safety and precision, reduced overall cost and time spent on a project as well as reduced number of errors” (Hajirasouli et al., 2022). The findings from a literature review conducted by Behzadi (2016) provide evidence of how AR will improve scheduling, communication and information retrieval, man-labor hours, and safety in the construction industry. These five examples of different AR technologies and how they will impact various aspects of construction and the people in the industry prove that the entrance of AR into the construction industry will change the professionals, methods, and overall field of construction by improving safety, communication, and efficiency. In my thesis, I will expand on these examples and include more examples from reading and analyzing articles in order to fully understand the impact AR will have on the construction industry.

In addition to finding examples through reviewing articles, I will also conduct an interview with Tim Gaylord of DPR Construction next semester to understand the effects of AR on the construction industry. Tim is the Corporate Director of Innovations at DPR, so I will interview him to hear about his perception of AR in the construction industry and how he thinks it will or already is impacting the industry. This interview will be a great addition to the method

of reviewing and analyzing literature because I will receive information about this topic through someone whose job is to explore new technologies for DPR to implement in the field, understand how these technologies will be used in the field, and understand the benefits and disadvantages of implementing these technologies. Gathering information through secondary sources, such as literature, is important, but being able to gather information through a primary source, such as an interview, is crucial to understanding what is happening in the real world and supporting the information gathered through the secondary sources.

Conclusion

The technical problem I am working on this year is to design and develop a set of construction documents for a private developer who would like to build a hotel in the Pantops area of Charlottesville. The sociotechnical topic I am addressing in my STS research is how Augmented Reality is changing the methods, professionals, and overall field of construction. This is important because as AR technologies advance, they are becoming more and more prevalent in the construction industry, so I want to understand the effects these AR technologies are having on the industry. I expect that my future research will reveal that AR is only changing the construction industry for the better by improving safety, communication, and efficiency on job sites.

References:

- Behzadi, A. (2016). Using augmented and virtual reality technology in the construction industry. *American Journal of Engineering Research (AJER)*, 5(12), 350–353.
- First Compliance. (2023, September 15). *Boosting productivity and safety: The importance of communication for contractors*. <https://firstcompliancesafety.com/boosting-productivity-and-safety-the-importance-of-communication-for-contractors/#:~:text=Effective%20and%20transparent%20communication%20plays,nece ssary%20precautions%2C%20thus%20averting%20accidents.>
- Hajirasouli, A., Banihashemi, S., Drogemuller, R., Fazeli, A., & Mohandes, S. R. (2022). Augmented reality in design and construction: Thematic analysis and conceptual frameworks. *Construction Innovation*, 22(3), 412–443. <https://doi.org/10.1108/ci-01-2022-0007>
- Kim, B., Kim, C., & Kim, H. (2012). Interactive modeler for construction equipment operation using augmented reality. *Journal of Computing in Civil Engineering*, 26(3), 331–341. [https://doi.org/10.1061/\(asce\)cp.1943-5487.0000137](https://doi.org/10.1061/(asce)cp.1943-5487.0000137)
- Noghabaei, M., Heydarian, A., Balali, V., & Han, K. (2020). Trend analysis on adoption of virtual and augmented reality in the architecture, engineering, and construction industry. *Data*, 5(1), 26. <https://doi.org/10.3390/data5010026>
- SAP. (n.d.). *What is augmented reality (AR)?*. <https://www.sap.com/products/scm/industry-4-0/what-is-augmented-reality.html>
- Stonemark Construction Management. (n.d.). *Why coordination is key in construction design: Benefits of integrating architecture and engineering*. <https://stonemarkcm.com/why-coordination-is-key-in-construction->

