

Introduction

Construction workers are constantly at risk of Work-related Musculoskeletal Disorders (WMSD) due to the dangers of their jobs. Construction workers are 50% more likely to develop WMSDs [1] and two times more likely to be injured compared to workers in other fields [2]. In 2018, the construction industry had 19,380 WMSD cases resulting in days away from work in the private sector, or 7.1% of the total WMSD cases in the private sector [3]. With the use of ergonomics assessment and Virtual Reality (VR) (Figure 1), it is possible to study the ergonomics of construction tasks.

Figure 1. VR office. PC: Kristine Huang



Objective & Impact of Professors' Research

Dr. Becerik-Gerber and Dr. Soibelman's research focuses on evaluating the ergonomics and the safety risks of construction workers controlling robots through Teleoperation versus directly controlling them on site. In order to do this, virtual modeling platforms such as Unity, Delmia, and SketchUp are used to design Virtual Reality Environments to simulate both situations. Along with Virtual Reality, Rapid Upper Limb Assessment (RULA) is used to assess the potential ergonomic risks of certain worker's postures.

This research is significant because it determines the ergonomic risk factors among construction workers. Since this field is very injury-prone, this research is key in order to identify ways to have a safer work environment.

Process and Results

We first used Unity and SketchUp to create model of a construction office and site for training purposes. Next, we compared the ergonomic risks of a construction worker on site and in a construction office with RULA. RULA is an ergonomic risk assessment tool associated with upper extremities that returns a score in the range from 1 (least risk) to 7 (most risk) based on the angles measured in various body parts, repetition and force. In figure 2, we created a manikin in a construction office.

Figure 2. Manikin in an office. PC: Kristine Huang



In figure 3, we created a manikin on a construction site behind the robot. The manikin is also carrying a control unit weighing about 3 kg.

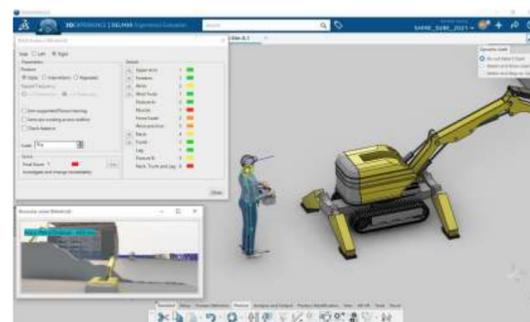


Figure 3. Manikin in on site. PC: Kristine Huang

As shown in the two figures, the workers' postures in both locations. In the office, the RULA score was 3, meaning a low ergonomic risk and some change may be needed. However, on site, the RULA score was 7, meaning a high ergonomic and that immediate change is required. Thus, this may be an indication that there are fewer ergonomic risks associated with working in an office than physically being on site.

Skills Learned

During SHINE, I was able to learn many new skills and deepen my knowledge of certain aspects of engineering work.

In SketchUp (Figure 4), I was able to use tools to model a 3D office with exact dimensions and proportions.

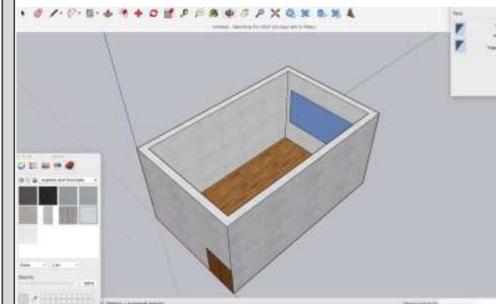


Figure 4. Modeling in SketchUp PC: Kristine Huang

In Unity, I was able to learn more about modeling in a virtual environment and animating. In addition, I was able to learn Scripting in C#, which allowed me to better control objects in the 3D model.

In Delmia, I was able to use the Ergonomics Evaluation tool in order to model a construction worker and his various joint positions and posture. I was also able to use RULA to assess the ergonomic risks of different postures.

References

- [1] Schneider, S. P. (2001). Musculoskeletal injuries in construction: a review of the literature. *Appl. Occup. Environ. Hyg.*, 16(11), 1056-1064.
- [2] Agumba, J. N., & Haupt, T. (2008). Perceptions of construction health and safety performance improvement enablers. *Proceedings of The Third Built Environment Conference 2008*, ASOCSA, Cape Town, South Africa, 184-200.
- [3] U.S. Bureau of Labor Statistics. (2020, May 1), *Occupational injuries and illnesses resulting in musculoskeletal disorders (MSDs)*, Retrieved July 20, 2021, from <https://www.bls.gov/iif/oshwc/case/msds.htm>

Next Steps

I would love to continue working with this research. Next steps would be testing the virtual environment with VR goggles to simulate the work of a construction worker remotely. I will also continue working with RULA to learn more about the causes and effects on posture, along with modeling on mannequins. Additionally, I will implement the skills I learned through this opportunity, VR and Ergonomics Evaluations, in different areas, such as through volunteer work.

How This Relates to My STEM Coursework

With my understanding of various topics from SHINE, I can incorporate many of these skills into my STEM Coursework. I can bring my experience of reading research papers to better understand topics in my science courses. I can also use my knowledge of scripting in C# in my computer science classes to code more efficiently and deepen my knowledge of different programming languages.

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