DESIGN AND CONSTRUCTION OF A CHAIN REACTION KINETIC ART WALL CLOCK
(Technical Project)

VIRTUAL AND MIXED REALITY SYSTEMS AS ADOLESCENT LEARNING TOOLS
(STS Project)

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 Mechanical Engineering

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December 12, 2022

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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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Introduction

The social attitudes of the 21st century have shifted into an overwhelming desire for a digital world. Almost every space and profession must reckon with this massive transformation towards a society of one's and zero's that seems to grow in inevitability daily (Forkosh Baruch & Erstad, 2018). Education is one field experiencing this transition. Education has long been integrating technologies into its world; voluntary changes have strengthened class engagement, such as the addition of interactive whiteboards (Firmin & Genesi, 2013). Additionally, events such as the Covid-19 pandemic have necessitated novel online learning methods. Advanced technology is quickly becoming an intractable part of the classroom experience.

With these developments in mind, the STS research paper shall investigate if virtual and mixed reality systems (VR/MR) can be effective learning tools for adolescent students. Research shall analyze benefits and disadvantages to determine if VR/MR systems can engage students and increase learning commitment.

As society shifts towards abstract technologies of simulation and modeling, the technical team determined it is important to preserve *tangible* creations that inspire learners. Thus, the technical project shall consist of a chain reaction kinetic art wall clock to exist as a lasting display in the University of Virginia Mechanical Engineering building. This clock will aim to fascinate building visitors while serving as an example of the hands-on possibilities of the University's engineering curriculum.

The prospectus first includes a description of the ideal final product of the technical project along with its elementary steps and potential learning opportunities. The prospectus then features a framing of the STS research paper. This includes an overview of the subject, establishment of research methods, detailing of STS frameworks that support the topic, and

identification of relevant players in the space at hand. Lastly, the prospectus presents a brief examination of specific texts important to the STS discussion.

Technical Project: Design and Construction of a Chain Reaction Kinetic Art Wall Clock

The capstone technical project will consist of a chain reaction kinetic art wall clock that will provide reliable, perpetual timekeeping and visual entertainment. The technical team noted faculty desire for student-designed display projects around the School of Engineering. Thus, the clock shall become a permanent wall fixture in the Mechanical Engineering building for visitor engagement.

With the chain reaction premise in mind, the technical team aims to generate exciting pinball motion across various paths around the clock face. These paths will synchronize with the clock striking unique times in distinctive ways. Every minute, a pinball is to travel around the face of the wall clock on a wireframe track, following a rollercoaster-type path of loops and drops. A ball reservoir at the top of the clock releases this pinball at a set interval. At the end of this "minute track," the pinball deposits into a holding block back near the top of the clock face. This holding block is to be reminiscent of the starting gates of a horserace, with individual pockets for each ball deposited.

At the start of the next minute, the upper ball reservoir releases another pinball onto the wireframe track. Thus, after nine minutes, nine balls will have built up in the holding block, which shall fill its capacity. At the end of its run around the track, the tenth ball will pass the holding block gates and trigger the release of the nine balls into a pegboard down the center of the clock, creating an exciting and chaotic waterfall effect every ten minutes. Following this event, a continually-rotating vertical gear at the back of the clock will scoop the nine "waterfall"

balls into its teeth and lift them to the top of the clock. At the top, the gear deposits these balls back into the initial reservoir for the clock to continue forward.

One final visual element of this design shall occur every hour. Around the clock's border and throughout the display, the technical team will affix programmable LEDs (light-emitting diodes). When the hour strikes, these LED strips will perform an exciting light show.

The clock is to be steadily maintained and monitored via a programmed mechatronic interface hidden from audience view, ensuring smooth timekeeping and providing fail-safes for errors in the various physical mechanisms of the piece. Motors shall operate the backdrop gear, and electrical circuitry will power the light show and certain regulatory mechanisms. All other mechanisms shall depend on physics rather than mechatronics. As for the logistics of constructing this project, the technical team will design, prototype and finalize the piece in the Fall 2022 semester with an approximate budget of $700.

Complex in its overall design, this chain reaction kinetic art wall clock will prove to be a fascinating and attractive physical display for the Mechanical Engineering building. This process will leave a tangible and lasting legacy while providing a unique, hands-on learning experience to the team. The technical team will gain skills in 3D modeling, 3D printing, laser cutting and physical assembly, essential abilities for future engineering careers. Above all, the clock project shall inspire current undergraduates, faculty, visitors and prospective students on engineering tours by demonstrating the exciting and advanced projects the mechanical program offers.

STS Research Paper: Virtual and Mixed Reality Systems as Adolescent Learning Tools

The STS research paper shall examine the cutting-edge simulation systems known as virtual and mixed reality. This technology is broad in its possibilities, including entertainment,

communication, and technical modeling. As society shifts towards digital dominance, one unique concept is the implementation of VR systems into the classroom. With the effectiveness and support of public education a hotly-debated topic, it is critical to consider if society's new technological frontier will make strides for the classroom or if it shall inhibit learning in any way (Hochschild & Scovronick, 2003). The ultimate determination will be if virtual and mixed reality systems can be effective educational tools for adolescents.

There are several significant players in this discussion. The children benefitting or being harmed by the implementation of VR/MR systems are of primary focus. Any decisions made regarding the usage of this technology have a direct impact on their education and mental health. In the current social context, this group is unique in that it is often powerless to influence decision-making. Various other actor groups possess authority and oversee this group. It should be noted that more receptive educational experiences consisting of class feedback and democratic learning processes are a modern possibility with many positives (Badley & Patrick, 2022). A class structure such as this could allow virtual reality a better chance to flourish as a learning tool, a theory that shall be explored further in the research paper.

Teachers are another essential group of actors here. How difficult will the transition be from current teaching styles to a method that integrates virtual spaces and tools (Lasić-Lazić et al., 2018)? Can all teachers make the transition uniformly, or is it only practical for a certain subset? These questions will be examined with the potential for educator success in mind. Elementary and middle school levels shall provide the confines of both the student and teacher actor groups.

Secondary groups that shall play into the discussion include school administration, which can include principals, school boards and local government. This actor group often maintains the

metrics that monitor student success. They are thus relevant to understanding the effectiveness of the new learning tool at hand. Additionally, VR developers play a role in directly influencing the features and capabilities of the potential learning aid.

To assess the research question, literature review shall be performed. Analysis of numerous secondary sources will determine the current successes of VR in the classroom and prospective benefits of its further introduction. These sources shall also include case studies of previous technological implementation in schooling, particularly for technologies functionally similar to VR/MR systems. This research method will prove effective in synthesizing several scholarly viewpoints into a cohesive argument on the efficacy of the technology at play. In many cases, these scholars have analyzed and translated raw data and metrics into a more explicit literary form. This pattern shall provide concise examples of past successes and failures that will aid in constructing a defined statement on the educational value of VR.

The STS paper analysis will fall under the Social Construction of Technological Systems (SCOT) framework proposed by Trevor Pinch and Wiebe Bijker. This framework harnesses the concept of social constructivism to argue that technology is dictated by social action and human desire. Technology and its content should be analyzed within its social context rather than as an independent creation that affects the world around it (Bijker et al., 2012). In this case, the social context involves increasing digital usage and attitudes supporting cyber-development (Forkosh Baruch & Erstad, 2018). This context mandates immediate analysis of the potential impact of VR implementation. The concept of technological momentum shall be an underpinning to the SCOT framework; since the growth of digital technology is a larger cultural movement that currently maintains much strength, Thomas Hughes' momentum concept is highly applicable to the spread of VR systems into the classroom (Bijker et al., 2012).

The Fall 2022 semester shall focus on collection of further sources, organized and synthesized into a reference guide for writing usage. The composition of the research paper will take place in the Spring 2023 semester.

Key Texts

The research paper writing process will be influenced by several key sources. *Engaging Virtual Environments* focuses on the conceptual necessities of implementing digital learning techniques. Most importantly, the work considers how to replicate online the abstract traits of the learning process, namely informality, spontaneity and student focus. These questions are mainly grappled with in a Covid-forced online learning setting. However, sentiments regarding instilling specific values into an inherently disconnected learning environment apply to VR systems that appear immersive but have a reality disconnect at their roots (Ricevuto et al., 2022).

Mixed Reality in Learning Factories is another source for analysis. This work analyzes the more technical challenges of implementing particularly mixed reality for learning. Beyond being able to convey educational lessons through the technology, can vast numbers of students be easily trained to *operate* systems such as these? Can educational systems execute this process with ease and within a brief period? A "hackathon" case study within the piece exemplifies some of the challenges along with some of the payoffs of integrating students into a virtual space, primarily reinforcing the potential for students to work smoothly with this advanced technology (Juraschek et al., 2018).

A third source, *New Perspectives on Virtual and Augmented Reality*, considers the benefits of virtual reality in an educational space. The work depicts several highlights of the technology, including visual excitement, learning speed, and information accessibility. The

writing frames the implementation of VR/AR systems into the classroom as an exciting challenge that can offer new opportunities. It will be a primary source for pulling technology success metrics and possible benefits (Daniela, 2020).

Lastly, *Virtual Reality, Augmented Reality and Artificial Intelligence in Special Education* analyzes how new technological frontiers such as VR will impact students diagnosed with SEN, or Special Educational Needs. When any field experiences sweeping changes, one must consider how specific sub-groups may be affected differently than who is perceived as the "primary" subject or user. This source will aid in assessing if there are any pitfalls of the new technology for a group that often does not receive the same attention as the "traditional" educational program. Likewise, potential benefits unique to this group will be addressed (Anderson, 2019).

Conclusion

The technical project deliverable shall be a functioning chain reaction kinetic art clock intended to form an inspiring and engaging wall display in the Mechanical Engineering building. The technical team will strengthen design, modeling and manufacturing skills in the creation of a cohesive final product. A final technical report shall document this process. The product will draw in visitors and demonstrate the prowess of University of Virginia engineering.

The STS paper will investigate the value of using virtual and mixed reality systems in the classroom, analyzing its potential for success in educating adolescents while noting potential drawbacks. A literature review methodology will apply to the research question, with arguments portrayed through the lens of the "Social Construction of Technology" STS theory. The paper

will ultimately assess the merit of introducing a newly-digital world into classic educational spaces.

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