Thesis Portfolio

The Design and Optimization of a Lighted Kinetic Art Surface Display

(Technical Report)

Developing Future Engineers at Home: A Deterministic Analysis of Various STEM Toys and their Effect on Learning and Enthusiasm in Children under Eight Years Old

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

A desire to improve engineering education motivates both the capstone project and STS research paper. The capstone project is a lighted kinetic sculpture designed to inspire interest in mechanical engineering for higher-education students. Following future developments, the lighted kinetic sculpture has the potential to serve as an educational visualization tool for students. Shifting to a younger target demographic, the STS research paper analyzes the effect of engineering toys on the learning and enthusiasm of children under eight years old. Like the kinetic sculpture, engineering toys have the potential to increase students' excitement for studying in a Science, Technology, Engineering, and Math (STEM) field.

The capstone project is a lighted kinetic art sculpture designed for installation in the Mechanical Engineering Building. The overall goal of the project was to create a mystifying sculpture that emphasizes the importance of mechatronic design and optimization and can serve as inspiration for future mechanical engineering students. The team first focused on optimizing a single lighted unit for minimal cost and assembly time. Design decisions were driven by the desire to maintain a balance between simplicity, functionality, and visual appeal. The team analyzed the limitations of prior art before developing a compact actuation system that preserves the visual effect and allows the motor to control both the lifting and lowering of the lighted acrylic rod. After several prototypes, the team decided that the most cost-effective and space-efficient solution is a quad-unit that incorporates four lighted rods and their actuation systems into a small area. To demonstrate the modularity of the design, the team presented a display of four quad-units and programmed the rods to move in a simple wave pattern. The project can be expanded to a larger display for a more mystifying aesthetic effect that will spark onlookers' interest in mechanical engineering. Future work will focus on user interaction, and the team

hopes that students will be able to program in their own functions and use the kinetic sculpture as a fun way to visualize surfaces, waves, vibrations, and more.

As the demand for engineers has increased and more students are becoming interested in working in Science, Technology, Engineering, and Math (STEM) fields, researchers and innovators are attempting to target the learning capacity of young children by designing STEM toys for use outside of the classroom. In addition to creating excitement about engineering topics, such toys have the potential to decrease gender bias in the field by introducing girls to STEM early, giving them more confidence to pursue engineering later in life. However, there is a lack of research to support the use of engineering toys. To address the research deficiency, the paper analyzes the effect of engineering toys on the learning and enthusiasm of children of under eight years old. Documentary research and interviews guide analysis of the different types of STEM toys and the extent to which certain toys have led interviewees to pursue study in STEM fields. The paper uses the technological determinism framework to study the ability of STEM toys to directly influence children's career paths and to identify any negative consequences associated with the use of engineering toys. The study will conclude with a concise guide to developing successful STEM toys, and the results of the study will allow innovators to design effective toys that will encourage real learning, promote the engineering profession, and help decrease the gender gap in STEM fields.

The lighted kinetic sculpture serves a similar function to an engineering toy for older students, and the capstone team designed the project with the goal of generating excitement for mechanical engineering. The STS analysis reveals that enthusiasm is important for increasing students' confidence entering engineering fields. Increased confidence in STEM can lead to a narrowing of the engineering gender gap, which is present in programs for younger students as

well as in universities and industry. Finally, the STS research also generally motivated the future work of the capstone project by emphasizing the importance of interactive engineering education for developing future engineers.