Spark of Imagination Capstone

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Work In Progress: “Spark of Imagination: Creating Interactive Elements On Student Tours”

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Abstract

This paper overviews the “Spark of Imagination” senior capstone team’s project which is to create interactive and innovative experiences throughout Ohio Northern University’s (ONU) first floor of the College of Engineering building. The primary motivation behind this project stems from the client specifically. The client, the Assistant Dean of the College of Engineering, wishes through these experiences to attract more prospective students and their parents, increase student retention through the full length of the program, and ultimately have more students attend ONU. The secondary motivation is to emphasize the “magic” of engineering – specifically what kinds of illusions and cool visual effects can be created through using the knowledge gained from a variety of engineering disciplines studied by the team’s members.

Research has shown that students' engagement with their academic environment significantly influences their overall success. Positive feelings toward their academic building can foster improved student retention, assist in student well-being, and create overall satisfaction with their college experience [1]. The capstone team also found that there is a competitive aspect to recruiting students for colleges, and having something that intrigues modern students can provide an edge for a university. One dissertation found that the modern student wants “their educational needs on their terms: their style, their space, their schedule” [2]. Other universities are following this model by giving more interactive tours. For example, the University of Alabama added technologies to their library to provide prospective students the ability to create 3D printed script Alabama logos and custom videos from their orientation.[3] By designing these creative experiences, the team hopes that prospective students will find the technology and collaboration between different majors makes the college a fun and exciting place, which should help students feel more comfortable seeking help and spending time in the building .

Currently, the College of Engineering has various cabinets which display famous alumni and awards won by the college. It also includes a large glass statue placed in the middle of the first floor atrium known as the Fountain of Inspiration (see Figure 1 below). A previous capstone

team wired up the statue with programmable lights in order to brighten up the college and act as a talking point for the Assistant Dean as he takes families around on tours.

Figure 1: Fountain of Inspiration

These can be viewed as competitors for this project. Each experience designed includes at least one light effect. Therefore, the experiences will comply with the wall outlet regulations set by the National Electrical Manufacturers Association (NEMA) standards [4]. Additionally, the components chosen for each experience have been selected to ensure that they will not negatively impact individuals walking past or the environment.

Stakeholders and their impacts from the final design have been identified. The primary stakeholders for this capstone project are the Assistant Dean and the prospective students and their families. However, anyone walking through the College and past the experiences (i.e., current students and professors) is also important to note. Discussions are currently underway with the Assistant Dean regarding how each experience should be visually presented when no tours are taking place (i.e., the "off" state). The proposed solutions from the team are elaborated upon towards the end of the paper.

Initially, viable design ideas were discussed that would place experiences throughout the entire College. However, after discussions with the capstone review boards and the Assistant Dean, it was realized that the goals for the project extended far beyond the scope. As a result, the ideas were narrowed down to focus primarily on the first floor of the College (i.e., the floor where prospective students will spend the majority of their tour). Each experience designed is connected through a story element called the 'Spark of Imagination.' This mystical energy follows the student, igniting each show location on the tour, using light and other effects to craft each experience. The first of these experiences is featured in the entryway into the Dean's Suite, where the 'Spark' will be projected onto the wall as prospective students and their families leave to begin their tour from the Suite. As the Assistant Dean passes by the Fountain of Inspiration with the tour group, the 'Spark' will flow through the base of the statue, showcasing the statue's life source as the 'Spark' emanates through it. The College of Engineering history wall will have the 'Spark' travel across its top as the tour group reaches the beginning of the timeline,

highlighting each section of the wall as the group walks past. At the end of the history wall, a mirror will be mounted so that when the prospective students stand in front of it they will see themselves as ONU Engineering's future. All experiences will be controllable for the Assistant Dean through the use of Bluetooth and two controllers (one acting as a beacon and the other as a receiver).

The team is building these experiences during the spring semester. With these ideas, the team hopes to bring intrigue and inspiration to prospective students touring the building. This project will give them a glimpse into what they can do with their engineering career as well as make them the center of the storyline. The hope, too, is that this capstone project can be a continued project for future senior engineering students to expand upon.

Problem Definition

The objective of this project is as follows: the team is to create interactive experiences that enhance the College of Engineering (CoE) tours that excite and help retain prospective students and their parents. The motivation for doing this project lies in two places. The first motivation (i.e. the Assistant Dean's motivation) is to enhance the College of Engineering in ways that will attract more prospective students and their parents, and ultimately lead to more students attending X University. The second motivation (i.e. the team's own motivation) for this project is that each member of the team has an interest in using his or her engineering knowledge and skills to create illusions and enchanting add-ons to the engineering building.

Project Approach

Constraints and Evaluation Metrics
The team has identified various constraints in regards to the project. All added experiences to the CoE must take up less than two minutes each when used on a general tour. The illusions and add-ons must include independent controls that allow the user to have full command over the hardware and software if it begins to go haywire. To have a cohesive storyline with all of the experiences, a light effect must happen within each of them. With this, there must be at least one active element within each experience, whether it is lighting, motion, sound, or another potential movement, and all regulatory standards must be followed (i.e. NEMA standards) [4].

One evaluation metric is that the products should be as noticeable as possible, but all the machinery used for the illusions needs to be as subtle as possible. The final product should enhance the abilities of the "magic" of engineering as much as possible. Since these experiences will be placed within the College of Engineering, the team wants to put them in places that minimize required changes in the Assistant Dean's tour route.

Stakeholders
The team has identified four main groups of stakeholders for the project:

- Assistant Dean of the College of Engineering
    - Due to the Assistant Dean leading the tours almost every time, his exposure to the capstone will be higher than current students. This means he will need to be on

board with all potential designs that were demonstrated and his opinions will be crucial to the final product's captivity.

- Prospective Students and their Families
    - Since the focus of the project is to change the stakeholders' experience during a tour, what the team will do will affect the impression that prospective students and their families have on the Engineering building.
- Current Students
    - Current students have something new in the building that can give them a reason to explore places they have not before.
- Professors
    - Professors that end up having to give the tour to prospective students will have something to show the students, rather than just showing them room after room. Given the aforementioned enhancements, this will hopefully provide professors a better, clearer, and more exciting tour path

Results and Discussion

Proposed Solutions

Solution 1: Footprints into the Dean's Office

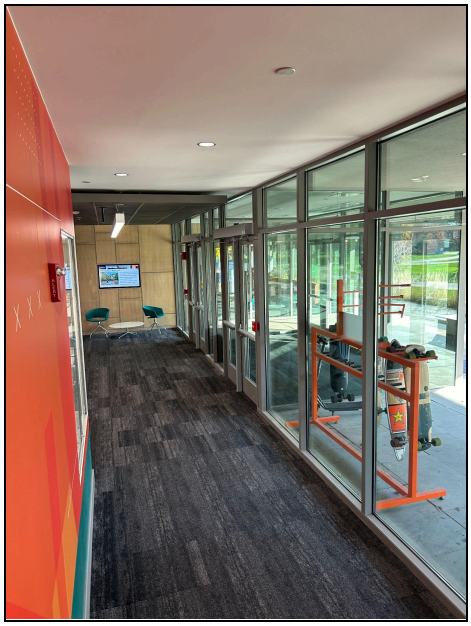

Figure 2: Entry Hallway to the Dean's Suite

When students and their families are coming into the Engineering building, they meet with the Assistant Dean in their office and then leave to begin a tour of the building. The Assistant Dean will manually turn on a projector with a wireless remote which starts the solution. As prospective students follow the Assistant Dean, the 'Spark of Imagination' will be projected onto the wall spelling out the letters ONU and making an arrow below the letters to guide the student to continue forward. Once they leave, the projector will then either shut itself off after a timed loop or be manually turned off again by the Assistant Dean.

This solution meets the needs of the Assistant Dean because it accompanies the storyline requested by the Assistant Dean, creates something visually appealing, and has movement. The use of projections makes these effects seem more “magical” to the prospective students and draws them to the college. This creates value by both assisting the Assistant Dean in making a more unique tour experience, and showcasing the work done by multiple types of majors within the college.

Solution 2: Atrium Statue (Fountain of Inspiration)

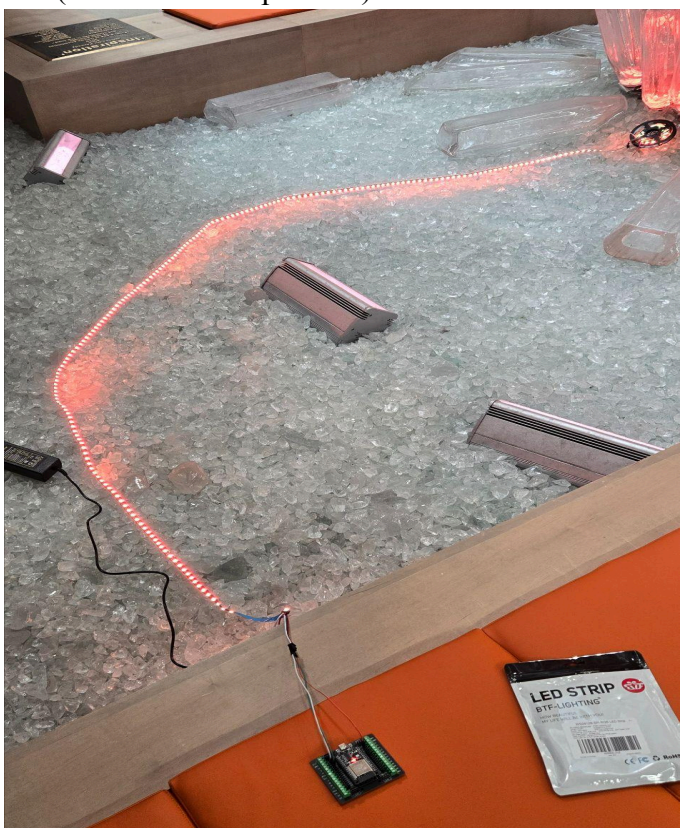

Figure 3: Test Lighting Strip in Fountain Base

This solution seeks to illuminate the Fountain of Inspiration with ‘the Spark of Imagination’ in the area beneath/around it as a tour group is traveling past through the use of wireless technology. By using an array of Red Green Blue light strips, the Fountain’s “water” (i.e. the glass rocks) at its base will appear as though the ‘Spark’ is swimming through the Fountain and then continues up the Fountain. The team’s effects will not directly connect to the preexisting coding inside of the actual statue. It will act independently, accenting the lighting effect already there.

The ‘Spark’ will be triggered by a receiver hidden under the “water” that identifies the transmitter which the Assistant Dean will be carrying with him. The Fountain consists of an 8ft x 8ft square base which would require a minimum of 25 ft of RGB light strips for the effect to be fully carried out.

The Atrium Statue's concept meets the desire of magic and imagination that the team seeks to bring for prospective students and their families. By illuminating the Fountain and the "water" at its base, the team is adding a spark of wonder about engineering and excitement to the touring students as the 'Spark' seemingly follows them along their path and appears to travel up the Fountain.

Solution 3: History Wall

Figure 4: History Wall Section to be Modified

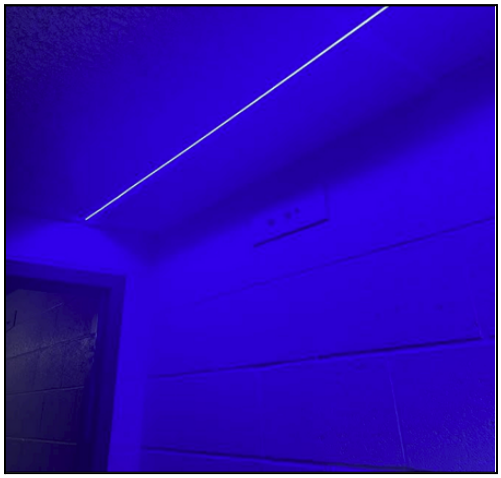

Figure 5: Light Strip Example

There are two primary ideas in regards to the history wall. The first concept is shining lights down onto the wall. The team plans to use WS-2812b BTF RGB Lights that allow for desired programmability [5]. As the Assistant Dean moves from one end of the hallway (i.e. the beginning of the timeline) to the other end (i.e. the most recent date on the timeline), sections of lights will shine down onto the different sections of the wall. These sections are based off of the years that are displayed on the wall. For this idea, the Assistant Dean will be carrying around a remote so when he (and the prospective students and their families) are within range of each designated section of the light strip, a button can be pressed to activate the lights for that section.

The second concept is adding a mirror to the end of the history wall. When the Assistant Dean and the prospective students move to the end of the history wall, they will reach a display containing a reflective plexiglass mirror. The mirror will be able to switch from translucent (in this state it will be picturing a design/text) to reflective when backlighting is turned on and off, respectively. In line with the storytelling aspect of the tour, this mirror is representative of the future of the ONU Engineering timeline. When a touring student steps in front of the mirror, the mirror becomes reflective and so the wall displays them as “the future”.

Solution 4: Wireless Communication Through ESP-NOW Protocol

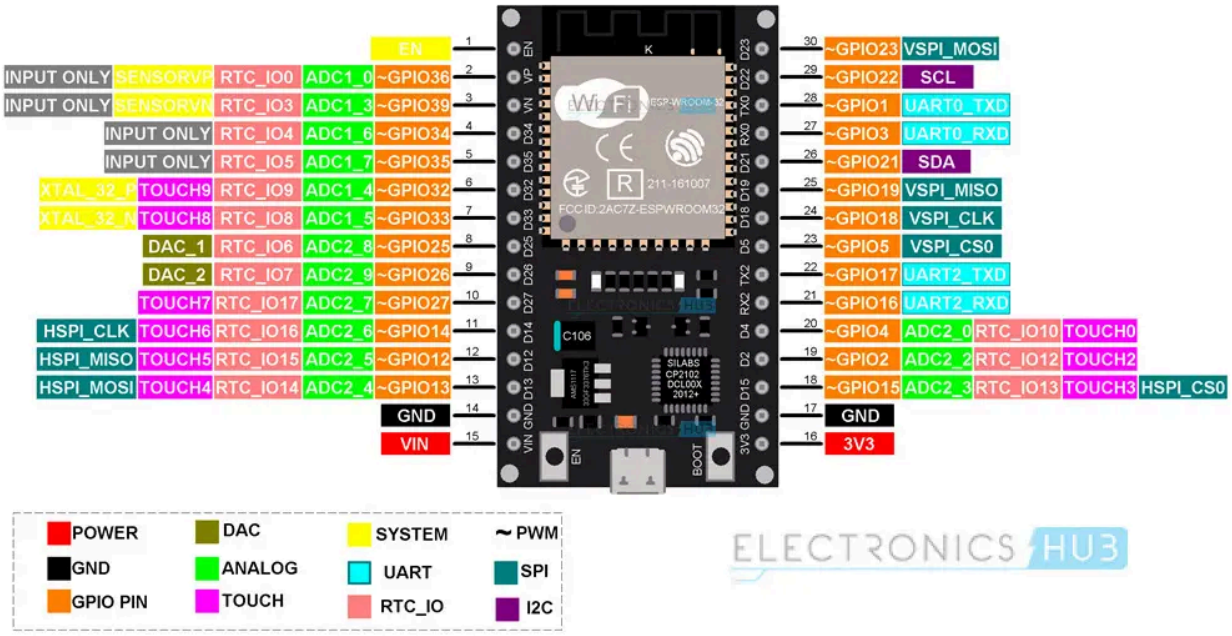

Figure 6: ESP-32 WROOM C Pinout Diagram [6]

To activate all of the team's experiences around the building, a solution has been found where the Assistant Dean will be able to walk close to the experience and trigger it wirelessly at the push of a button. The Assistant Dean will carry around a remote that will consist of an ESP-32 WROOM C microcontroller connected to a battery pack [7]. Each experience will also be powered by the same controller. The two chips will communicate using a protocol known as ESP-NOW [8]. This protocol takes the standard OSI network model and compresses it down into one single network layer. This allows for faster and more efficient transmission of data between the two chips at around 214 Kbps. It also has the ability to communicate with up to 20 devices, which means the team's project could hold a capacity of 19 experiences and 1 remote.

In order to determine which of the experiences the remote is transmitting to, the communication protocol broadcasts an incrementing numerical value to determine whether the experience is on or off. By using modular arithmetic, a value can be set for the number of times the button can be pressed before it gets reset back to state zero. For example, assume that there are 6 specific sections of the History Wall that need to be illuminated by our lighting array. The remote carried around by the client will constantly increment by 1 to an arbitrary limit based on the compute power of the ESP-32’s Arm based architecture. On the controller side of the history wall, it will receive whatever value is being sent by the remote, divide by 7 (the number of sections needed

per the assumption plus 1 for the off state) and then store the remainder. This stored value will be an integer in the range of 0-6, which allows a different lighting condition, including the off state, to be set for each possible integer indexed from 0. ESP-NOW has the ability to send multiple values at the same time, therefore by using multiple integers, it is possible to control all three experiences with the same remote.

The lighting effects will be controlled by the same chips using a controller library called FastLED[10]. This allows the user complete control over what colors are being displayed and permits expandability in the number of lights that need to be controlled. Combined with the ESP-NOW protocol, they form the foundation of the entire project.

Conclusion

Due to the nature of the project, it does not have much of an external market implication. However, the internal market implication – such as ONU revenue from new students applying and joining the college – would be the main focus. The potential base group would be the prospective students looking to join the College of Engineering. There is not a traditional profit incentive with this project. However, due to the nature of the project the hope is that there is an increase of students who are in the College of Engineering. In the case of prospective students, the team would hope to see an increase of at least 15-20% for students that are interested in the college itself due to the project. In terms of changes, the team looks for flexibility in the edits that can be made to the building itself (changing lights, running electrical work through walls, drilling or cutting into walls, etc.) and, if there were more available time, wishes to extend the project to more spaces within the building. The desire to make changes to the building itself has been discussed with the Dean of the College of Engineering, and he is willing to accommodate and has approved a majority of the team's wishes. And, as mentioned before, the idea of having this project be a multi-phase capstone (i.e. include it as a capstone option for the upcoming years) has been discussed. This appears to be a favorable idea due to the encapsulation of the mind that this project accomplishes through its enhancements towards the College of Engineering.

Acknowledgment

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