

# Senior Design Proposal Template

## 1 Introduction

This project will aim to create an enjoyable time for the user by recreating an arcade-style pinball machine with specific features to model the electrical engineering experience at Notre Dame. No pinball machine on the market right now truly encapsulates what it is like to be a student quite like this one will. The project will incorporate several moving parts to emulate the difficulty and challenge of the original game. The pinball machine will use a simple spring mechanism to launch the ball into the board. Then, a series of motors will allow for elements to move and vibrate on the board to continue moving the ball. These moving elements will include pressure sensors to determine point values. The pinball machine will be connected to a serial monitor on a computer via a USB port to display leaderboard and score counts as well as allow the player to input their initials. Audio clips will play and LEDs will surround the board and use data on the movement of the ball and total score to create different, complex lighting effects.

## 2 Problem Description

The widespread reliance on screens has created issues like excessive scrolling and reduced social interactions, leading to isolation. This challenge is especially prevalent for stressed students, like those in the Notre Dame electrical engineering curriculum, where the rigorous curriculum can lead to heightened stress levels and need for effective outlets. Our EE-themed pinball machine will address these problems by encouraging users to take a break from their electronic devices, and interact with others in a shared environment. It will serve as both a stress relief and community-building tool.

The pinball machine will incorporate elements inspired by the electrical engineering curriculum at Notre Dame. For instance, the “final boss” could be the senior design course or a professor. Additionally, there will be funny auditory recordings of professors, including funny quotes from Professor Fay, Professor Stevenson saying “you will not graduate” or “not enough tech electives” or “you still need to take a lab” in the event someone loses, and Professor Huang yelling “Patrick Mahomes” when a good or bad play occurs. Obstacles that get in the way of the ball will be labeled after difficult courses, including “signals and systems” and “digital design.” All of these elements will create a playful and relatable experience that will resonate with Notre Dame electrical engineering students. The game’s thematic design will foster a sense of community and camaraderie among students, creating an appreciation for the shared experiences.

### **3 Proposed Solution**

Although screens and technology are aspects of our project, the focus for the user will be focusing on the movement of the ball and being present with the people around them. A lot of the LED and display screens are to add excitement and hilarity to the game to allow users to have something to socialize over while they play. Also, the inclusion of the leaderboard and the scoring system will bring out the competitive nature of the user and engage more complex aspects of their brain than typical social media. Overall, the flashy nature of the machine and the competition involved will engage users and allow the machine to be a place for friends to play with each other and enjoy each other's company.

### **4 Demonstrated Features**

#### **1. Complex LED light show**

The LEDs will be controlled using feedback from the sensor and thus will be controlled using our microcontroller. This will require different LED responses based on the outputs from the sensor. The LED light show will also correspond to the audio feedback. These different LED responses will be controlled by the coding that determines how many and which LEDs should be put to HIGH or LOW.

#### **2. Moving motor-controlled obstacles (horizontal movement)**

Our group will CAD and 3D print differently shaped parts to be used as obstacles along the track. These parts will be connected to a motor that will allow the part to have slight horizontal movement to make the game more difficult for the user.

#### **3. USB Interface to Scoreboard**

The frame of the machine will have a USB C port that allows you to connect to a computer and its corresponding serial monitor. This will allow for communication between the microcontroller and the serial monitor. At the start of the game, the user will be able to input their initials using a keyboard and see the machine's high score. As the user gains points as the game progresses, the serial monitor will update with the new score every time this occurs.

#### **4. Pressure sensors to detect ball movement**

The pinball machine will be able to detect the ball being fired from the spring mechanism, hitting the target mechanisms, and when the game is over.

#### **5. Display to show “final boss” and other graphics**

On the headboard of the pinball machine, a screen will be used to display vintage graphics that are reminiscent of older pinball machines. One graphic will include a “final boss” at the end of the game.

#### **6. Computer program to calculate pinball score**

We will write code to keep track of the score of the user for each game based on feedback from the pinball’s movement and contacts. If the user exceeds one of the scores saved in the registers for top scores, this top score will be rewritten with the user’s score.

#### **7. Speaker to play music and accompanying sounds**

A speaker will be used to play background game music throughout regular play of the game. During key parts of the game, such as reaching a high score or losing, voice snippets will respond with either something positive or negative.

#### **8. Start button to initiate machine**

The pinball machine will contain a button on the front end that the user will press to start the machine. We will program a button interrupt so that pressing the button will be the condition that allows for other outputs of the microcontroller to work. Pressing the start button will also begin a specific lighting display and the starting screen on the serial monitor.

## **5 Available Technologies**

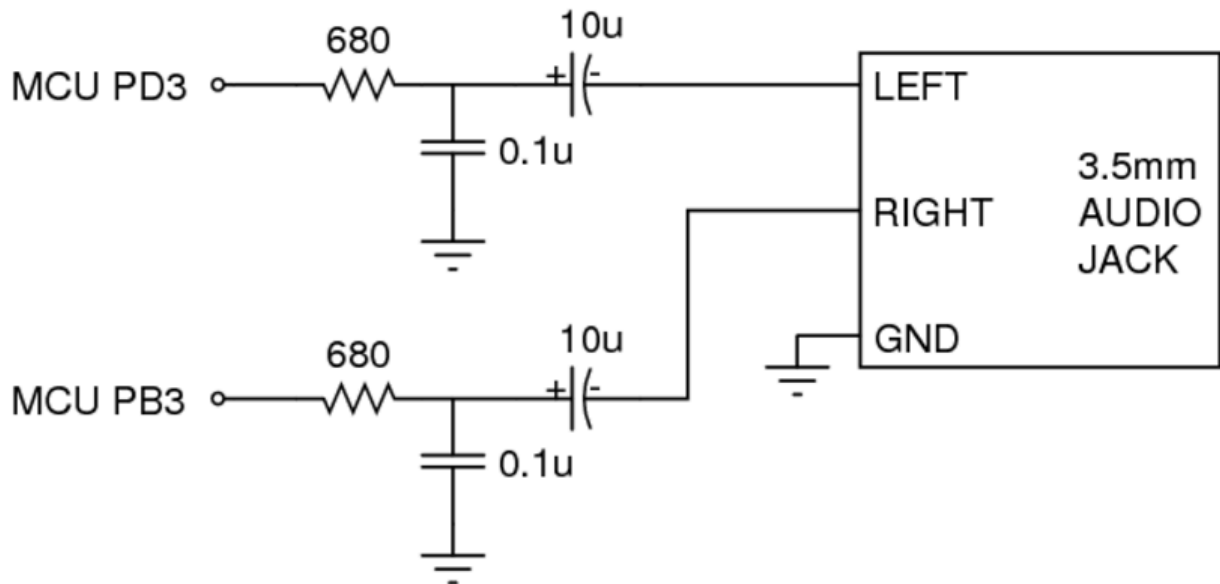
**Microcontroller:**

**Motors:**

[Rotational Motor \(\\$2.10/unit\)](#)

**Speaker:**

Circuit Schematic:



Parts:

[Audio Jack \(\\$5.99\)](#)

[Dual Speakers \(\\$20.94\)](#)

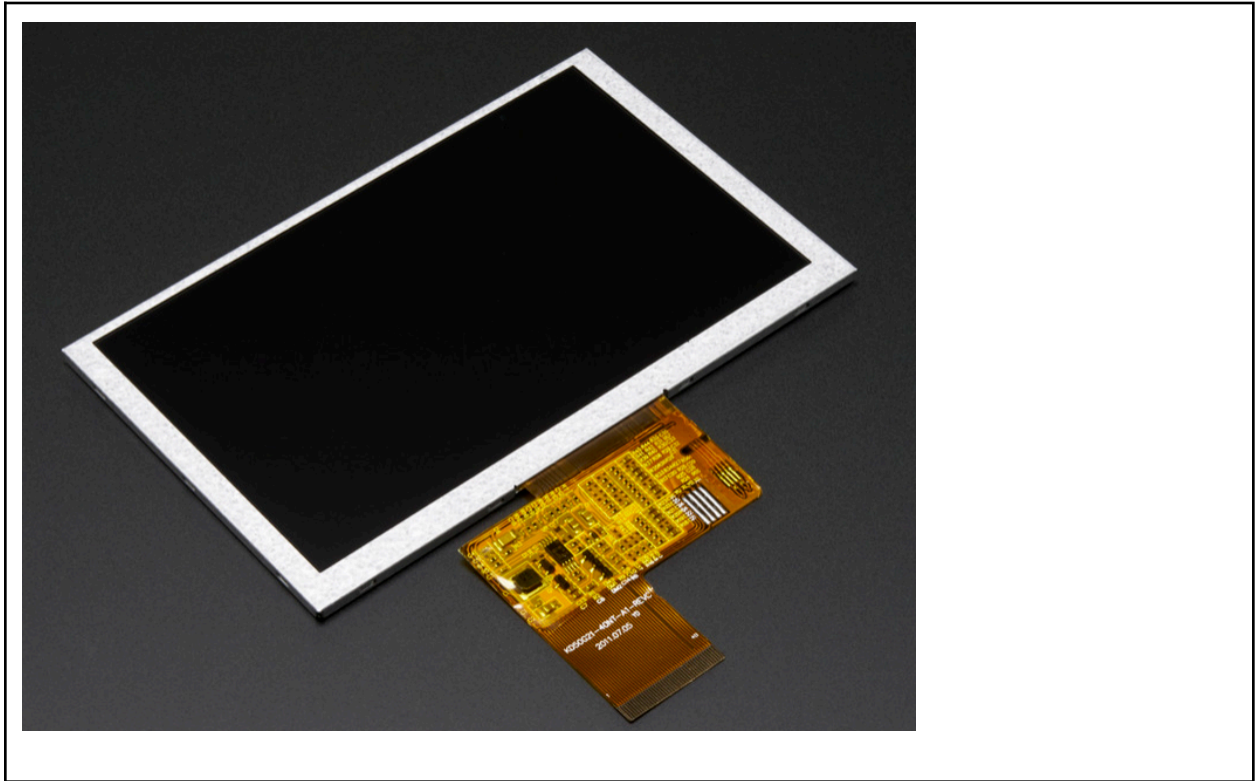
**Circuit board: \$50**

[Push buttons: 3D printed parts & interface: \\$0.30 each](#)



**Pinball flippers & buttons**

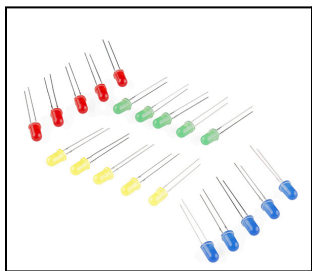
**Display:** \$27.50



**Pinball Shooter:** \$30 or composed of assorted parts



**Lines of LEDs:** about \$20 total (we are also considering LED strips, but individual LEDs give a more classic design)




**\*estimated budget for wooden parts, balls, poster: \$100**

**Flippers:**



**Ebay sells a pair for \$16 [here](#)**

**Solenoid for moving the flippers: \$23 [here](#)**

Image	Part#	Availability	Price
	<b>Coil - solenoid flipper</b> #A-30468 <a href="#">Less info</a>	In Stock	\$22.99

**PRODUCT DETAILS**

Gottlieb 3 terminal, dual winding flipper coil.

Reference:

A-30468

Replaces A-27643

Weight: 4.7 oz

## **6 Engineering Content**

We will need to use CAD and other modeling softwares to design the physical parts of our pinball machine like the bumpers and targets. We will also need to utilize the full suite of tools in the EIH to fabricate the box containing the pinball machine. Furthermore, we will need to do significant wiring to connect all the sensors and electronic parts from the play area to the display and main computer running the game. Finally, we will have to use a microcontroller to take inputs from the play area (i.e. ball impacting the targets, beginning the game, and losing). This will then output scores to the screen to keep track of the player's progress and high score.

## **7 Conclusions**

Our design will be a fun, community building experience for all ages, with a specific focus on Notre Dame electrical engineering undergraduates. This personal pinball machine will feature multiple targets, an interactive display, and a speaker to enhance the user experience. This machine will allow the user to launch the ball into play with a spring loaded mechanism which will start the game. The user will then use buttons on the side of the machine to move the 3D printed paddles and hit the targets. Hitting these targets will trigger buttons underneath the board which will provide immediate feedback, displaying feedback on the LCD and outputting audio on the speaker. It will also cause the player's score to increase. When the player loses, the ball will impact another button and display a losing animation and audio piece. Then, if the user achieved one of the top three scores, they will be able to input their initials using the paddle bumpers and the machine will store their score for future users.