Thesis Project Portfolio

Self-Playing Xylophone with Real-Time Note Detection

(Technical Report)

Coevolution of Audio Playback Technology and the Music Industry

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Two of my favorite things are engineering and music. Over the last four years, I have rapidly increased my knowledge and skills in both fields, and have found ways to integrate them into each other, including building my own instruments, designing a guitar pedal, and perhaps my favorite of these creations – my capstone project. I, along with my wonderful teammates, designed a self-playing xylophone, pictured below. I believe this project alone, of all I've done, was able to perfectly capture the essence of engineering, and mesh it together with music in a critical way that exemplifies engineering methods, and research. After its completion, this capstone project helped inspire my STS research paper, which focuses on the mutual evolution of audio playback devices and the music industry. It started with a curiosity about other self-playing instruments, and then my learning about how long ago the first player piano was invented. This motivated me to seek out the driving force behind music technology, and eventually I settled upon researching this coevolution between technology and its commercialization.

My capstone project is a self-playing xylophone that we titled the "Simophone." We gave it two primary functions. The first was to play MIDI files off an inserted thumbdrive, which are a commonly used type of file that encodes musical pieces, and can be easily downloaded from the internet, edited, or created. Our second feature, from which we derived this device's name, is an implementation of the game "Simon." It will play short pieces of a song loaded on the device, and the user will be prompted to repeat the notes; this gradually increases in length until the user either completes the piece or fails. The Simophone is able to play notes by striking the keys from underneath using solenoids. Each key on the xylophone has a solenoid, along with some driver

circuitry like a bipolar junction transistor (BJT) connected to our power supply and a microcontroller. To detect notes played by the user, we employ a microphone to send recorded audio signals back to the microcontroller, which performs Fast Fourier Transforms alongside some other digital signal processing to determine which note has been struck. Our microcontroller of choice, the MSP432, is further controlled by yet another microcontroller, the Raspberry Pi. We use this second microcontroller for its ease of reading files, and ability to develop a user interface using a touch screen. These two devices continuously communicate with each other in order to maintain functionality of the Simophone.

My STS research paper explores the history and coevolution of both the music industry and audio playback technology. It begins in the mid-late 1800s, following several inventors independently discovering similar methods of recording sound, and culminating in Edison's famous phonograph. From there, many different groups sought to commercialize this device, most notably Edison himself. This competition fueled technological innovation, as each company tried to get an edge over the other, until the two largest companies merged after a series of intense legal battles. The disc became the standard audio media format, and gradually improved until World War II, when a shortage of shellac encouraged the switch to a new material, polyvinyl chloride (PVC, or vinyl). This material had great properties that allowed record labels to print more music on discs, of much higher quality, and a "golden age" of music started. Nearer to the turn of the century, other recording mediums rose to prominence, including magnetic tapes and compact discs (CD). Vinyl was pushed into obscurity, and the digital age began. Eventually, it became possible to stream music over the internet, and platforms such as iTunes and Spotify were able to make music more accessible and marketable than ever before.

I will admit, I am a bit disappointed with my STS research, as it wasn't as nuanced or complex as I'd expected it to be, but I enjoyed doing the research and learning more about the history of

music in the process. During my time during this last year, I've had to do much of my own research, reading documentation, and developing complicated circuits from scratch. It's been a great exercise on my mind, and I look forwards to my future career as an engineer and being able to constantly take in and learn more information.