Improving upon the Self-playing Xylophone: the Simophone

The Role of Musical Playback in the Development of Music and its Industry

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 Computer Engineering

By
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November 26, 2023

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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General Research Problem: Development of Musical Playback Technology

Undoubtedly, music is an essential part of society. Almost anywhere you go, you can either play music, or you already hear it. Be it in stores, in restaurants, in your car, or on your phone, music is everywhere. But how did we get to this point? The technology that allows this level of accessibility to music has not always been present. My research entails musical playback technologies, how they've shaped and been shaped by music, and their history.

The player piano and other self-playing instruments seem to universally catch the attention of people nearby. In museums, antique stores, or anywhere else they can be found, you can usually find a few people interested in it, watching and listening with excitement. There's something fascinating seeing a mechanical device playing music, something typically performed by humans. My Capstone team took interest in this, and as such, I will be researching the design of one of these musical playback devices; we will be developing a self-playing xylophone.

I believe that technologies such as the phonograph, the record, the radio, and digital media formats have strongly influenced music over the years. As music became accessible to more people due to this technology, music has been reshaped to meet the demands of the people. Songs (generally) became catchier, shorter, and more attention-grabbing. My STS research is loosely coupled to the technical research, and will explore how musical playback has affected the development of music and the music industry.

My research will give us a better appreciation for how much music has changed since before playback technology existed. We'll learn more about the complexities of the technology itself, and I will learn more about the mutual shaping between the two entities. The technical research is being carried out over this Fall 2023 semester, and the STS research will be carried out over both this and the next.

Improving upon the Self-Playing Xylophone: The Simophone

How can we design and improve upon self-playing Xylophones?

My team's capstone project is the development of a self-playing xylophone, with a couple of other features as well. The xylophone will have multiple programs, with the main two my team is focusing on being the ability to play music from a file, and a game that is similar to "Simon Says." This game gives our creation its name - the "Simophone." It is played by the device playing a sequence of notes, and prompting the user to repeat the sequence; if the user is successful, the device will expand the sequence of notes, prompt the user to play it again, and continue this cycle until the player fails. In addition to "Simon Says", and if time allows, we may also implement programs that do things such as playing harmonics to a tune it detects through a microphone, effectively playing alongside other music. Of course, the core feature of this device, without which other functionality will not be possible, is that it will be able to play any combination of notes. These notes could be from a recording made by the user, something manually programmed into the machine, a formatted audio file, or perhaps even something

generated by the machine itself. In other words, musical playback is the core concept we're focusing on!

This musical playback will be achieved through the use of solenoids placed underneath each key of the xylophone. When powered, the solenoids will quickly strike the keys with a metal rod. These will be controlled through custom solenoid drivers we develop, in conjunction with a power supply and two microcontrollers. In order to detect the user playing notes on the Simophone, we will have microphones placed beneath, recording short samples of the user playing the device. A Short Time Fourier Transform (STFT) will periodically be performed on these recordings, which will pick out the audio frequencies with the highest magnitude, and then compare them to a list of specific notes and their frequencies, so the device can determine which notes the user has played. These core processes are central to our system working, as the Simophone couldn't work without its ability to play and detect notes.

We will have an MSP432 (a type of microcontroller) to interface with the majority of our hardware. We chose this device because it has more than enough general purpose input/output (GPIO) pins to interface with each hardware component and will give us very low-level access to its features through the C programming language. The MSP432 will be performing the previously described STFTs, controlling our power system, and sending signals to our solenoid drivers in order for the Simophone to play a note. Our second microcontroller will be a Raspberry Pi 4, which will handle the user interface, like the touch screen we will be using for user control as well as file storage on a USB stick. The Pi will parse our song files, which are uploaded by the user onto the USB drive, and will send the note data over to the MSP432 using a serial communication protocol.

Through our design process we hope to acquire many skills, such as a better understanding of the functionality of solenoid driver circuits, MIDI file parsing (our chosen audio file format), serial communication protocols, hardware interrupts and polling, power management, and digital signal processing using an STFT. Whilst there is no one specific problem being targeted by our Capstone project, we have aimed our development process to cater to a specific audience. Our intended target includes a wide range of people, such as aspiring musicians, hobbyists, children, and perhaps music teachers. We intend that towards the end of development, our Simophone will be able to teach users how to play specific songs with its "Simon Says" program. The Simophone will be highly interactive, and perhaps educational to its users. In all, our capstone project does not necessarily look to solve a specific problem, but rather to improve upon other existing self-playing instruments by adding additional functionality.

The Role of Musical Playback in the Music Industry

How have the development of musical playback and the music industry shaped each other?

Undoubtedly, the invention of audio recording has reshaped music as a whole. Music was brought to a much wider audience and became more available than ever before. Instead of requiring a group of musicians to be present playing music, one could simply play a record on a whim. In more recent times, the LP, tape, CD, MP3 players, and media streaming platforms have only changed music ever more. Music has been quickly changing over the last century, with many artists wanting to make as many sales as possible. They've had to adapt as technology has improved, and fundamentally changed the recording of music, and the consumer's tastes and wants for music changing.

It is important to understand how playback technology has impacted music, because it continues to do so to this day. The music industry is absolutely massive, and is now nearly inseparable from the lives of many people. It's hard to quantify the worth of the entire industry, but the revenue from this last year alone amounts to over thirty-one billion dollars. It's important to understand the roles that technology has played both in the past and in the modern world, so that we might understand where the industry will go in the future. The music industry and technology both have a hand in shaping the development of the other. Many actor groups influenced the shape of the early music industry, which then in turn shaped music itself. I seek to explore how this has happened, and how future music will continue to be shaped.

First, I plan to explore the history of musical playback, and the musical industry. My STS paper will elaborate on the parallels between the development of both, and how they were mutually shaped. As the technology improved, it is certain that the industry had to adapt; and as the industry and popular demand changed, it motivated the technology to improve. Many articles, seminars (Zhang, 2018), and research paper have explored these histories thoroughly.

I will use my research resources to form a chronological outline of relevant events which will include key points in development of the playback technology, large actors in the music scene such as the Beatles, and major world events that may have affected the industry. Once this outline is established, I plan to further research each item in it, and specifically look for both similarities between parts of the outline, and how items and concepts had interacted with each other. As an example, World War II caused a shortage of shellac, and this greatly influenced the production process of records, forcing them to find a new material for the discs – polyvinyl chloride (PVC) (Osborne, 2012). This material had better physical properties than shellac, allowed for more grooves on a record, and had a much higher sound quality. This new, higher quality then allowed record labels to sell more records. An international war weakened the market and necessitated a change in the music industry, which then caused an improvement in musical playback technology and inadvertently ended up strengthening the industry. I will assess each of these links between playback technology and the musical industry, and compile my findings in my STS paper.

I believe this research method will enable me to fully address, understand, and provide a detailed answer to my proposed question of "How have the development of musical playback and the music industry shaped each other?" I will have collected clear historical evidence and

developed solid links between playback technology and the musical industry, such that I can confidently present my findings on their mutual shaping.

Conclusion

My research explores the development of musical playback devices as well as the music industry. As of now, I have an intuitive understanding of how and why these two ideas are intertwined, but I wish to be able to define a demonstrable cycle of interactions between these two fields, shaping and advancing each other. Mayhaps I will even glean an insight as to where this technology will go in the future, or if this mutual development has finally reached an end in this digital world we live in. Maybe mainstream music will become interactable, as we aim to do with our Capstone project. In addition, I hope to gain an understanding of how many of these playback devices function, through the construction of our Simophone; we will learn much about audio file formats as well as audio processing. Through my research, I hope to acquire a more substantial, solid, and qualitative grasp upon the mutual shaping of playback technology and music.

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