Thesis Project Portfolio

Self-Playing Xylophone with Real-Time Note Detection

(Technical Report)

The Impact of Music Games on Music Education

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

This past fall, I worked on my technical project in the course *Embedded System Design* (ECE 4400). The project created was called the Simophone. The Simophone is a self-playing xylophone that stores Music Instrument Digital Interface (MIDI) files in the system. These MIDI files were sent over a microcontroller that would determine which note would be played at which time based on the information in the MIDI file. Under each bar of the xylophone, there are solenoids that strike the bar from underneath when a high voltage is applied to the solenoid. Users can interact with the Simophone through an LCD screen which contains the user interface of the system. Users can select two modes: MIDI playback and Simon Says. When MIDI playback is selected, the user can select songs such as Good Old Song, Hot Cross Buns, Super Mario Bros Overworld Theme, Never Going to Give You Up by Rick Astley, and many more. This will play the chosen song to its entirety. When Simon Says is selected, the user will be given a list of difficulties: Easy, Medium, and Hard. The User can press Start and the xylophone will first play a sequence of notes, wait a second, count the user off with four beats in the tempo of the song, then listen for user input. The user will then have a chance to repeat the sequence with mallets. If the user gets the sequence correct, they can advance to the next level, give up, or try again. They can also try any song from a given difficulty level. For Easy Mode specifically, the timing does not matter for when the notes are hit, but for Medium and Hard timing is considered. For determining if user input is correct, a note detection algorithm is used to capture what notes the user plays in real time with the assistance of a microphone. The finished product is shown in the figure below.

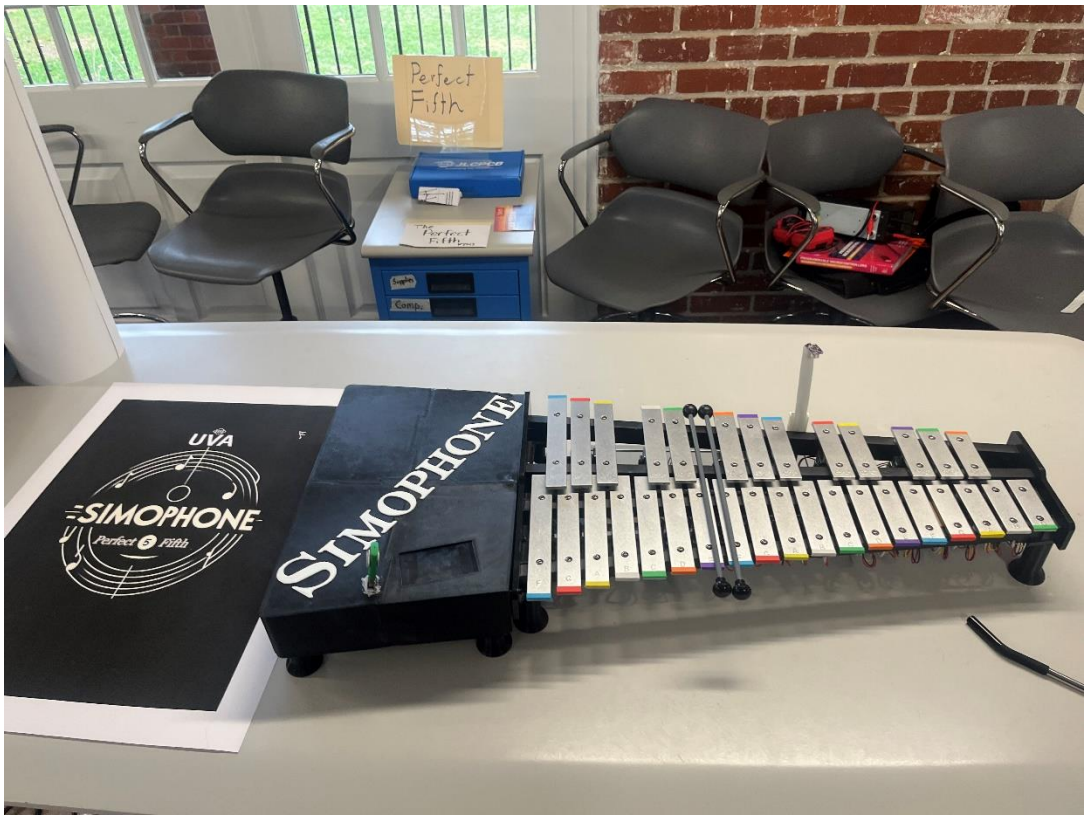

Figure 1: Finalized Version of the Simophone

My STS Project investigated the impact of music games on music education. In my prospectus, I outlined a research plan and formulated research questions. In my thesis, I performed research to supplement the research question. The question I was trying to answer was how music games impacted music education and if there were any cognitive benefits for those who played music games. For my research, I performed interviews with music teachers from Woodbrook and Ivy Elementary School, sent out a survey for those involved in the fine arts community at UVA, and performed a literature review. From the information gathered from the interviews, the music teachers at Ivy and Woodbrook Elementary prefer a more hands-on approach to learning music. Rather than learning theory, they have their students play instruments and repeat sequences. The idea of having music games in the classroom was taken

with positive reception because they give instantaneous feedback and are engaging. The results from the survey indicated that music games did not help much with learning a song or with music theory, but helped people learn the rhythm to a song and increased overall engagement of a song. For the literature review, I reviewed case studies from many different universities about how music games have impacted learning music and if there were any cognitive benefits. I also reviewed the motivations of the companies who published these games using the Actor Network Theory (ANT) framework. From the literature review, it was discovered that there were positive cognitive benefits for those who play music games and that music games help with learning rhythm but cannot help with completely learning a song or music theory.

The STS project and technical project tie in together through the use cases and implications of the Simophone. With the MIDI playback and Simon Says features of the Simophone, it makes it easy to learn how to play the xylophone. Users can listen to a song and see how it is played and try to play it themselves. They can keep doing this until they eventually learn the song. This can also teach them how to keep rhythm for a specific song and which notes to play. At a high level, the Simophone can be considered as a music game that also could benefit music education in the same way as the music games analyzed in the STS project. Xylophones are also much simpler to pick up compared to string or brass instruments so it would be a good starting point for people to learn music. If the Simophone was integrated into music education, it would overall help students maintain a sense of rhythm like other music games and share similar cognitive benefits.