Design of Method/Device for Power Walker Related Experimentation
(Technical Paper)

How Changes in Music Production Technology Have Impacted the Industry
(STS Paper)

A Thesis Prospectus
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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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Prospectus

Introduction

The lead singer of Katrina and the Waves, describes her gait as "walking on sunshine" in her hit song that shares the name with this feeling. Nancy Sinatra emphasizes that the purpose of boots is for motor functionality in her song "These Boots Are Made for Walkin'." Unfortunately, many children are born with the motor disorder cerebral palsy (CP) that can severely limit their ability to walk and experience the joys of walking described in these songs. Research toward a walker that will help these children return to some degree of motor normalcy will encompass the technical project proposal. Additionally, the STS research paper proposal will focus on how music production technology has changed the industry.

The objective of the walker is to provide a pulling or pushing force, depending on the type of walker, to children so that they exert less energy while moving around. Reducing energy exertion is crucial because pushing around a walker is tiring for them and limits their ability to keep up with their peers (Walkers, n.d.). For children who have already experienced the hardships of a motor disability, just being able to walk a little longer will greatly improve their quality of life and return some of the lost normalcy. Previous experimentation has indicated that providing a force of 8% a person's body weight will allow less energy to be spent walking (Zirker et al., 2013). However, this experiment was conducted using treadmills, which affects the users' joint and muscle activity (Lee & Hidler, 2008). Therefore, these results cannot be generalized to people walking on flat ground. The technical project will focus on constructing two systems that provide a pulling and pushing force to a person walking on flat ground as a modification of the treadmill experiment. The ideal force discovered from this experimentation and reported in the paper (which is expected to be around 8% of a person's body weight) will be

used in the development of the intelligent, motorized walker for children with cerebral palsy. By exerting less energy walking, perhaps the child will have more energy to dance.

The STS research paper proposal will explore the inventions and systems of the American music industry. More specifically, the proposed paper will analyze the technology behind music production and how that has changed over time. It will explore how music has changed with this technology in sound and creation process. Since music is a crucial component of culture around the world, understanding how it is produced gives insight to the climate and time in which it was created. The scope of this project will look at more specific devices rather than macroscopic concepts, such as the workings of record labels. However, record labels and similar stakeholders will be discussed since their involvement also shaped the industry. The Actor-Network Theory (ANT) will be employed to fully analyze this system. The STS paper will result in an analysis of how music production technology has shaped the music industry which will assist future musical engineers in better predicting the impacts of the production technology they are developing.

Technical Topic

People tend to take the ability to walk for granted, but not everyone is born with the same level of motor functionality. Cerebral palsy occurs in about 1 per every 345 children in the US, and it is the most prevalent motor disability that develops in children (CDC, 2020). Not only can CP make it challenging to walk, but it can also affect precise motor skills, sensory processing, speech functionality, social/emotional/behavioral skills, cognitive functionality, and vision/hearing (Reiter, 2016). While the presentation and severity of these symptoms vary, these developmental challenges can greatly hinder the life of a child in comparison to other children of

the same age. There are three types of CP: spastic, dyskinetic, and ataxic (*Cerebral Palsy (CP) (for Parents) - Nemours KidsHealth*, n.d.). Spastic CP is characterized by stiffness, dyskinetic by uncontrolled movements, and ataxic by balance and depth perception challenges (*Cerebral Palsy (CP) (for Parents) - Nemours KidsHealth*, n.d.). Unfortunately, there is no cure for this disease, but surgery, therapy, and assistive devices are generally used to help increase a child's quality of life (*Cerebral Palsy (CP) (for Parents) - Nemours KidsHealth*, n.d.). Walking, although a simple action many people take for granted, is greatly beneficial for physical and mental health. The impact from when the foot hits the ground sends blood through the arteries and to the brain (*How Walking Helps Your Brain*, 2020). More blood in the brain means more oxygen, which in general causes an improvement of memory, cognitive function, and durability (*How Walking Helps Your Brain*, 2020). Not only do these children need something to help them participate in life's activities like other children their age, but also, they need to walk for the health benefits of having more blood sent to their brains.

For 7.8% of children with CP, the ability to walk is accompanied by the need for a hand-held device, such as a walker (CDC, 2020). Anterior walkers are pushed in front of the user, and posterior walkers are pulled from behind (*Understanding Anterior versus Posterior Walkers*, n.d.), and both are commonly used. Pushing a walker causes the user to expend more energy than walking normally, so children are not able to keep up with their peers in terms of mobility (Walkers, n.d.). To help these children live as normal a life as possible, Barron Associates is developing an intelligent, motorized walker that will provide a forward force to children as they move. However, this company needs to confirm that providing this force will in fact reduce energy expenditure. A study titled "Changes in Kinematics, Metabolic Cost, and External Work During Walking With a Forward Assistive Force" conducted by Christopher Zirker, Bradford

Bennett, and Mark Abel in 2012 found that providing a force that is 8% of the subject's body weight results in the least amount of energy expenditure (Zirker et al., 2013). However, this experimentation used a treadmill and needs to be recreated on flat ground. The aim of this independently conducted project is to find the percentage of body weight a forward force must provide so that a subject walking on flat ground exerts the least possible amount of energy. This data will be used in the walker to help children with cerebral palsy, but the design and construction of the walker itself is outside the scope of this project.

As of this writing, the experiment will be conducted two ways. The first way is to set up a series of pulleys in the lab and attach the subject to a rope around these pulleys. A weight will be hung from one end, which will provide the pulling force to the subject. The benefit of this method is that it is relatively inexpensive and intuitive. However, the weights are fixed in whole number intervals, so it will lack precision. The second method will be done by utilizing a motor that can be controlled using MATLAB. The benefit of this method is precision, but the problem lies in cost and challenge from the necessity to program the motor. As with the setup, the attachment and energy efficiency measurements will be experimented with to find the most practical and accurate ones. The ropes will be attached to the subjects using a harness or by having them hold onto a handlebar. Energy efficiency will most likely be measured using a muscle energy expenditure model or a device to measure VO2.

If the experimentation results in data that will cause the walker to successfully reduce energy expenditure in children with CP, then the technology can be used for other purposes. For example, the walker could be adjusted to help the elderly population or people with other types of motor disabilities. The final deliverable for this project is a quantitative understanding of what percent of a person's body weight will result in minimal energy expenditure, which will then be

used for programming the motor in a walker for children with CP. Walking is a critical human function that contributes to so much of daily normalcy. Returning this function for anyone from whom it was taken would make anyone feel as if they are walking on sunshine.

STS Topic

From disco anthems to TikTok trends, there is no denying the impact music has on American culture. Television shows such as the *Grammys* and *American Idol* or the fact that 155 million people paid for a Spotify subscription in the last quarter of 2020 show just how desperately people yearn for new music (Parker, 2021). As a recent example, the social media platform TikTok allows artists to promote their music without needing a record label and exposes users to a vast array of songs because the music used in videos is not the main focus of the app's algorithm (*How the TikTok Boom Has Impacted the Music Industry | MI*, 2021). Olivia Rodrigo's "Driver's License" became popular on TikTok, and now she has had multiple songs rank in the top 10 of Billboard Hot 100 Chart (*The Hot 100 Chart*, n.d., p. 100). However, this new technology does not always benefit every party. For example, the introduction of the internet and music streaming technology has caused artists to lose sales in albums. The industry has combatted this loss of profit with strong resilience, though, and many artists have increased their focus on concerts as the primary source of income (*The Impact of Technology on the Music Industry*, 2021). However, the COVID-19 pandemic brought live music to a halt, leaving many artists without substantial income (*The Impact of Technology on the Music Industry*, 2021).

Production equipment has also dramatically affected the industry as well. Starting from the beginning, Thomas Edison's phonograph was invented in 1877 and allowed music to be recorded (*The Impact of Technology on the Musical Experience*, n.d.). This technology led to the

recording of the first song: “Mary Had a Little Lamb” (*Early Sound Recording Collection and Sound Recovery Project*, 2012). Now, producers use MIDI keyboards and digital audio workstations (DAWs) which have drastically changed the production process from studio recordings to digital work (*How to Produce Music*, n.d.). Technologies like these have brought the studio into the home and made creating and sharing music more accessible to the public.

The objective of the STS research paper will be to investigate how the music production technology and process has changed over the years and influenced the American music industry. This paper will explore turning points in the industry caused by technology as well as explore the current technologies producers use. The time frame will span from the invention of the phonograph in 1877 to the recent COVID-19 pandemic (*The Impact of Technology on the Musical Experience*, n.d.). This paper will also discuss specific songs, how they impacted the industry, and the production techniques/methods that made them possible.

This topic is important because music plays and has played such a large role in cultures throughout time and across the globe. Music can be used to create social change, to affect moods, as a career, to give insight into a past culture, and so much more. From psalms in the Bible to songs used in TikTok videos, music has influenced cultures for centuries. Understanding how it is created reflects the technological advancements and techniques that were valued at the time of its creation. For example, music used to be mixed as the artists played, and the artists would continue recording until they recorded it perfectly (“How Evolving Tech Has Changed Music Production,” 2016). However, technology now allows music to be mixed after recording, and pieces from various artist recordings can be clipped together (“How Evolving Tech Has Changed Music Production,” 2016). Computerized equipment reflects how society has become

dependent on digital technology to the point where mixing and composing are arguably more important to a song than the artists' recordings.

Computerized equipment is just one player in the music industry game, and understanding how all the players are connected will provide insight as to how they affect each other. The framework that will be used to analyze this paper is the Actor-Network Theory (or ANT). ANT essentially examines the different participants, or actors, in a system and analyzes how they are connected within that system, or the network (Cressman, 2009). The research question asks how technology impacts society in the music industry, but there are many actors in this network that must be addressed to get a holistic view of the topic. Producers, artists, recording studios, equipment, streaming apps, concerts, social media, etc. all must be considered because they all play a role in using the technology that affects society. The various actors will be discussed in both how they connect to the industry and how they connect to each other. The primary strength of ANT is that the actors can be both human and non-human (Cressman, 2009). However, this is also a contributor to one of it's weaknesses in that there is no differentiation in importance between human and non-human actors (*Criticism of Actor-Network Theory*, n.d.) Since both are important in the music industry network, this will likely not affect this analysis too negatively. Another criticism constitutes a similar idea in that there is no way to differentiate levels of importance at all when using ANT (*Criticism of Actor-Network Theory*, n.d.). However, every actor plays some role in the music industry, and this paper analyses how technology has caused the industry to change. Therefore, understanding levels of importance is less crucial than understanding that there is an importance. Perhaps one of the biggest drawbacks of using this framework will be that it does not give much insight into the passage of time (Cressman, 2009). Not considering time will be problematic since the change of technology over time is why music

today is vastly different than music from the 1950s. However, it can be fixed by using the framework multiple times for each time period where a crucial technology was developed. This will help show which connections between actors remain and which shift over time.

Research Question and Methods

The research question is: how has music production technology changed over time, and in turn, influenced the American music industry? Three methods will be used for research: discourse analysis, historical case studies, and network analysis. The discourse analysis will be used to find articles, YouTube videos, and possibly podcasts to identify technologies that were turning points and how they work/are used. The technologies, such as the phonograph or streaming platforms, will serve as the historical case studies. Network analysis will be used to take all of the pieces and show how they connect in a way that music production is possible and integrated into society. Most of the sources come from "how-to" tutorials found on Google as well as blogs and YouTube videos evaluating equipment and articles depicting the timeline of technology introduction.

Conclusion

The technical portion should result in a successful system/device that provides a pulling and pushing force to a person walking on flat ground and quantifies energy expenditure. This experimentation will determine if the results of the study by Zirker et al. remain true for a person walking on flat ground rather than a treadmill. All of this will contribute to an intelligent, powered walker to improve the quality of life for children with CP, even though the walker itself is outside the scope of this project.

Dancing is a motor function that may be challenging for children with CP, but music still undoubtedly plays a huge role in shaping American culture. The STS portion will present an organized analysis of technological changes in the music industry using the ANT framework. It is expected that there will be specific inventions/software that led to drastic changes in music production and distribution, such as the phonograph or streaming platforms. Since music plays a large role in society, understanding how it is produced and distributed is insightful to understanding the workings of American culture from the invention of recording technology to the COVID-19 pandemic to today.

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