Portative MIDI Pipe Organ

Analog vs. Digital Music: A Never-Ending Struggle

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 Mechanical Engineering

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November 1, 2021

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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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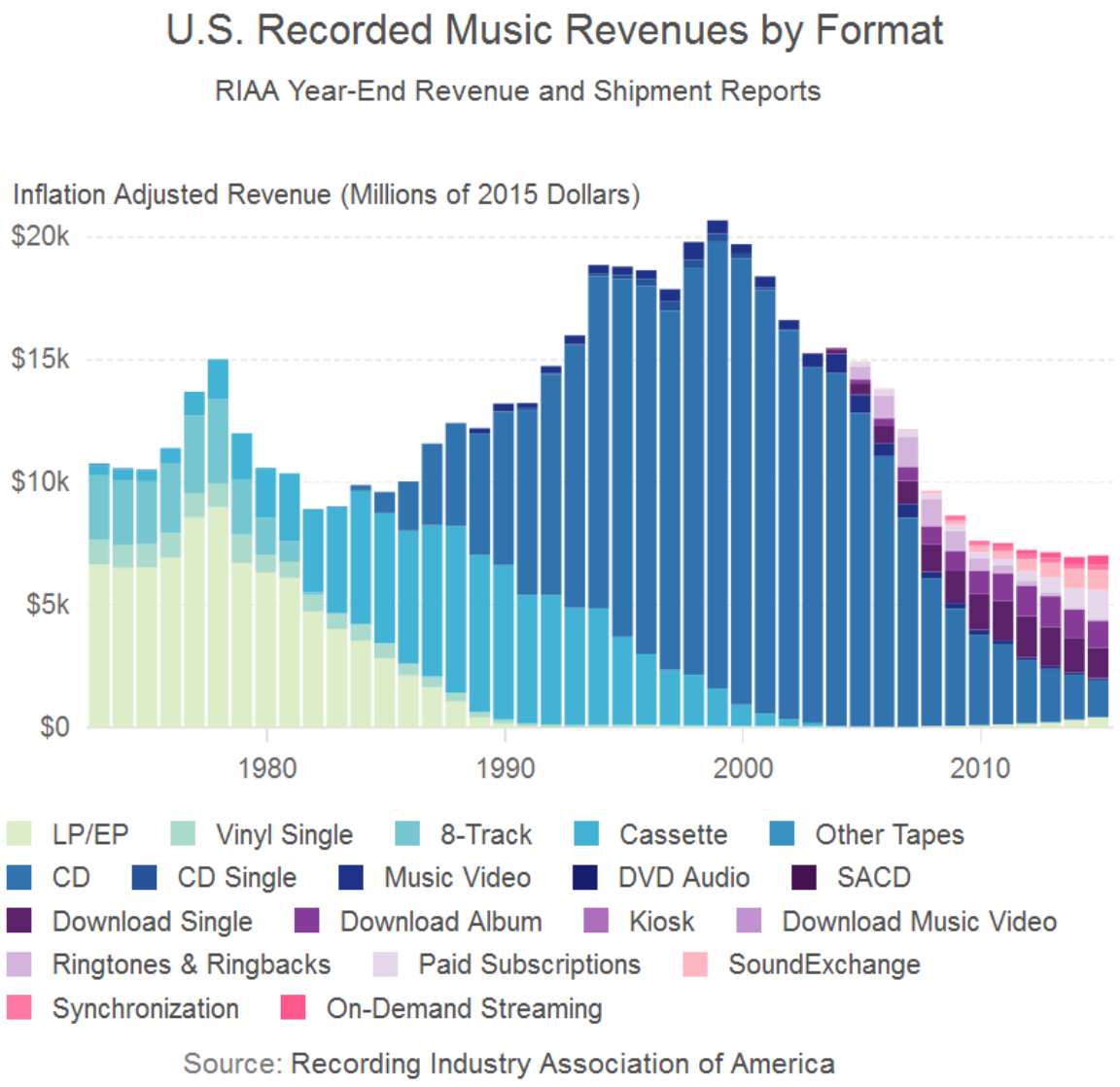
Introduction

The concept of analog and digital signals has only really existed within the past century. Specifically, in the 1940s when the terms "digital computer" and "analog computer" came into being as antonyms (Mall, 2003). When talking about electronics, a technology that is analog based transmits information or energy through "electric pulses of varying amplitude" while digital technology conveys information through a binary format (ones and zeros) (DiGiose, 2016). In simpler terms, the information of analog is continuous and fluid while digital can only be either on or off. Both methods have their strengths and weaknesses, but in the case of music technology, it has become difficult to determine which is better. The history of music distribution has been riddled with constant change. Initially, vinyl and similar record based analog platforms were domiant. Everyone had a record player in their home because it was the only consistent method to listen to music. However, as time went on, the cassette, 8-track, and eventually in 1983, the compact disk (CD) was introduced. The CD was the first music distribution technology that was fully digital based. It was the love child of two technologies: the "optical readout of information" being stored to a disk and the "digital coding/decoding" of audio signals (Peek, 2010, p. 10). Basically, the CD worked by having a laser shine onto a disk to read ones and zeros off it. Initially, people were excited about this technology because the lack of "surface noise," "distortion" and "clarity" that was prevalent in previous analog technologies (Walsh, 1983). However, this excitement became soured with the introduction of the MP3 in the mid-90s. The MP3's main issue comes from its core goal of making audio files as small as possible so people could access it from the internet. This led to smaller digital files and loss of resolution from the CD. Despite this lower quality, the MP3 became the dominate distribution method because it was "accessible to everybody" (Rose & Ganz, 2011). The introduction of the MP3 was the first

technology that led to lower quality audio, but it continued to dominate for most of a decade. As shown below, the history of music distribution from the 1970s to the 2010s can be best outlined showing the sales history of each format.



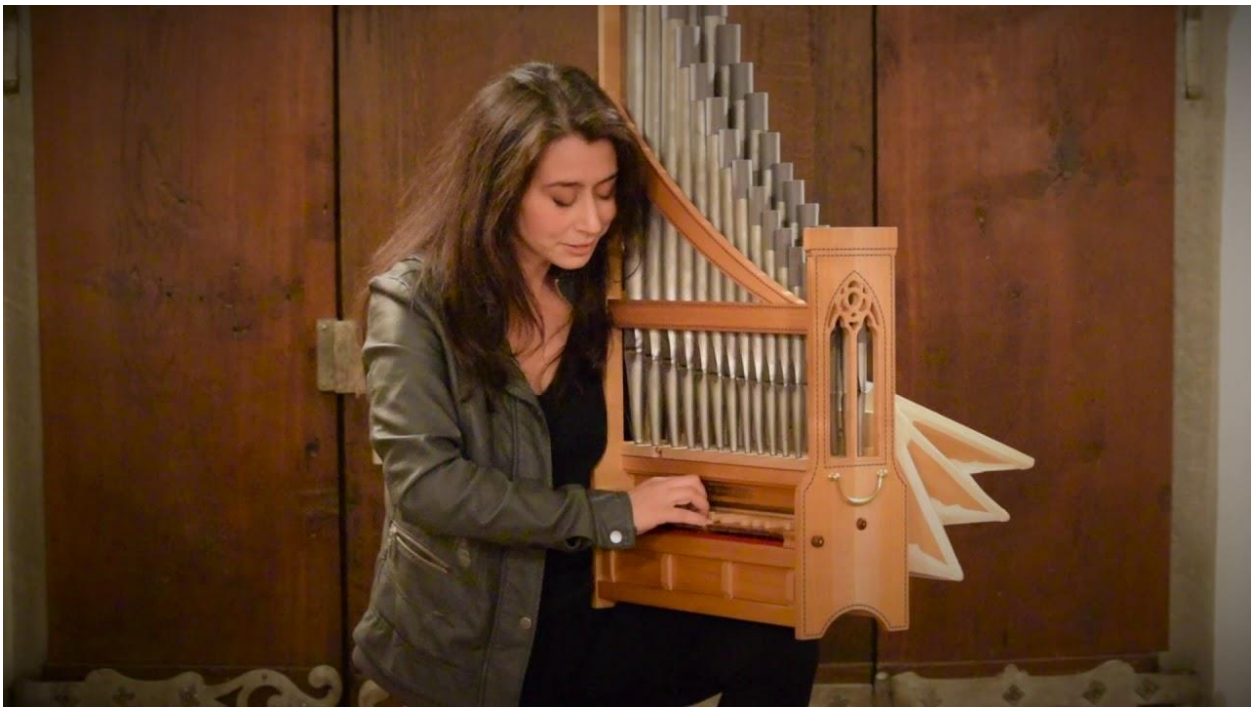
Note. Graph showing recorded music revenues organized by the format sold. From "*Recorded music sales by format from 1973-2015, and what that might tell ...*" by M.J Perry, 2016

As can be seen in the graph above, digital, internet-based technology continued to dominate until recently with an interesting rise in vinyl interest. In recent years, vinyl sales have increased dramatically with an expectation of a USD 1.2 billion increase in sales within the next seven

years (ESOMAR, 2022). Despite vinyl being a relatively outdated, inconsistent technology, people continue to buy it. This rise has led to an increase in debate between analog and digital music distribution. It is this debate that will be at the core of this paper. In relation to Society and Technology Studies, the social drive behind this debate will be analyzed in a variety of methods. The technological, psychological, biological, and social aspects of this issue will be explored to determine exactly why music distribution technologies have always been so polarizing. The technical topic of paper will be exploring the physical analog and digital technologies that will go into the creation of a Portative MIDI Pipe Organ. The end goal of this paper is to explore, through an STS and technical lens, why the debate between analog and digital music distribution has continued to persist since the introduction of digital music distribution in 1983.

Technical Project

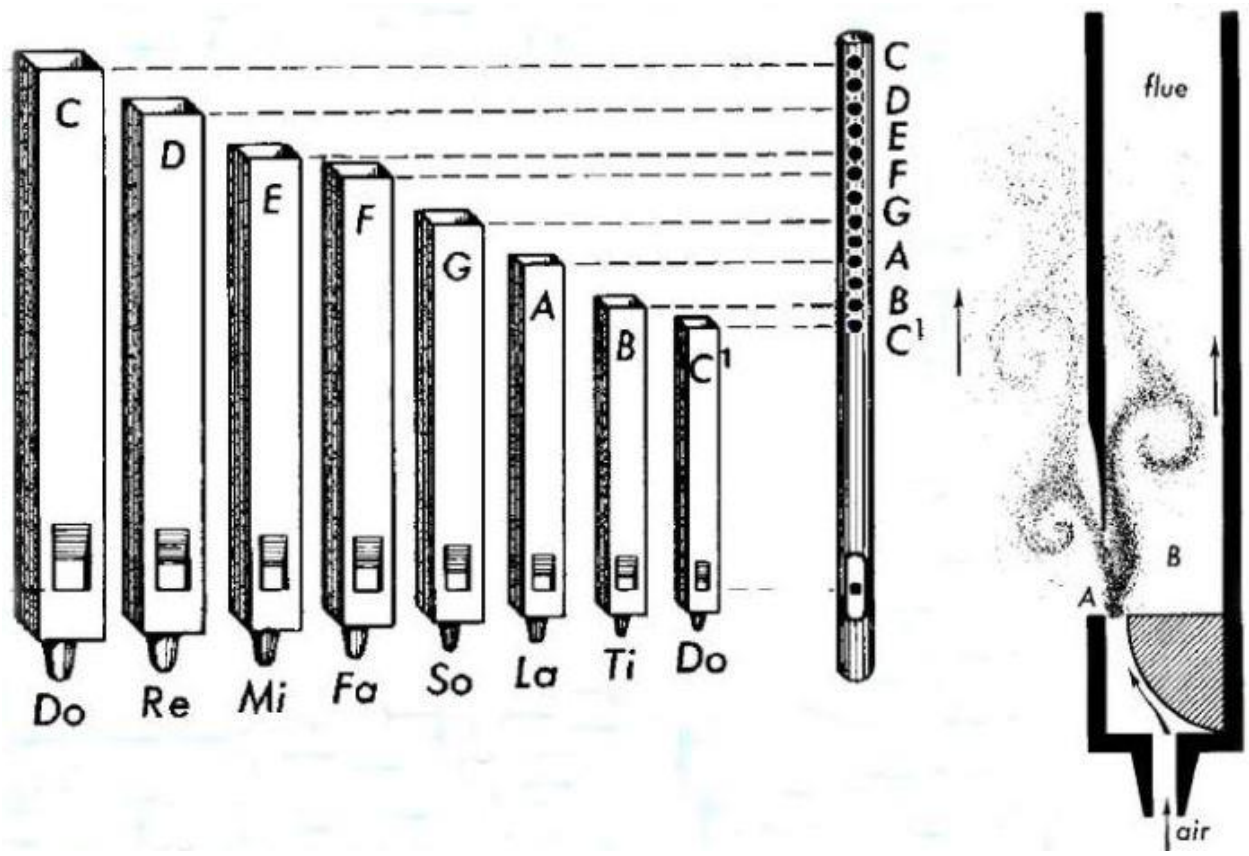
The coincident technical project has the goal of creating a Portative MIDI Pipe Organ to place in the Virginia Discovery Museum in Charlottesville. Currently, there are several portative pipe organs in the market. However, these organs require the player to manually create airflow by pushing a bellow as shown below:



Note. Image showing portative pipe player using a bellow to play the instrument. From "*Catalina Vicens - Medieval Portative Organ"* by Catalina Vicens, 2014.

Our pipe organ aims to make the portative pipe organ more like a regular piano by creating an automatic bellow and implementing a Musical Instrument Digital Interface (MIDI). This technology, created in 1982, provides a quick and easy method of connecting a physical keyboard to a computer by communicating musical information. MIDI itself is only concerned with data transmission. A MIDI file can communicate when a note is played, what note it is, how loud it was played, the tempo, and the structure of the piece (Swift, n.d.). Using MIDI in the portative pipe organ will allow for two things. First, it will make it possible to easily connect a MIDI keyboard to the organ. This will allow people to come up and play it as if it were a regular piano. Secondly, it will allow MIDI files to be uploaded to the organ which will allow the organ to automatically play any musical piece if it's in the form of a MIDI file. The organ will also be building off hundreds of years of pipe organ creation. Specifically, the pipes on the portative organ will be modeled after a stopped diapason. A stopped diapason has a two major parts: the

flue and the stop. The flue is the physical body of the pipe. The bottom part of the flue works by creating a "low pressure condition inside the pipe." This causes the higher-pressure air from outside the pipe to force its way through the pipe's mouth and begin oscillating. This oscillation is mainly adjusted by changing the length of the pipe. The longer the pipe, the lower the frequency. A typical diapason flue is shown below.



Note. Image demonstrating how a typical diapason flue looks and works. From *"How Organ Pipes Produce Different Sounds"* by Jack Hardman, n.d.

The stop (not pictured above) is placed at the top of the pipe to create a seal. The stop's main purpose is tuning. Moving the stop up and down adjusts the frequency of oscillation, so once, the desired frequency is reached, the stop is left in place and the pipe is set to the desired note (Hardman, n,d,). To create these pipes, dimensional equations were acquired from Raphi Giangiulio. Giangiulio created several equations that calculate the exact dimensions necessary to

create a desired frequency of a Stopped Diapason pipe. Using these equations makes sure that every pipe is accurately tuned to the desired note (Giangiulio, n.d.). Our team's goal is to complete construction of this organ by the end of the semester. Regarding the STS objective of this paper, the portative organ is heavily involved in the interplay of digital and analog sound. The physical pipes that create a sound through air resonance is an analog sound. However, once MIDI is implemented, the musical information delivery becomes digital. Having MIDI makes the portative organ into both an analog and digital instrument. Exploring both methods of musical delivery will help deepen the understanding of both analog and digital music.

STS Topic

To create a solid framework of investigation into this issue, I will first explore the purely technical aspects of analog and digital signals. The goal will be to define exactly what an analog signal is and what a digital signal is. This explanation will cover the mathematical definitions of both signals, the origin of these signals in our technology, and their previous and current usage in the music industry. This foundational exploration will allow both me and the reader to go forward with a purely technical understanding of the differences between each signal. This is important for being able to understand and contribute to any discussions in the debate between both signals. This exploration will lay out an objective understanding of both signals that will technically reinforce the all aspects of the framework I am trying to create. This is the technical leg of my STS framework.

The next section will technically explore the physical and social differences between people's opinions of analog and digital music. This will be done through exploring the fields of biology and psychology. Specifically, the biological exploration will aim to scientifically

understand if people can physically tell the difference between an analog or digitally recorded sound. Understanding the physical aspects of our perception will further strengthen the framework around this issue. This will help begin to bridge the gap between the technical and social aspects of this issue since this exploration could be viewed as both technical and social depending on the lens being used. The psychological exploration will revolve around the idea of "psychological ownership." This psychological concept can be used to explain the emotions that drive people's decision to choose either analog or digital music. This explanation will help explain some of the human forces that cause people's decisions. This will help further strengthen the framework by providing a mostly social, technical exploration into the forces that drive people's decisions. Both the psychological and biological explorations will help me to create a scientific understanding of the social forces that have led to this heated debate.

Finally, I will create a framework around the purely social aspects of this issue. This will be done by looking into real people's opinions and debates. I will aim to understand why people have formed the opinions that they do. I will seek out examples of people who will only listen to vinyl, people who think digital mediums sound better than analog, and people who just listen to the most convenient option for them. In my brief time surrounded by this debate, I have found that these are the three main types of people involved in this debate. Trying to understand examples of these individuals will prove extremely helpful in beginning to define exactly why this is an issue. It will help me to form my own personal case study around this debate, and it will make sure that whatever conclusion I come to has foundational grounding in the actual people involved with this debate.

These three sections of the STS portion will help to create my entire framework that will allow me to truly analyze and understand both the technological and social aspects of this issue.

Thinking of STS as an exploration of all the social and technological aspects of issues, the framework that I create here will aim to fully explore all sects of both. Like a gradient exploration, I will define all the technical and scientific aspects, and then I will use that to understand the social and personal forces that are driving it.

Research Question and Methods

The research goal of this paper is to answer the following question: Why is the debate between analog and digital music so polarizing? While this seems like a relatively simple question, there are a significant number of forces behind this polarization. This paper hopes to explore these forces and outline the depth and importance of this issue. To analyze these aspects, several methods will be used. To help facilitate the framework being made, research looking into the technical, psychological, biological, and social forces behind this debate will be used to outline why this is an issue that is both technical and social. However, prior to this, economic analysis will be used to help establish a background. Studying the economic trends of music distribution will provide an insightful overview of the reality of music technology. Having this will help provide a detailed outline of this issue which will make the paper much easier to follow. In addition, interview methods will be used. Several interviews will be conducted. Currently, I plan to interview my music professors, one of my engineering professors who deals with analog and digital signals, and someone (who I have yet to find) who's livelihood stems from vinyl records. Either a record store owner or some sort of Audiophile. All of these people will have strong, differing opinions about analog and digital music technology. Conducting these interviews will hopefully provide insight into the reasons why people prefer the music platform that they do. This will help strengthen the analysis of social forces. Utilizing all these research methods will facilitate the framework of analysis on this issue.

Conclusion

With the aims of exploring the debate between analog and digital music technologies, this paper hopes to fully explore the technical and social forces driving this issue. With economic, technical, psychological, biological, and social analysis, this paper will conclude that people's preference is determined more by personal bias then any actual technical difference in sound. Every single method of research acquisition can be used to facilitate this conclusion. Whether its economic trends showing people always choosing the most accessible option, technical explanations pointing out the miniscule differences between the two, psychological and biological explorations pointing out the internal bias that many people have in audio perception, or social trends pointing out the specific, personal reasons why people choose what they do, all these methods point towards peoples preferences being based more on personal, social forces rather than actual, concrete audio differences between the two technologies. Exploring this issue brings up interesting discussions about technological development and its interplay with social forces. The most cutting-edge technology is not always the best when the consumer is making the choices. People like things for different reasons, and this paper hopes to provide a case study in this exact phenomenon.

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