

# **Coevolution of Audio Playback Technology and the Music Industry**

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring 2024

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**

Music has been around for millennia, but humans have not been able to record it until the last 150 years we have been here. In that time, we have gone from primitive, low quality audio recording being a very niche and hardly available technology to just about anybody being able to record hours and hours of high-quality audio on a handheld device. It could be argued that we wouldn't have this technology today without the music or film industry's involvement. My research focuses on how the music industry and audio playback technology have shaped each other, as I believe these two to be the "primary" actors in this sociotechnical system.

After its advent, people quickly realized the potential of audio playback, and began to record music using this new technology. As technology improved, artists became more able to sell music through new companies, called record labels, and eventually even independently. This industry quickly expanded, and it became competitive, which in turn created an even higher demand for better technology. Audio playback technology and the music industry have been coevolving for the past 100 years or so, continually pushing each other further and further, and presumably will continue to do so for the rest of our existence, or until we reach some plateau caused by either saturating humanity's musical needs, or a technological peak; but this is purely speculation on possible results of this coevolution.

I believe it may be important to understand this coevolution, so that we may be able to understand how the system may continue to evolve. The music industry is worth many billions of dollars, and studying how its previous major changes have come about may allow us to predict

what future changes may come. It may be possible to determine what parts of the audio technology will be improved upon, or what potential future innovations could be capitalized on.

## **Background**

The main two actors/actants in the system my research intends to explore are, of course, musical playback technology, and the music industry. The focus of this research will involve a lot of actor-network theory, with a lot of interplay between these two groups in specific, as they evolve and influence each other over time. Of course, there will be many other groups involved - such as the original inventors of this technology, and what their original intentions were when creating it - or the existence of World War II motivating the switch to a new material (vinyl) for records. Many of these other actor groups and actants, or as I will call them “events,” act more as a catalyst for change between the interaction of the two main groups, and don’t come about too often; the main driving force between the coevolution of musical playback and the music industry comes mainly from the drive for better technology, better music quality, and better sales. To begin, I would like to establish a sort of background understanding of this history.

In the 1880s, Thomas Edison invented the phonograph. Its original intent was not to play music but rather to research sound and record voices for messages. After this, there were many years of constant improvement and iteration upon this new audio recording technology. In 1886, Alexander Graham Bell invented the graphophone, whose advantages over the phonograph were quickly taken by Edison and implemented into his “perfected phonograph.” Scholars agree that Edison seemed to have not originally recognized the significance of this device, but after Bell’s improvements, he realized that it was a commercially viable product. By the 1920s, things had mostly settled down with machines that resemble modern record players. A disc with grooves

had been chosen as the best shape for the sound recording medium, and shellac solidified as the most used material for these discs.

It is not actually known *exactly* when or how the first example of selling recorded music appeared, but the earliest known instances were privately owned machines where you could insert a nickel to have a song played. Records weren't mass produced until the time shellac became a popular material. At this time, it became increasingly easier for discs to be produced, allowing musicians to record songs onto them, and sell them. In the late 1940s, shellac became harder to source, due to WWII and President Franklin ordering a cut in 70% of shellac record production. Columbia Records started to use polyvinyl chloride (vinyl) as its new disc material. Vinyl had better sound quality, was less brittle, and could store much more music on it, much more reliably.

Starting in the mid-1920s, commercial radio broadcasting stations arose, further solidifying the new place that the music industry was finding in the world. People were now able to listen to music that they did not own, and in places they had not previously been able to, such as in automobiles. Arguably the next big development in music playback technology would be the Sony Walkman in 1979, and soon after, other brands of portable cassette players. This was the first small, portable music playing device. It was developed not because the general public knew they wanted it, but rather because of a Sony executive's wishes to be able to listen to music on a long plane ride. It was a near instant hit, and quickly spread from the Japanese market to the rest of the world. Portable cassette players were quickly replaced by portable CD players in the 80s, and MP3 players in the late 90s. In the early 2000s, the first online music streaming platforms came into prominence, leading us to where we are today.

## **Methods**

In order to create a research framework to better understand the topic and form connections between actors in this socio-technic system, I have explored the general histories of both audio playback technology and the musical industry. From this broader research, I will form a broad, general outline of key points in the development of both these entities. This outline will be in chronological order, and contain details of major actors and events, such as the invention of the phonograph, the invention of the LP, and so on. Once this sequence of major events has been fully constructed, I plan to perform more detailed research into each of them. This research will include much finer details and form many connections between many social groups and technological innovations. These connections would be similar to my previously explained reference to WWII indirectly causing the rise of vinyl records. I believe that this information gathering stage will be straight forward and fairly simple, without need for much analysis, as these events will tend to be a historical sequence of events.

Once this framework has been fully developed, I intend to delve deeper into linking the points together, and further exploring the systems that culminated in each major event. The idea behind this is to tie as many events together as possible, such that there's a somewhat continuous pattern of coevolution between audio playback technology and the music industry; that if one changes, it will affect the other and vice-versa. I expect several of these events to have been discussed previously in other literature and research, although not all. I can use these other works to further reinforce my claims. At the end of the research process, I should have a thoroughly connected chain of causes and events linking the music industry to technology, without many

seemingly random or spontaneous events eliciting changes in one of the systems but not the other. The analysis for this step of the research will be trickier than that of the last, as I will have to parse through many more events, and look for much more specific data, possibly even including patents and music sales and trends throughout the years.

## **Findings**

This timeline begins in 1853, when Édouard-Léon Scott de Martinville began studying how to record sound (Feaster, 2010) in order to seek an auditory analogue to the photograph. He began working using a set of fundamental auditory principles, some of which are listed as follows:

“The motion that produces sound is always a motion of vibration.

“When a body resonates... its oscillations propagate themselves in any ponderable surrounding material...

“Aerial vibrations do not transmit themselves to solid bodies without losing considerably in their intensity.

“Not only are thin plates and stretched membranes susceptible to vibrating by influence, but they also find themselves in conditions which render them apt to be influenced by any number of vibrations.”

By 1857, he was able to construct a device consisting of a large trumpet with a taut membrane on either end, one of which had a much smaller diameter than the other and would influence a stylus carving into a large wheel of wax. He notes that the larger the intensity of the

noise, the larger the movements carved into the wax, the higher the pitch, the tighter together the movements appear on it, and the purer the sound, the clearer and less “shaky” the recording appears on the wheel. On March 24, 1857, he applied for a patent, which was published in France in 1867 under the number 17897.

Scott’s device was unable to actually play the sound back and was solely able to represent audio waves visually to study. Thankfully, Charles Cros, a poet and inventor, expanded upon Scott’s original work (National Parks Service, 2017). He realized that you could effectively engrave Scott’s recordings onto a metal sheet, and effectively reverse the process used by the phonautograph to record the sounds. The stylus would run over the groove in the metal, vibrate the smaller membrane, and be amplified by the larger membrane once more. He called this the paléophone. Unfortunately, his innovation was overshadowed by Edison’s nearly simultaneous breakthrough with the phonograph in 1877.

Thomas Edison’s phonograph followed the same general idea as Scott’s phonautograph to record sound. Vibrations in the air would be transmitted to a stylus which would form an indentation upon a recording medium, in this case, tin foil around a cylinder which would be hand turned using a crank. This cylinder could then reproduce the original recorded audio, although the recording was of exceptionally low quality, and would quickly deteriorate and become unrecognizable after as few as three playbacks. Edison originally believed the use cases of this device were very limited, and that best use would be to record incoming telephone signals. Soon after acquiring the patent, Edison stopped work on the phonograph in favor of focusing on what he believed to be more commercially viable inventions.

Others worked to further develop the phonograph and perhaps develop a commercial product, slowly advancing the technology. Alexander Graham Bell and his associate Charles

Tainter made great advances in the recording medium throughout the 1880s. Instead of using tin foil on the cylinder, they began to coat the cylinder with paraffin wax, which could be shaped more precisely by the stylus than the tin foil. In addition, instead of using a stylus to indent the surface of the cylinder, they developed something with more of a chisel shape for the recording, which would cut material away instead of simply pushing it around. The audio playback stylus remained like the original, but Tainter had the idea to balance it in a way that would exert less force on the groove, causing it to “float” and have less friction. Each of these improvements added together to a machine which had much greater longevity of its recordings as well as much higher sound quality overall. In 1886, they patented this device, calling it the “Graphophone.” (Millard, 2005; Osborne, 2012).

As it became more evident that audio recording had commercial viability, Edison returned to the scene, and created his “perfected phonograph,” which was essentially the same machine as Bell and Tainter’s graphophone, but with an electric motor to turn the cylinder at a constant rate instead of relying on a hand crank. As Edison continued to commercialize the phonograph, the music industry was born. The first company to sell recorded music- records- was Edison Records, and thus begins the coevolution of audio playback technology and the music industry. (Millard, 2005; Osborne, 2012).

Edison proposed three recording mediums that audio recording could possibly continue to develop through. These were the cylinder, the disk, and a tape. Edison firmly believed that work should be focused on improving the cylinder, as it was familiar to most people in this quickly developing field, easy to work with, and had a few advantages over other formats. The disc, for example, had a spiral groove cut into the top of it; as the disc turned, the stylus would move inwards, and there would be less material for the stylus as it spiraled inwards, leading to



lower audio quality. Tape was unnecessarily difficult to work with and was the most volatile (Millard, 2005; Osborne, 2012).

In 1888, Emile Berliner realized the importance of being able to infinitely duplicate, or reproduce, recordings. He imagined a world in which a user could purchase any number of a copy of some audio recording; where “Prominent singers, speakers, or performers, may derive and income from royalties on the sale of their phonautograms, and valuable plates may be printed and registered to protect against unauthorized publication.” (Berliner, 1888, pg. 21). Berliner discovered other advantages the disc had over the cylinder, such as being able to store longer recordings, being more compact and easier to store, and having overall higher sound quality despite it decreasing slightly towards the center of the disc. (Millard, 2005).

Throughout the 1890s, the music industry remained relatively small, and there was no need yet for mass duplicates of recorded music. The disc was not yet able to use its greatest advantage over the cylinder format, and as such, it remained a competitive market. Each format was backed by a few companies, and both sides campaigned and advertised the advantages of their machine. The cylinders were more geared towards easy recording, able to be done from the comfort of one’s own home; recording on discs was much more inaccessible to the public, but offered better sound. Although they tried to sell machines to the public, most profit made by phonograph companies at this time came from the rise of “nickel-in-the-slot” machines, a precursor to the jukebox. These machines were typically able to make over \$100 in a week, or approximately \$3,400 today. (Millard, 2005).

At the turn of the century, it was becoming more apparent that discs would win this battle. The largest record company, the Columbia Phonograph Company, began to produce discs, and launched lawsuits against Berliner’s National Gramophone Company. Berliner ceded,

withdrawing from the record industry and being succeeded by Eldridge R. Johnson. Johnson immediately began making innovations, greatly improving the method by which discs were produced and duplicated. The legal battles with Columbia continued, and the two companies pooled their patent rights, establishing themselves as the two largest forces in the phonograph industry. By 1912, Columbia had fully abandoned the cylinder, and other companies began to switch to the disc as well. The need for mass production of records had finally arrived, and the disc was simply the better option. In 1929, the Edison Phonograph Company left the business, no longer being able to compete with the disc. (Millard, 2005; Osborne, 2012).

Improvements to the record were continuous throughout this period. Shellac solidified itself as the disc material of choice, and both recording and playback methods as well as duplication continued to increase in quality. In the early 1930s, the US Union Carbon and Carbide Company began the first manufacturing of polyvinyl chloride (PVC, vinyl). This material was not frequently used, but it allowed for much longer recordings to fit on a disc by virtue of it being a harder material that could handle the grooves being closer together. Its main use case was to record popular radio shows and other programs.

WWII acted as a catalyst for a major change in the industry, causing a switch to using vinyl instead of shellac. During the war, Japan occupied multiple regions that were major producers of shellac, causing a shortage. It was becoming harder for record companies to acquire more shellac, and eventually President Franklin Roosevelt ordered a 70 percent cut in shellac record production. This motivated the switch to the at the time less popular material of vinyl. The industry quickly realized the advantages gained by this new material, including the previously mentioned longer recordings, as well as less surface noise and a wider audio frequency response. The new technology culminated with the LP, or “long play.” This was a 12 inch disc that would

be played at 33 rotations per minute, allowing for over twenty minutes of recording on each side, at a previously unheard of quality. After the LP, audio quality began to increase at a slower rate than before, and no more massive leaps in the disc technology were made for quite some time.

In 1898, Danish engineer Valdemar Poulsen developed a method by which to record sound onto a steel wire magnetically. He called this device the “Telegraphone,” and continued working on it through the 1920s. He was never able to make a commercially viable product, as it was both technologically inferior to the phonograph and more expensive. Just before the second World War, a machine which replaced the steel wire with magnetic tape had been proposed by German engineers, called the “Magnetophon.” This technology was used by the Germans during the war, but the technology was not able to spread to the rest of the world. Development continued in Germany, and by the end of the war, had advanced enough to have high quality stereo recording. After the war, this technology was finally able to reach the rest of the world. (Brittanica, 2017; Kimizuka, 2012).

Development continued primarily in America and Japan. Two companies dominated the American market, being Ampex and Magnecord. Ampex focused on business-focused models and made expensive machines for business uses. Magnecord focused on smaller, cheaper, household models. Tape recorders found remarkable success in radio show use cases, as magnetic tapes were easier to record to, had higher quality, and degraded slower than discs. Many radio stations could now pre-record their shows, and recording technology became much more accessible to the public, whereas with disc only playback was reasonably accessible. (Brittanica, 2017; Kimizuka, 2012).

In 1946, Masara Ibuka founded Tokyo Tsushin Kogyo (Totsuko), an electrical engineering company that looked to improve upon many new technologies. The company

managed to secure access to an American Magnecorder, and worked on developing similar technology. Although they had little reference material and no documentation of the device, Totsuko was able to develop their own tape recorder, the “G.” It cost around 150,000 Yen, and was quite expensive, but the company was able to secure a patent on AC Biasing that was able to keep competition away. In 1951, they released the “H,” which was around half the price of the G, while being higher quality and easier to use. Totsuko began to rapidly produce more models, many of them cheaper than the last, while also being technologically superior, and dominated the Japanese market. In 1958, Totsuko changed their name to Sony. By this point, their products were both cheaper and higher quality than American counterparts. (Kimizuka, 2012).

Despite all of the innovations had until this point, the technology was still unable to compete with the LP for quite a while, until the Compact Cassette, released in 1963. The original design of the cassette allowed for home recording and portable use. The audio quality on these devices was not the greatest and was not suitable for music at first. These problems were addressed throughout the 70s, which began to cause a decrease in LP sales. This all culminated with the Sony Walkman in 1979. The Walkman was fully portable and allowed for private listening by the use of headphones. The Walkman exploded in popularity and sold over 100 million units within ten years of its release.

In 1982, Sony and Philips released the first compact disc (CD) system. The CD stored data digitally, which offered many benefits over analog devices. They were much more durable, could store more data, and offered even higher sound quality. Initially, CD systems were expensive, but by 1985 they had become cheaper, and became very popular, similarly to how the Walkman had done a few years prior. (Shapiro, Patridge, McCafferty, Herstin, Gupta, Leveillee; 2012). By this point, the LP was beginning to fade into obscurity, as other technology was

objectively better than vinyl discs, and they didn't sell as well. Other digital media formats were developed, such as MP3 players, but none had the impact that the CD did.

Finally, the most recent innovation in audio playback technology, and in the music industry, was the advent of online streaming services. As the internet grew, companies realized they could sell music online, and consumers could either download it or stream it with an active Wi-Fi connection. The media no longer had a physical aspect, other than what device the user chooses to play it on. This meant no more carrying around a separate device for portable music listening, no more storing dozens of records, tapes, or CDs. Services such as Pandora Radio, Spotify, and iTunes were able to make practically any piece of recorded music imaginable available to anybody at the click of a button. As streaming services increased in popularity throughout the 2000s, it became much easier for artists to record their own music and publish it.

## **Discussion and Conclusions**

First, I would like to establish the link between commercialization and the improvement of technology. Although there were a few instances of innovations happening purely from the passion of the inventors- Léon Scott, Bell and Tainter, and Poulsen for example- most major breakthroughs were motivated by the want of commercial success. After seeing the potential of Bell and Tainter's Graphophone, Edison immediately began work on his perfected phonograph, and very heavily marketed it. Edison is known for doing this with many of his inventions; as soon as he caught a glimpse of commercial success in a product, he would begin to heavily improve upon it (Osborne, 2012). This can be seen with the lightbulb, motion picture camera, the telegraph, and the telephone.

In the early 1900s, there were three main actors in the music industry. Edison's Phonograph company, the National Gramophone Company, and the Columbia Phonograph Company. Each of these three companies were in a constant struggle to gain an advantage over the others and produce a better product. Many innovations arose because of these clashes, until in the end, legal battles rendered Columbia a sort of "victor," with a strong connection to the National Gramophone Company. As the relevance of radio stations in this network grew, a need for a better recording medium became necessary. Most companies began to switch to using discs over cylinders, and shellac was settled upon as the material of choice. Edison's refusal to switch to these discs and failure to innovate eventually led to the company's later lack of commercial success and then downfall (Millard, 2005). Commercial success and technological improvements are clearly very heavily correlated, and this trend continues as time goes on.

During WWII, the commercial success of shellac was artificially decreased by government mandates. As such, the network had to quickly adapt to this change, and vinyl quickly rose to prominence among most music recording companies. It also happened to be more profitable, and of higher quality than shellac (Millard, 2005). After the war, availability of magnetic tape allowed for the technology to spread throughout the world and was quickly picked up by radio show hosts due to its ease of use, and later by music recording companies for its quality and other advantages over vinyl. Relatively disconnected from the rest of the world and therefore music industry network, Totsuko (Sony)'s rapid development of magnetic tape led to near complete market dominance in Japan. No other companies were able to compete with Totsuko's ingenious engineers (Kimizuka, 2012).

As it became easier for Sony to provide their technology to the rest of the world, tape became the medium of choice for the music industry due to its technological superiority,

replacing vinyl. CDs did the same later, and again more recently with other digital mediums (Shapiro, Patridge, McCafferty, Herstin, Gupta. Leveillee; 2012). It seems that as soon as a technology improves beyond the current one, it quickly spreads throughout the network, and the market switches to using it.

It is for this reason that streaming services will likely be the last great innovation we will see in terms of audio playback technology. It is hard to imagine what other major improvements could be made in terms of the recording medium itself. Current technology allows for millions, possibly billions, of songs to be accessed from nearly any electronic device. It is as portable as possible, and the medium in which the audio is stored is digital and does not deprecate or lose quality as analog devices do. I believe most advancements to come are simply going to be higher quality recording devices, and better speakers; but even those are limited by what the human body can perceive. Any further major innovations would likely need to come from biological modifications of humans.

To conclude, I would like to assert that technological improvements correlate to commercial success. Any major improvement made- such as the use of shellac discs, or cassette tapes- tends to cause a massive commercial success, and a switch away from older technology. Anything in the musical industry network that chooses not to embrace the newer recording technology quickly loses sales.

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