FANTASOUND: A RETROSPECTIVE OF THE
GROUNDBREAKING SOUND SYSTEM OF DISNEY

by

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ABSTRACT

The recording techniques and creation of the Fantasound system changed the way moviegoers perceive the motion picture experience. This thesis explores the creation, adaptation, and presentation of Fantasound. This is accomplished through an in depth look at Fantasia; including special features from bonus DVD materials, interviews with the creators, fresh interviews with leading experts, and period articles about the Fantasia experience. The purpose of this retrospective is create a single collective of information about Fantasound, what came before and what followed.

The form and content of this abstract are approved. I recommend its publication.

Approved: Sam McGuire, Chair
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CHAPTER I

INTRODUCTION

Purpose of Retrospective

This retrospective will explore the creation, adaptation, and presentation of Fantasound. It has been created in order to gather the information about Fantasound into a single collective reference about Disney’s audio innovation and provide an abbreviated history of progress to current sound systems.

Methods of Retrospective

Much of the information in this retrospective has been found through historical articles and scientific documents. There is also some information that has been gathered from previous interviews and discussions with modern specialists.

This retrospective has been limited by the amount of information readily available from the literature review. Further information is either lost or buried in the archives of Disney Enterprises, Inc., which are currently unavailable.1

Disney and Fantasia

Walt Disney burst into the still fairly young film industry with the help of his brother, Roy, in late 1923.2 Through their unique perspective on entertainment, and their drive for innovation, the world of film sound has been given many techniques;

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1 See letter from Disney Enterprises, Inc. in the Appendix
2 October 16th Disney Brothers Cartoon Studio sign contract with M.J. Winkler Productions. (Polsson)
some of those techniques are still in use today. They started with a series called the
_Alice Comedies_, which featured a live-action Alice exploring an animated world.³

The Disney Company had proven that animated feature films could sell when
they released _Snow White and the Seven Dwarfs_ in 1937.⁴ Inspired by success,
Disney released two feature films in 1940: _Pinocchio_, in February,⁵ and _Fantasia_, in
November.⁶ Both, in true Disney fashion, led into a new world of animation and
sound reproduction.

Disney introduced the public to his love of music in 1929 with the _Silly
Symphonies_ collection, the first being _The Skeleton Dance_, which is still a Halloween
favorite to this day.⁷ Walt’s love for new technologies appeared in _Silly Symphonies_
when his friend Herbert Kalmus, the creator of Technicolor,⁸ convinced him to
produce _Flowers and Trees_ in color.⁹ Since that time, all of the _Silly Symphonies_
were in color.

_Fantasia_ was started, like many things in Disney’s world, by a mouse. Walt
Disney wanted to create one of his _Silly Symphonies_ using Paul Dukas’ symphonic
piece _The Sorcerer’s Apprentice_, starring Mickey Mouse, for which he obtained the

³ Winkler pays for six of the Alice films, with an option for six more. (Polsson)
⁴ December 21st, the first full feature animated film. (Polsson)
⁵ Premiered at the Central Theatre in New York. (Polsson)
⁶ Premiered at New York’s Broadway Theater. (Polsson)
⁷ May 10th. (Polsson)
⁸ a system of making color motion pictures by means of superimposing the three primary colors to
produce a final colored print. (dictionary.com)
⁹ July 1932 (disneyshorts.org)
rights in 1937. One night he had an impromptu dinner with the famous conductor Leopold Stokowski, who expressed interest in helping to create the music for the short. This recording was done with eighty-five studio musicians at the Pathé Studio, in Culver, California in 1938. They were experimenting with different recording techniques in order to better capture the work done by the orchestra. This included capturing the orchestra in sections instead of as a whole.

The [orchestra] shell was then divided into five sections by means of double plywood partitions. Two difficulties were encountered with such a set-up; one was poor low-frequency separation; the other was the inability of the musicians at the rear of the sections to hear the music from the other sections, to such an extent the tempo was impaired.

This was when the idea of Fantasound began to develop with the Disney engineers. As expected by those who work for Disney, they met the challenges given to them with their full creative force.

The creators of Fantasia were so confident of its success that, despite a war in Europe, they were already planning the musical selections for the next installment. Once it was decided that Fantasia would be a feature film, Disney intended for it to be like any other concert you may see performed by an orchestra; after the initial release, new pieces would be added to the repertoire while still keeping some of the

10 It was intended to be a comeback feature for Mickey. (Solomon)
11 They had both been eating alone when Disney chose to sit with the conductor. (Solomon)
12 Now called Culver Studios (Culver Studios)
13 Culhane, pp 15-16
14 Garity and Jones – Experiences in Road-Showing
15 Peri was told this by multiple artists in his books
16 Disney commented that he thought Fantasia would outlive him (Robins)
old favorites. This is implemented in *Fantasia 2000*, when *The Sorcerer's Apprentice* was left in the lineup with the new technologically advanced pieces.

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17 Disney is quoted saying they could release a new version every year. Stevens, 1991
18 Noxon, 1999. “One measure of Disney's commitment is the presentation of the film in Los Angeles. Unable to reach an agreement with the operators of the only Imax theater in central Los Angeles, Disney has built a temporary theater especially for the run of *Fantasia 2000*.”
CHAPTER II

REVIEW OF LITERATURE

Articles

For this thesis, articles published about Fantasia both recently and when Fantasia was originally released in 1940 have been reviewed.

Disney Again Tries Trailblazing by Sam Robins. One of the first articles written about Fantasia was a promotional piece written by Sam Robins for the New York Times Magazine, ten short days before the premiere. He talked about the atmosphere at the Disney studios, remarking specifically on how everyone was on a first name basis. While he did not exactly name Fantasound, he did make mention of the sound system and gave descriptions of what it should accomplish.

But over everything there is music, music coming not through one loud-speaker behind the screen but through many strategically placed speakers around the theatre. Thus, when the waters hurl Mickey Mouse down a flight of stairs in Dukas’ “The Sorcerer’s Apprentice,” the music pours out of one corner of the theatre and floods across the auditorium.  

Robins continues his colorful descriptions, describes Disney’s hopes for the film, and goes on to talk about the recording of the Philadelphia Philharmonic. The recordings were done at the Philadelphia Academy of Music which had been deemed the perfect acoustic environment for the recording based on tests done by Bell Labs.

Small Articles of Interest, New York Times. There were a couple of articles written about a dinner that was to be held prior to the premiere of Fantasia, where all

19 Robins, 1940
of the proceeds would be going to relief assistance for the bombings in Britain. While America was currently not involved in the war, they still heavily favored helping out the British people. There was at least one article detailing a group of New York debutantes that would be passing out programs and acting as ushers during the premiere to help raise money for the relief effort.

_Hollywood Gets a Peek at ‘Fantasia’: A Problem of Too Many Extras and Amateur Range-Riders by Douglas Churchill._ In another article released prior to the premiere by Douglas Churchill, Fantasound is discussed in slightly more detail. He starts off explaining that while the animated sequences were not quite finished, the sound system had already been crated up and shipped to Manhattan. “The Disney engineers have solved the problem of dimensional sound which has been regarded in many quarters as the next step toward reality on the screen.”20 The article goes on to explain that the moviegoer would be immersed in the sound of the orchestra and that the entire event would be a spectacular experience for all.

_Fantasound by William Garity and J.A. Hawkins._ Many of the specifics on the recording process were found in a technical paper published by William Garity, the head audio engineer on the Fantasia project. It was originally released in the August, 1941 issue of the _Journal of the Society of Motion Picture Engineers_ and walks through the process used to develop Fantasound. Garity begins by defining the deficiencies of the “conventional sound-picture reproduction.” He lists them in this

20 Churchill, 1940
order: limited volume range, point-source of sound, fixed localization of the sound-
source at screen center, and fixed source of sound. In order to address these issues the
Disney engineers developed new equipment. They developed the pan pot to move
the sound away from the center speaker, allowing the sound to also follow the
characters on screen. They created the variable-gain amplifier and the tone-operated
gain-adjusting device to combat the amplification and clarity problems. This will be
covered in detail later on.

*A Sorcerer, Not an Apprentice by Theodore Strauss.* In an almost biographical
article written by Theodore Strauss, we were given one of the few numerical values
about the amount of speakers being used in a theater. He was speaking of Disney
awaiting the run through of *Fantasia* before the premiere that night. “…all about the
half-lit house engineers were stringing new cable to loudspeakers – more than
seventy in all – fixed to the sides and back walls.”21

*Disney’s Experiment: Second Thoughts on ‘Fantasia’ and Its Visualization of
Music by Olin Downes.* One of the reviews on the production was published in the
*New York Times* by Olin Downes four days after the premiere. He distinguishes
between those viewers who go to see a movie and those who go to see a concert. The
comments and critiques he collected from moviegoers ranged from “the music was
too loud,” to questions on the musical selection. He did not comment on the actual
sound system that was in place for the premiere.

21 Strauss, 1940
Mickey Mouse Goes Classical by Andrew R. Boone. In January of 1941, the magazine Popular Science released a three-page article about Fantasia and its wonderful sound system. The article, written by Andrew Boone, noted the number of microphones, simplifying their uses, and the sheer amount of optical film that was used. “Exactly 483,000 feet of sound track were recorded in forty-two days.” He also makes mention of the nine complete tracks that the Disney engineers had trouble syncing together. In the end, they dubbed the amount of tracks down to four; three for actual film content and one to assist with volume control.

Walt Disney’s New Movie Imparts Life to Music by Bide Dudley. In the Denver Post on November 17, 1940, journalist Bide Dudley seemed to compliment and insult the project at the same time. He commented that the audience is robbed of its own imagination by the animators at Disney, going on about how some enthusiasts believe that opera should not contain words for the same reason. Then he continues, claiming that if Disney was indeed flawed by this, then his animators had done a wonderful job of replacing the audience’s imaginations with something equally as wonderful, yet down to earth.

The Nation: Films by Franz Hoellering. Franz Hoellering from The Nation wrote a lengthy commentary in their November 23rd issue in 1940. He commented that Disney had no chance of being able to match the genius of Bach or Beethoven with his animations. He did not understand why Disney strove to hear pictures or see.

22 Boone, 1940
music, and thought it to be “fundamentally wrong.” He did, however, compliment
the sheer mass of the sound being produced and the pieces that lent themselves more
naturally to stories, such as the ballets and The Sorcerer’s Apprentice.

*Fantastic Fantasia*: Disney Channel Takes a Look at Walt’s Great Experiment
in Animation by Charles Solomon. While Fantasia had several revivals over the
years, the most recent one was in the early 1990s, when the decision was made to
release the movie in its original form. Over the years, several sequences had been cut
and the commentary from Deems Taylor had been completely removed. Thankfully,
Roy Disney convinced the Board of Directors not only to make a new Fantasia but to
also give the public the full, as-original-as-possible version that most had never seen
before. This choice was cataloged in the *Los Angeles Times* in August of 1990, by
Charles Solomon, an animation historian, critic, and lecturer at UCLA.

**Interviews**

In all of the publicity for Fantasia, Disney always expressed his excitement for
all of the new things that were happening in the creation process. Disney reportedly
said, “You know, I think this picture will make Beethoven” to Deems Taylor and
Leopold Stokowski in the early stages of the project.23 He spoke of the new
developments with animation and showed enthusiasm for the Fantasound system.

As far as the public is concerned, maybe there’ll be a few concertgoers who
will take exception to our conception of the music, but they’re a minority. To

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23 Merlock Jackson, 2006
millions who’ve always thought of classical music as longhaired and arty it may reveal some of the excitements of listening to the great composers. Disney knew that he was on to something when he introduced the system. He did it not only to improve the experience of his picture, but because he knew that it would change the audio world.

In the commentary performed on the newer releases of Fantasia, Roy E. Disney, the nephew of Walt Disney, informed us that the original roadshow was presented as an event. It was played with the entire Fantasound system installed in twenty-five theaters at most. He also commented that Fantasia was reshown in 1942, though all of the commentary by Deems Taylor had been cut out, shortening the show by almost an hour.

There are three leading professionals in the current sound world who were contacted in order to obtain fresh interviews about Disney’s historic sound system. Those professionals were Tomlinson Holman, who has worked closely with LucasFilms, Ioan Allen from Dolby and Larry Blake from Swelltone Labs. These interviews were conducted by email almost exclusively in the month of February, 2015. See the appendix for full transcriptions. They were able to shed light on the lack of a comprehensive document regarding the reasons and workings of the Fantasound system. They also shed light on how the system failed to catapult the industry into surround sound in 1940. Larry Blake stated that, “It was cumbersome

24 Churchill, 1940
25 Fantasia commentary included with the Fantasia Anthology collection
and expensive,” and that it was a one-off event that didn’t directly influence any sound system developments that came after it. Tom Holman responded to the same questions with, “The wind had gone out of its sales by Dec. ’41 since it had opened 13 months earlier and was running out of box office gas long before that date so it wasn’t the onset of WWII.”(that caused the failure.)

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26 Email Interview with Larry Blake, 2015  
27 Email Interview with Tom Holman, 2015
CHAPTER III
THE ROAD TO FANTASOUND

Vision

Not long after the first recording had been made, Disney announced they would be creating a full-length feature of musical animation. This decision was reached when the cost for *The Sorcerer's Apprentice* exceeded what it would presumably draw in. Thus, within a year of the fateful dinner, Stokowski was contracted to conduct the entire symphonic collection.

Leopold Stokowski was a dynamic and impressive conductor, known for being able to stretch musicians to the edge of their talent before pushing them to a new level of musical performance. His musicians were the best, not necessarily because they had massive talent but because he was able to lead them to create something cohesive as a group.

"Stokowski conducted hundreds of broadcasts and world premieres; thousands of recordings; the first transcontinental orchestral tour; and the revolutionary film *Fantasia*, which introduced stereophonic sound, brought symphonic music to mass audiences, and established his orchestra and himself as popular institutions."

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28 Garity and Hawkins, 1940
29 The cost was already over $125,000. Solomon, 1990. That’s about $2.5 million today
30 Polsson
31 Chasins, 1979. p. x of the prologue
Stokowski began his professional training at the Royal College of Music, in London, England, when he was thirteen, and began professionally conducting at St. James Church when he was appointed organist and choirmaster at eighteen. His small amount of fame grew for him as an organist, and then as an orchestral conductor, until he arrived to conduct the Philadelphia Orchestra, beginning in October of 1912, where he then spent the majority of his career. While in Philadelphia, he conducted many premieres of orchestral works and orchestrated or adapted many older pieces to suit his orchestra. As a lifelong fan of the newest and most experimental techniques in recording, Stokowski spent much of his time studying the technologies and had his orchestra recorded by several of them. He worked closely with Bell Labs starting in 1930 to create high fidelity recordings and broadcasts. In early 1932, they participated in what is considered the earliest stereophonic recordings.

“In March, 1932, Bell Laboratories recorded the Philadelphia Orchestra in ‘binaural’ or stereophonic sound, by connecting two different microphones each to its own cutting stylus, with each moving [a magnetic] cutting stylus. The two cutting styli were each in its own arm, parallel to the other, but one recording from the outer edge of the wax disk (as was normal), and the other beginning half-way into the disk. As a result, each stylus would cut half of the 78 RPM disk with a record groove containing a right or a left audio channel. Playback was the reverse process, using two playback styli.”

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32 Chasins, 1979, p 4
33 Chasins, 1979, p 9
34 Robinson, 1977, p 15
35 He made the first electrical recording of a full symphony in 1924. Artner, 1990
36 This included some of the first stereo recordings. Artner, 1990
37 Leopold Stokowski, Harvey Fletcher and Bell Laboratories Experimental High Fidelity and Stereophonic Recordings 1931-1932
In April 1933, he participated in the first long distance concert to ever be broadcast. It was of the Philadelphia Orchestra, under the conduction of assistant conductor, Alexander Smallens, while Stokowski controlled the sound balance of the recording.\(^{38}\) This broadcast boasted the capture of 10 kHz with the use of Class A telephone lines. After recording *The Sorcerer’s Apprentice* and being further contracted to record the rest of the feature, he had Disney record most of the soundtrack over the same Class A telephone lines laid down to the basement of the Academy of Music in Philadelphia.

The working title for the full film was simply *The Concert Feature*, and the studio was entertaining many different story ideas, musical selections and art styles. At Stokowski’s suggestion, Disney changed the name of the film to *Fantasia*.\(^ {39}\) The pieces of music were narrowed down and chosen by Disney and Stokowski with the assistance of famous musicologist Deems Taylor, who later acted as the commentator for the film.

Taylor, the main radio art critic of the time, was believed to be trusted by the audience to make the introduction to each piece of music to help the audience feel comfortable with the whole experience.\(^ {40}\) Another interesting thought for the

\(^{38}\) Leopold Stokowski, Harvey Fletcher and Bell Laboratories Experimental High Fidelity and Stereophonic Recordings: 1933 Long Distance Concert - Philadelphia to Washington

\(^{39}\) Solomon, 1990. It was postulated by Chasins in his book in 1979 that a full feature was always Stokowski's intention. P 168

\(^{40}\) Pegolotti, p 235
experience was to include scents to be pumped into the theater, something that was never taken off the drawing board by Disney until the creation of Disneyland many years later.

Fantasound started out with the idea that having the music move across the screen with the animation would make a wonderful show. While this was not a completely new idea, it had never been successfully attempted; Disney wanted to make it happen. The idea expanded as they continued working on the system and was, in the end, created to fully immerse the listener in sound. It was intended to have the viewer feel as though instruments were dancing around them. Fantasound actually accomplished a pseudo stereophonic mix on a large scale, one that could be sent around from the front to the side, and then to the back speakers in a movie theater with the use of newly developed equipment. They not only created a multichannel mix but also helped to create the equipment to send the sound around the room. This was monumental and astonished its audience.

Previous Innovations

The experimentation of sound with film started back in the late 1870’s with Thomas Edison stating that his phonograph was so clear that if paired with a

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41 Robins, 1940
42 Garity and Hawkins’ paper gives a detailed technical description of the advancements. It is discussed more later.
stereoscopic photograph, “it would be difficult to carry the illusion of real presence much further.”

Stereoscopic photographs are two copies of a single image placed side by side to give the illusion of a 3D image. It was very shortly after that statement when Wordsworth Donisthorpe, an Englishman, suggested pairing the phonograph with his Kinesigraph, an early moving film camera. Edison attempted the pairing with his own invention, the Kinetoscope, in 1891; he ran into two major problems, synchronization and amplification.

The Lumiere brothers created projected films on a cinematograph, in 1895, and people were so impressed by the rapid advancements of film that the lack of

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43 Ulano quoting Edison in his article “Moving Pictures that Talk”
44 Dictionary.com
45 In an article he wrote in early 1878 (Ulano)
46 1891 is when he applied for the patent for the Kinetoscope. He started his people on it years earlier. (Ulano)
recorded sound seemed to be unimportant to the general public.\textsuperscript{47} “Silent” films were accompanied by live musicians with sound effects and music, or traveling theatrical groups that learned the lines of several different films.\textsuperscript{48}

\textbf{Figure 2 - Labelled Cinematograph}

Despite the lack of interest in recorded sound by the public, the first optical sound recordings were created in the early 1900s. In 1901, Ernst Ruhmer’s invention, the Photographophone used selenium cells to record light variations.\textsuperscript{49}

\textbf{Figure 3 - Photographophone}

\begin{footnotesize}
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\item \textsuperscript{47} For the most part, people were just excited that the pictures moved. (Ulano, part 2)
\item \textsuperscript{48} Film Reference
\item \textsuperscript{49} Ruhmer, 1901
\end{itemize}
\end{footnotesize}
In 1904, the Frenchman, Eugene Lauste, tracked signals from a microphone with a fixed mirror on a diaphragm to reflect light onto film stock.\textsuperscript{50}

![Figure 4 - Sound on Film System and Film Strip](image)

The most successful of the engineers and inventors who tried to improve the motion picture experience in the early 1900s was arguably another Frenchman, Leon Gaumont. He demonstrated his Chronophone sound projection system in 1910 to an audience of almost four thousand people.\textsuperscript{51} He linked it with the Auxetophone by C.A. Parsons, which used compressed air, and successfully improved amplification.\textsuperscript{52}

![Figure 5 - Gaumont's Chronophone Vocal Projection System](image)

\textsuperscript{50} Monaghan, 2010  
\textsuperscript{51} 100 Years of Cinema Loudspeakers, Aldred  
\textsuperscript{52} Ulano, Part 2
While he was not the only inventor working on loudspeakers at the time, he is distinguished as the inventor who first dreamed of having the speaker located behind the projection screen.\textsuperscript{53} It is also said that he was interested in having a stagehand behind the screen to move the speaker with the film, to make the story more realistic. These ideas were to hide the mechanics and improve the illusion created on film.\textsuperscript{54}

By the late 1910s several companies were in the business of building and improving audio amplifiers. Many of these companies, such as Bell Labs and Siemens, based their technology off of telephone speakers that were modified to project and amplify the sound. The complications with this were poor amplification and small frequency range.\textsuperscript{55}

Another ten years would pass until recorded sound successfully returned to the theater, most effectively in the form of the Warner Bros’ Vitaphone sound on disk system. It was originally developed by Bell Labs and was cumbersome, with a large projector attached to a record player in an attempt to keep the two in sync. The sync was inconsistent and did not draw crowds to recorded sound films as originally expected.\textsuperscript{56}

\begin{flushright}
\begin{tabular}{l}
53 Aldred \\
54 Aldred originally published in AMPS newsletter issue 21 \\
55 Aldred also speaks about Theodore Case \\
56 Vitaphone information from The Belknap Collection
\end{tabular}
\end{flushright}
The theater would receive two items, a roll of film and a record, to be played together for the audience. Using this system, the company released *Don Juan* in 1926, which used the system to play music and sound effects through a single amplifier into an auditorium. They soon followed this success with *The Jazz Singer* in 1927, which featured Al Jolson singing and playing the piano.57

When they began work on *Fantasia*, recorded sound had been used in theaters for about fifteen years.58 All of these theaters were setup with a single mono loudspeaker that was situated behind the projection screen. The first broadcast of a stereo performance was done by Leopold Stokowski and the Philadelphia Orchestra with the assistance of Bell Labs. The audience at Constitution Hall in Washington

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57 Vitaphone website  
58 Holman, 1998
D.C. listened to the broadcasted orchestra through three large loudspeakers sitting on stage, while colored lights decorated the lowered screen.\textsuperscript{59}

The actual orchestra was still sitting in the Academy of Music concert hall in Philadelphia while Stokowski simply operated three tone level controls for the speakers. The engineers at Bell Labs had setup their equipment there because they found that the hall had wonderful built-in acoustics and transmitted their performance from there.\textsuperscript{60}

A main contributor to the mechanical pieces of the Fantasound system was RCA, the Radio Corporation of America. The company was created at the end of World War I, when private companies such as General Electric joined together with the U.S. government to create a business intended to keep America at the forefront of transatlantic communications.\textsuperscript{61} Their involvement with Disney during the creation of Fantasound is often glossed over for other innovations accomplished by the company. RCA engineers were greatly involved in the sound reproduction research and assisted in the creation of the Fantasound system.\textsuperscript{62} When the soundtrack was transferred to magnetic tape in the 1950s, it was RCA who handled the transfer over the same type of Class A telephone wires used in the original recording.\textsuperscript{63}

\textsuperscript{59} Broadcast in Color, Rothman
\textsuperscript{60} Rothman again
\textsuperscript{61} Encyclopedia Britannica; RCA
\textsuperscript{62} Klapholz, p 68
\textsuperscript{63} Klapholz, p 70
CHAPTER IV

DISNEY INNOVATIONS

Recording Techniques

Recording began in April 1939 and lasted for seven weeks at the Academy of Music in Philadelphia, the orchestra's home, which was chosen for its excellent acoustics, as proven by Stokowski and engineers from Bell Labs in 1932. Thirty-three microphones were placed around the orchestra, capturing the music onto eight optical sound recording machines placed in the hall's basement. They would create a visual representation of the sound onto a piece of film. Each one represented an audio channel that focused on a different section of instruments: cellos and basses, violins, brass, violas, woodwinds and tympani. The seventh channel was a mixdown of the first six, while an eighth channel provided a distant pickup of the orchestra.

A click was created, more for the animators than the other musicians, who were led by Stokowski and thus had no need of the track; animators lined up their frames of animation with the musical track by the click.

The first major advancement asked for by Disney was to have the sound moving across the stage. They began this process by developing the pan pot system. With the help of research done by Bell Labs, they discovered that placing the speakers about twenty feet apart made it possible to move the sound without the

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64 Stokowski, Fletcher, and Bell Labs
65 Garity and Hawkins, 1941 pp 14-15
66 Stokowski, p 172
sound completely disappearing in the middle. This effect could not be accomplished with simple volume control, thus the pan pot, or panoramic potentiometer was created.\textsuperscript{67} It allowed the signal to travel through a left, center, and right speaker using constant fades as it shifts from speaker to speaker to create a seamless movement of sound. It took six people to operate those first various pan pots in real time. Leopold Stokowski himself conducted the troop with the level and pan changes which he had marked on his score. The next advancement of the pan pot came from the complications of having so many people making adjustments, “only because the musical director, the music cutter and the ‘enhancing mixer,’ could no longer remember from one rehearsal to the next, ‘What should come out where?’”\textsuperscript{68} One of the struggles the engineers were not able to fix with their equipment at the time was that the panning was not as discrete as one would hope. The point of discrete panning is to hide the location of the actual speakers from the listener. Their eyes should not be drawn across a room as the sound moves, but rather, stay fixed on the screen despite the sound’s movement.

\textsuperscript{67} Garity and Hawkins, 1941 p 4
\textsuperscript{68} Garity and Hawkins, 1941 p 13
In addition, Disney ordered several tricolor oscillators from Hewlett-Packard, a brand new company having been founded in January 1939, to monitor levels at lower frequencies. These oscillators were the predecessor to VU meters used today, ensuring that the lower frequencies were included in the music. “Almost a fifth of the film’s budget was spent on its recording techniques.”

**System and Setup**

As mentioned before, William Garity defined four deficiencies of sound-picture reproduction that the engineers worked to address: limited volume range, point-source of sound, fixed localization of the sound-source at screen center, and fixed source of sound. By limited volume range, Garity means that the extremely dynamic works produced by symphonic orchestras are marred by excessive ground noise or interference, and amplitude distortion. Point-source of sound means that having all sound come from a single speaker alters the perception of effects and music over dialog, often resulting in phasing. Fixed localization of the sound-source at

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69 Peri
screen center gives the audio engineer less to work with to enhance the picture. He describes how having multiple sources allows for a more flexibility with the sound medium. Lastly, fixed source of sound is speaking directly of the inability of movement of sound across the screen. This movement was Disney’s original request of his engineers; much like Gaumont, he wanted the sound to move with the picture.

The engineers discovered that by placing two speakers approximately twenty feet apart they could move the sound from one to the other through fading, without too much loss of sound. The technique was simplified with the pan pot, a 3-circuit differential junction network used to move the sound from one to all three of the speakers smoothly while maintaining sound levels throughout. While panning is used in almost every instance of recorded music today, this was the origin of the invention and first application of the device.

Garity also explains what he calls the brains of the reproduction system: the TOGAD or tone-operated gain-adjusting device. This device included two main functions: the variable-gain amplifier and the tone rectifier. Figure 8 shows the simplified block diagram from Garity’s paper to illustrate the system. The variable-gain amplifier, abbreviated VGA, is an electronic amplifier that can change the

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70 Garity and Hawkins, 1941 p 2
71 Garity and Hawkins, 1941 p 1
72 Garity and Hawkins, 1941 p 3
73 Garity and Hawkins, 1941 p 4
74 Garity and Hawkins, 1941 p 8
75 Garity and Hawkins, 1941 p 4
perceived level of the audio based off of voltage control. This, coupled with the tone rectifier which converts alternating current to direct current, simplified the volume control through the system.\textsuperscript{76} By converting to direct current the engineers were afforded more control over the volume than ever before.

![Diagram of Variable-Gain Amplifier](image)

**Figure 8 - Simplified diagram of the Variable-Gain Amplifier**

The Mark I Fantasound system used a five speaker setup, three across the front and two in the back corners of the theater. Two audio tracks were used to test this system: one in the center speaker, the other sent through the other four speakers using a four-circuit pan pot system. This proved the advantages of a broad sound-source to the engineers; problem two solved.\textsuperscript{77}

\textsuperscript{76} Garity and Hawkins, 1941 p 5
\textsuperscript{77} Garity and Hawkins, 1941 p 12
The Mark II was an expansion of the first, placing three additional speakers: two on the sides, about halfway back from the screen, and one on the ceiling in the center of the house.

This system used three tracks and a 6-circuit, manually controlled differential junction network. In addition to creating the effect of moving the sound around the theater, the controls allowed side to side movements in any plane between the screen and rear wall of the house. Simultaneous fore and aft control was also available.78

The problem that arose with this version was that the pan pots were operated by a single engineer. This was not only difficult for the engineer but also presented the problem of human error for the need of consistent performances.

These problems were addressed in the Mark III system which implemented a single channel TOGAD expander. Control of the system was handed over to either an oscillator or tone track. New problems arose, this time as crosstalk, timing, and amplitude issues.79

![Figure 9 - Circuit Diagram for first Tone-Rectifier](image)

78 Garity and Hawkins, 1941 p13
79 Garity and Hawkins, 1941 p13
The Mark IV replaced all manual control with the TOGAD. It also added eight tone controls on a single control track that was logarithmically spaced. This whole system was moved with the Disney Company from their studio on Hyperion to the new Burbank location early in 1940.\footnote{Garity and Hawkins, 1941 p13}

The next advent, the Mark V, still had eight speakers, three program tracks and the eight tone controls. With the advancement of eight hybrid coils in the program circuits they found that the system was more flexible. This system, however, was only in use for a single day, as they found that the musical director, the music cutter and the "enhancing mixer" could no longer remember from one rehearsal to the next where each element should be placed in the speakers.\footnote{Garity and Hawkins, 1941 p13}

The Mark VI system's main contribution was narrowing the amount of program mixers needed for the dubbing. There were originally ten, but with the use of newly designed pan pots, six mixers were able to control the twenty-four program circuits.\footnote{Garity and Hawkins, 1941 p13}

By this time, Disney had started working heavily with RCA, Radio Corporation of America, to help them design the new system. They manufactured the Mark VII, which was created with a different tone rectifier. The previous systems used a log-log tone rectifier, whereas RCA put in a linear tone rectifier. This was an
important development because of the way the rectifiers work. A log-log rectifier will amplify by multiplying the signal tone by its logarithmic number, approximately 1.2 times the original signal. A linear rectifier will multiply the signal by itself.

The Mark VIII system is said to have been rearranged, though Garity does not specify how. He also mentions that RCA redeveloped the log-log tone rectifier and returned it to the system, as it proved to be more effective than the linear model. The signal was clearer and better amplified by this new model. It is interesting to note that the system that was actually used for the premiere was not the final advent, the Mark X, but was instead the Mark VIII.

The second dubbing of Fantasia was done through this system. After adding a stand-by channel, this equipment was installed in the Broadway Theater in New York for Fantasia’s World Premiere.

After the premiere, the Mark IX system had another rearrangement of equipment. Two sets of rear-house speakers were switched in to supplement the left and right screen speakers, sometimes completely replacing them. This system was used for eight of the roadshow stops.

The final advent of the system, the Mark X was identical in setup to the Mark IX, however, the system was now completely automatic with a relay timing system connected to the notches in the film. This system was installed at the Carthay Circle.

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83 Garity and Hawkins, 1941 p14
84 Garity and Hawkins, 1941 p14
85 Garity and Hawkins, 1941 p14
86 Garity and Hawkins, 1941 p14
Theater in Los Angeles and is said to have included over thirty speakers, though this information could not be corroborated.\textsuperscript{87}

Fantasound used two projectors running at the same time; one contained the picture film with a mono soundtrack for backup purposes, while the other ran a four-track sound film mixdown from the original eight-channel optical recording.\textsuperscript{88} Three of those channels contained the audio for the left, center and right stage speakers, while the fourth was a control track with amplitude and frequency that drove the amplifiers to control the volume of the three audio tracks. In addition, there were three house speakers placed on the left, right and center of the auditorium whose signals were derived from the left and right stage channels which acted as surround channels. As the original recording was captured at almost peak modulation to increase signal-to-noise ratio, traditionally about 40dB, the control track was used to restore the dynamics to where Stokowski thought they should be. Several reviews and articles mentioned having up to sixty-eight speakers in one given setup, though

\textsuperscript{87} Emails with Mr. Holman, 2014
\textsuperscript{88} Garity and Hawkins, 1941 p14
this may have simply been hype.

Figure 10 - Simplified Diagram of Fantasound Road-show Rig
CHAPTER V

PRESENTATION AND BEYOND

Production Factors

The first tour of Fantasia began in New York in November of 1940. Disney leased the Broadway Theater for a year, equipping it with a complete Fantasound system that took a full week to install. Fantasia ran at the Broadway for forty-nine consecutive weeks, the longest run achieved by a film at the time. There were twelve other roadshows held throughout 1941: Los Angeles, Pittsburgh, San Francisco, Cleveland, Boston, Chicago, Philadelphia, Detroit, Buffalo, Minneapolis, Washington D.C. and Baltimore. While Fantasia initially did well in the box office it was expensive to move and setup for each showing, thus limiting its profits. It took the crew several days to install it each time they moved to a new theatre.

Another event that limited profits for Fantasia was the Second World War. It prevented plans for a potential release in Europe, normally a great source of income for the studio. The studio had to be careful of their musical selections for the presentation as well, ensuring that there was no potential for showing support of one side or the other. At this time, America was largely a neutral party in the conflict.

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89 Garity and Jones, 1942
90 Peck from Scientific American, 1941
91 Klapholz, 1991
For this reason, Wagner’s *Ride of the Valkyries*, which had originally been storyboarded for the first *Fantasia*, was removed from the lineup.\(^{92}\)

Up to eighty-eight engagements were outlined across five years, but wartime demands for material limited the number of Fantasound prints to sixteen. All but one of the Fantasound setups were eventually dismantled and given to the war effort. In this capacity they were repurposed as pieces for communications for the US Army.

Upon acquiring the film’s distribution rights RKO initially continued the roadshow. After the first half of the tour in theaters, however, Fantasound use was discontinued; instead they presented the film in mono, which was easier to exhibit.\(^{93}\) This was not as well accepted by moviegoers because of the now limited volume and frequency ranges. They had lost the entire immersive factor that Fantasound brought to the film. *Fantasia’s* potential was stunted by the impractical nature of the Fantasound setup. Theaters were forced to close for a week to install the sound system. Because of the closures, *Fantasia* ended its tour at a greater loss than *Pinocchio* just a year earlier.

*Fantasia* was also greatly altered in later releases, in some cases cutting up to at least an hour of the original footage.\(^{94}\) All of the commentaries presented by Deems Taylor and several scenes with Stokowski were removed, eliminating the intermission and further straying from the intention of *Fantasia* being a complete experience.

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\(^{92}\) Fantasia 2000, comment made by Bette Midler

\(^{93}\) Klapholz, 1991

\(^{94}\) Neibaur, 1958
With the help of conductor Irwin Kostal the entire soundtrack was re-recorded for the 1982 release of Fantasia. It was mixed for Dolby Stereo and used a 121-piece orchestra and 50-voice choir. To ensure that the film would still align with the music, Kostal matched the tempos used by Stokowski. He also used Stokowski’s cuts and revisions for everything except Night on Bald Mountain, where he used the original score.95 This new recording was able to fix some of the two-frame lag that was caused by the recording techniques originally used. The narrations by Deems Taylor were completely removed and a voice over was created by Hugh Douglas, as the studio felt the modern audience "is more sophisticated and knowledgeable about music."96

It wasn’t until the 1990s that the full performance was put back together. According to the commentary from the DVD, the footage of Deems Taylor had been saved, but all of his actual commentary had been lost.97 Luckily for the people at Disney, a transcription of his work had been made, allowing them to have voice actor Corey Burton impersonate the famous critic for the new presentation.

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95 Bob Thomas, 1982
96 Paris, 1982
97 Fantasia, dvd commentary, 2000
After Fantasia

Fantasound brought together, for the first time, the idea of moving sound and picture in a pseudo-stereophonic system; it introduced to the world the first multi-channel sound system. These technological advancements branched off, progressed and upgraded over again separately. Cinematic sound saw what Disney had done with Fantasound and was not prepared for the revolution. After Fantasia, the advancements in cinematic sound dwindled, mostly because of the advent of television.98 People watched from their home screens, and cinematic sound further developed stereo sound systems with the release of Cinerama in 1952.99 It employed a widescreen format shot on three-parallel strips of 35mm film with seven complete audio channels.

The individual frames were six perforations high instead of the usual four and the frame rate was increased from 24 to 26 frames per second to reduce the apparent flicker on the giant 146 degree screen. Cinerama's three frames formed an image of approximately six times the definition of the conventional 35mm film.100

Fantasound’s multi-channel system was a foundational gift to the musical recording world. Cinerama began the true progression from single channel recordings to the multi-channel. There were five front channels that handled all of the front speakers and two auditorium speakers.101 This is a similar setup that

98 Holman, Surround Sound Up and Running, 2008, p 5
99 Cinerama, American WideScreen Museum, 1996
100 Cinerama, The American WideScreen Museum
101 Cinerama, Memories Worth Preserving.
Fantasound employed in the final versions of the system. Cinerama premiered at the same theater as Fantasia had done twelve years earlier.

![Cinerama System](image)

Figure 11 - Cinerama System

In 1953, 20th Century Fox developed what they called CinemaScope which developed a way of lowering the hiss of speakers when they were not being used. The simple device generated at 12 kHz tone, too high for speaker reproduction of the time, to turn the speakers on and off. The four track magnetic audio was striped on the edge of the 35mm film.

Michael Todd, along with his son, had paired with American Optical in 1955 to create the Todd AO system. This utilized 70mm film in an effort to give the visual and audio information more physical purchase on the film. Their system included a single auditorium track while still using five tracks from the front of the

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102 Garity and Hawkins  
103 CinemaScope, originally published in the March, 1953 issue of *American Cinematographer*.  
104 Todd-AO business site, they now focus more on post production, and were acquired by 3rdStreetADR in Nov 2014
house. This single auditorium track was split in two so that the sound could come from both sides.

Figure 12 - Todd-AO System

Quadrophonic sound was developed in the late 1960s through the early part of the 1970s. It used a reel-to-reel system that pumped four tracks through each of the four speakers. Though it was not a commercial success, it did create two different mixing philosophies: sound all around, and sound up front.

Figure 13 - Quadrophonic Diagram

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105 Todd-AO business site
106 Popular Science, Hans Fantel, 1971
It was around this time that Dolby Labs appeared on the scene, first marketing a noise reduction system geared for professional studios.\textsuperscript{107} Dolby released Dolby Stereo in 1975; the noise reduction system allowed for more channels on a 35 mm stereo optical film.\textsuperscript{108} This system was installed in thousands of theaters worldwide in less than ten years. Dolby has been a leader in theater sound ever since.

When Lucasfilms released \textit{Star Wars: Return of the Jedi} in 1983, an audio/visual reproduction standard was created by Tomlinson Holman called THX.\textsuperscript{109} This strict standard was created to ensure that the film was heard and viewed in the optimal environment no matter what location it was screened at. While not a part of the sound reproduction equipment, it did play a major role in assuring that movies were presented in a predictable environment, making the job of the mixing engineers easier. The idea of this was very similar to the touring version of the Fantasound system. In order for all of the people to experience their movie as it was originally intended they created something new.

\textsuperscript{107} Dolby Labs FAQ  
\textsuperscript{108} Dolby Timeline  
\textsuperscript{109} THX website, The THX Story
In the late 1980s, surround sound was becoming popular with movie makers and theaters began to install surround systems in their auditoriums. Many systems were available to make this conversion, and by the 1990s they were all also moving into the digital era. The three main systems were Dolby Digital, Digital Theatre Systems (DTS), and Sony Dynamic Digital Sound (SDDS). Dolby Digital was released in 1992 with the movie *Batman Returns*, and contains six channels of discrete sound. Typically, the first five channels are used for higher audio content while the last is used for super low frequencies that were fed into the subwoofer. It was created as an advanced form of digital audio coding, making it possible to store and transmit digital sound more efficiently and at a higher quality than previously possible. DTS was developed to be a versatile system that could be manipulated to fit any theater or recording setup was available; it appears on a film strip as a dotted time code. SDDS, Sony Dynamic Digital Sound, was made by Sony and was originally slated to appear before Dolby Digital in theaters, however, the system was delayed and not able to appear until almost a year after Dolby’s system was on the market. While SDDS runs along the edges of the film on both sides, Dolby takes the place between the holes in film.

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110 Miller, History of Surround Sound, 2004
111 IMDb, *Batman Returns*
112 Dolby FAQ
113 Dolby FAQ
114 Notes from Fred Johnson’s Surround Sound Class
The two biggest names in immersive cinematic sound systems right now are Dolby Atmos and Auro-3D. As seen above, Dolby has been deeply involved in cinematic sound since the creation of the company. Their latest creation, the Atmos system released in 2012,\textsuperscript{115} is the closest we have come to Disney’s vision of Fantasound. While Fantasound did not directly inspire these advancements, it is clear that they have been trying to achieve the same goal: a completely immersive sound environment.

Dolby Atmos is an object based system, which uses imbedded technology to relay audio information to designated speakers in a theater’s specific setup. It makes it possible to separate individual objects from their backgrounds, allowing more control over the production.\textsuperscript{116} This creates a 3D audio effect in real time for each particular film and theater. This theory allows smaller theaters to be able to produce a similar effect as large theaters that can house more speakers.\textsuperscript{117} The difficulty with

\textsuperscript{115} Pixar’s \textit{Brave} was the first movie it was used for, BBC.com, 2012
\textsuperscript{116} Dolby Atmos White Paper, p 7
\textsuperscript{117} Dolby Atmos White Paper, p 12
this system, much like previous advancements, has been the cost for the theaters to upgrade and install the equipment.

Figure 16 - Dolby Atmos Diagram

The Auro 3D 11.1 system made by Galaxy Studios and Auro Technologies was initially created to address the addition of a height channel to further draw the audience in aurally.\textsuperscript{118} The system boasts the Auro 3D Octopus codec, allowing all audio to be reduced for the setup of current theaters and, with the decoder, allowing those theaters to switch to the new system when they are ready.\textsuperscript{119} The advantage of

\textsuperscript{118} Auro-3d.com
\textsuperscript{119} Auro 3D Octopus White Paper, p 2
this codec is the ability to still show movies that have been mixed for Auro during the
lengthy and expensive process of converting to the 11.1 system.

![Auro 3D Diagram](image)

**Figure 17 - Auro 3D Diagram**

Though these systems have their differences, both have been successfully
installed and used in theaters around the world. They have also been adapted into
home use systems. It is hard to say which one will be more widely accepted in the
long run or if they will both continue to be utilized.

As it is with many of these advancements, Fantasound is often only mentioned
in passing to new students of the audio trade. Audio engineering history is taught in
conjunction with other courses or in master classes such as the one put on by Dubspot
LA and Disney Interactive. While the industry is focused on the future it should
never overlook the past accomplishments of pioneering audio engineers. This is why
Fantasound and the advancements that followed should not be forgotten.

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120 Dolby.com and Auro-3d.com
121 Entitled “The History of Fantasia and Fantasound: Technical Innovations for Multitrack Recording and Production”, and was put on in May 2014 prior to the release of the game *Disney Fantasia: Music Evolved*
CHAPTER VI

CONCLUSION

In conclusion, Fantasound has had a large impact on how we view movies today; though the systems of today were not directly influenced by it, they were changed by its contributions. When asked what Fantasound’s greatest contribution to movie sound was, Tom Holman responded, “Without a doubt, multichannel sound. While the TOGAD counted too, the primary contribution is the spatial sensation.”122

The engineers at Disney gave the world techniques that are taken for granted today, because the pan pot and the Togad systems’ electronic descendants come included in all modern systems. With these technologies, and with the help of Leopold Stokowski, Bell Labs, RCA, and engineers such as William Garity, Disney was able to create a multi-channel sound experience for the audiences of America in 1940 and 1941.

*Fantasia* was created to be a completely new experience, and while this was accomplished it was imagined to be so much more. With the technology available to the audio world today, surround sound is approaching *Fantasia’s* original intent. The Fantasound experience was impressive, but slightly diminished, because of the limitations of the technology of the day; it was unable to completely immerse the audience in sound. Because of *Fantasia*’s accomplishments it has led music production to pursue complete viewer immersion: a goal we are still striving for.

122 Email interview with Mr. Tom Holman, 2015
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*Kentucky New Era*, p. 10.


A. Email interview with Mr. Tom Holman

Tomlinson Holman  
Tue 2/17/2015 4:58 PM  
To:  
Griffin, Kristina;  
On Feb 17, 2015, at 1:53 PM, Griffin, Kristina wrote:

Hello Mr. Holman!

Thank you very much for the help you have given me with my thesis thus far! One of the suggestions of my thesis committee was to conduct a slightly more formal interview, via email. Your contact information would, of course, be removed from any content used for the publication. I have four questions for you. The first, I know you have already answered in part from our previous emails. You may answer any or all of them with whatever information you would like to pass on. Thank you again! I look forward to your answers!

Kristina Griffin

P.S. I have copied this email to my thesis advisor, Sam McGuire, so that he stays informed on my progress.

1. Do you have any knowledge or information of the speaker setup used in the touring version of the Fantasound system?

No I don’t have any information other than what I’ve given you. I don’t think Disney has any records either. The people I knew have retired but you could try calling a librarian at the Disney library.

2. What, in your opinion, was Fantasound’s greatest contribution to modern theater sound?

Without a doubt, multichannel sound. While the TOGAD counted too, the primary contribution is the spatial sensation. If you see the introduction to my book Sound for Film and Television there I break down the sensations of hearing into frequency range, dynamic range, and spatial capability, and while it pushed the first two, it introduced the third for the first time.
3. It has been speculated that Disney’s Fantasound could have catapulted us into the surround sound age many years before we actually arrived there had world events not prevented it. Do you agree or disagree, and why?

I disagree. The wind had gone out of its sales by Dec. ’41 since it had opened 13 months earlier and was running out of b.o. gas long before that date so it wasn’t the onset of WWII.

4. What do you believe are the top three influences for modern surround sound?

1. Fantasia
2. 4-track 35mm mag and 6-track 70mm mag prints in the 1950’s.
3. Star Wars

Tomlinson Holman

B. Email Interview with Mr. Larry Blake

Wed 2/18/2015 4:15 AM
To:
Griffin, Kristina;  
Cc:  
McGuire, Sam;  
You replied on 2/18/2015 6:41 PM.  
Hi Kristina;

Yes, David told me of your work.

My answers are below, in ALL CAPS, not for shouting, but for visual clarity.

I am sending this to you on the condition that I see any quotes that you have of mine, in context, before your thesis is published. That is, that I not just see your quotes of mine, but those surrounding it so I have context.

Thank you.

best,

Larry

On Feb 17, 2015, at 4:56 PM, Griffin, Kristina wrote:
Mr. Blake,

My name is Kristina Griffin, and I am a student of David Bondelevitch at the University of Colorado Denver. He recommended that I contact you as a professional on Fantasound.

For my thesis I am attempting to amass a complete collection of information on Fantasound, which will also include a brief history of theater sound before and after Disney's creation. I am currently conducting interviews with professionals which will be included in my thesis documentation; from which your contact information will, of course, be removed. If you would be willing, I have four questions that I would like to begin with in the hopes that it will lead us into an educational conversation. Thank you in advance for your assistance!

Kristina Griffin  
MSRA Candidate  
University of Colorado Denver  

P.S. I have copied this email to my thesis advisor, Sam McGuire, so that he stays informed on my progress.

1. Do you have any knowledge or information of the speaker setup used in the touring version of the Fantasound system?  
NOTHING MORE THAN YOU HAVE PROBABLY ALREADY UNCOVERED IN SMPE JOURNALS.

2. What, in your opinion, was Fantasound's greatest contribution to modern theater sound?  
NONE . . . IT WAS A ONE-OFF EVENT AND INFLUENCED NOTHING, NO STUDIO, NO MOVIE. EVERYTHING THAT CAME LATER--CINERAMA, CINEMASCOPE, AND TODD-AO--HAD NO CONNECTION TO FANTASOUND.

3. It has been speculated that Disney's Fantasound could have catapulted us into the surround sound age many years before we actually arrived there had world events not prevented it. Do you agree or disagree, and why?  
"COULD HAVE"?? POSSIBLE. BUT IT DIDN'T. IT WAS CUMBERSOME AND V. EXPENSIVE.

4. What do you believe are the top three influences for modern surround sound?  
FORMATS OR FILMS?
April 24, 2015

VIA PDF & MAIL.

Ms. Kristina Griffin

Dear Ms. Griffin,

Thank you for your email message of March 25th requesting permission to conduct research in the Walt Disney Archives on the Fantasmic system for your University of Colorado Denver thesis.

Regrettably, I am placed in the unenviable position of having to inform you that we must deny your request. Given the increasing demands on the services of the Walt Disney Archives, we must necessarily decline almost all external requests for access so that the staff can adequately meet our internal demands.

We thank you for your interest in Disney, and we wish you success with your future endeavors.

Best regards,

[Signature]

Margaret Adamic
Paralegal Specialist, Publishing
Corporate Administration

cc: Rebecca Cline