The Stereo Impulse: High-Fidelity Cinema and the Making of Modern Surround Sound Aesthetics

by

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Abstract

This dissertation examines the economic and social factors that led Hollywood to establish aesthetic ideals for incorporating stereophonic sound technology into motion picture storytelling practices. Contrary to current scholarship, which prioritizes multi-channel audio during and after the 1970s, I argue that the media industry codified its contemporary ideals for stereophonic sound design between the late 1920s and the late 1950s. By examining an assortment of surviving documents—including technical correspondence, patents, oral histories, lawsuits, transcripts from industry meetings, and surviving stereo mixes—I reveal the contentious debates that led the industry to arrive at a definition for what stereo was conceptually and what constituted proper stereo technique. I contend that the widespread adoption of stereo practices by the end of the 1950s was fueled by a host of social forces, such as the showmanship of engineers, corporate alliances, union battles, desires to control the exhibition marketplace, and a structural dependency on preexisting practices. Nevertheless, this institutional infighting engendered a set of preferred techniques for telling stories through multiple loudspeakers, techniques which were widely adopted because they proved economically beneficial to major studios and theater chains. As a result of the broader institutional and commercial value of these stereophonic practices, I argue that films released in Dolby Stereo, digital 5.1, and other contemporary formats continue to embody the aesthetic ideals for three-dimensional sound design that engineers and technicians successfully codified during the studio era.

Chapter 1 begins with the development of multi-speaker sound systems during the transition to talking pictures. I show how these systems were initially designed to amplify soundtracks in the industry's largest venues. This use of multiple loudspeakers, however, gave

rise to multi-channel stereo systems. Examples include the unique systems built for *Hell's Angels* (1930) and *Napoléon Bonaparte* (1935), as well as the experiments of Alan Blumlein and Harvey Fletcher. Chapter 2 investigates the industrial conditions that shaped stereo's association with volume effects. Specifically, as the Academy standardized the acoustical range of optical soundtracks, stereo became a means to offer audiences louder sound designs. Chapter 3 analyzes Hollywood's many attempts to design a successful stereophonic optical sound format following the implementation of the Academy's acoustical standards. Noteworthy experiments included *Fantasia* (1940) and *Portrait of Jennie* (1948), as well as Fox's short-lived 50mm stereo system. I argue that Hollywood's continued use of optical soundtrack technology prevented these stereo formats from being widely adopted by studios and theaters.

Chapter 4 traces Hollywood's transition to magnetic recording. Because the adoption of new equipment was motivated by a need to save money, this transition did not encourage major aesthetic changes to Hollywood's soundtracks. Chapter 5 examines how other production centers, namely London and New York, used magnetic recording to distinguish themselves as technologically ostentatious. I look at the four-track magnetic stereo format developed by Raymond Spottiswoode for the Festival of Britain in 1951, as well as Cinerama's seven-track format developed by Hazard Reeves of New York. I argue that while neither Spottiswoode's nor Reeves's innovations were used in Hollywood, they influenced the decisions made by Hollywood sound engineers throughout the 1950s.

Chapter 6 looks at Hollywood's first serious attempt to cash-in on the success of Cinerama's surround sound system. This attempt took the form of the triple-track stereo format, a short-lived magnetic technology that was deemed too cumbersome to be considered viable sound format for Hollywood. I end the chapter with a comparison of three films all released in

triple-track stereo: *It Came from Outer Space* (1953), *Miss Sadie Thompson* (1953), and *House of Wax* (1953). Chapter 7 focuses on Hollywood's subsequent attempt to adapt Cinerama's seven-track soundscapes for 35mm screens: Fox's four-track CinemaScope. I show that Fox deliberately positioned its format as a safe investment compared to the many acoustical problems of triple-track. I end the chapter with analyses of *The Robe* (1953) and *House of Bamboo* (1955).

Chapter 8 explores other stereo formats that emerged during the 1950s and that became serious threats to CinemaScope's reputation as the premiere format for 35mm screens. I focus on Perspecta, a single-track sound system that was considered "pseudo stereo" by many within the industry, but that nonetheless managed to create inventive stereo effects. I demonstrate these effects with analyses of *Forbidden Planet* (1956) and *Silk Stockings* (1957). Chapter 9 examines how Fox retooled its mixing techniques in order to compete with Perspecta. The result was a set of aesthetic principles that continued to inform the way surround sound films were mixed in the decades that followed. I define these principles through analyses of *Compulsion* (1959) and *Journey to the Center of the Earth* (1959). I conclude this dissertation with a re-evaluation of *Star Wars* (1977) as an extension of studio-era mixing practices. In sum, this dissertation treats stereophonic sound as a case study that illuminates both the broader logic behind the industry's codification of stylistic norms, as well as the economic and social forces that govern Hollywood's resistance to technological change.

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Introduction

When we think of digital stereo systems, I suspect that we generally think of the thrill-inducing surround sounds that permeate blockbusters like *The Dark Knight* (2008), *Gravity* (2013), *Wonder Woman* (2017), and *Black Panther* (2018). We rarely associate these multi-speaker systems with low-budget romantic comedies set in Manhattan. And yet in 2003, Paramount released their Matthew McConaughey and Kate Hudson rom-com *How to Lose a Guy in 10 Days* (2003) in digital "5.1" surround sound.[1] That is, the film played for audiences through three separate loudspeakers behind the screen and two banks of surround-sound speakers in the rear of the theater. Additionally, the film played through a massive subwoofer—the .1 of the 5.1 moniker—that was designed to boost low-frequency rumbles.

How to Lose a Guy in 10 Days was far from the first film released in digital 5.1. As Mark Kerins documents, the stereo technology was used throughout the early 1990s on such blockbusters as *Days of Thunder* (1990), *Terminator 2: Judgement Day* (1991), *Batman Begins* (1992), and *Jurassic Park* (1993).[2] Before the format's unveiling, if studios wished to release their action movies with six separate stereo channels, they needed to create 70mm prints with six magnetic soundtracks and then distribute these prints to theaters equipped to handle the wide-gauge technology. Digital 5.1, however, was a much more materially efficient format. The soundtracks could be stored as digital code along the sides of 35mm prints, and this material design encouraged studios like Universal to distribute all types of films—including prestige dramas like *Schindler's List* (1993) and *In the Name of the Father* (1993)—in the premiere audio format with little added cost.[3] Studios even distributed smaller romantic comedies like *Speechless* (1994) and *The Last Days of Disco* (1998) in digital surround sound.[4] The release of

How to Lose a Guy in 10 Days was thus far from unprecedented. Instead, it represents a typical 5.1 sound design, and by that, I mean that it does not appear to have been designed *for* digital stereo; it just happens to be released *in* digital stereo.

Indeed, the decision to use this immersive soundtrack technology seems to have little to do with the film's story. Unlike the big-budget titles released in the same year—such as the sequels to *The Matrix* and *X-Men*—the quieter *How to Lose a Guy in 10 Days* omits suspenseful helicopter chases and shoot-outs, and it fails to end with a climactic battle between a machine-gun-toting Hudson and a massive spaceship that hovers over the New York skyline (a battle sequence that would surely call for musical *sforzandos* and laser explosions to blast from the loudspeakers surrounding the audience). Instead, the McConaughey-Hudson date flick largely consists of witty dialogue and romantic courtship, most of which took place within the confines of upscale apartments. Having watched the film dozens of times and having even taken the time to examine the stereo effects that play through the rear loudspeaker channels, I can confirm that very few sounds in fact play from the surrounds. Much like many other titles released during the 1990s and 2000s, it is puzzling that Paramount wanted the rom-com to be heard in a stereo format defined by surround sound thrills and low-frequency rumbles.

What then was it about the 2003 comedy that warranted its release in digital 5.1 stereo? Although the answer is unclear, it is also worth noting that similar questions can be asked of most titles mixed and released in surround sound. Arguably three of the most famous multi-channel movies of the twentieth century—*Star Wars* (1977), *Close Encounters of the Third Kind* (1977), and *Apocalypse Now* (1979)—were widely heard in stereo. Yet they also played on television sets throughout the 1980s and 1990s, and these home theater screenings often lacked any stereo or surround sound capabilities. Speaking from personal experience, when I was young

my family television offered two separate speaker channels on the sides of the box, but they were so close to each other that any localization of sound effects was not perceivable from the couch. Moreover, any stereo effects were largely drowned out by the other noises emanating throughout my house. I imagine sound designer Ben Burtt did not want the low rumbles of a washing machine to mask the acoustical signature of the Death Star. Nevertheless, in my household the enemy base was defined by the "thump… thump… thump" of a misaligned top-loading Whirlpool.

That said, the seemingly poor soundscape of my parents' living room did not cause *Star Wars*, *Close Encounters*, *Apocalypse Now*, or any other major stereo release to lose their dramatic effect or narrative coherence. This was especially true of *Apocalypse Now*. The opening sequence, in which the sounds of a traveling helicopter transform into the rotations of a ceiling fan, remains a powerful sensory moment, even if experienced without its intended stereo design. Larry Blake—a prominent sound editor and an outspoken champion of Francis Ford Coppola's Vietnam epic—recently made the point that the film would be "scarcely harmed" if it were to play without its special stereo surrounds. As Blake specifically argues: "The greatness of that sound job lies in its ideas, which won't be diminished if a Loach [helicopter] doesn't precisely criss-cross the theater."[5] I suspect that many people like me, who grew up only knowing the film's mono version, would agree. When a stereo film like *Apocalypse Now* is properly mixed, we typically do not notice the soundtrack. We instead pay attention to the screen and the story. Perhaps it is only upon repeat viewings, when our eyes and ears wander away from the characters, that we begin to more actively notice the stereophonic design. But even then, I suspect most audiences pay little attention to the kinds of multi-channel effects associated with Walter Murch's intricate sound design.

Such inattention toward stereo is even more pronounced during romantic comedies. In a 2013 article for the satiric newspaper *The Onion*, titled "You Haven't Seen *Frances Ha* Until You've Seen It In IMAX," director Noah Baumbach (or, more likely, someone posing as the director) promotes his quirky "indie" comedy by arguing that "you have to hear whimsical French composer Georges Delerue's spritely score thundering out in Dolby digital surround sound or, frankly, you might as well not buy a ticket for the movie at all."[6] The article is sure to make those familiar with *Frances Ha* laugh, for nothing about the low-key, black-and-white Greta Gerwig vehicle suggests that, like *Gravity*, it has to be seen in 70mm IMAX 3D and heard in digital surround sound stereo.

Ironically, *Frances Ha* actually was released to theaters in digital 5.1 surround sound.[7] Delerue's score was never "thundering out" of the rear loudspeakers, but it did echo from behind the audiences repeatedly. And yet these effects were so subtle that the humorists at *The Onion* failed to notice. They instead concocted an article around what they thought was the absurd and incongruous notion of hearing the romantic comedy via state-of-the-art acoustical technology. They were not wrong. Like *How to Lose a Guy in 10 Days*, the idea that *Frances Ha* was released in digital stereo is curious, if not comical. It means that producer Scott Rudin spent resources on costly equipment and post-production labor that was largely inaudible to audiences. This decision seems illogical, and ostensibly so too does the broader use of stereo throughout Hollywood. Despite its implementation on nearly every film, stereo at times seems to have little to no discernable aesthetic value. How then can we account for the technology's widespread use as a premiere release format for motion pictures?

Challenging the Basic Story

When I began this project, I set out to discover why Hollywood ever adopted stereophonic sound technology. At the time, I pondered whether or not surround sound systems enhanced most film-watching experiences, and if not, then what was the reason for their continued use throughout Hollywood. Romantic comedies like *How to Lose a Guy in 10 Days* were integral to the formation of this research question. Given the apparent inaudibility of their surround sound effects, these films suggested that stereo was often of little consequence to the story, if not also to audiences. But over the course of conducting this research, I determined that stereo is indeed of incredible value to Hollywood, just not in the manner that is typically articulated in histories of the technology.

The "basic story" of stereo—that is, the version of history that is most often repeated in popular criticism—suggests that stereo technology is widely used in cinemas because it enhances the way motion picture stories are told, specifically science-fiction and war movies.[8] The clearest articulation of this basic story can be found in the scholarship of Gianluca Sergi, namely his book *The Dolby Era* (2004) as well as his accompanying articles and chapters like "Tales of the Silent Blast" (1998) and "A Cry in the Dark" (2007).[9] These works collectively chronicle the history of film sound from the 1930s to the early 2000s and portray this history as a narrative in which filmmakers and audiences discovered the full aesthetic potential of stereophony only after a prolonged period of failure.

Accordingly, the history of stereo sound in Hollywood is divided into two eras: the earlier studio era of the 1930s through 1960s, in which filmmakers were unable to convince producers and exhibitors of stereo's storytelling value; and the later Dolby era (named after the popular Dolby Stereo format of the 1970s through 1990s), in which the industry successfully

adopted stereophonic sound as a playback standard for motion pictures. As Sergi explains, the failure of stereo during the studio era is attributable to industry regulations.[10] Beginning in 1938, studios were governed by an acoustical standard—known as Academy Mono or the Academy Curve—that placed severe restrictions on the frequency and decibel ranges of theatrical sound systems. For Sergi, the restrictions were so severe that soundtracks during the studio era sounded no better than a telephone call.[11] Any attempts to improve the quality of film soundtracks with stereophonic upgrades—such as Disney's three-channel Fantasound and Fox's four-channel CinemaScope—were greatly hindered by these regulations, an observation that leads Sergi to conclude that there were few major technical improvements to cinema acoustics during the studio era.[12]

The basic story nonetheless has a happy ending. In the 1970s, Ray Dolby and Ioan Allen of Dolby Laboratories introduced a two-track stereo system, branded Dolby Stereo. The format was promoted as a major improvement over previous stereo technology, largely due to its reliance on inexpensive optical tracks and on an effective form of noise reduction that removed unwanted hiss from these narrow tracks. As Sergi explains, Dolby's technology allowed for filmmakers to explore new types of stereo effects that had yet to exist in the cinema.[13] Such effects were particularly pronounced throughout *Star Wars*, *Close Encounters*, and other action blockbusters generally geared toward male audiences. Sergi specifically contends that during the 1970s and 1980s, "Dolby achieved nothing less than a comprehensive industry-wide transformation, from studio attitudes to sound, filtering through to filmmakers' creative use of sound and audience expectations."[14] In sum, stereo technologies, like those promoted by Dolby, were only adopted once it became clear that multi-channel playback could add aesthetic value to motion pictures, both in terms of its acoustical fidelity and its thrill-inducing effects. And

because Dolby Stereo was reportedly the first format to accomplish such aesthetic feats, its arrival in the 1970s became a momentous event that changed the way filmmakers and audiences valued stereo sound—if not all sound—in cinemas.

This basic story of stereo remains the dominant explanation for why the motion picture industry adopted stereo technology, and why it chooses to release films in stereo today. Nevertheless, I suspected that the story was a relatively simplistic account of how Hollywood came to value multi-channel audio. For one thing, stereo technology did not simply undergo a series of failures before the advent of Dolby Stereo. If stereo was merely associated with failure—akin to "Smell-O-Vision" or "Odorama" in the olfactory realm—then it would have been illogical for a company like Dolby Labs to have invested countless resources into developing its own stereo system.[15] Like any business would, Dolby intended to cash in on the popularity of three-dimensional audio, and such financial incentives were possible because filmmakers and audiences alike already valued these kinds of acoustical reproductions.

This history of value construction is easy for someone to miss if he limits the scope of study to the success or failure of individual technologies. As I detail in later chapters, the Fantasound system was used on only one film in 1940 and the WarnerPhonic Sound system was used on fewer than ten films in 1953, so both could be seen as studio-era failures. That said, stereo history is more than just a chronology of individual multi-channel formats. First and foremost, stereo history is about the development of an idea. Stereo refers to the concept of three-dimensional sound reproduction as well as to the many pleasures associated with hearing such an acoustical experience. Stereo also refers to a set of techniques and practices that can achieve such pleasurable experiences—such as the careful use of musical reverb in the back of the theater, or the panning of dialogue between the left and right channels. Although there was

no single format during the studio era that was able to carry the torch for these sorts of acoustical practices, the host of formats that were used throughout the 1930s, 1940s, and 1950s—as short lived as many of them were—did nonetheless foster esteem for the idea of stereo reproduction and the kinds of auditory effects these reproductions could create. I suggest that the story of stereo is about how such esteem came into being.

Further, stereo effects need not involve outlandish explosions or helicopter fly-bys in order to be deemed useful to the cinema. Take for instance the use of stereophonic sound in the four-channel stereo prints of *How to Marry a Millionaire* (1953). As was typical of romantic comedies in the 1950s, Fox's rerecording mixers panned dialogue across the front three channels and similarly allowed the side channels to add reverberation to the orchestral score. In effect, stereo was treated as a tool to provide subtle stylistic emphasis to narrative information without calling too much attention to the technology itself. And such techniques continue to be heard today, even in films released in more ostentatious sound systems like digital 5.1. The subtle use of stereo throughout a film like *How to Lose a Guy in 10 Days* is merely a continuation of the kinds of stereo techniques used in *How to Marry a Millionaire* (despite the contradictory instructions in their titles). We when open up our inquiry to these kinds of subtle stereophonic practices, we can see that the technology's value to Hollywood is more complicated than the basic story would suggest. The history of stereo is also about how multi-channel audio became valuable to all genres, not just science-fiction blockbusters.

Additionally, the basic story of stereo treats the premieres of individual films like *Star Wars* and *Apocalypse Now* as momentous events in the history of mixing techniques. However, it fails to mention that many of these films often had more than one stereo mix. *Star Wars*, for instance, was mixed in two-track stereo for 35mm screens, and six-track stereo for 70mm

screens, and these two mixes were acoustically very different. As Jay Beck notes, Dolby obscured this distinction by routinely invoking its Dolby Stereo brand for both its two-track and six-track systems, despite the fact that the six-track system—which was nearly identical to Todd-AO's 70mm format from the 1950s—was able to offer audiences louder low-frequencies and more directional thrills.[16] Notably, the six-track mix for *Star Wars* was the only version of the film to fully include the famous moment of stereophonic showmanship during the first reel, when the roar of an enemy battleship pans from the rear speakers to the front speakers as it travels into frame. Audiences who saw the film in 35mm Dolby Stereo, may not have known that the 70mm Dolby Stereo release contained a vastly different stereo design.

Further, it remains unclear exactly how many filmgoers heard these sorts of auditory thrills during the film's initial theatrical run. 70mm venues were prominent, but nonetheless more of a novelty than a norm when *Star Wars* was released in 1977, and as a result the vast majority of audiences who patronized Dolby theaters only heard its 35mm two-track mix. And even this mix was a relatively rare occurrence. As Beck further documents, fewer than fifty screens nationwide were equipped with the necessary hardware to play Dolby's two-track prints when the film was released to theaters. As a result, most audiences were only hearing the film in mono.[17] Such a limited release even led the two-track mix to mistakenly exclude important sounds that were heard in other releases, such as lines of dialogue and sound effects. According to sound designer Ben Burtt, "That mix was rushed out of the door, and we didn't think it was that important because it was only going to be heard in a few theaters."[18] In other words, the importance of the 35mm mix is arguably overstated within the basic story of stereo. Though the two-track format was the greater technological innovation, the six-track mix was the more aesthetically adventurous version of the film. Furthermore, it is unclear if scholars should place

historical emphasis on the stereo designs of *Star Wars* when most audiences in 1977 heard the film only in mono.

These ambiguities about different versions are not unique to the Dolby era. Throughout history, motion pictures have been released without a single definitive stereophonic version. Todd-AO's *Around the World in 80 Days* (1955) was one such example. It was distributed to small theaters on 35mm prints with four magnetic tracks of audio (for three loudspeakers behind the screen and an effects channel for the rear of the theater) and was simultaneously distributed to larger theaters on 70mm prints with six magnetic tracks of sound (for five channels behind the screen and one for the rear speakers—like *Star Wars*).[19] Even more, many of its 35mm four-track prints were mixed with special control tones that could direct the effects track to three additional loudspeaker channels behind the audience, thereby opening up 35mm prints to six audio channels in participating theaters.[20] And in recent decades, two more stereo soundtracks have been designed for the film's VHS and DVD releases: a two-channel version and a digital 5.1 version. Indeed, if one were to study the film's stereo aesthetics, one would not only need to determine which version from the 1950s was the more historically significant mix, but—even more troubling—how to even go about tracking down this mix given that it is not accessible on home video.

This practice continues today. A film like *Pacific Rim* (2013), for instance, was released to theaters and on DVD and Blu ray in more than six different versions, including three 5.1 mixes (one for IMAX, one for standard theaters, and one for DVD), a 7.1 surround sound mix for high-end screens, a two-track Dolby Stereo mix for low-end screens, and a mix in Dolby Atmos, which offers as many as 64 channels of sound, including dedicated channels for ceiling loudspeakers, for the industry's largest flagship venues.[21] And with the advent of Dolby Atmos

for the home, there are now additional ways that *Pacific Rim*'s Atmos mix can be heard. Some audiophiles might play the film through a limited number of specially installed ceiling speakers, while others might play the film through state-of-the-art loudspeakers that rest on the living room floor but that nonetheless bounce high-frequency effects off of the ceiling. And there are of course also those like my parents, who watch *Pacific Rim* on HBO through a small television that down-mixes any version of the film's surround sound design to left-right stereo. It is thus seemingly impossible to talk about the way *Pacific Rim* sounded—or the way *Around the World in 80 Days* and *Star Wars* sounded—when the way it sounded differed in nearly every room.

The regularity of this problem across history suggests that determining which version is *the* definitive stereo mix may simply be missing the forest for the trees. As I detail throughout this dissertation, the fact that Hollywood films are routinely mixed for multiple stereo formats indicates something much more obvious about why the industry values multi-channel audio: stereo is about volume and fit. Instead of relying upon a single speaker at the front of the theater to blast sounds at deafening volume levels—levels that allow a film to be heard by audiences seated in the back of a large auditorium—it has become more practical for the industry to play films through multiple speakers located on every wall of the theater. Sometimes multiple speakers enable filmmakers to separate the music from the dialogue in order to keep spoken information clear to audiences. Other times the speakers can help amplify onscreen dialogue without needing to blast such sounds to uncomfortable levels. Because each venue varies in size, studios merely need to convert the stereo mix for the number of speaker channels being used in each theater. And the existence of multiple stereo formats—such as two-track, 5.1, and Atmos—then provide studios with a practical way to generate different stereo versions without worrying about continually customizing their products for each and every theater. In other words, stereo's

broader institutional function is to boost the volume of motion pictures without undermining the quality of their soundtracks. We might therefore think of stereophonic sound as the art of merely fitting a single soundtrack into a number of differently sized theaters.

At the same time, the value of stereo systems need not even pertain to sound. As I detail in chapters one and two of this dissertation, stereo originated merely as an obscure property of telephone technology, but one without an innate purpose to ordinary folks. It was a raw resource that required refining in order for it to even be considered as an accessory to motion pictures. And this refinement of stereo took several decades to occur, from its initial telephonic experiments before the turn of the 19th century to its commodification in Hollywood by the 1950s. In this respect, stereo is different from other filmmaking technologies. The advent of synch sound recording, for instance, may not have been universally loved, but—as Douglas Gomery details in depth—there was little debate as to whether or not the addition of hearing an actor's voice could change cinema in some way.[22] How stereo could change motion pictures was harder to define, for sound—being mere waves of air—is by definition already three dimensional. Extra loudspeakers allow for localization effects, but they are not necessary for sounds to appear three dimensional when they reverberate through the space of an auditorium.

Consequently, I found that many films are stereophonic for reasons beyond the technology's storytelling potentials. More often, stereo formats serve as tools that could ward off competition within the greater film economy. Stereophonic sound can be a barrier for entry when producers seek access to the industry's largest and most profitable screens, and it is at times similarly a pretext to charge higher ticket prices and boost weekend box office numbers when projecting films onto these screens. Within Hollywood's professional community, mixing a film in stereo could function as a sign of virtuosity and status among sound technicians, and it could

even become a means to showcase a mixer's knowledge of physics, especially when asked to speak at length about the psycho-acoustical theories that shaped a film's multi-channel recording or mixing decisions.

Such findings can be illustrated by *Apocalypse Now* and *Frances Ha*. These very different films were released in stereo not simply because the technology could provide audiences with thrills. More interestingly, each stereo release could showcase the knowhow of its mixers, it could help secure bigger and even more profitable theatrical openings, and it could further establish each film's prestige over competing independent productions. Any resultant discussions of stereo's storytelling value can in turn become a means to conceal these financial benefits from audiences. Of course, as I make clear in the many case studies that I analyze throughout this dissertation, stereo effects do enhance the way movie stories are told. However, this storytelling function of stereo was and remains secondary to the financial value that the technology offers the motion picture business.

Finally, and most surprisingly, I discovered this cultivation of film stereo occurred not during the 1970s or 1990s—as the basic story suggests. Instead, the codification of stereo practices occurred well before 1960. It was a product of the economic and social forces that defined Hollywood's studio-era economy, and its value to Hollywood has since remained unchanged. Despite many accounts that claim that contemporary stereo aesthetics are a product of more recent technological and creative developments, such as the arrival of Dolby stereo or the creation of a sound designer as a professional trade, modern-day stereo releases typically reinforce the normative practices for multi-channel audio that were established by engineers and technicians during the 1930s through 1950s. As *How to Lose a Guy in 10 Days* and *Gravity* demonstrate, there is a great deal of variation within this set of aesthetic practices. Some films

might feature subtle effects like reverb while other films might boast more emotionally salient acoustics like the panning of sound and music to different speakers around the audience. But none of these sound designs are new thrill-inducing tricks. They were refined by an earlier generation of engineers. In sum, the definition of what constituted proper stereophonic sound in Hollywood was codified a long time ago, and the economic and aesthetic ideals that emerged during this period of codification have remained firmly in place ever since.

These discoveries shed new light on the process of technological adoption in Hollywood. The emergence of what we know today as stereo was not the result of a single film or invention, nor was it the product of a small group of innovative individuals who revolutionized the way we hear movies. More accurately, the "dos and don'ts" for how to use stereo were formed over a long period of time and through a series of decisions made by a host of individuals—from investors and studio heads, to engineers and mixers, to even critics and audiences—many of whom were unwittingly shaping the history of film aesthetics through the choices they made. In other words, many of the practices that define stereo today came into being incidentally.

Accordingly, this dissertation demonstrates that the motion picture industry does not operate as a free market for new ideas or new technologies, at least not in the ways that we might think. The innovations that have the greatest success are not necessarily the ones that are technologically more advanced, nor the ones that are the cheapest, nor the ones that help design the most aesthetic pleasing motion pictures. Instead, Hollywood is more likely to adopt filmmaking technologies that cause the least amount of disruption and, in turn, offer the greatest compatibility with pre-existing practices. As the history of stereo makes clear, one's ability to sell the value of a sound system to Hollywood is directly tied to his ability to sell that system as a cost-saving instrument, rather than an aesthetically revolutionary tool—despite the technological

showmanship of many filmmakers. This story of stereophonic sound's integration into Hollywood's modes of production and distribution, and the subsequent development of what we might call "proper stereo technique," provides us with a way to nuance the economic forces that shape the way films are made, specifically the way they sound.

Data and Methodology

This project's historical undertaking draws upon an extensive examination of archival documents, technical correspondence, and the surviving multi-channel mixes for a number of Hollywood features. My goal during this endeavor—as impractical as it sounds—was to uncover every single manifestation of stereophonic sound in Hollywood before 1965, from fully completed motion pictures, to the half-articulated ideas found in studio memoranda. Naturally, I did not find *every* instance of stereo before 1965, but I did uncover an enormous quantity of new documents that allowed me to construct a robust revisionist history of multi-channel audio and of the codification of what constituted proper stereo practices in Hollywood.

I began by finding any mention of stereophonic, three-dimensional, or multi-speaker sound in the film industry's trade publications. Such trades included *Variety*, *Motion Picture Daily*, *Box Office*, *Hollywood Reporter*, *The Film Daily*, *Motion Picture Herald*, as well as the entertainment sections in both *The New York Times*, and *The Los Angeles Times*. As there was no controlled vocabulary for speaking about stereophonic sound for much of the studio era, simply running searches for any discussion of "stereo" was inadequate. Instead, it was much more productive to skim each publication for any mentions of the following terms: horns, speakers, loudspeakers, sound, acoustic, audio, binaural, sonic, -phonic, dimensional, directional, 3D sound, auditory perspective, and other derivations of these phrases. This method proved

especially useful when looking for relevant information regarding the use of a sub-woofer channel during screenings of MGM's *San Francisco* (1936) as well as the use of a dedicated surround sound "dummy projector" for showings of Selznick's *Portrait of Jennie* (1948). Neither multi-speaker sound design was branded as stereo at the time of their unveiling, and yet both were important prototypes for understanding the construction of modern stereo technology.

Further, these publications also provided details about the relative success or failure of each innovation, in terms of its box office performance and the reviews of its special demonstrations on studio lots. As I discuss in chapter three, for instance, when in 1940 Nathan Levinson of Warners first unveiled to industry insiders a multi-speaker sound system known as Vitasound, the trades indicated that the system was warmly received by critics.[23] However, this response stood in stark contrast to its lackluster performance among filmgoers, as the technology failed to make even a dent within the competitive market for theater technologies at the time of its unveiling.[24] Indeed, along with directing me to specific instances of stereophonic innovation, the trade press also alerted me to inconsistencies regarding each innovation's reception, a sign that in 1940 the motion picture industry as a whole was actively negotiating ways of selling its stereo innovations to audiences.

I then supplemented these publications with engineering journals, those that routinely detailed the technical development of a proper stereophonic aesthetic. These publications included *The Journal of the Society for Motion Picture Engineers*, *American Cinematographer*, and *International Projectionist*, which was the official publication of film projectionist's unions. Being that many of the technical innovations that bolstered stereo's success were conducted by engineers working within the Bell System, I also followed their many publications in the *Bell Laboratories Record*, *The Bell Technical Journal*, in addition to such noteworthy publications as

Electrical Engineering, *Journal of the Acoustical Society of America*, *Audio*, *Audio Engineering*, and the *Journal of the Audio Engineering Society*.

Beyond offering a more refined picture of how stereo technologies worked and why they were being invented, these articles also provided insight into how multi-channel innovations were used and developed throughout the telecommunication and recording industries. As I chronicle in chapter four, for example, before multi-track magnetic recording tape was fully adopted by the studios, it was being researched, theorized, and promoted in the pages of the *Journal of the Acoustical Society of America* by engineers such as Marvin Camras. It was arguably Camras's respectability as a leader in magnetic recording at the Illinois Institute of Technology that then led to his own work in Hollywood as a consultant on the development of multi-track equipment, and later, on the emergence of triple-track stereo tape.[25] Thus, these technical trades served as evidence of how the concept of stereo, or three-dimensional sound, was being constructed and evaluated, and how such conceptual formations were shaping the development of stereo recording and stereo reproduction in Hollywood.

These articles also led me to track down the published biographies of technicians and filmmakers who contributed to the development of stereophonic sound systems. These included the memoirs of Semi Joseph Begun, among the first engineers to commercialize magnetic recording.[26] They also included the memoirs of Susan McCarthy Todd and her brother Michael Todd, Jr, a cameraman who witnessed the original multi-track recordings of *This is Cinerama* (1952).[27] He was also the son of the famous showman Michael Todd, which meant that he also witnessed the development of the six-track Todd-AO motion picture format shortly after Todd left Cinerama's technical team. Similarly, I combed through the many detailed interviews and oral histories offered by the engineers and practitioners who established the best practices for

using early stereo technologies. They included published conversations with Joseph Maxfield, among the first Bell System engineers to design a motion picture stereo system; John Frayne, the promoter of Western Electric's two-track PhotoStereo system; George Groves and James G. Stewart, two studio sound engineers who oversaw the installation of their own multi-track systems; as well as George Adams, Milo Lory, and Murray Spivack, three rerecording mixers who worked on the final surround sound designs for a handful of titles made at Disney, MGM, Twentieth Century-Fox, and Todd-AO.[28]

The oral histories also included interviews with those whose acoustical innovations helped lead to the development of stereophonic systems, such as John Hilliard, whose multicellular high frequency horn was integral to several multi-channel sound systems, as well as the published recollections of John Mullin, whose promotion of German-made magnetic recording machines helped usher in Hollywood's transition to magnetic stereophonic playback.[29] At times the interviews pointed to new sources of information—such as ERPI's contest for generating a name for multi-channel audio, or that an elderly engineer reportedly died of a heart attack after accidentally erasing a stereophonic recording of *Oklahoma!* (1955).[30] For the most part, however, these interviews largely articulated the acoustical beliefs that informed the creative decisions of the industry's engineers and technicians. Indeed, within studio-era audio cultures existed many shared ideas about how audiences processed sounds cognitively and about how to measure the levels of pleasure generated by a given soundscape. These many interviews, though at times factually questionable, nonetheless offered some of the best means of illuminating the aesthetic concerns that shaped how stereo practices were developed.

These publications and interviews all represent the stories of stereo that was constructed for public consumption. That is, it is the story that the industry has designed and shaped to

promote the accomplishments of its own personnel. But it is not the full story. To supplement the public claims made by Hollywood's technical community, I also tracked down the actual legal patents that were the subject of public discourse on the invention of stereo. The patents themselves are written in somewhat promissory fashion, wherein inventors at times make claims about the potentials of their machines without evidence that such these potentials are possible. Nonetheless, as legal documents these patents often cite earlier inventions—often to differentiate their work from prior ideas—and this provides a more forthright chronicle of technical influence within film sound history.

This detailed search through the history of audio patents uncovered an assortment of stereophonic technologies that were never licensed or used by the motion picture industry, but that nonetheless were part of the larger conversation on three-dimensional sound reproductions. These patents include Lee De Forrest's two-color and two-track stereo system from 1929, George Beers "stereosonic" patent for steering a single soundtrack to multiple loudspeakers, as well as Bruce Bogert's 1955 patent for multi-channel audio, which to the best of my knowledge is the first stereo patent to account for the psycho-acoustical biases (nicknamed the "Haas Effect") initially outlined in the experiments of psychologist Helmut Haas.[31] Each of these inventions have been largely discarded in the public record, but they remain valuable tools for remapping how the contemporary concept of proper stereophonic sound design developed over the course of several decades.

My examination of the standard version of stereo history also led me to analyze documents housed in a host of different archives at universities and businesses across the country. Several public archives proved especially integral to my detailing of the intellectual origins of stereo. The Margaret Herrick Library in Los Angeles has digitized many of the

acoustical standards that led to the codification of single-channel sound, and—as I detail in chapter two—this monaural playback standard galvanized a series of experiments in multi-channel alternatives. Similarly, the Wisconsin Centre for Film and Theatre Research here in Madison, Wisconsin holds many of the contracts that studios signed with audio manufacturers like Electrical Research Products, Inc., contracts which were criticized as anti-competitive and potentially illegal by the Federal Communications Commission in 1938, and which were therefore detrimental to ERPI's ability to license its stereophonic sound systems to studios in the years that followed.[32]

Of even greater importance were the university archives that held the papers of several inventors of stereophonic technology. The David O. Selznick collection at the Harry Ransom Center in Austin, Texas contained the sketches, blueprints, and correspondence detailing James G. Stewart's development of the Multi-Sound stereo system, as well as its installation in select theaters for the release of *Portrait of Jennie*. Likewise, the Earl Sponable papers at Columbia University in New York, New York housed correspondence, financial documents, technical sketches, as well as various other relevant evidence detailing Sponable's entire career as head engineer at Twentieth Century Fox. Such papers were not only useful in accounting for every design decision that went into the construction of the studio's four-track CinemaScope format. The papers also housed the sketches and correspondence outlining the studio's abandoned 50mm three-track format, as well as information on competing stereo technologies, such as Paramount's five-track stereo system. Indeed, Sponable's reconnaissance when investigating competing studio innovations proved exceptionally valuable not only to the history of stereo, but—as Paramount 's five-track system demonstrates—to the history of 5.1 specifically.

To further supplement these public archives, I also tracked down a number of private collections held by various individuals who inherited documents but had not donated them to an institution. These private collections were particularly useful in explaining the curious technical designs of Cinerama, a seven-track stereo format that was developed by the New York based Hazard Reeves between 1947 and 1952, and that became a popular alternative to standard motion picture experiences being offered by Hollywood. Reeves's son provided me with Hazard's technical diaries, as well as an unpublished manuscript that shed incredible insight into the production culture at Cinerama, Inc. and Cinerama Productions. Additionally, Cinerama historian and restoration director David Strohmaier allowed me to read through and analyze his own private collection of Cinerama documents, particularly the papers of Richard Pietschmann, the lead sound engineer on the first several Cinerama features. This particular archive—located within Strohmaier's private collection in Van Nuys, California—housed detailed diaries that documented the many technical problems that plagued the seven-track productions, including the minute-by-minute notes taken during the post-production mixing sessions for *This is Cinerama* and *Cinerama Holiday* (1955), as well as the cue sheets that were to be followed by Cinerama projectionists in order to turn each film's seven-track sound design into eight-channel soundscapes in theaters. In sum, these private collections allowed me to see just how acoustically problematic the Cinerama format was, and how the format's technicians created aesthetic solutions that amplified the eccentricity of Cinerama's stereophonic soundscapes.

None of these paper documents were nearly as useful as were the films themselves. Indeed, I worked to find every film made between 1926 and 1965 that were either released for special multi-speaker sound systems, or that were mixed and released with official stereophonic soundtracks. This collection process, however, was beyond difficult. A great number of films

that were reported to have been released in some form of multi-channel stereo no longer survive in their original format. Such, for instance, was the case with *Fantasia* (1940). The Disney animated feature was among the first films released with separate left, center, and right audio channels, and as a result it has arguably become the most famous instance of stereophonic experimentation during the studio era. And yet, this original three-channel mix was never properly preserved and is therefore no longer able to be heard.[33] To complicate the matter, Disney has since rerecorded the entirety of the concert film and repeatedly remixed it for contemporary stereo formats—first for four-channel stereo in the 1950s, and later for 5.1 and 7.1 surround sound following the transition to digital sound in the 1990s. The current Blu ray of the film is arguably far from a reliable reconstruction of how the film might have sounded during its initial road show release.

And the story of *Fantasia* is not an isolated instance either. A number of films that were released to select theaters with some form of a stereophonic sound design, such as *Hell's Angels* (1930), *The 5,000 Fingers of Dr. T* (1953), and *Vertigo* (1957) are now only available as monaural soundtracks or as modern stereo remixes. Other titles, such as *House of Wax* (1953), are similarly available only in a somewhat restored and remixed version that bares only a modicum of resemblance to the original stereo design. How then might someone go about researching and studying these original stereo designs?

I was fortunate that some studios preserved their original stereo mixes, and have since made them available for study. Fox is especially commendable when it comes to preservation. Many of their 1950s CinemaScope releases—from *The Robe* (1953) to *Journey to the Center of the Earth* (1959)—have been released onto either DVD or Blu ray with two audio options: a newly up-mixed 5.1 surround sound release, and the original 1950s four-channel surround sound

release. Historian Matthew Malsky, who works extensively into researching the provenance of these four-channel mixes, has corroborated that Fox has been a remarkable force when preserving the initial stereo mixes for its library titles, especially when compared to other studios.[34] Warners and MGM, for instance, have done little to preserve and make available their original four-channel CinemaScope mixes. My point is less to criticize the studio's current archival practices; rather, it is to index how these studios treated multi-channel audio during the 1950s. The fact that some studios like Fox valued their four-track mixes enough to preserve them, whereas others like Warners and MGM did not, indicates that in the 1950s the long-term value of stereo sound was still being debated.

And to a certain extent this debate is still very active today. Major stereo releases like *Apocalypse Now*, *Star Wars*, and *Superman* (1978) continue to be remixed for home video with little consideration given to preserving the original acoustical design. I am thus quite lucky that studios like Fox have held onto the original stereo mixes for films like *How to Marry a Millionaire* (1953), *House of Bamboo* (1955), and *Compulsion* (1959), as well as select Todd-AO titles like *South Pacific* (1958) and *Cleopatra* (1963). Without such preservation efforts, much of this dissertation could not have been written.

The act of analyzing these films, however, was not easy. It involved more than simply listening to the soundtracks through a high-quality stereo system. Instead, I carefully examined the design of each and every audio channel using a host of computer programs. I first uploaded a digitized copy of each film to my computer using Handbrake ripping software. Handbrake allows for a soundtrack to be stored in a manner whereby the individual stereo channels remain discrete signals. I then watched the films play through Quicktime 7 Pro, software which allows one to isolate and listen to any one channel, or any combination of channels, when analyzing a scene.

So, if I wished to watch a sequence with only the surround channel playing, I could (and did frequently). To further examine details within the files themselves, I ran the soundtracks through Audacity, a program which presents each track as waveforms. From this digital workflow. I was able to locate various stereo effects such as the panning of sound between different channels, as well as the way these types of panning practices increased over the course of just a few years. Further, I was able to isolate various metadata, such as the fourteen-thousand-cycle control tone that Fox added to its surround channels in order to deactivate the channel in theaters during scenes when it was not in use. In other words, computer software enabled me to reverse engineer many of the technical decisions that went into the creation of Hollywood's earliest four-channel releases. From these decisions, I could discern how stereo effects were being used to enhance each motion picture, and infer what types of effects were valued by sound engineers throughout the 1950s.

In addition to Fox, several other studios also made available some of their original stereo mixes from the studio era. These include triple-track stereo releases, such as Universal's *It Came From Outer Space* (1953) and Paramount's *Those Redheads From Seattle* (1953). These also include the early two-track Binaural Films made by Alan Blumlein at EMI studios in London, and the demonstration films for the similar two-track PhotoStereo system developed by Westrex. Further, the seven-track mixes for the first five Cinerama releases survive, and they have been made available on all of the recent Blu ray releases as 5.1 audio tracks. For these releases, the left-surround and right-surround tracks have been preserved, as have the left, center, and right channels. I was thus able to study the surround sound effects that helped to define the format's three-dimensional audio experiences, and along with the cue sheets I was also able to determine

how the two surround channels were turned into three-surround channels at select moments during the original Cinerama screenings.

Another tack involved the analysis of restoration documents archived at Chace Audio in Burbank, California. The company has been a premiere postproduction house for studios that wish to digitize their optical and magnetic soundtracks for home video release. Chace also offers studios the option of up-mixing these titles for contemporary stereo formats, such as two-track Dolby Stereo, or digital 5.1 surround sound. Many older stereo films, such as *Seven Brides for Seven Brothers* (1954) and *The Battle of the Bulge* (1965) were digitized and up-mixed at Chace's facilities, and I was granted access to examine records of these restorations, many of which contained extensive documentation for each film's original stereo and surround sound channels. I used Chace's files as further evidence to substantiate observations I was making about Cinerama's seven-track stereo designs, as well as several 70mm mixes, such as *West Side Story* (1961), *How the West Was Won* (1962), and *It's a Mad, Mad, Mad, Mad World* (1963).

Of greatest value to me, however, was Chace's detailed restoration of *House of Wax*, a film that was digitized for two-track Dolby Stereo in 1992. At that time, the only audio tracks that survived were the monaural down-mix of the entire film and the original surround channel for the film's initial theatrical release. From these two extant recordings, a team of engineers at Chace, led by audio technician Ray Young, created what was essentially an entirely new stereo mix, one that would fit within the limitations of Dolby's two-track compression technology. However, Young's files also include a detailed record of every single sound initially stored on the film's surround sound channel. While the original track is now held in Warner's vault and is no longer accessible to the public, I was able to use Young's notes to discover patterns about when the film deployed its famous surround sound effects, and what these effects might mean

with regard to the value of stereophonic sound when the film was initially released. From these findings, I was then able to clarify in chapters six and seven the importance of Warners' *House of Wax* to the way Fox constructed its own four-track CinemaScope technology during the remainder of the 1950s.

There was, however, one stereo format—Perspecta—that proved difficult to analyze. As I detail in chapter eight, Perspecta was a complicated sound reproduction system, one that manifested a technical design that even led many in Hollywood to claim that it offered only "doctored" or "watered-down" stereo. It was therefore of great importance that I uncover how Perspecta soundtracks actually sounded. Unlike other formats, Perspecta releases were stored entirely on a single optical track. This track then housed three separate low-frequency control tones—at 30 cycles, 35 cycles, and 40 cycles—which corresponded to the left, center, and right loudspeaker channels. Despite its single-track construction, the system could bounce and pan the soundtrack across the three front channels, or it could blast from all three channels simultaneously, depending on the scene. Thus, in order to uncover the multi-speaker sound design of a Perspecta release, I needed to unearth its three control tones.

Most DVD and Blu ray releases are digitally remastered in a manner that removes such low-frequency metadata. As luck would have it, however, many of these DVDs also contain the original French language tracks, and these tracks continue to house the three Perspecta control tones. To study these tones, I ran several films through Sonic Visualizer software, a program designed to provide pictures of all the data located on a sound file. It therefore enabled me to see the control tones for a select number of Perspecta releases—including *Forbidden Planet* (1956) and *Silk Stockings* (1957)—and recreate their original multi-speaker sound designs. Using this software, I was able to determine how exactly Perspecta sound designs differed from other multi-

channel sound designs, and why Perspecta was deemed a fake stereo technology during its short tenure as a viable sound system for motion pictures.

By drawing upon this wide-ranging collection of documents, and by closely analyzing these documents, I was able to conclude that stereophonic experimentation was far more ubiquitous and more intricate during the studio era than typically reported. Indeed, such experimentation was not limited to a small number of films and formats. Stereo was a massive industry that greatly shaped the formation of all motion picture sound practices—from noise reduction procedures to loudspeaker designs.

Literature Review

In order to engage with the many documents that record the history of film stereo, I consulted a number of books dedicated to the social and cultural study of cinema. Several monographs on the history of film and media sound proved particularly significant both to my understanding sound reproduction and its innovations within the telephone and radio industries. These works included Helen Hanson's *Hollywood Soundscapes*, Donald Crafton's *The Talkies*, Steve Wurtzler's *Electronic Sounds*, as well as the comprehensive textbook *Hearing the Movies* written by James Buhler, David Neumeyer, and Rob Deemer.[35] There were similarly a number of articles and book chapters that further nuanced my understanding of sound technologies and techniques, including Rick Altman's theory of "Crisis Historiography" from *Silent Film Sound* and Lea Jacobs's invaluable study of post-production labor, "The Innovation of Re-Recording in the Hollywood Studios," published in *Film History*.[36]

I am also indebted to both theoretical and historical scholarship on the business of Hollywood as an institution, from its financing, through its reliance on select theater circuits, to

the commodification of its aesthetics. Such studies include, and are in no way limited to, the following works: Janet Wasko's *Movies and Money*, William Paul's *When Movies Were Theater*, John Caldwell's *Production Culture*, Jeff Smith's *The Sounds of Commerce*, and Patrick Keating's *Hollywood Lighting from the Silent Era to Film Noir*.[37] This scholarship as a whole remained in the forefront of my mind as I researched, wrote, and countlessly revised this dissertation, and as a result it greatly shaped the concepts and explanations that I develop in each chapter.

For the most part, however, there was no single monograph that addressed how and why Hollywood adopted surround sound technologies. Indeed, the history that I document in detail has been mysteriously excluded from film studies literature. Certainly, the reason has nothing to do with the quality of work dedicated to stereophonic sound. My own interest in sound was formed by the rigor of stereo scholars like Jay Beck, Mark Kerins, and John Belton. Their work has provided necessary insight into the role that production culture plays in shaping sound design, the role that technology plays in shaping contemporary surround sound aesthetics, and the reasons why Hollywood either adopts or rejects theater technologies more broadly. I contend, however, that their focus on these specific areas of inquiry have led them to bypass vital questions pertaining to the development of stereo's economic value to the motion picture industry.

For instance, Beck's 2016 book *Designing Sound* details the ideologies that manifested themselves within the culture of the New Hollywood film sound communities, as well as how these ideologies shaped the soundtrack construction of major Dolby Stereo releases like *Star Wars*, *Apocalypse Now*, and *Raging Bull* (1980).[38] His study includes in-depth examinations of major figures in sound design, such as Jim Webb, Randy Thom, Walter Murch, Christopher

Newman, Frank Warner, Richard Portman, and Ben Burtt, many of whom Beck himself interviewed personally. In so doing, Beck successfully isolates the technologies and techniques that were valued by motion picture sound technicians. Moreover, he traces how these evaluations were negotiated between the late 1960s to the early 1980s, a period in history that Beck suggests was one of the most innovative moments for motion picture sound design.

Beck's work is best understood as part of a larger initiative in media scholarship that works to amplify the invisible labor of below-the-line crafts people and other creative professionals whose voices are often removed from film histories in favor of directors. We can therefore situate Beck's monograph in relation to other recent studies of media production and its labor, including Vicky Mayer's *Below the Line* and Miranda Banks's *The Writers*, each of which isolates the power struggles of media makers from television workers to screenwriters.[39] Beck's work is nonetheless more than just an institutional study of power relations within Hollywood's post-production communities. It also offers close formal analyses of recording, editing, and mixing decisions in order to demonstrate that the sounds of New Hollywood were not determined solely by auteur directors, but by the many boom operators, production mixers, re-recording technicians, and ADR editors whose craft was largely overlooked. Beck's work is arguably the most thorough chronicle to date of the social dynamics and creative ideologies of film sound practitioners during the formative years of New Hollywood.

Beck's reliance on personal interviews and oral testimonies nonetheless limits his investigations of the past. Although first-person accounts can hint at creative conflicts that existed between individual technicians—such as the controversy over Frank Serafine's choice to call himself a sound designer—these accounts become questionable when they detail sound practices before the 1960s.[40] For instance, Beck's interview with Murch specifically states that

his surround sound mix for *Apocalypse Now* (1979) was different from those of earlier sound technicians.[41] But naturally, Murch did not witness how studio-era soundtracks like *Fantasia* or *The Robe* were actually designed, let alone how more experimental surround sound releases like *Around the World in 80 Days*, *How the West was Won*, or even the British-made *Tommy* (1975) were actually mixed. As such, his historical accounts are at best impressionistic.

Further, and as I detail elsewhere, these sorts of claims are often forms of self-legitimization.[42] Hollywood sound technicians have a tendency to hyperbolize the historical and dramatic significance of their own technical decisions in order to correct the widespread belief that the film's creative choices are solely made by the director. As a result, the oral testimonies of New Hollywood sound practitioners suggest that the history of stereo artistry (and sound design more broadly) were the result of the technical ingenuity of 1970s crafts people. In turn, these testimonials suggest that there is really nothing of note to study in earlier decades—perhaps with the exception of Murray Spivack's work on *King Kong* (1933) or Louis and Bebe Barron's work on *Forbidden Planet* (1956), films that are often referenced in passing to establish the credibility of the interview subject's historical claims. Beck's work, and others like it, provide readers with thorough examinations of New Hollywood aesthetics, as well as the production cultures that promoted the value of these aesthetics, but their reliance on oral testimonies can inadvertently give the false impression that there is little reason to dig further into practices of the studio era. Perhaps it is the result of this assumption that Gianluca Sergi, William Whittington, and other historians begin their histories of stereo after the 1960s.[43]

One important example of this pattern is the 2011 monograph *Beyond Dolby (Stereo)*, written by historian and filmmaker Mark Kerins.[44] In it, Kerins largely agrees with Beck that modern stereo aesthetics were not continuations of practices codified during the studio era,

though he pushes back at the claims that the 1970s were the formative years for such aesthetics. Instead, he provocatively argues that it was the advent of digital surround sound technologies during the 1990s—namely digital 5.1 formats like Dolby Digital, Digital Theater Systems (dts), and Sony Dynamic Digital Sound (SDDS)—that were the major force behind the establishment of today's surround sound practices. Kerins posits that there exists a single set of aesthetics that can unify contemporary motion picture soundtracks, and he offers what is perhaps the clearest definition of what these aesthetics are and how the transition to 5.1 helped to amplify their presence in motion pictures.

Kerins bases his claims on the notion that digital encoding processes enabled films to be reproduced at an extraordinarily wide frequency range, far wider than earlier forms of sound recording. Indeed, optical and magnetic sound systems recorded acoustical signals by translating the peaks and valleys of sound waves into either light and dark photographic images, or into positive and negative electromagnetic charges. Digital encoding, however, was different. It translated the peaks and valleys of sound waves into bits of information that were stored as a string of digital code. This transcoding process was much more precise than were other processes, and it introduced far less noise and distortion into the final soundtrack. As a result, a digital surround sound system could record and reproduce sounds between 20 cycles and 20,000 cycles, an acoustical spectrum that is roughly as wide as the range of hearing for most humans.[45] Accordingly, digital technologies enabled filmmakers of the 1990s to begin creating stereo designs that were not possible during the 1950s or even during the 1970s and 1980s.

As Kerins details, these designs manifested a surround sound aesthetic that he dubs the "ultrafield."[46] Because digital surround sound channels were capable of reproducing acoustical information that was highly detailed, the channels were able to play background and atmospheric

sounds that situated audiences within specific locations within the onscreen setting. Kerins characterizes this aesthetic as a "*shifting* soundscape that varies with what is seen onscreen."[47] Such is illustrated through the baseball drama *For the Love of the Game* (1999). Sound designer Glenn Morgan recorded sounds of Yankee stadium at different locations, and then sent each recording to the rear channels in coordination to the location of the onscreen actions. Thus, when the scene takes place in the outfield, audiences are able to hear background noises like cheers and buzzers specifically from the perspective of someone standing in the middle of the outfield.[48] As Kerins suggests, such coordination between the picture and the surrounds could not have occurred using earlier stereo technologies, because such acoustical details were simply unavailable to filmmakers who used these earlier systems. In other words, this ultrafield aesthetic was only possible following the industry's adoption of digital 5.1 stereo.

As the analyses of *For the Love of the Game* demonstrates, Kerins's monograph offers readers a relatively in-depth studies of surround sound in the cinema. That said, without a firmer understanding of the history of stereophonic sound, Kerins inadvertently exaggerates just how different digital soundtracks were from their optical and magnetic predecessors. For instance, while Kerins was correct that digital encoding allowed for wider frequency ranges, such ranges were not necessarily audible in dubbing rooms, let alone in movie theaters. The reason is relatively simple: the adoption of digital stereo was not complimented by a substantial upgrade to surround sound loudspeakers.

As I detail in chapters six and seven, during the early 1950s, many exhibitors began installing small speakers on the rear and side walls of their theaters in order to play the surround effects that were routinely being included in major Hollywood releases.[49] Some of these surround effects were being stored on optical tracks, as was the case with films like *House of*

Wax, while others were being stored on magnetic tracks, as was the case with films like *House of Bamboo*. Because of the relatively limited frequency ranges that these tracks afforded, and because no exhibitor wanted to install heavy loudspeakers that could fall off the walls, these surround sound speakers were relatively small in size. And as a result, they were capable of only playing a limited range of sounds at a comfortable volume, namely mid-frequencies and some high frequencies.

Over time, there were many small improvements to the designs of these surround sound speakers, often in concert with the various innovations to loudspeaker technology and noise reduction processes. However, it was not until the advent of Dolby Atmos in 2012 that theaters began upgrading to full-range surround sound capabilities, either by replacing their loudspeakers with those able to handle wider ranges, or by moving subwoofers into the auditorium to amplify the low frequencies that were lost to most wall-mounted speakers.[50] In other words, digital 5.1 formats were able to record surround sound effects between 20 cycles and 20,000 cycles, but it was and remains difficult for surround speakers to actually reproduce sounds at this frequency range. Knowing this limitation, it was thus equally unlikely that sound technicians mixed their films for such wide range effects, for doing so might introduce unwanted distortion into the playback signal. In turn, it remains unclear if audiences actually heard what sound designer Glenn Morgan says they heard play through the surrounds when they watched *For the Love of the Game*, or when they watched other films for that matter. The ultrafield of the 1990s was arguably not very different from earlier surround sound practices.

More accurately, digital surround sound aesthetics are best understood as extensions of the many storytelling experiments that Hollywood deployed during the 1950s, experiments that led to a set of practices by the end of the decade that I playfully term “stereo-telling.” As I

chronicle in chapter nine, stereo-telling was much like the ultrafield in that it was comprised of shifting atmospheric effects, as well as an assortment of sound effects sent to specific locations in the theater in order to further establish the audience's simulated location with respect to the onscreen actions. In sum, the ultrafield—though louder and more noticeable in the digital era—is far from new. However, its longstanding presence in the cinema is difficult to hear if historians only analyze contemporary motion pictures. Indeed, the focus on modern film sound technology creates a situation akin to Drew Barrymore's condition in the comedy *50 First Dates* (2004). Every experience in the theater will seem new if you have no memory or knowledge of what came before it. Histories like *Beyond Dolby (Stereo)* at times seem to manifest a similar malady. They argue that contemporary aesthetics are shaped almost exclusively by digital stereo formats, when in fact these aesthetics are merely continuations of the mixing practices developed by an earlier generation of filmmakers. By focusing squarely on today's sound systems, and by not investigating the material history of these technologies, such scholarship implies that stereo history is indeed largely immaterial.

Finally, many histories of stereo focus their attention on studio-era practices. However, these histories are often either limited to several pages within a more encompassing history of film sound and music, or they are often defined as one of several technological solutions to the decline in box office receipts following World War II.[51] In turn, Hollywood's earliest uses of stereophonic sound have been characterized by concepts like narrative absorption that do not define the intricacies of multi-channel audio. Perhaps the most famous example is John Belton's anthologized chapter "1950s Magnetic Sound: The Frozen Revolution," published in 1992.[52] Belton's influential work was part of a much larger study of other immersive theater equipment, namely widescreen formats like CinemaScope and Todd-AO.[53] As a result of this broader focus,

Belton treats stereo's slow implementation in Hollywood as a foil for widescreen cinema's relative success. Indeed, Belton characterizes 1950s magnetic stereo as a "frozen revolution," a moment in history when all of stereo's technical components were available to studios, but when most filmmakers and theaters were unwilling to fully adopt them. His chapter subsequently accounts for why magnetic stereo seemingly failed to replace optical monaural as the preferred playback technology for motion pictures.

Belton's work is a valuable entry point to understanding the basic story of stereo's tenure in the 1950s. Unlike other histories of film sound, it offers a necessary glimpse into the rise of magnetic recording in Hollywood, and it provides several clear examples of how some of the earliest multi-channel films sounded, including examples from both *This is Cinerama* and *The Robe*. Ultimately, he accounts for magnetic stereo's history in Hollywood with respect to two metaphors: realism and spectacle. For Belton, magnetic stereo promised greater fidelity and realistic sounding motion pictures. It was thus comparable to the increase in detail and fidelity offered by 70mm and other large-format film gauges. The problem, according to Belton, was that the simultaneous advent of stereo sound and widescreen cinema was too much change for most filmgoers. The sensory experiences of watching widescreen motion pictures needed to be tempered. In turn, most widescreen releases continued to be released in optical monaural sound. As Belton specifically argues, "monaural sound provided audiences with a stabilizing convention to help them navigate the bewildering spectacle of the widescreen revolution."[54] The exception to this rule were the handful of widescreen blockbusters like *Oklahoma!* and *Mutiny on the Bounty*, those which flaunted an aesthetic of spectacle through their widescreen presentations, and which were therefore a better aesthetic fit for the intense sensory experiences provided by magnetic stereo and surround sound. Despite its initial promise of greater realism, magnetic

stereo ironically became associated with spectacle, while the majority of films continued to feature only monaural soundtracks due to their newfound association with what Belton calls everyday reality.[55]

Belton is right to point out the ongoing tension that existed between the ways that studios valued stereo, and the ways that audiences valued stereo. As I detail throughout my dissertation, the early stereophonic era in Hollywood is best understood as a story of how the industry balanced the varying interests of audiences with the economic needs of studios and sound engineers. However, terms like realism and spectacle are ineffective at articulating this tension. They are aesthetic categories without clear distinctions. Arguably, surround sound releases like *This is Cinerama*, *House of Wax*, *The Robe*, *How the West was Won*, and *Mutiny on the Bounty* collectively offer more realistic representations of embodied perception by creating the impression of an aurally immersive environment. Yet these films are also spectacular in that this greater realism alters the norms and expectations as to what sorts of experiences are possible in the cinema. Indeed, there is a great deal of overlap between a realistic and spectacular sensory experience, and it remains unclear how we can apply only one of these terms to a stereophonic motion picture.

Further, the use of these two terms suggests that stereo's slow adoption can be explained in terms of genre. That is, the more spectacular genres—such as colorful musicals or fantasies—boasted surround sound mixes, whereas the more realistic genres—such as black-and-white character studies—featured only mono sound. However, there is actually little correlation between a film's genre and whether or not that film was released in stereo. For instance, notable historical dramas like *The Diary of Anne Frank* and semi-documentary procedurals like *Compulsion* were each released to theaters in surround sound, despite being clear examples of

cinematic realism. And there is no evidence that audiences suddenly felt that these presumably spectacular soundtracks were incongruous with the black-and-white narratives. (Like with *How to Lose a Guy in 10 Days*, I have a strong suspicion that most filmgoers failed to even notice that they were listening to stereo.)

Instead, there is a much stronger correlation between genre and the *types* of stereophonic effects deployed by studio mixers. My dissertation illustrates that science fiction and horror films were more prone to directional effects, namely the panning of sounds to specific locations in the theaters, while musicals or dramas were more prone to proportional effects, namely the increasing and decreasing of sound's apparent size. Indeed, films from all genres boasted stereo mixes, it was just a matter of what kind of stereo effects were used. And terms like realism and spectacle simply do not account for these important nuances. Belton never provides us with a glimpse into the process through which stereo practices were codified in Hollywood. By drawing upon broad aesthetic categories, we are left with merely a false sense of knowing how stereo aesthetics were actually established.

Much like Beck, Kerins, and others who have contributed to the current version of stereo history, Belton's work is a valuable step forward for understanding Hollywood's construction of multi-channel audio. And as such, it merely scratches the surface of what this complicated history entails. These examples of stereo histories invite even more questions as to the technical, financial, and aesthetic problems that the technology faced during the studio era, as well as how these many problems account for the curious uses of stereo and surround sound today. The following chapters, in turn, provide a comprehensive explanation for why stereophonic sound was ever adopted by Hollywood, how the financial needs of the industry shaped its construction, and why the three-dimensional technology—which remains inaudible to many audiences—

nonetheless became an economically valuable addition to motion picture storytelling for more than half a century.

Chapter Structure

I divide this dissertation into nine chapters, each of which chronicles a different stage in stereophonic sound's development from a technological curiosity in the 1930s, to a widely used storytelling tool in the 1950s. Each chapter isolates a different period within stereo's long development. Sometimes they focus on an individual studio, sometimes on a unique technology, and sometimes on a collection of seemingly random practices that are ultimately unified by a set of tacitly held beliefs as to the proper way to add three dimensional sounds to motion pictures.

The first three chapters detail the first wave of optical stereo releases in Hollywood. Chapter one traces the many problems associated with amplifying talking pictures in large auditoriums, and with using multi-speaker sound systems to address these problems. I argue that there were three different ways in which multi-speaker effects were constructed: one for emphasis, one for mimesis, and one for three-dimensional illusions. I then specify how these three constructions manifested themselves in a number of films and concerts, from Howard Hughes's *Hell's Angels*, to Abel Gance's biopic *Un grand amour de Beethoven* (1936), to Alan Blumlein's binaural film experiments at EMI in London, to Bell Telephone's "Auditory Perspective" experiments in both Washington, D. C. and Manhattan. It was during this era of multi-speaker sound, I contend, that the concept of stereophonic sound emerged.

Chapter two focuses on how the industry came to value stereophonic sound, and why the idea of three-dimensional sound was preferred over other types of multi-speaker systems. I chronicle the relationship between the development of stereo aesthetics and the adoption of a

motion picture acoustical standard, known as Academy Mono. The standard placed considerable limits on the decibel and frequency ranges of single-channel loudspeaker systems, and it therefore invigorated engineers to develop new ways of widening the playback range of motion pictures. It was in the wake of Academy Mono that engineers reconstructed stereo as a workaround to the standard's constraints, and thus it became a valuable addition to cinemas. To show this, I analyze two of the first sound systems for motion pictures that were branded with the stereophonic sound moniker. One was developed by Joseph Maxfield, the other by Harvey Fletcher.

Chapter three details the various ways that Fletcher's conception of stereophonic sound was then adapted for use by Hollywood studios throughout the 1940s. I specifically detail the production and distribution of major releases—including *Fantasia* and *Portrait of Jennie*—as well as the development of several lesser known multi-speaker technologies—such as Warners' Vitasound and Fox's 50mm stereo films. I assert that these many stereo experiments failed to replace Academy Mono as a motion picture standard largely because of the many costs and acoustical problems inherent to optical sound technologies. I conclude however that the idea of stereo did not fully disappear from Hollywood. Instead, its principles were merely relegated to the back burner until studios adopted a cheaper and less noisy format for the recording and reproducing of sounds with motion pictures.

The next two chapters examine the process through which the motion picture industry replaced its optical sound technologies with magnetic technologies. Chapter four looks at Hollywood's relatively slow transition to magnetic recording tape. I divide this transition to two periods: the era of magnetic wire and steel (before World War II), and the era of flexible magnetic tape (between 1946 and 1952). I document that due to various economic conditions, as

well as Hollywood's continued reliance on Academy Mono as the soundtrack standard for release prints, the transition to magnetic recording did not result in the massive aesthetic change that the inventors and promotors of magnetic tape initially promised.

Chapter five then ventures outside of Hollywood to trace how engineers and producers in London and New York developed their own magnetic reproducing technologies in order to both differentiate their films from Hollywood releases and take advantage of the aesthetic and storytelling possibilities that magnetic prints offered cinemas. I specifically show how magnetic tape facilitated the rise of multi-channel theater technologies. I begin by looking at the four-channel magnetic stereo films that premiered at the Festival of Britain in 1952. I then examine the development of the seven-track stereo technology that was designed to complement Cinerama's enormous, three-picture movie screen. I contend that because both the Festival of Britain and Cinerama were produced outside of Hollywood, they were not constrained by typical filmmaking norms. They were thus able to demonstrate to audiences just how thrilling magnetic technology could be when compared to the standard acoustical designs of films released in Academy Mono.

The last four chapters then explore the many obstacles that Hollywood studios faced when attempting to incorporate magnetic stereo technologies into their own modes of production and distribution. Chapter six uncovers the history of a dual-print system known as triple-track stereo, which served as Hollywood's first viable attempt at a magnetic stereo sound system. I explore the conceptual origins of this format as well as its short rise and fall within the theatrical marketplace during 1953. Further, I analyze the ways that studios integrated triple-track stereo effects into a number of releases—including Universal's *It Came From Outer Space*, Columbia's *Miss Sadie Thompson*, and Warners' *House of Wax*. I argue that while triple-track stereo was

arguably too technologically cumbersome to be treated as a viable alternative to standard Academy Mono prints, its films introduced a host of stereophonic effects that would have a lasting impact on the way Hollywood conceived of proper stereophonic sound design in the years that followed.

Chapter seven then details the early years of Fox's CinemaScope technology, a magnetic stereo format that—unlike triple-track—stored four channels of sound and a widescreen picture all on the same strip of film. I trace how this novel design of CinemaScope technology was a response to the many problems that triple-track stereo created, such as mechanical failures and labor protests. Further, I examine the surround sound designs for several CinemaScope films—including *The Robe* and *House of Bamboo*. From these analyses, I posit that Fox deliberately designed its earliest CinemaScope releases in a manner that downplayed its stereophonic capabilities in order to prevent the format from being associated with the failures and headaches of triple-track stereo.

Chapter eight investigates how others within Hollywood responded to Fox's initial construction of CinemaScope. I specifically investigate the rise of several cheaper alternatives to four-channel magnetic stereo. Chief among these alternatives was a single-track optical stereo system known as Perspecta. Though its use of multi-channel compression led many in the industry to view it as merely a "pseudo stereo" technology, Perspecta nonetheless posed a serious challenge to CinemaScope's market share, largely because it was cheaper to install in dubbing rooms and theaters. Further, I analyze several surviving Perspecta sound designs—including *Forbidden Planet* and *Silk Stockings*—to demonstrate that the format was also far more acoustically experimental than CinemaScope releases. As a result, I assert that Perspecta technology dramatically lowered the value of four-channel stereo in Hollywood. In turn, it forced

the users of four-channel stereo to change their practices in order to save the format from disappearing in theaters.

Chapter nine details how exactly the engineers and executives at Fox responded to cheaper formats like Perspecta, as well as to the persistence of Academy Mono in the industry. I show how the studio changed its policies toward stereophonic sound installations, which thereby allowed exhibitors to choose between playing either magnetic stereo or optical soundtracks in their theaters. I also detail the extent to which Fox boosted the value of stereo sound by incorporating stereo mixers into the studio's pre-production meetings, and by designing their stories in ways that could allow for the sound department to take advantage of surround sound effects. I call such sound design practices "stereo-telling" and I examine how they manifested themselves in two very different films: the psychological thriller *Compulsion* and the fantasy adventure *Journey to the Center of the Earth*, both released in 1959. I then conclude this dissertation with a brief discussion of *Star Wars*, a film which further illustrate Fox's stereo-telling aesthetic, and which demonstrates that the stereo renaissance of the 1970s was not the beginning of a new era in motion picture sound, but rather a continuation of technical practices established during prior decades.

In sum, this dissertation traces how film stereo came to be what it is today, from its origins as merely a tool to enhance the thrill of talking pictures in larger theaters, through its codification as a way to create three-dimensional auditory illusions, ending with its crystallization as a set of stylistic practices used by studios to enrich the telling of motion picture stories. The many technical, economic, and aesthetic factors that shaped its development over the course of several decades were the result of numerous individuals—inventors, technicians, engineers, studio heads, critics, and filmgoers—many of whom had no idea that their decisions

would help to create a concept of proper stereophonic and surround sound design by the end of the 1950s, let alone a concept that would remain in place for more than half a century. The history of stereo's ideals and practices involve a host of moving parts at any point in time, and its study thus requires multiple lines of inquiry and multiple areas of focus that occurred over the span of several decades, and which commenced as early as the 1930s.

I begin this dissertation just before this history commences, specifically in 1926, when Warners and Bell Laboratories unveiled the first viable talking picture technology for motion pictures. The technology was the Vitaphone. Like earlier attempts to add sounds to cinemas, the Vitaphone was quiet. Perhaps too quiet. It required not one but many horns behind and underneath the stage in order for filmgoers seated in the back of the theater to hear the music and effects that were stored on each Vitaphone record. Indeed, as the following chapter details, for many within the industry the earliest talking pictures needed better forms of amplification. They needed the aid of an acoustical technology that did not yet exist, but that would soon be invented. Talking pictures needed stereo.

Citations

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Chapter 1: The Identities of Multi-Speaker Sound, 1926-1937

Don Juan (1926) is a film about murder, adultery, and lust, and as such, Warners dressed it with scantily clad women and a tightly pants-*ed* John Barrymore. To no surprise, the literary adaptation performed well at the box office during its initial New York run.[56] Today, however, historians remember *Don Juan* less for its licentious story and *mise-en-scène* and more for its off-screen innovations. In lieu of a standard silent film accompaniment, for which a live orchestra would provide leitmotifs and moods for each scene, its music and effects were recorded and mixed onto a special sound track that was stored onto a set of gramophone disks, each designed to run in synchrony with a different reel.[57] Jointly developed by Warner Brothers, Western Electric, and Bell Telephone Laboratories, the film's sound-on-disk technology was known as the Vitaphone.[58]

The Vitaphone was the first synchronous recording technology to be employed by a major Hollywood studio for a feature-length release. As such, *Don Juan* became the first picture distributed alongside a pre-recorded sound track. Its Broadway premiere at the Warner Theatre on August 5th and 6th of 1926 was designed to highlight this technological achievement.[59] A series of Vitaphone shorts preceded the film's screening. These included an address to the audience by Will Hays, president of the Motion Picture Producers and Distributors of America (MPDDA), as well as a performance from *Rigoletto* by soprano Marion Talley.[60] Each short was screened to showcase a different acoustical benefit of the new format, with particular attention given to the clarity of speech and the fidelity of musical reproduction. The novelty and popularity of the sound recording technology would encourage Warners to release more features and shorts with sound-on-disk accompaniment.[61] Other studios would soon follow suit by

releasing their own films on competing sound-on-film formats, such as Fox's variable-density optical tracks and RKO's variable-area optical tracks. By the early 1930s, Hollywood would fully transition to synchronous sound recording technology, a feat that changed the industry's product from a mere motion picture to a moving and talking picture.

The success of *Don Juan*'s premiere, and in turn the broader popularity of the "talkie," was also due to the ingenuity behind Vitaphone's theatrical sound reproduction system. Designed by engineers at Electrical Research Products, Inc. (ERPI), the motion picture division for Bell Telephone, the monophonic multi-speaker system installed for the premiere of *Don Juan* featured two rows of Western Electric horns at the front of the theater.[62] The upper row consisted of model 12-A horns, which were mounted above the screen and pointed horizontally toward the audience. The lower row consisted of slightly larger model 13-A horns, which were installed into the theater's orchestra pit, and pointed up toward the theater's balcony at a diagonal angle.[63] ERPI engineers initially envisioned that the two rows of loudspeakers would allow a film's soundtrack to emanate from two different locations.[64] Films comprised of dialogue might play from the on-stage horns, allowing the actors' voices to more closely align with the location of their mouths. Likewise, films comprised of only music might play from the pit speakers, which as ERPI's Howard Santee described, allowed the accompaniment to "simulate the actual sound from an orchestra."[65]

Rick Altman rightlyu observes that by installing horns in the orchestra pit, and by intending to send recorded music to these speakers during screenings, engineers were constructing an identity of the early talkie that was tied to silent cinema's accompaniment practices.[66] At the same time, these design intentions also showed considerable forward thinking, for it would be several decades before filmmakers would request that sound systems enable

dialogue, music, and effects to emanate from different rows of loudspeakers installed at specific locations around the auditorium. ERPI engineers, however, would remove these directional capabilities from their system. By the time of *Don Juan*'s Broadway premiere, the system played the entire sound track through the on-stage speakers, while it allowed the projectionist to control the levels of the lower speakers if louder decibel ranges were desired.[67]

Although it is unclear why ERPI abandoned the localization of sound as a design feature, the company's subsequent reconstruction of the lower horns as additional volume boosts speaks to a much larger acoustical problem that plagued motion picture engineers at the time: The majority of the industry's theaters were designed well before the transition to recorded sound. The dimensions of theaters and the materials along the walls and ceilings were not always conducive for electrically reproduced sound waves.[68] The new talking pictures needed to fit inside a multitude of venues, and yet amplifying a soundtrack to fit theaters with poor acoustical conditions often led to distortion in the final playback signal. Such problems were not new to the industry. As William Paul argues, the moving picture screen was itself a poor fit in many large theaters during the medium's earliest decades.[69] Standard modes of projecting 35mm film created an image that was very small compared to the size of the proscenium. Filmgoers seated on specialty seats in the upper balconies and on the sides of auditoriums—specifically horseshoe auditoriums—at times faced the screen at such poor angles that the image would be distorted, and the illusion of motion picture representation was undermined. That cinema did not always match the exhibition space was a dilemma that the transition to sound only exacerbated. The job of the sound system was not just to reproduce dialogue, music, and effects with acceptable clarity and detail. More practically, it first needed to ensure that all patrons heard the film.

This task proved difficult to achieve.[70] A good sound system needed to broadcast a soundtrack to the theater's back row, but it was undesirable if that broadcast meant simultaneously deafening the front row. More so, theaters came in different sizes and shapes, and any one sound system needed to be adaptable to variations in auditorium design. The sound system that ERPI developed for *Don Juan*'s premiere addressed these problems with reasonable adequacy. The lower horns were pointed upwards so that their increase in volume would not be met at the expense of patrons seated by the orchestra pit. The system was also adaptable to large and small theaters. The number of amplifiers could vary according to the width of the stage, and theaters without balconies could potentially forgo the installation of the lower horns.[71] Vitaphone's theatrical sound system therefore represented a practical means of employing multiple loudspeakers in order to amplify the soundtrack without distorting the signal. But as Vitaphone engineer Vesper Schlenker would acknowledge in 1930, the decision to privilege practicality over aesthetic pleasure left much to be desired:

> ... the Vitaphone Corporation decided to accept some responsibility for the correct transmission of sound in the theaters from the loud speakers to the audience. The officials and engineers had learned through disheartening experience that sound which is properly recorded in the studios may become almost unintelligible when reproduced under certain conditions.[72]

In other words, such practical solutions offered mixed results. The reproduced signal was loud, though at times admittedly unappealing.

As a consequence of these shortcomings, ERPI's theatrical sound system would undergo a series of revisions over the next several years.[73] At the same time, many competing systems would soon appear, each of which promised to improve sound quality with respect to frequency range, noise, distortion, and amplification. Some engineers, such as Alan Blumlein in London, looked to reduce the number of loudspeakers in theaters, as doing so could minimize any

distortion that would be introduced when multiple sound waves collide. Others, such as Abel Gance and André Debrie in Paris, took the opposite approach. Instead of reducing the number of loudspeakers, they arranged an assortment of horns around the auditorium so that the reproduced signal might create an even louder assault on audiences. The fruits of these different designs, in turn, would enable filmmakers to harness the creative potential of multiple loudspeakers for greater storytelling effect.

This chapter provides an historical account of these largely forgotten experiments in sound system design. I argue that by attempting to ascribe a set of coherent functions onto sound systems comprised of multiple loudspeakers, its earliest users conceived of the emergent audio equipment as extensions of pre-existing communication tools. Altman refers to this phenomenon as jurisdictional conflict, a moment in history when a new technology does not yet have its own unique identity but, instead, is defined by a set of competing identities that are each tied to earlier practices.[74] In some circumstances, the names given to the technology can reveal these conflicting conceptualizations. As Altman notes, this was the case when qualifiers like "living photographs" and "advanced pictorial vaudeville" were once applied to cinema as a means to conceive of the new technology as extensions of fine art and theater.[75] With respect to sound systems, a similar identity crisis occurred during the late 1920s and early 1930s, and can be illustrated through each multi-speaker system's name and technical design. I suggest there were three ways that such sound systems were identified as extensions from earlier practices. One identity treated multiple loudspeakers as tools to enhance the emphatic effects produced by widescreen technologies. A second identity treated them as extensions of the mimetic effects created with binaural headphones. The final identity saw them as a means to simulate the three-dimensional effects achieved with stereoscopic devices.

In the following pages, I chronicle the way these competing identities for multi-speaker systems were patented, tested, and installed for limited runs during the transition to sound. Although these specific systems failed to become viable and widely adopted theatrical formats, they nonetheless became the crude first steps toward the development of the more intricate exhibition technologies that the motion picture industry would introduce over the next several decades. Specifically, I contend that these systems formed the conceptual and technical foundation upon which the industry would soon define proper stereophonic sound.

Emphatic Loudspeakers

As *Don Juan*'s musical accompaniment illustrates, some of the first sound track designs were themselves derived from silent era conventions. These design influences, however, were not limited to musical accompaniment. In some instances, the new loudspeaker technologies were treated as tools that enhanced the many stage and screen effects that had become common to gala premieres and exclusive engagements in prior decades. As historians Gilliam B. Anderson and Ross Melnick detail, lighting effects and aromas were at times a means to enhance the motion pictures produced by director D. W. Griffith and exhibited by theatrical showman Samuel "Roxy" Rothafel.[76] By the late 1920s, the spectacle of a wider and taller screen was similarly employed as a comparable technique to intensify the story's emotional resonance, if not the filmgoing experience itself.[77] As the following paragraphs detail, filmmakers including Howard Hughes and Abel Gance merely continued this tradition of showmanship into the era of electrical amplification. For these directors, multi-speaker sound systems were not merely conduits for narrative information, much as they were for Warners during the making of *Don*

Juan. Like a sudden change in screen size, the creative use of loudspeakers constructed an acoustical spectacle designed to provide comparable dramatic emphasis during motion pictures.

Twelve Horns for Hell's Angels

The use of multiple loudspeakers for the release of Hughes's *Hell's Angels* (1930) was one of the earliest illustrations of such dramatic enhancements. By the time of the film's premiere, ERPI's theatrical sound system for larger movie palaces had transformed from its initial two-row horn design to a much simpler one-row design.[78] This reduction in equipment was made possible by the industry's widespread adoption of perforated movie screens, which enabled engineers to install horns directly behind the screen as opposed to both above and below it.[79] The reduction was further made possible by the advent of Western Electric's model 15-A and 15-B horns, which dispersed sounds at a wider vertical angle than did the 12-A and 13-A horns, and which therefore precluded the need for as many speakers to be pointed in different directions to the fill the auditorium with sound.[80] An expansive venue like Sid Grauman's Chinese Theatre in Hollywood, for instance, had installed only three 15-B horns for standard film showings at the time that *Hell's Angels* premiered.[81] And had *Hell's Angels* received a standard film release, then it likely would have only used these three horns.

The war picture's premiere, however, were anything but standard. To upstage earlier cinematic spectacles, particularly Paramount's production of William A. Wellman's *Wings* (1927), Hughes provided audiences with even more lavish, sensory novelties in select venues nationwide, including in Grauman's Chinese and the Criterion and Gaiety theaters in New York.[82] To achieve such novelties, Hughes and ERPI developed a unique sound system that allowed for multiple channels of sound to play simultaneously through a total of twelve horns

behind the screen.[83] The result was a two-channel sound track, potentially the first of its kind for a major Hollywood release.

The film's story is rather straightforward: two English fighter pilots fall for the same woman and are subsequently captured by the German military during the first world war. This relatively simple story, however, was not necessarily the main draw at the time of the film's premiere.[84] Many first-run audiences would have been just as interested in the spectacular imagery, particularly the aerial stunts that inflated the budget by several million dollars.[85] Likewise, many filmgoers were perhaps equally curious to hear the film's reportedly meticulous attention to sound design.[86] To provide audiences with high quality acoustics, ERPI engineers stored the dialogue, music, and effects into a variable-density track housed on its own strip of 35mm film, which in turn required the sound to play through a set of "dummy" projectors that ran in synchrony with the picture.[87]

This practice of housing the sound and image on separate filmstrips was initially developed by Roy Pomeroy for the release of *Wings* several years prior.[88] The dual-inventory allowed the silent film, which was shot and composed for the silent aspect ratio of 1.33-to-1, to screen alongside a special music and effects track without requiring Paramount to crop the side of the picture to make room for an optical track. While most theaters played a live score to accompany *Wings*, select theaters offered audiences the opportunity to hear this exclusive sound design comprised of music and effects, a design not unlike the Vitaphone soundtrack that accompanied the premiere of *Don Juan*. Studios continued to employ this dual-system sound-on-film technique in select theaters, such as the Astor on Broadway, for they felt that it improved the acoustical quality of the film.[89] In addition to allowing the sound track to run through a projector without intermittent movement, engineers specifically argued that by printing the sound

track onto a separate strip of film, the picture track could be optimized for visual details during its development process, while the optical soundtrack could be independently optimized for higher contrast and lower levels of noise and distortion.[90]

Exclusive engagements of *Hell's Angels* featured this very dual-system technology largely as a result of the film's unique production history. Hughes initially conceived *Hell's Angels* to be a silent war epic in the spirit of *Wings*.[91] As such, many of its action sequences were shot during 1927 in the silent aspect ratio of 1.33-to-1. When Hughes later decided to reshoot the film for synchronous dialogue recording, he continued to use the standard 1.33-to-1 ratio, a decision which maintained uniform picture dimensions between these new dialogue sequences and the action sequences that were shot silent. Though the use of synchronous recording differentiated *Hell's Angels* from its silent cinema predecessors, Hughes nonetheless employed the dual-system sound track used by silent films like *Wings*. The higher quality sound track and the wider aspect ratio that the sound track in turn distinguished *Hell's Angels*' select theatrical engagements from more standard sound-on-film releases at the time.

What made *Hell's Angels* stand out even more was its use of a second sound track to provide audiences with a far greater number of sound effects in these select theaters. This second track was itself an enhancement of silent film practices, specifically the practice of performing sound effects live in theaters. *Wings*, which featured a music and effects track in select theaters, also featured live performances of additional sound effects in order to punctuate many of the film's more lavish action sequences.[92] A small handful of audiences were therefore able to experience both live and recorded sound effects when seeing the film, a rare occurrence during the industry's transitional era.[93]

Much like *Wings*, *Hell's Angels* played in select theaters with an additional set of sound effects aimed at enhancing the film's aerial battles. Hughes's sound team, however, recorded and mixed its additional sound effects onto a second optical sound track that was printed onto its own strip of 35mm film.[94] To increase the amplification of these effects, ERPI's H. A. DePalma and Lawrence Aicholtz oversaw the installation of nine additional 15-B horns behind the screen, for a total of twelve: a row of three horns above the initial three, and two columns of three horns each flanking the left and right sides of the initial three.[95] Thus, the film's main sound track—which contained dialogue, music, and effects—emanated from three horns, whereas the film's special sound effects track—which contained the roars of planes and the launching of missiles—emanated from nine horns.[96] The resultant decibel level when all twelve horns played simultaneously was reportedly five times the volume of a standard sound track. As a result of this two-track technology, *Hell's Angels* became a dual system release, at times even requiring three projectors to play at once: one for the picture and two picture-less dummy projectors for the two separate sound tracks.

Significantly, the conception and use of the film's two-track technology was not only tied to silent era's sound effects but also its stage effects, specifically those that employed special projection equipment to increase and decrease the size of the picture. *Hell's Angels* was among the few films to use a unique widescreen format known as Magnascope.[97] The format required special lenses that magnified a 35mm print so that it could be projected onto specially installed screens with heights and widths comparable to later wide-gauge formats. Paramount introduced the Magnascope format to the public during the late 1920s to provide greater picture spectacle to silent films.[98] The first film to receive a Magnascope release was *Old Ironsides* (1926), which saw its premiere at Roxy's Rivoli Theatre in New York.[99] The studio later used the format to

enhance the cinematography on a limited number of their more visually stunning silent features, including Ernest B. Schoedsack and Merian C. Cooper's melodrama *Chang: A Drama of the Wilderness* (1927). Not coincidentally, *Wings* was also among the titles to receive a Magnascope release during its initial theatrical run.[100] The use of this widescreen format for the release of *Hell's Angels* was therefore yet another way that Hughes ostensibly designed his film to offer comparable spectacles to those provided by Wellman's 1927 war epic.

Although Magnascope enabled filmmakers to increase and decrease the size of the image both to create dramatic effects and to more adequately fill large theatrical prosceniums, the technology manifested a significant aesthetic constraint. Magnascope relied on special lenses that were to be mounted onto a projector during each screening, and as a result the size of the screen could not quickly turn on and off with the flick of a switch. Instead, lenses had to be mounted to projectors before the beginning of each reel, and to prevent the film from stopping mid-screening, projectionists needed to refrain from removing the lens until that reel was complete.[101] In other words, the Magnascope process could enhance a given action sequence so long as that sequence began and ended in correspondence with a reel change. *Old Ironsides* solved this technical constraint by reserving the Magnascope effects for naval battles, whereas *Chang* reserved its widescreen effects for the elephant stampede.[102] *Wings* likewise saved the wider picture for the reels that contained spectacular aerial stunts.[103] *Hell's Angels* followed a comparable structure. Its plot was strategically designed so that the film's aerial battles occurred only during reels three and five of the six-reel feature.[104] The film's use of silent cinema's theatrical effects to enhance its picture therefore amounted to roughly forty minutes for each screening.

The additional loudspeakers for *Hell's Angels* were tied to this Magnascope process. The second sound track containing plane engines and gunfire was intended to punctuate the aerial battles, which meant it was specifically designed to play only during the film's widescreen sequences. As the size of the picture increased, so too then did the size of the sound. Thus, the film's two-track sound design illustrates the extent to which filmmakers like Hughes identified multi-speaker technologies as extensions of pre-existing cinema practices, namely the wider picture effects that were used to emphasize on-screen drama. The key difference between *Hell's Angels* and earlier theatrical effects was what made the effects novel: in addition to a special lens, and in place of live sound effects, a second sound track played through nine additional horns. In this regard, the multi-speaker sound system designed for *Hell's Angels* was conceived by the industry as merely a new tool that could enhance the industry's tradition of theatrics.

Abel Gance and Perspective Sonore

A similar illustration of how loudspeaker effects were conceived as an extension of the screen occurred several years later at the overseas premieres of motion pictures directed by French filmmaker Abel Gance. For these exclusive engagements, much like *Hell's Angels*, Gance oversaw the installation of multiple loudspeakers to be employed throughout the auditorium. What made Gance's sound system different from that developed for *Hell's Angels*, however, were the types of formal effects the new loudspeaker arrangement enabled. In addition to proportional effects—wherein loudspeakers could alter the size of the sound—Gance's system allowed for the creation of directional effects—wherein the placement of loudspeakers could alter the location of the sound within the theater.

Gance's sound system was an outgrowth of his own three-strip widescreen system, known as Polyvision, which the director unveiled at the Paris Opéra for the premiere of his three-hour biopic *Napoléon* (1927).[105] Like Cinerama technology of the 1950s and 1960s, Polyvision consisted of three separate 35mm filmstrips that, when projected in synchrony, created the left, center, and right portions of the expansive moving picture. Each filmstrip contained an image with an aspect ratio of 1.33 to 1, which when combined resulted in an aspect ratio of 4 to 1.[106] The larger Polyvision screen could in turn consist of one contiguous image, and at times Gance used this to illustrate the panoramic landscapes and the hundreds of extras that re-enacted the French general's historic battles. At other times, the Polyvision screen could contain three separate pictures, not unlike a triptych painting, or—as John Belton describes—the individual stages of a three-ring circus.[107] Lastly, Polyvision also allowed for the film to play from only the center projector. Thus, the width of the screen could expand in order to punctuate a film's more spectacular moments. Similar to Magnascope, Polyvision was a means for Gance to increase the size of the image so that it would better fit within the Paris Opéra's impressive stage. And like Magnascope, its immense visual scope would soon engender a sound system that could continue to expand the proportions of a film so that it's acoustical design would also more closely fit within the space of a large auditorium.

Gance nonetheless struggled to construct this sound system, perhaps due to his own lack of familiarity with audio technology at the time. In one early description of his concept, Gance wrote that the system was to produce sounds from all sides of filmgoers, including from "*sous le fauteuils*" (under the seats).[108] The description recalls how Roxy once introduced the smell of burning sulfur throughout his theater during special engagements of *The Last Days of Pompeii* (1913), an aroma intended to assault the audience's senses during the eruption of Mount

Vesuvius.[109] Gance's idea to blast sounds from all sides of the audience would have no doubt produced a comparable sensory experience.

However, when Gance attempted to articulate how his device would work, he used the phrase "*une serie de microphones*" (a series of microphones) in place of "*une serie de haut-parlours*" (a series of loudspeakers) to describe the equipment that was to be installed under the seats of filmgoers.[110] Gance's inadvertent reference to a recording technology, as opposed to a playback technology, suggests his initial difficulty when finding the words to describe his immersive sound system (that, or Gance thought it was a good idea to stick a microphone that close to a *monsieur's derriere* for hours on end). To no surprise, Gance's first attempt to patent this immersive sound technology in 1929, then titled "*Procede pour ameliorer et renforcer l'effet des representations de cinematographe parlant*" (Method to Improve and Enhance the Effect of Talking Cinema Representations) suffered from a similar lack of technical specificity.[111] Instead of outlining the mechanical procedure involved in his invention, the application described only the experience of sonic immersion more broadly. As a result, Gance's sound system was subsequently denied a patent.

Gance in turn enlisted engineer André Debrie for help in turning his acoustical concept into a viable apparatus. An established film inventor since the 1920s, Debrie had previously worked with Gance to patent the Polyvision picture format several years prior.[112] Their 1932 patent "*Perspective sonore à haut-parleurs multiples*" (Sound Perspective for Multiple Loudspeakers) would be accepted by France's Ministry of Commerce and Industry in 1933, and was soon known as Perspective Sonore.[113] The apparatus was similar to ERPI's initial Vitaphone sound system, for both consisted of a single track of optical sound that was to play from a host of horns located at the front of the theater. The one important difference was that the Perspective

Sonore sound track had the ability to play from one or more loudspeakers individually and was therefore not forced to play from every loudspeaker at the same time. Sounds of cannon fire could in turn bounce between different loudspeakers, as if to give the impression that cannon balls were launching from one end of the theater and landing on troops in the opposite end.

Unbeknownst to Gance and Debrie, their patent greatly resembled a failed invention of Edward Ament, a California engineer whose early motion picture technologies—including the "Magniscope" (not to be confused with Magnascope) and the "Audo-Moto-Photo"—helped garner him the Edison-inspired nickname “The Wizard of the West.”[114] Amet’s 1911 patent, titled “Method of and Means for Localizing Sound Reproduction,” bolstered his reputation even further. It specifically allowed for a projectionist to turn a switch in order to direct a sound track to any number of loudspeakers located around the theater.[115] This enabled sounds to travel between multiple locations within the auditorium, including the front and back walls, to enhance the dramatic excitement of a given motion picture. Yet like many other early synchronous sound machines during the 1910s, it never saw widespread success due to the various problems concerning synchronization and amplification.

Gance and Debrie’s multi-speaker system ostensibly created a means to turn Amet’s manually operated invention into a series of automated commands. In so doing, Perspective Sonore resembled the way early data systems would encode information as holes that were strategically punched into long, continuous strips of paper.[116] With Perspective Sonore, one strip of film was the standard 35mm print that housed the film’s picture and sound; the second strip of film contained a series of holes and was designed to run through the projector in synchrony with the sound track.[117] The configuration of small holes on this second filmstrip was the coded information that directed the film to one or more of loudspeakers installed along the walls of the

auditorium. By storing coded information, later known as a control track, onto a second strip of film, Gance was able to create the type of immersive sound effects that he envisioned in his early writings on a multi-speaker sound system.

According to historian Malte Hagener, Gance initially planned for his science-fiction film *Le fin du monde* (1931), to be the first film to utilize the Perspective Sonore technology.[118] However, due to Gance's disagreements with producers over the film's release, in combination with the sound system's technical failings at the time, *Le fin du monde* received only a standard sound system for its European and North American runs. Gance would not unveil Perspective Sonore until the premiere of his *Napoléon Bonaparte* (1935) at the Paramount Theatre in Paris.[119] Gance's second cinematic venture into the life of Napoleon reused many of the famous battle sequences from the 1927 biopic, but with added dialogue, music, and effects. The picture also included an assortment of new sequences that were filmed and recorded with the intention of synchronous sound playback.[120] Unlike with *Hell's Angels*, it remains unclear when in the film Gance employed his Perspective Sonore system to create these immersive acoustical effects, for the film's second strip of hole-punched tape no longer appears to exist. Nonetheless, it is reasonable to infer that the loudspeaker effects occurred during the film's many battle sequences, wherein sounds of weaponry could explode from all sides of the audience as a means of expressing the chaos of Nineteenth Century warfare.

The technological ingenuity of Perspective Sonore, and the acoustical effects that it enabled, would lead Gance to use the sound system one more time for select screenings of his biopic *Un grand amour de Beethoven* (1936). According to historian Roger Icart, Gance employed multi-speaker effects to create a contrast between Beethoven's experiences of being deaf, and his hallucinations of immersive acoustical symphonies.[121] In one notable scene, it is the

imaginary collage of outdoor noises that leads Beethoven to hear in his mind the opening movement to his Sixth Symphony, the "Pastoral." To express a comparable psychological experience for audiences, the sequence begins in silence, and at the moment when Beethoven starts to imagine noises in his head the soundtrack erupts with distant hammers, bells, and bird whistles. At the Paris premiere, this cacophonous collage would have propelled from loudspeakers pointed in different directions around the auditorium, leveling a barrage on the senses of filmgoers. Despite such sensory effects, however, neither *Napoléon Bonaparte* nor *Un grand amour de Beethoven* played in North America in theaters that had installed Gance and Debrie's special sound system. Like *Hell's Angels*, very few audiences had the opportunity to hear Gance's immersive invention first hand.

That said, the scarcity of these technologies was likely intentional. In order for special theatrical engagements to become valuable, and in order for theaters offering these engagements to differentiate themselves from competing venues, their multi-speaker systems needed to be reserved for limited runs of limited films. Like the two-track system developed for *Hell's Angels*, Gance and Debrie's invention functioned as a promotional tool. By using the technology, a filmmaker or a theater could elevate the value of their product by selling it as an exclusive filmgoing experience. The system was developed not to replace standard motion picture sound systems but to create an opportunity for novelty. Similar to the many screen and stage effects employed by D. W. Griffith, Samuel "Roxy" Rothafel, and other silent cinema showman in earlier decades, Perspective Sonore was valuable because it was rare.

Although the two-track system of *Hells Angels* and the Perspective Sonore system of *Napoleon Bonaparte* and *Un grand amour de Beethoven* would not be utilized in the years that followed, the idea of creating an exclusive multi-speaker sound system would remain a regular

occurrence within the industry. The scarcity and exclusivity of a new sound system would allow the system to be promoted as a must-hear theatrical event. MGM's musical *San Francisco* (1936), for instance, featured a multi-speaker system for its premiere at the RKO Capitol Theatre in New York.[122] The system was wired to play low-frequency effects that could shake the theater during the earthquake sequence, an effect that garnered MGM's sound department an Academy Award for sound.[123] Even more notable were the exclusive engagements of Goldwyn's *The Hurricane* (1937). For the film's titular storm, sound technicians including Fred Albin, Tom Moulton, and Paul Widlicska layered together a symphony of atmospheric howls, each of which were intended to have their own personality. As these technicians would later describe to *Variety*:

> ... they developed definite tones and characters into their sound effects with two dominant characteristics, one the weird, eerie wall of the wind, and the other the rumbling roar that is nature's overtone when she's het up. The 'hurricane orchestra' eventually had nine pieces, all operated by a strange novel creation perfected by Widlicska and named by him 'Solly the Serpent.'[124]

To heighten the expressive effect of the sequence, the studio installed extra amplifiers and loudspeakers at some of the larger venues scheduled to screen the film, including the Astor Theatre in New York.[125] And like *San Francisco*, the use of these multiple loudspeakers in *The Hurricane* helped Moulton win an Oscar.[126] Indeed, when studios limited the deployment of spectacular effects to select theaters, the effects were not only valued for their novelty, but the use of multi-speaker sound as a whole became an indicator of a motion picture's acoustical artistry.

Mimetic Loudspeakers

Because Hughes's and Gance's conception of multi-speaker sound limited their systems to select numbers of theaters and films, there was an opening for sound engineers to develop multi-speaker technologies that were more than mere theatrical novelties, and that could be broadly implemented by the industry without their widespread use inadvertently decreasing their market value. By the early 1930s, several engineers patented and tested such sound systems. Their technologies were conceived specifically as a means to enhance the audiovisual correspondence between a film's *mise-en-scène* and its sound track. That is, if an actor walks from screen-right to screen-left, so too would his voice travel from the right loudspeaker to the left loudspeaker. The value of such an effect was therefore not due to their acoustical scarcity but to their ability to provide audiences with sensory experiences that were already common in day-to-day activities. In other words, these multi-speaker systems were developed to strengthen the larger potential for mimesis within motion picture sound tracks.

Such mimetic effects, however, were only possible due to the physiology of filmgoers. One's ability to detect a sound's location is due to her binaural, or two-eared, hearing. A sound to the left of a filmgoer will emit a sound wave that reaches her left ear slightly before it reaches her right ear. Further, this wave will have a slightly greater intensity when it reaches her left ear. As a result of these small acoustical differences, the filmgoer can determine that the sound is to her left rather than to her right. In order for a binaural signal to contain these localization effects, it therefore needed to consist of two separate microphone and playback channels: one for the left ear and one for the right. By the late 1920s, audio engineers were regularly exploring ways of perfecting the recording and transmission of binaural acoustical signals.[127] And by the early 1930s it would become common for engineers to create "dummy" heads that wore two

microphones by their ears and that could then serve as a stand-in for a headphone-wearing auditor waiting at the other end of the transmission. Bell Laboratories would even showcase their own acoustical achievements in binaural technology by allowing the public to interact with the company's famed dummy head, affectionately named "Oscar," at the 1933 World's Fair in Chicago.[128]

Yet this concept of a binaural signal had been a musical and scientific curio for more than half a century before Oscar's Chicago unveiling. One of the earliest prototypes for binaural technologies, Clément Ader's *Théâtrophone*, saw its first public demonstration at the World's Exhibition in Paris in 1881.[129] For each night of the Exhibition, Ader transmitted live performances from the Paris Opéra—the same auditorium that would later premiere Gance's *Napoléon*—through two kilometers of telephone wire and into four specially equipped rooms at the Exhibition's *Palais de l'Industrie*.[130] Patrons waiting in long queues were able to hear each performance for up to three-minutes at a time through a binaural headset designed to play separate signals for the left and right ears, signals that corresponded to two different channels of sound recorded by microphones positioned at the foot of the opera's stage.[131] As translated in *Scientific American*, French critic Edouard Hospitalier observed clear differences between standard monaural reproduction and the *Théâtrophone*'s binaural sound reproduction:

> ... in listening at a telephone, it is practically impossible to have even a vague idea of the distance at which the person at the other end of the line appears to be. To some listeners this distance seems to be only a few yards, to others the voice apparently proceeds out of a great depth of the earth. In this case [the *Théâtrophone*] there is nothing of the kind. As soon as the experiment commences the singers place themselves, in the mind of the listener, at a fixed distance, some to the right and others to the left. It is easy to follow their movements and to indicate exactly, each time that they change their position, the imaginary distance at which they appear to be.[132]

Hospitalier's comparisons between single-channel and two-channel transmissions illustrate the extent to which Ader's technology, like other binaural technologies, provided listeners with the opportunity to perceive localization effects during an audio signal's transmission. The second identity of multi-speaker sound systems was merely an extension and an enhancement of this longstanding tradition of binaural sound reproduction. The one difference was the size and location of the reproduction equipment. Instead of transmitting sounds to small headphones located directly next to a person's ears, binaural sound systems transmitted two-channel signals to loudspeakers mounted on the sides of the auditorium's walls.

Two Early Patents

One feature that defined this new conception of multi-speaker technology was that, unlike *Hell's Angels* and *Napoleon Bonaparte*, many mimetic systems did not rely upon multiple projectors or multiple strips of film. Instead, engineers designed hardware that could store multiple tracks of sound onto a single print. One of the earliest and most interesting of these single-strip systems was patented in 1929 by Lee de Forest, inventor of one of the earliest sound-on-film formats known as the PhonoFilm.[133] De Forest's multi-speaker system, known as simply "Binaural Recording and Reproducing Sound," consisted of two channels, left and right, that were recorded onto two separate variable-density optical tracks using separate left and right microphones.[134] During reproduction, the two microphone channels were sent to corresponding left and right loudspeakers located at the front of the theater. Thus, when actors spoke and moved in front of the left and right microphones, the voices of the actors would emanate from the left and right loudspeakers in a manner that simulated the movement of sounds recorded in front of the camera.

Of particular note was the way de Forest stored the two channels onto a single filmstrip. He devised a method by which one of the tracks would be tinted blue, the other tinted red. This unique color scheme allowed for the left and right channels to be superimposed on top of each other during the printing of a standard strip of 35mm film. During projection, a special sound head would separate the red and blue signals using red and blue lenses. The sound head could then read each signal separately and send these signals to their corresponding left and right loudspeakers located behind or to the sides of the screen. By superimposing the two soundtracks on top of each other, de Forest allowed for the picture track and each sound track to maintain their widest possible width, and thus their highest possible quality. In other words, the localization effects of a binaural signal, and in turn the audiovisual correspondence between sound and image, would not be undermined by an increase in noise that would otherwise accompany a pair of narrower optical tracks.

A second example of such systematic approaches to multi-speaker sound was the four-speaker sound system similarly developed in 1929 by inventor Wikke Bouma, and assigned to First National Pictures president Thomas L. Talley.[135] Bouma's system, like Perspective Sonore, directed a single track of sound to different loudspeakers, as opposed to directing multiple tracks of sound to their own loudspeakers. However, there were two key differences between Bouma's system and earlier multi-speaker technologies. First, in place of a separate strip of film, Bouma developed a means of storing control track information directly onto 35mm prints in the narrow, horizontal space between each frame. If the control track featured a strip of light on the left side of this narrow space, the sound track was to emanate from the left loudspeaker. If the control track featured light on the right side, the sound track was sent to the right loudspeaker. Bouma's

one-strip system was thus more materially efficient than was Gance and Debrie's two-strip system.

Second, Bouma did not envision his multi-speaker system as a means of providing an assault on the filmgoer's senses, as experienced during films like *Napoleon Bonaparte* and *Un grand amour de Beethoven*. Like de Forrest's sound system, it was a means to provide more direct correspondence between the sound and the image. Bouma specifically designed his system for four loudspeakers located behind the screen. As he described in his patent application, this four-speaker system addressed the problem of sound localization during scenes involving a musical performance:

> ... during the projection of a picture of a singing quartette when any of the singers is singing alone and may be at either end of the line of singers, present day reproducers cast the sound only from given sources irrespective of the fact that the singer may be at an extreme corner of the projected scene with the result that the sound pictures have an unnatural and false impression.[136]

The four loudspeakers behind the screen were therefore designed specifically to correspond to a picture with four separate sources of sound, such as a row of four singers. If a singer in frame-left had a solo, the left-most section of the control track would allow light to pass through, and this light signal then directed the soundtrack to emanate from the loudspeaker located directly behind frame-left. This technology then allowed the filmgoer's binaural hearing to detect the sound as coming from its corresponding location within the image. Further, the system was not limited to the reproduction of vocal music. As indicated in the patent's drawings, the sound format could be used for films that feature flying airplanes, such as *Hell's Angels*. If a plane were to travel from frame-left to frame-right, Bouma's invention could enable the roar of that plane to correspond to its location in the image. The sound would pan from the left loudspeaker, to the center loudspeakers, and to the right loudspeakers. Thus, Bouma's technology was distinct from

that use of multiple horns in *Hell's Angels*. The roars of Bouma's airplanes were tied to specific locations behind the screen, whereas the roar of Hughes's airplanes merely increased in size.

Despite these aesthetic benefits, the absence of any substantial discourse surrounding Bouma's patent suggests that it was largely ignored by those within the industry. [137] This includes the patent's own assignee, Thomas Talley. At the time of the patent's application, Talley's First National Pictures was a subsidiary of Warners and was therefore releasing its talkies using Warners' monaural Vitaphone sound-on-disk technology.[138] With the exception of Bouma's patent there is no known evidence that Talley was intending to promote a new sound system in competition with Vitaphone. Speculatively, Talley's role as assignee may have only been a nice gesture to help a friend pay for the legal protection of his invention.

Like de Forest's system, there is also no evidence that any film was released—or even thought to be released—using Bouma's multi-track and multi-speaker system. Nonetheless, De Forest's and Bouma's patents serve as documentation of a shared conception among engineers for what might constitute proper multi-speaker sound system designs. Specifically, there was interest among inventors to develop systems that could provide studios and theaters with a mode of reproduction that simulated the acoustics of our day-to-day listening experiences. That neither system was ever adopted in any public form might speak to a much larger problem facing inventors at the time: in order to convince studios and theaters that their systems were worthy of adoption, inventors needed to show that their systems could work as described. With no documentation that working prototypes ever existed, it remains conceivable that neither de Forest nor Bouma were capable of meeting this expectation.

Alan Blumlein and Binaural Sound

Not every inventor of mimetic technology, however, suffered the same trajectory as de Forest and Bouma. The 1931 multi-speaker patent of British engineer Alan Blumlein not only developed into a working prototype, but within a few years of its application Blumlein and colleagues at the Columbia Graphophone Company (later Electrical Musical Industries, or EMI) filmed a series of short demonstration films that showcased the loudspeaker effects outlined by Blumlein.[139] Like de Forest, Blumlein called the acoustical phenomenon exploited by his invention binaural sound, a name that associated his technology with a filmgoer's two-eared physiology. Unlike de Forest, however, Blumlein did not superimpose two optical tracks on top of each other. And unlike Bouma, Blumlein's invention did not merely simulate a multi-channel recording by directing a monophonic sound track to play from different loudspeakers behind the screen. Instead, EMI engineer Cecil Browne designed for Blumlein 35mm prints with two tracks of sound—each unilateral variable-area—placed side by side within the narrow space to the left of the picture that was typically reserved for a single track of sound.[140]

This design was notable for several reasons. It allowed for two channels of sound to be housed and stored onto 35mm prints without the need for dual projectors and without the need for complicated colored lenses to read the binaural signal. Further, Blumlein encoded the system's binaural signal onto 35mm film in a manner that greatly shaped the aesthetics of its reproduction. Instead of the left and right tracks corresponding to the left and right microphone channels, the two tracks each contained elements of both channels mixed together.[141] The left track housed the sum of the two microphone channels (also known as *M* or middle). Likewise, the right track housed the difference between the two channels (known as *S* or side).[142] One way to create these two tracks was to record the sound event with two velocity microphones, one

pointed toward the left side of the stage, the other pointed toward the right, much like in standard binaural practice. This recording technique could be achieved by pointing microphones perpendicular to the stage. It could also be achieved by swapping the positions of the left (L) and right (R) microphones and then by pointing their heads at the opposite sides of the stage "with their axis perpendicular to one another and each axis at 45° to the direction to the center of the screen [stage]."[143] In either arrangement, a mixing console would then perform "L + R" in order to create the sum channel, and "L - R" to create the difference channel.

Because adding and subtracting the two microphone channels had the potential to distort the phases of the final binaural signal, Blumlein also developed an alternative recording technique. Two microphones were to be placed very close to each other, if not on top of one another. One microphone, the sum channel, would be pointed directly at the stage at a perpendicular angle. This position allowed for the balance between the left and right sounds to be equal while it simultaneously privileged the middle of the stage. At the same time, a velocity microphone with a two-way, or bi-directional pickup pattern, would be turned 90° off-axis so that its two ends were parallel to the stage. This microphone position privileged the sounds that emanated from the very sides of the stage, and its recorded signal could thus function as the difference channel.[144] Blumlein's alternative technique recorded the individual sum and difference channels directly into their own microphones, and in turn it eliminated the phasing problems introduced when creating new sum and difference channels from left and right microphone channels.[145]

Both methods of storing the sum and difference channel onto their own tracks nonetheless required a special unit, known as the “shuffler,” to apply a series of operations in order to separate the left and right signals and direct them to their corresponding loudspeakers

during playback.[146] To separate the left channel, the shuffler would add the sum and difference track together, "(L + R) + (L - R)," which produced "2L" or the left signal. To separate the right channel, the shuffler would subtract the difference channel from the sum channel, "(L + R) - (L - R)", or "2R."[147] Blumlein's two-track format therefore could replicate the binaural effect of de Forest's color-dye system, but its microphone techniques and encoding processes were perhaps more complicated, if not also counterintuitive.

There are several potential reasons for such complicated and counterintuitive designs. For one, they helped to establish Blumlein's reputation as an ingenious, if not eccentric, innovator of multichannel sound. As one legend goes, Blumlein conceived of his binaural invention in 1931 while on a date at the local movie theater.[148] He is said to have grown frustrated by moments when an actor spoke from one side of the screen all while the speech emanated from a loudspeaker behind a different part of the screen. Upon leaving the theater, Blumlein supposedly promised his girlfriend in a moment of excitement that he would one day invent a sound system that fixed this problem, one that would enable a blind person to determine the location of the actors, much as they might when attending live theater. That the system he devised was ultimately very intricate and complex was therefore evidence of the inventor's unique methods of thinking outside of the box to solve acoustical engineering problems.

That said, by 1931 multichannel sound was far from a new idea, even in the cinema.[149] The sum and difference channels, while themselves unique, were likely a means for Blumlein to avoid many of the patents and royalties associated with standard left and right electrical transmissions. Notably, Blumlein's concept of binaural sound was not limited to cinema, but was applicable to all media, including disk recordings, and at the time of the patent's application there were many engineers exploring multi-channel reproduction for such equipment.[150] Engineers at

Bell Laboratories, for instance, were at work conducting their own research into binaural sound-on-disk media.[151] Unlike Blumlein's design, Bell maintained the separation of left and right channels from the recording stage, through the transmission stage, and to the reproduction stage.[152] Blumlein's decision to store the left and right signals into sum and difference channels therefore enabled EMI to circumnavigate a lengthy and costly legal battle against an international telephone company over the ownership of two-track signal transmissions.

Blumlein's unique system carried acoustical benefits as well. For one, the system's two optical tracks were narrow in width, and therefore carried significantly more noise than would a standard optical track. This increase in noise had the potential to mar the binaural signal's localization effects. Blumlein's sum and difference channels, in contrast, allowed for an engineer to manually increase the difference channel during transmission, a feature which amplified the left and right position of the sound, and which thus allowed for the narrower and noisier tracks to continue to carry a discernable binaural signal. In so doing, an engineer could also magnify the apparent distance between the left and right playback signals. In terms of cinematic reproduction, this meant that an off-screen sound would not necessarily emanate from behind the screen but from the left and right wings of the theater. By increasing the intensity of the difference or side channel, the roar of a bus passing in front of the camera could then sound as if it was moving through the theater, beyond the edges of the frame. To this extent, Blumlein's system allowed for the binaural signal to increase the acoustical mimesis of the sound tracks. His system not only enabled the simple reproduction of left and right channels, it added capabilities that filmmakers could use to further enhance the construction of realism within motion picture narration.

EMI's Binaural Films

The most important advantage of Blumlein's system—one that separated it from de Forest's and Bouma's—was that it was financed by a company that was willing to build a multi-speaker sound format that could serve as an alternative to monaural sound. Under the backing of EMI, Blumlein and his colleagues filmed a series of test films at EMI's studios (now Abbey Road Studios) to showcase the multi-speaker technology's ability to simulate binaural hearing.[153] Some of these films were very simple in nature, not unlike the earliest film experiments made forty years earlier. One of the first binaural test films, *Trains at Hayes Station* (1935) was merely an extreme long shot of a train arriving at the nearby station. The content of the film recalled Auguste and Louis Lumière's *L'arrivée d'un train en gare de La Ciotat* (1895), although the long distance between Blumlein's camera and the Hayes train yard likely prevented anyone in the audience from gasping in fright once the train approached the station. The distance between the microphones and the train also prevented the film from fully exploiting the sound system's directional effects. Blumlein would correct this issue in the recording of the film *Fire Engine* (1935) several days later. In that short, a fire truck passes by Blumlein's motionless camera twice, from left to right, each time rattling its siren so that the spatial localization of the sound and the image had a more salient correspondence.

Most of the other test films shot by Blumlein are wryly comedic, suggesting the extent to which the engineers at EMI saw the binaural technology as a toy. This is most apparent in the three test films shot before a curtain on an EMI stage. One film, titled *Stick Game* (1935), consists of the EMI engineers humorously contorting their bodies so they could jump over a small wooden stick, a shtick perhaps likely to have been popular in a vaudeville circuit. The other two stage films, combined as *Walking and Talking* (1935), consist of the engineers

standing on the left and right sides of the stage reciting days of the week in almost absurd seriousness. Following this recital, the engineers pass from left to right counting to themselves in an equally dry tone. While the films are intended to exploit the binaural phenomenon produced through Blumlein's invention, they function more as documents of the way Blumlein's colleagues played with the technology to self-consciously become the butt of its jokes.

This sense of humor and discovery is most apparent in a short playlet titled *Move the Orchestra* (1935), performed on the EMI stage by the EMI Amateur Theatrical Group.[154] The scene depicts several patrons in a restaurant who attempt to order food from a clumsy waiter, but whose attempts to do so are thwarted by a string orchestra that overwhelms the restaurant's atmosphere with volume. The orchestra is off-screen the entire time, and its location can be determined by the binaural signal reproduced through the two loudspeakers.[155] When the orchestra overwhelms the patrons in frame right, its sounds emanate at a loud volume from the right loudspeakers. Likewise, when the orchestra moves and overwhelms the patrons in frame left, it emanates at a loud volume from the left loudspeaker. The punch-line of the scene, one that can only be determined through the binaural signal, is that when the orchestra is told to move to a different location within the restaurant, it merely moves to a different loudspeaker. In other words, Blumlein's binaural system had the ability to induce certain emotions from its audiences, emotions that made Blumlein's sound designs rather unique. Whereas films like *Hell's Angels* and *Napoleon Bonaparte* used multiple loudspeaker to generate awe among audiences, films like *Stick Game* and *Move the Orchestra* were designed to generate laughter.

Following the production of these test films, Blumlein would turn his attention to wartime technologies, particularly improvements to radar communication using the concepts of spatial signal transmission that he explored during his binaural experiments.[156] And it was his

wartime work that led to his ultimate demise. While testing a new radar system on a four-engine Handley Page Halifax in 1942, the bomber crashed on the coast of Wales, killing everyone on board including Blumlein.[157] EMI would in turn shelve its work in binaural sound until 1953.[158]

The failure of his multi-speaker technology, as well as those of de Forest and Bouma, however, were not merely the result of misfortune. They were due to the way these engineers constructed the identity and value of their technologies. Any interest in extending binaural technology to theaters appeared limited to only engineers. Producers and theater owners wishing to utilize multi-speaker sound systems instead were more likely interested in salient dramatic effects. Blumlein's attention to the comedic potential of binaural reproduction made his multi-speaker system distinct from others, but this distinction was ultimately not sensational enough to market the technology to the industry. Thus, while binaural technology formed a unique identity for multi-speaker sound systems, it was not as valuable as the widescreen effects experienced at gala premieres and other exclusive theatrical engagements. The mimetic effects that defined the inventions of de Forest, Bouma, and Blumlein were perhaps too similar to everyday acoustical experiences to be of any real novelty to motion pictures.

Three-Dimensional Loudspeakers

The third and most popular identity of multi-speaker sound systems drew upon the concept of three-dimensional audio, a concept that combined many attributes found in earlier sound systems. Like the emphatic technologies developed for *Hell's Angels* or *Napoléon Bonaparte*, the creation of three-dimensional acoustical illusions became another way for showmen to enhance the theatergoing experience. And like the mimetic technologies developed by de Forest or Blumlein, these systems similarly allowed audiences to experience acoustical

reproductions as emanating from specific locations on stage. Yet in addition to merely combining these earlier attributes, sound systems that were designed to create three-dimensional effects were also self-consciously drawing upon pre-existing novelties, namely stereoscopic photographic viewers.

Derived from the Greek words *στερεος* (stereos) meaning "solid" and *σκοπεο* (skopeo) meaning "to watch" or "to see," stereoscopes enabled people to see three-dimensional solid objects when peering into flat, two-dimensional photographs.[159] The illusory toy was first introduced as a physical, marketable device during the later half of the nineteenth century by a host of inventors, including Parisians Francois Soleil and Jules Duboscq, as well as London scientists Sir David Brewster and Charles Wheatstone.[160] The scientific principle behind the stereoscope was as follows: two photographs, each with a slightly different vantage of the same event, were viewed simultaneously so that a person's left eye would only see the left-leaning perspective, while the right eye would only see the right-leaning perspective. By viewing both photographs in this manner, the viewer's brain would reconstruct the two flat photographs into a single, three-dimensional image, one with a foreground that extends toward the viewer and a background that extends into the distance. Thus, the photographic representation was no longer flat; it was given visual depth, as if elements within the photograph were occupying physical space right before the viewer's eyes.

As a popular visual novelty during turn of the century, the photographic illusions that the stereoscopes created would soon be explored as the basis for acoustical reproduction. Among the most well-known of inventors to exploit such stereoscopic principles with respect to sound was Harvey Fletcher. As a noted audio engineer and hearing specialist at Bell Laboratories, Fletcher helped to develop the first electric hearing aids, and in 1920 he published the highly acclaimed

monograph *Speech and Hearing*, a summary of his research into the physiological process of listening, research that led to a series of improvements to radio and telephone technologies in the years that followed.[161] In addition to these achievements, Fletcher was also one of the first American engineers to articulate the concept of three-dimensional sound, and by the early 1930s his research into multiple loudspeaker systems would produce one of the first viable alternatives to single-channel audio reproduction.[162]

Harvey Fletcher and Auditory Perspective

Fletcher's system was technologically simple compared to the hole-punched control track of Gance and Debrie's Perspective Sonore or the sum and difference channels of Blumlein's Binaural Sound. Fletcher merely required the installation of three evenly staged microphones—left, center, and right—which recorded three different signals that were kept separate during transmission. Upon reproduction, Fletcher's system sent these three recorded signals to three similarly staged loudspeakers. The resultant soundscape would therefore manifest three different acoustical vantages of the same performance. As Fletcher argued, the difference between hearing one acoustical perspective and three distinct perspective simultaneously, "may be compared to that between the appearance of a photograph of a scene and the same scene when viewed through a stereoscope."[163] Like a stereoscopic image, there would now be a foreground and a background of that soundscape, and audiences could experience the multi-speaker reproduction as a three-dimensional, solid object. By the end of the decade, Fletcher would even toy with a name for his sound system, one that would further encourage audiences to identify the technological fruits of his research with the illusory phenomenon of stereoscopic photography: stereophonic sound.[164]

Fletcher's multi-mike recording system, however, was arguably not a new idea. By the early 1930s, it was common for production mixers to record orchestras with three separate microphones that corresponded roughly to the left, center, and right of the orchestra.[165] Warners' George Groves even used a multi-mike technique as early as 1926 when recording *Don Juan*'s musical accompaniment, as doing so was believed to greatly increase the quality of the symphonic reproduction.[166] So while the identity of Fletcher's sound system was associated with three-dimensional novelties, the recording technique was itself derived in part from the modes of practice previously established for monaural sound systems. The technology merely extended multi-mike staging techniques into multi-track recording and, ultimately, multi-channel playback.

Fletcher's three-channel system was also derivative of the many sound systems being tested and developed at Bell Laboratories, namely their two-channel binaural sound system for gramophone disks. In 1932, Bell's Arthur Keller would specifically oversee a series of experimental, multi-track recordings with Leopold Stokowski conducting the Philadelphia Orchestra.[167] For these recordings, Keller cut two audio channels—left and right—onto the record's grooves in order to explore the possibility of three-dimensional sound using only two tracks of sound.[168] Significantly, each track was overseen by Stokowski, a multi-speaker enthusiast who later served as one of the creative directors behind each of Fletcher's multi-speaker sound concerts. Fletcher's decision to eventually dub his three-channel sound system as stereophonic sound was perhaps then a rhetorical maneuver, one that not only differentiated his product from other multi-speaker systems at the time, but that also helped differentiate his system from earlier modes of sound reproduction at Bell Labs.

What made Fletcher's system nonetheless unique from other multi-speaker technologies was the theoretical concept that was widely cited as having informed its technical design. This concept, dubbed "auditory perspective," referred to the psychological and acoustical phenomena that allowed audiences to experience three-dimensional sound illusions. Perhaps we might conclude that the construction of this concept was another rhetorical gesture on the part of Fletcher to further differentiate his multi-speaker sound system from, say, the binaural systems of de Forest or Blumlein. Yet this cynical understanding of auditory perspective flattens many of the larger ideas that the concept intended to address.

Auditory perspective was concerned with the ineffable experience of hearing live sounds, and as ineffable experiences go, Fletcher acknowledged a serious difficulty in articulating them. Writing in 1933, Fletcher observed:

> When one sits in an auditorium and listens to a symphony concert he experiences something that is over and above the effect produced by the actual frequency and volume range given out by the orchestra. This additional appeal is difficult to describe, and almost impossible to measure. It is partly due to a spreading of the sound in all directions so that it fills the entire volume of the auditorium and thus reaches one's ears by various paths. It is partly due to other factors; but whatever its cause it results in a richness and texture of tone that no ordinary electrical reproduction can provide. For lack of a better term, the effect may be called auditory perspective. Without it the music would be one dimensional and not expanded into its true spatial relationship.[169]

For Fletcher, the concept of auditory perspective was a way to identify the unique characteristics of a live concert experience. Whereas binaural sound reproduced a sound's left and right orientation—its lateral attributes—Fletcher's sound system reproduced a sound's three-dimensionality—its sagittal attributes. In so doing, it allowed audiences to sense the depth or presence of a soundscape. Although this distinction between three-dimensional sound and binaural sound was not easy for Bell engineers to identify and articulate, the continued discussions of auditory perspective suggests that there were differences between stereophonic

and binaural experiences that drove Fletcher's push to contrast his multi-speaker system from earlier technologies.

In later decades, such differences would become easier for audio engineers to define. Writing in 1958, British sound technician James Moir wrote that binaural sound—due to its origins as a headphone apparatus—transported the listener to the hall of the original concert performance, whereas stereophonic sound transported the original performance from the concert hall to the listener.[170] In describing the distinctions in this manner, Moir subsequently reinforced the way that each technology was designed to enhance pre-existing scientific processes. For binaural sound, the microphones and loudspeakers serve as extensions of the listener's two-eared physiology. For stereophonic sound, the microphones and loudspeakers serve as extensions of the sound's physicality, namely its sound waves.

Moir's descriptions further help to clarify Fletcher's choice to dedicate considerable attention to discussing air and sonic vibrations in descriptions of his sound system. According to Fletcher:

> An ideal transmission and reproducing system may be considered as one that produces a similar set of vibrations in a distant concert hall in which is executed the same time-sequence of changes that takes place in the original hall. Since such changes are different at different positions in the hall, the use of such an ideal system implies that at corresponding positions in the two halls this time-sequence should be the same.[171]

By referencing "a similar set of vibrations." Fletcher argued that a proper three-dimensional sound signal needed to transport the sound waves of a live performance from a concert hall into a new auditorium. As such, the loudspeakers were required to reproduce not just the sounds themselves but the way the sounds would vibrate the air throughout the hall. This meant that proper multi-speaker technique did not necessarily involve recording the sound signal at close proximity, as was standard practice for sound reproduction. Quite the opposite: the technique at

times insisted upon recording the waves that each signal produces at the moment when these waves are at a discernable distance from the sound's source. Such unorthodox recording practices indicate that the concept of auditory perspective was more than a concept. It was as a set of governing principles and proper techniques for how to record and reproduce a three-dimensional sound illusion.

Fletcher and his colleagues outlined these principles throughout articles published in the *Bell Laboratories Record*, *Electrical Engineering*, and later reproduced for the film industry in the *Journal of the Society of Motion Picture Engineers*. In one article, titled "The Reproduction of Orchestral Music and Auditory Perspective," Fletcher argued that in order to properly reproduce the sound waves of a live concert, the recording, transmitting, and reproducing technologies must translate these waves into electrical signals without any loss in quality.[172] This required the sound system to expand its range of audible sounds in order for the frequencies (cycles per second) and intensities (decibels) of the original sound waves to remain indistinguishable from their reproduction.[173] In terms of frequencies, Fletcher determined that the average person could hear a range between 16 and 20,000 cycles. In terms of intensities, Fletcher similarly determined that the average person could hear a range from 20 (a faint whisper) to 120 decibels (the threshold of pain), or a range of roughly 100 decibels. Any sound that fell outside of this range therefore would not need to be transmitted in order for the sound reproduction to be indistinguishable from the live event.

Fletcher, nonetheless, found that most sound events do not transmit waves that the extreme end of either range. A symphonic orchestra, for instance, was determined to produce sound waves within an intensity range of 70 decibels, and a frequency range between 40 a 15,000 cycles.[174] Fletcher in turn installed equipment that could transfer acoustical signals into

electrical signals within these more common acoustical ranges.[175] To record the sound waves, Fletcher settled upon moving coil microphones provided by Western Electric, which were used in conjunction with Western Electric No. 262A vacuum tube amplifiers to boost the amplitude of the recorded signals. To reproduce the sounds, Fletcher used loudspeakers with separate low and high frequency horns that could boost individual ends of the entire range of frequencies without distorting the signals. This design of the high frequency horns also allowed for sounds to be dispersed across a wider angle throughout the theater. As Fletcher argued:

> ... the audience, in a large hall equipped with the ordinary loud speakers, never hear quite the proper blending of frequencies. Those directly in front of the horn receive too great a proportion of the higher frequencies, while those on the sides receive too much of the low frequencies. To avoid this effect, the horn of each high-frequency element is divided into 16 diverging rectangular sections which spread the sound over an arc of 60 degrees vertically and one of 60 degrees horizontally. Two of these units placed side by side thus spread the sound over a horizontal angle of 120 degrees—a far wider coverage than has been obtained before and one which distributes the sound throughout the auditorium with a faithful blending of the frequencies.[176]

The resultant effect of this wider range and angle of dispersion was a sound that moved through the space of the auditorium and interacted with physical objects at the back of the hall. As Fletcher would later playfully demonstrate to the audience for one of his earliest multi-speaker sound concerts:

> You probably noticed also that some low frequencies caused rattling from somewhere in the room. I assure you it was not from the stage. It was from the window panes and various panels in the room which were resonant to the frequency we were producing. If we make that frequency loud, you will notice that it will shake the panels very vigorously.[177]

In other words, the wider frequency and decibel ranges enabled the sound waves not only to play from specific locations on stage, but also to be felt and experienced as a physical object that moves throughout the theater.

Such sound reproductions also necessitated that engineers arrange the high-quality microphones and loudspeakers in a manner that aligned their angles of transmission so that—like a stereoscopic photographic—a three-dimensional sound illusion could be perceived. William Snow, Fletcher's colleague at Bell Laboratories, was in charge of designing this staging process. In an article titled "Auditory Perspective," Snow theorized that to create a proper three-dimensional signal, the recording and reproducing technology would need to function much as a sonic curtain.[178] According to Snow:

> It is obvious that when one listens directly to music, such as a symphony orchestra, one hears sound that—at least originally—passes through the opening between stage and auditorium. If this space were filled by an array of microphones, therefore, each of which was electrically connected by an individual circuit to a loud speaker similarly placed before an audience at a distant point, the audience would then hear—assuming perfect transmission—exactly what they would have, had they been listening directly.[179]

In effect, Snow felt that it was the job of the microphones and the loudspeakers to serve as a conduit for sound waves to travel across spaces, uninterrupted. Like a powerful wavefront, sound vibrations that begin on one stage should be recorded by a great many microphones on one stage, and reproduced through an equal number of loudspeakers on a different stage so that these vibrations can travel from the performance to the audience as one continuous wave.

The equipment demands of this ideal transmission were arguably impractical. Snow nonetheless argued: "it is quite conceivable that a much smaller number of microphones, properly placed and connected by individual circuits to similar set of loud speakers, might produce an effect substantially similar."[180] To determine the proper number of microphones and loudspeakers, Snow conducted a series of experiments in which he recorded nine sound sources, spread across the width and depth of the stage in a grid formation, through several types of microphone and loudspeaker formations.[181] One formation, for instance, consisted of three

microphones channels reproduced through two loudspeakers, while another consisted of two microphone channels reproduced through three loudspeakers. He determined that a three-microphone and three-loudspeaker configuration best reflected how audiences localized sounds on a live stage. This one-to-one sound transmission would later be known as a wavefront system.[182]

The Bell Telephone Concerts

Fletcher and his team at Bell Labs first demonstrated their multi-speaker sound technology to the public on April 27, 1933 at Constitution Hall in Washington, D.C..[183] Though this event focused primarily on virtues of auditory perspective as a theory of three-dimensional sound reproduction, it was also a means to promote Bell's many other technological innovations. The demonstration, for instance, showcased state-of-the-art amplifiers, each of which were designed to reproduce the necessary frequency and decibel ranges to allow for audiences to experience a proper three-dimensional sound illusion.[184] More so, the event was itself made possible with the help of Bell's mid-Atlantic telephone wires, which were capable of transmitting three audio channels from the Academy of Music in Philadelphia to Constitution Hall supposedly without any detectable loss in signal quality.[185]

In order to align Fletcher's demonstration with the prestige associated with high art, the three-channel narrowcast featured a live concert of symphonic favorites played by the Philadelphia Orchestra. The pieces included Bach's "Toccata and Fugue in D Minor," Beethoven's "Symphony No. 5 in C Minor," Debussy's "L'apres-midi d'un Faune," and the finale from Wagner's *Götterdämmerung*. At the podium in Philadelphia was Associate Conductor Alexander Smallens, for the orchestra's Principal Conductor, Stokowski, chose to act

as the concert's live sound mixer in the rear of Constitution Hall.[186] Throughout the evening, Stokowski sat before a console and adjusted the decibel levels of each audio channel, as doing so would ensure that the orchestra would be reproduced through the three loudspeakers at an acceptable volume at all times. Stokowski saw the console as an extension of the baton, and he treated it as the most important piece of the sound reproduction process. Accordingly, it was ultimately the mixer, not the conductor, who had final say over the balance of the symphony and the volume of the individual orchestral sections.[187]

That said, it is worth noting that by 1933 the maestro's obsessions with sound mixing had earned him the reputation of an enfant terrible among engineers, particularly NBC radio engineers. According to historian Robert McGinn, a sonically disastrous broadcast of a concert with Stokowski in the control room encouraged one engineer to build a placebo console that could be handed to the conductor without simultaneously giving him access to the control of future broadcasts.[188] It is therefore unclear if Bell similarly gave Stokowski sole control over the final balance of the three-channel transmission, or—unbeknownst to Stokowski—if there were additional mixers wired into the circuit, each designed to prevent a single, haphazard turn-of-the-dial from deafening the audience or from ruining the intended wavefront aesthetic in any way. Given what happened at NBC, it seems conceivable.

Indeed, the illusion of a three-dimensional reproduction was of such importance to Fletcher that—in addition to any mixing precautions—there were also visual constraints imposed upon the concert. In lieu of projecting motion pictures, the concert was accompanied by an abstract light show designed by Stanley McCandless of the Yale School of Drama.[189] The light show was constructed in a manner that encouraged audiences to pay more attention to what they heard, and less attention to what they saw. In this respect, the concert was ostensibly experienced

much like a symphonic tone poem, where the design of the music might prompt concertgoers to actively conjure up their own images and pictures while they listen. The goal was for audiences to notice the ineffable and illusory qualities of three-dimensional sound that informed the design of Fletcher's multi-speaker system, and that could sell the virtues of the system to the entire entertainment industry.

The illusory effects of this sound-only design were most apparent that following January, when Fletcher demonstrated his system jointly to members of the Acoustical Society of America and the Society of Motion Picture Engineers.[190] This concert was slightly different from Constitution Hall, for instead of transmitting a live performance between different cities, the performance was sent from the fifth floor to the first floor of the Engineering Societies Building in New York. The concert was also notable for including a more involved series of smaller demonstrations during its intermission. Unlike at the Academic of Music in Philadelphia, the Engineering Societies Building had two stages on its fifth floor. One was a small stage that housed a symphony orchestra. The second was a stage that was reserved for intermission and that was designed to showcase various kinds of sound effects that a traditional symphonic performance could not privilege. For instance, the sound of a nail being hammered into a block of wood was sent to one of the three loudspeakers on stage in the auditorium, while the sound of someone sawing that block of wood was sent to another loudspeaker. Collectively, these sounds could showcase the system's ability to direct sound effects to specific locations on stage.

At one point during this demonstration, a man who was pretending to play the trumpet walked between the loudspeakers on the auditorium's stage. Meanwhile, a man who was actually playing a trumpet walked between the microphones located on the fifth floor's sound effects stage. During this curious incident, Fletcher asked his audience to "determine, if you can, which

one is playing."[191] The most remarkable moment, however, involved the sound of a pistol firing a bullet from one side of the stage to another. In order to achieve this effect, Fletcher explained that "a man on one side of the miniature stage on the fifth floor clapped two boards together, another ran across the stage, blowing a whistle; the man on the other side then struck a metal circular saw that was handy."[192] Although the blowing of the whistle and the "boing boing" of the wobbly saw was cartoon-like in quality, the three-channel transmission was said to make the sound effect more vivid, as if the system made the flat, cartoonish bullet develop three-dimensional qualities in the minds of audiences.

Although at first it appears counterintuitive for Fletcher to promote his multi-speaker system to the motion picture industry without demonstrating how his system might directly enhance motion pictures, his promotional tactic nonetheless made the system more intriguing. In contrast with Blumlein's demonstration films, Fletcher's concerts would not constrain the potential uses of the new technology to the limited imaginations of audio engineers. Instead, the lack of motion picture accompaniment effectively passed the burden of developing creative uses for the system to the producers at the studios, many of whom would likely be interested in exploiting a new technology for financial gain. Thus, in lieu of imposing limitations upon the imagination of his audiences, Fletcher's sound-only demonstrations invited concertgoers to imagine the limitless potentials of his invention.

Moreover, Fletcher worked to distinguish his multi-speaker sound system as a sign of technological status and prestige. This reputation was aided largely by the fact that Fletcher was himself a highly regarded audio engineer throughout the 1930s. To no surprise, Fletcher referenced his earlier research at Bell Labs in his demonstrations and in accompanying articles.[193] By doing so he effectively argued that his sound system was the result of years of

psychoacoustical investigations, and that his concept of three-dimensional reproduction was scientifically proven to be pleasurable for audiences. Indeed, Fletcher's work to establish himself as a leader in multi-speaker sound designs, and by extension his work to establish his sound system as the most advanced system on the market, shaped the very discourse surrounding sound reproduction long after his retirement from Bell Laboratories in 1949.[194] It is perhaps the result of this influence that multi-speaker sound technology would become known in the decades that followed not as Perspective Sonore or Binaural Sound, but as stereo.

Conclusion

This chapter chronicled the conflicting ways that filmmakers and engineers constructed the aesthetic functions of multi-speaker sound systems during their first decade in existence. I revealed that ERPI's Vitaphone sound system for *Don Juan* treated the new technology merely as a conduit for soundtracks to reach the far ends of the auditorium. However, later films like *Hell's Angels*, and later systems like that designed by Harvey Fletcher, each treated the multi-speaker technology as a storytelling tool in and of itself. Drawing upon Altman's concept of technological identity, I argued that these more creative uses for multi-speaker sound systems were the result of audio engineers having conceptualized the technology as extensions of pre-existing communication tools. Some constructed the technology as an extension of the movie screen, some constructed it as an extension of binaural headsets, and some constructed it as an extension of stereoscopic photography. These conflicting constructions, or identities, for sound systems led engineers to exploit the emphatic, mimetic, and three-dimensional potentials of the new technology. In turn, such aesthetic enhancements showcased the multitude of ways that multi-speaker systems could enhance cinematic storytelling.

Consequently, these identities for early sound systems formed a foundation on which Hollywood would define proper stereophonic sound in the years that followed. That said, the motion picture industry initially showed little interest in adopting Blumlein's or Fletcher's inventions. Instead, it would take years for the major studios to consider such technologies as viable and valuable alternatives to monophonic sound. In the following chapter, I trace the economic factors that account for this initial lack of interest, as well as the factors that led the industry to re-evaluate multi-speaker and multi-channel sound as an attractive solution to the acoustical problems of standard, single-track prints.

Citations

[56] Donald Crafton, *The Talkies: American Cinema's Transition to Sound, 1926-1931* (Berkeley: University of California Press, 1997), 81. Crafton notes that the film's Broadway run profited nearly $20,000 per week, largely as a result of tickets ranging from anywhere between $1 and $10 per seat. The film, however, experienced a generally more mixed box office performance in subsequent cities. See Gomery, *The Coming of Sound: A History* (New York: Routledge, 2005), 40.
[57] Joseph P. Maxfield, "The Vitaphone—An Audible Motion Picture," *Bell Laboratories Record* vol. 2 (July 1926): 200-04.
[58] "Vitaphone Creates Sensation at N. Y. Premiere," *Motion Picture News*, August 21, 1926, 661-63; A. P. Peck, "Giving a Voice to Motion Pictures," *Scientific American*, June 1927, 378-79.
[59] "Synchronization of Recorded Music With Motion Pictures Successful in Vitaphone," *The Talking Machine World*, August 15, 1926: 120.
[60] Crafton, 76-77.
[61] Gomery, 43; Crafton, 82. Crafton notes that Warners had committed to an all-Vitaphone policy for the remainder of its 1926-1927 season less than three-weeks after *Don Juan*'s premiere, well before the full success of the new technology could be adequately gauged with respect to box office revenue.
[62] H. M. Wilcox, "Data for Projectionists on Operation of Vitaphone," *Exhibitors Herald—Better Theatres Section*, July 9, 1927: 11-12, 26-27.
[63] W. W. Simons, "1926—Twenty Years of Horn Progress—1946," *International Projectionist*, September 1946, 52-54; Bjørn Kolbrek, "Development of Horn Loudspeakers Before 1940," *Proceedings of the Forum Acusticum* 2014, Krakow, 7-12 September, 2014.
[64] Earl I. Sponable, "Some Technical Aspects of the Movietone," *Transactions of the Society of Motion Picture Engineers* vol 11 (Sept 1927), 473; H. B. Santee, "Western Electric Sound

Projecting Systems For Use in Motion Picture Theatres, Part II" *Transactions of the Society of Motion Picture Engineers* vol. 12 (Sept 1928), 687-88.
[65] Santee, 687-88.
[66] Rick Altman, "Sound Space," in *Sound Theory / Sound Practice*, ed. Rick Altman (New York: Routledge, 1992), 47-49.
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[68] See: F. R. Watson, "Acoustics of Motion Picture Theaters" *Transactions of the Society of Motion Picture Engineers* vol. 11 (Sept. 1927), 641-50; Schlenker, 302-314; S. K. Wolf and W. J. Sette, "Factors Governing Power Capacity of Sound Reproducing Equipment in Theaters," *Journal of the Society of Motion Picture Engineers* vol. 15 (Oct. 1930), 415-27.
[69] William Paul, *When Movies Were Theater: Architecture, Exhibition, and the Evolution of American Film* (New York: Columbia University Press, 2016), 21-61.
[70] Gomery, 24-31.
[71] Scriven, 675; Santee, 680.
[72] Vesper A. Schlenker, "A Truck Mounted Laboratory for the Diagnosis of Theater Acoustic Defects," *Journal of the Society of Motion Picture Engineers* vol. 16 (Mar 1931), 302.
[73] Simons, 52-54.
[74] Rick Altman, *Silent Film Sound* (New York: Columbia University Press, 2004), 15-23.
[75] Altman, *Silent Film Sound*, 19.
[76] Anderson notes that Griffith's extensive use of large orchestras and complicated lighting effects "contributed to the pressure in England and the United States to construct new movie palaces that could accommodate these forces and technical requirements." Gillian B. Anderson, "D. W. Griffith's *Intolerance*: Revisiting a Reconstructed Text," *Film History* vol. 25, no. 3 (2013), 58. Melnick notes that at showings of *The Last Days of Pompeii* (1913, Kleine), Roxy diffused "the smell of burning sulfur into the auditorium during the eruption of Mount Vesuvius," an aromatic effect Roxy would later repeat during exclusive engagements of *Quo Vadis* (1913, Kleine). Ross Melnick, *American Showman: Samuel "Roxy" Rothafel and the Birth of the Entertainment Industry* (New York: Columbia University Press, 2012), 90-93.
[77] John Belton, *Widescreen Cinema* (Cambridge: Harvard University Press, 1992), 34-51.
[78] H. B. Ely, "A Shallow Horn for Theatre Use," *Motion Picture Projectionist*, February 1931, 17-18.
[79] Among the earliest of these perforated screens were the Transvox and the Da-Tone-X, both of which were recommended to be used with Western Electric horns and amplifiers. See: "Layout for W. E. Sound Equipment," *Motion Picture Projectionist*, November 1928, 15-16; S. K. Wolf, "Reproduction in the Theatre," *Projection Engineering*, March 1930, 7-12; "Care and Setting of Sound Screens," *Motion Picture Projectionist*, June 1930, 52.

[80] De Hart G. Scranton, "Apparatus for Amplifying and Distributing Sound Waves," US Patent no. 1852793 (Nov. 24, 1928).
[81] "Progress in the Motion Picture Industry," *Journal of the Society of Motion Picture Engineers* vol. 15 (Dec 1930), 777.
[82] "Two Theatres for Talkie," *New York Times*, July 25, 1930, 23; "Hell's Angels to Have N.Y. Premiere Simultaneously in 2 Broadway Theatres," *Los Angeles Times*, August 10, 1930, H6.
[83] "Unique Reproduction Effects for Special Film," *Motion Picture Projectionist*, August 1930, 5-6.
[84] One critic noted that the story "must have partly fallen on the cutting room floor, for by the time the heroine, Jean Harlow (another cute Chicago divorcée who has made the grade in films), goes wrong, nobody cares." Rosaline Shaffer, "'Hell's Angels' in Spectacular First Showing," *Chicago Daily Tribune*, June 8, 1930, E2.
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[86] "'Angels' $3,200,000," *Variety*, Dec. 4, 1929, 5; "Accurate Attention Given Film," *Los Angeles Times*, June 13, 1930, B8.
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[88] Crafton, 134-35.
[89] "Separate Sound Print in Key Theatres," *Motion Picture Projectionist*, April 1930, 47.
[90] " Reproducing Sound from Separate Film," 148-58.
[91] Tony Thomas, *Howard Hughes in Hollywood* (Secaucus, NJ: Citadel Press, 1985), 34-54.
[92] "Sound Device in 'Wings'," *Motion Picture News*, March 31, 1928, 1029.
[93] It is unclear how many theaters played the special optical track. Some reports suggest that the Criterion in New York, and potentially other theaters, played the film's effects track from gramophone disks rather than from filmstrips. "General Installation of Sound Devices Long Way Off, Is Film Men's Current Belief," *Variety*, April 18, 1928, 10.
[94] "Two Sound Tracks Are Made by ERPI to Show 'Hell's Angels'," *Exhibitors Herald-World*, July 26, 1930, 40.
[95] Progress in the Motion Picture Industry" (1930), 777.
[96] "Two Sound Tracks Simultaneously Prove Success," *The Film Daily*, July 18, 1930, 7.
[97] "Screen Over 24 Ft. Called Impossible in Most Cases," *Exhibitors Herald-World*, October 25, 1930, 27.
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[99] Harry Rubin, "The Magnascope," *Motion Picture Projectionist*, November 1928, 13.
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[101] The add-on that would allow the projectionist to more quickly switch between lenses would not be unveiled until 1931. "Simplex Builds a Triple-Lens Turret," *International Photographer*, April 1931, 31.
[102] Rubin, 13.
[103] "Critical Focusing: Technical Reviews to Aid the Amateur," *Amateur Movie Makers* (April 1928), 234.
[104] Richard Watts Jr., "On the Screen," *New York Herald Tribune*, August 16, 1930, 6.

[105] Kevin Brownlow, *Napléon: Abel Gance's Classic Film* (London: Photoplay Productions, 2004), 137-145. Gance would recut the film over the course of his career, lengthening it well beyond its initial three-hour running time.
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[107] Belton, 39.
[108] Roger Icart, *Abel Gance, ou Le Prométhée foudrouyé* (Lausanne: Éditions L'age D'homme, 1983), 235.
[109] Melnick, 90.
[110] Icart, 235.
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[115] Edward H. Amet, "Method of and Means for Localizing Sound Reproduction" US Patent no. 1124580 (July 3, 1911).
[116] George Dyson, *Darwin Among the Machines: The Evolution of Global Intelligence* (Philadelphia: Basic Books, 1997), 143. The continuous strip of paper was itself a derivative of the more common punch card.
[117] Gance and Debrie, 2.
[118] Malte Hagener, *Moving Forward, Looking Back: The European Avant-Garde and the Invention of Film Culture 1919-1939* (Amsterdam: Amsterdam University Press, 2007), 153.
[119] "3-Dimensional Sound in Paris," *Variety*, March 20, 1935, 12.
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[121] Icart, 299.
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[126] "Academy Honors to 'Zola,' Spencer Tracy, Luise Rainer," *Motion Picture Daily*, Mar 11, 1938, 6.
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[137] The *Journal of the Society of Motion Picture Engineers* seems to have been the only publication to discuss Bouma's patent at length, and it occurred only once within a much longer article that details many new patents that might be of interest to the Society. "Abstracts of Recent U. S. Patents," *Journal of the Society of Motion Picture Engineers*, vol. 16 (May 1931), 643-44.
[138] Gomery, 115-16.
[139] Norman Green, "The Blumlein Stereo Films," preprint no. SWP-C4, Sound with Pictures Conference, May 17-18, 1988.
[140] Robert Charles Alexander, *The Inventor of Stereo: The Life and Works of Alan Dower Blumlein* (Jordan Hill, OX: Focal Press, 1999), 80. Blumlein initially stated in his patent that his system could work with both variable-area and variable-density tracks, though Browne perhaps found that the narrow variable-density tracks produced too much noise and were thus unsuitable for the two-track sound system. Blumlein, 3.
[141] Alan Dower Blumlein, "Improvements in and relating to Sound-transmission, Sound-recording and Sound-reproducing Systems," UK Patent no. 394325 (Dec. 14, 1931).
[142] Though M and S are sometimes treated as shorthand for mono and stereo, they were derived from the German words *mitte* (middle) and *seite* (side). Norman H. Crowhurst, *Hi-Fi Made Easy* (New York: Gernsback Library, 1959), 207.
[143] Blumlein, 5.
[144] The bi-directional velocity microphone, what Blumlein called a "moving strip" microphone in reference to either the moving coil or moving ribbon variety, had a two-way pick-up pattern, one for the front and one for the rear. Because the vibrating component recorded the rear sounds 180° out of phase, by turning it on its side it allowed for the front to record a positive left channel and a for the rear to record an inverse right channel, which was the same as "L - R." Alan Dower Blumlein, "Improvements in Electro-acoustic Devices," UK Patent no. 369063 (Mar 13, 1931).
[145] Blumlein specifically states, "Since the microphones are close together no phase differences are experienced between them and if their outputs are summed and differenced after a suitable amount of relative amplification the two final channels differ in magnitude in the correct manner for operating the loud speakers to give the desired directional effect." Blumlein, 5.
[146] For an detailed look at Blumlein's shuffling technique, see Michael Gerzon, "Stereo Shuffling: New Approach Old Technique," *Studio Sound* vol. 28 (July 1986), 122-30; Gerzon,

"Applications of Blumlein Shuffling to Stereo Microphone Techniques," *Journal of the Audio Engineering Society* vol. 42 (June 1994), 435-53.
[147] The intensities of the sum and difference channels were halved before encoded as individual tracks, so that the sum was more accurately "(L + R)/2" and the difference "(L - R)/2." Blumlein, 2.
[148] Alexander, 60-61.
[149] Without citing any specific system, Blumlein admits this much in his patent's description. "It must be understood that the controlling of intensities of a plurality of loud speakers spaced, for example, round a motion picture screen has previously been proposed and no novelty for mere intensity control per se is claimed, except insofar as the nature of the control is such as to provide the necessary phase and intensity difference sensations." Blumlein, 2.
[150] Blumlein, 6-7.
[151] A. C. Keller, "Early Hi-Fi and Stereo Recording at Bell Laboratories (1931-1932)," *Journal of the Audio Engineering Society* vol. 29 (April 1981), 274-280.
[152] Arthur. C. Keller, "Sound Recording," US Patent no. 1910254 (Oct 30, 1929).
[153] Russell Burns, *The Life and Times of A D Blumlein* (London: Institution of Electrical Engineers, 2000), 140-41.
[154] For a full description of the making of both versions of *Move the Orchestra* (also known as *Playlet*), see Alexander, 90-91.
[155] According to Alexander, the "orchestra" was actually a gramophone disk that was picked up and carried behind the backstage curtain.
[156] Burns, 300-04.
[157] Alexander, 302-44.
[158] Burns, 140.
[159] David Brewster, *The Stereoscope: Its History, Theory, and Construction* (London: John Murray, 1856), 1.
[160] J. B. S., “Tinted Stereoscopic Slides,” *The Athenaeum*, Oct 23, 1869, 532.; “The Stereoscope,” *Scientific American*, Nov. 25, 1876, 337; A. Stroh., “A New Form of Stereoscope,” *Scientific American*, May 29, 1886, 340. Coincidentally, this was the same Charles Wheatstone who in 1957 developed the hole-punched paper tape machine that Perspective Sonore would later resemble. For an account of Wheatstone’s early theories of stereoscopic illusions, see Charles Wheatstone, "Contributions to the Physiology of Vision—Part the First," *Philosophical Transactions of the Royal Society of London*, vol. 128 (1838), 371-94; Charles Wheatstone, "The Bakerian Lecture: Contributions to the Physiology of Vision.—Part the Second," *Philosophical Transactions of the Royal Society of London*, vol. 142 (1852), 1-17.
[161] Harvey Fletcher, “High Quality Transmission and Reproduction of Speech and Music” *Journal of the American Institute for Electrical Engineers* vol 43 (Mar 1924), 230-238., and Harvey Fletcher, “The Theory of the Operation of the Howling Telephone with Experimental Confirmation” *Bell System Technical Journal* vol 5 (Jan 1926), 27-49. In 1968, Fletcher would recall how his work in speech and hearing even led him to build a personal hearing aid for Thomas Edison. Stephen H. Fletcher, “Harvey Fletcher: September 11, 1884 - July 23, 1981,” in *Biographical Memoirs* vol 61 (Washington, D.C.: National Academy of Sciences, 1992), 176-7.
[162] Harvey Fletcher, "The Reproduction of Orchestral Music in Auditory Perspective," *Bell Laboratories Record*, vol. 11 (May 1933), 254-61.
[163] Fletcher, "Reproduction of Orchestral Music," 256.

[164] The exact moment when Fletcher settled upon this name is unclear. In many of his earlier articles he does not refer to this system by name but, instead, by the term "auditory perspective," a reference to the acoustical phenomenon that the system created. Fletcher's sound system demonstration to the American Institute of Electrical Engineers in New York in January 1934 appears to be the first time he uses the term, but he does so only once. According to the transcript, Fletcher stated: "But just what use would be made of this stereophonic system in music, must be determined by the musicians after they have a chance to use it and to compose their music with it in view." Harvey Fletcher, "Transmission and Reproduction of Speech and Music in Auditory Perspective," *Journal of the Society of Motion Picture Engineers*, vol. 22 (May 1934), 322. His use of "stereophonic" in this context nonetheless was enough for it to appear in a *New York Times* piece about the demonstration. Perhaps this critical response to the term was what encouraged Fletcher to continue using it. "'Solidified Music' Shakes a Building," *New York Times*, January 25, 1934, 15.
[165] Charles Felstead, "Monitoring Sound Motion Pictures," *Projection Engineering* (Jan 1931), 12-18.
[166] George Groves, interview with Irene Atkins, in *American Film Institute/Louis B. Mayer Oral History Collection*, "Early Sound and Music Editors" (Glen Rock, New Jersey: Microfilming Corporation of America, 1977), 8-10; John G. Frayne, Arthur C. Blaney, George R. Groves, and Harry Olson, "A Short History of Motion-Picture Sound Recording in the United States," *SMPTE Journal* vol. 85 (July 1976), 517.
[167] Robert E. McGinn, "Stokowski and the Bell Telephone Laboratories: Collaboration in the Development of High-Fidelity Sound Reproduction," *Technology and Culture*, vol. 24 (Jan. 1983), 50-54.
[168] Keller, "Early Hi-Fi and Stereo Recording," 274-80.
[169] Fletcher, "Reproduction of Orchestral Music," 255-56.
[170] James Moir, *High Quality Sound Reproduction* (London: Chapman & Hall, 1958), 557-59. See also John Sunier, *The Story of Stereo: 1881-* (New York: Gernsback Library, 1960), 22-23.
[171] Harvey Fletcher, "Auditory Perspective—Basic Requirements," *Electrical Engineering* (Jan. 1934), 9.
[172] Fletcher, "Reproduction of Orchestral Music," 254-61.
[173] Fletcher, "Reproduction of Orchestral Music," 255.
[174] Fletcher, "Reproduction of Orchestral Music," 256-58.
[175] E. C. Wente and A. L. Thuras, "Auditory Perspective—Loud Speaker and Microphones," *Electrical Engineering* (Jan. 1934), 17-24.
[176] Fletcher, "Reproduction of Orchestral Music," 258.
[177]Fletcher, "Transmission and Reproduction," 323.
[178] W. B. Snow, "Auditory Perspective," *Bell Laboratories Record*, vol 12 (Mar. 1934), 194-98.
[179] Snow, 194.
[180] Snow, 194.
[181] Snow, 195-97.
[182] T. Somerville, "Survey of Stereophony," *Proceedings of the Institution of Electrical Engineers* vol. 106 (Nov. 1959), 201-08.
[183] A preliminary concert for engineers and critics was also held on April 12. "Amplifier Gives Orchestra Tone of 1,600 Pieces," *New York Herald Tribune*, April 13, 1933, 14; "Musical Improvement Demonstrated by Bell," *The Film Daily*, April 13, 1933, 6.

[184] E. O. Scriven, "Auditory Perspective—Amplifiers," *Electrical Engineering* (Jan. 1934), 25-28.
[185] H. A. Affel, R. W. Chesnut, and R. H. Mills, "Auditory Perspective Transmission Wires," *Electrical Engineering* (Jan. 1934), 28-32.
[186] Fletcher, "Reproduction of Orchestral Music," 259.
[187] Leopold Stokowski, "New Horizons in Music," *Journal of the Acoustical Society of America* vol. 4 (July 1932), 11-19.
[188] McGinn, 45.
[189] Fletcher, "Reproduction of Orchestral Music," 259.
[190] Fletcher, "Transmission and Reproduction," 314-29.
[191] This moment would be re-enacted decades later—likely as a pure coincidence—at the "Club Silencio" in David Lynch's *Mulholland Drive* (2001, Universal).
[192] Fletcher, "Transmission and Reproduction," 320-21.
[193] See, for instance, Fletcher, "Reproduction of Orchestral Music," 256; Fletcher, "Transmission and Reproduction," 315.
[194] "Harvey Fletcher Retires, J. B. Fisk Succeeds Him," *Bell Laboratories Record* vol. 27 (Nov 1949), 408-09. In 1951, the Society of Motion Picture Engineers would publish a new analysis of Fletcher's work in an attempt to restart the discussion of Fletcher's findings during the era of magnetic stereo. H. G. Kobrak, "Auditory Perspective—A Study of the Biological Factors Related to Directional Hearing," *Journal of the SMPTE*, vol. 57 (Oct 1951), 328-35. In September of 1953, the same Journal would publish a special issue dedicated entirely to the subject of stereophonic sound wherein they would republish Fletcher's article on auditory perspective alongside those of his colleagues.

Chapter 2: A Reason for Stereo, 1936-1940

On the evening of August 17, 1936, concertgoers at the Hollywood Bowl were treated to a unique acoustical experience courtesy of Harvey Fletcher and his colleagues at Bell Laboratories.[195] Though at first glance, the concert program arguably appeared like any other. Maestro Irvin Talbot led the Los Angeles Philharmonic through several orchestral works, after which Paramount composer Victor Young ascended the podium to premiere his own orchestral piece, "Arizona Sketches." Following a brief intermission, Leopold Stokowski took the baton and conducted works by Debussy and Bach, in addition to arias from Wagner's *Gotterdamerung* and Bizet's *Carmen*, which were performed by Paramount mezzo-soprano Gladys Swarthout.[196] The combination of famous concert pieces and celebrities was common on the Bowl's stage. Nonetheless, what made this specific night different from all other nights was the use of a newly designed sound reinforcement system that boosted the evening's show to remarkable volumes.

Six microphones were placed in pairs around the hundred-piece orchestra, and they each fed signals to the three pairs of loudspeakers fixed to a metal frame erected above and to the side of the Bowl's signature shell.[197] In the center of the audience rested a mixing console, behind which seated an engineer charged with adjusting the decibel levels of each microphone. These adjustments enabled solos from quieter instruments to remain properly balanced, yet audible, for the thousands of concertgoers seated in all sections of the expansive outdoor amphitheater.[198] Those seated in the upper rows specifically commented that there was "a decided improvement in sound conduction, especially when the Paramount soloists were on the air" and that "the brass section blended with the orchestra better with the microphones than they do without."[199] As

many attested, the sound system succeeded in dispersing minute orchestral details across significant distances, all the way to the Bowl's farthest reaches.

The evening was billed as a benefit for the women's division of the Philharmonic Orchestra's maintenance fund, but it was much more than just a fundraiser.[200] The technical pageant showcased the aesthetic potential of multi-speaker sound systems, namely their ability to enhance the acoustical details of symphonic performances written and performed by creative personnel from a major Hollywood studio. Given that most studios had not yet implemented multi-speaker technologies into their own modes of production and exhibition, such pageantry remained a priority for the engineers of Bell Labs. Accordingly, a successful demonstration of multi-speaker sound might convince studio heads to adopt the technology for a forthcoming musical or melodrama.

At the same time, it was also among the first concerts to be branded by the "stereophonic sound" moniker, and this branding is one of historical importance. There remains disagreement among scholars, critics, and even industry technicians as to the genesis of this term stereophonic. Western Electric engineer John G. Frayne, for instance, once claimed the term was coined for a contest held at the end of the 1930s that was tasked with describing the multi-channel reproductions being produced at ERPI throughout the decade.[201] Of course, other evidence suggests that the term was used prior to any such contest. As the previous chapter noted, critics and engineers had used the term in January 1934 to describe Fletcher's concert for the Society of Motion Picture Engineers. And Helen Hanson also notes that the Oxford English Dictionary has traced an even earlier use of the word to 1927 in the pages of *Wireless World* magazine.[202] Stereophonic was no more than a clever portmanteau of stereoscopic and phonographic, and the

1936 Hollywood Bowl concert was one more public event that helped codify this term as the identifiable name for multi-speaker sound systems.

However, the Hollywood Bowl concert marked a significant shift for the aesthetic development of stereophonic sound's value to the theatergoing experience. Earlier uses of the phrase referred to the concept of a three-dimensional acoustical illusion, which rendered it a mere synonym for what Fletcher called "auditory perspective" in his concert demonstrations. Indeed, much like a toy stereoscope, early stereophonic entertainment was little more than a novelty act, one that could be orchestrated by showmen for the amusement of concertgoers and engineers. But by the end of the 1930s, the term stereophonic would refer to more than just a special effect. As the sound reinforcement system at the Hollywood Bowl illustrated, its definition became inextricably linked to acoustical range. Stereophonic sound meant loud sound.

This chapter traces how the idea of multi-speaker sound changed during its first decade of use. I argue that stereo's newfound value as a decibel enhancement technology was shaped by the economic needs of the film industry. I begin this chapter by chronicling the creation of an acoustical standard for motion picture soundtracks. Known today as Academy Mono, the standard curtailed many of the technical issues that reportedly plagued theaters during the 1930s. The standard, however, also placed considerable restrictions on the decibel ranges of sound systems. Following this discussion, I then trace how motion picture engineers responded to the standard by repurposing stereo technology to address the industry's playback limitations. Specifically, I show how stereo became associated with the reproduction of authentic concert volumes, often at the expense of its prior associations with three-dimensional novelties.

A Wider Decibel Range

The importance of volume to motion picture storytelling was largely a continuation of the proportional effects found on the stages of concert halls. The memorable *sforzandos* during an opera's climax, or the uses of silence for dramatic emphasis during melodramas, were all part of a broader sound design tradition in which storytellers held the attention of their audiences through abrupt, surprising shifts between loud and quiet moments.

Such practices were enriched by the arrival of electrical amplification and the installation of loudspeakers in select concert venues. As Stokowski once proclaimed, the innovations were valued because they promised to solve the many acoustical issues that plagued live performances.[203] The conductor specifically argued in a speech to the Acoustical Society of America that these new technologies could be used to address the supposed problem of casting an unattractive singer as the romantic lead in an opera. As he famously, and controversially, described:

> Venus, the most beautiful woman who ever existed should tempt Tannhäuser from the narrow path of virtue. But unfortunately Venus was chosen because she had a marvelous larynx and unfortunately sometimes she weighed too many pounds and unfortunately—but I leave that to your imagination. And so the whole evening, the whole point and meaning of that drama is changed and spoiled because you couldn't imagine anybody (laughter) well—
>
> It is such a pleasure to talk to physicists. They understand everything!
>
> Can we change that lady? She might change herself if she would exercise, if she would eat less spaghetti, but it is really not going to be necessary. Electricity will change the lady.[204]

His solution called for a creative implementation of sound systems, either the use of loudspeakers to boost the voice of a lightweight singer, or the use of hidden equipment to broadcast the virtuosic yet unattractive singer from off-stage while a different singer merely mimes the performance on-stage. Stokowski's proposals, offensive as they may be to

contemporary readers, were significant at the time for the way they encouraged acoustical engineers to reconceive of their professional duties. Electrical amplification need not be about fidelity. Instead, according to showmen like Stokowski, volume was about good storytelling, and at times this meant fabricating audiovisual relationships that undermined the authenticity of the original performance.

Such was especially true for motion pictures, a medium that would soon thrive on the decibel affordances of wide-range sound systems. However, during the earliest years of talking pictures, the industry's leading sound technology suffered from relatively narrow decibel ranges. Microphones, transmission cables, and other equipment all added hisses and hums to a recorded signal. Quiet recordings were muffled by this noise, while louder recordings were marred by an equally unpleasant phenomenon known as signal distortion. The decibel range for clearly recorded sounds that fell between this distortion ceiling and noise floor was known as the signal-to-noise ratio, and for early talking pictures this range was quite small.[205] The limitation made it difficult for studios to record and reproduce many sounds at a comfortable volume. More, the ratio varied according to a sound's pitch. Whereas spoken dialogue was generally easy to record within this limited decibel range, low frequencies like thunder and high frequencies like a soprano's aria were often too noisy or too distorted to be reproduced both clearly and audibly. Early sound technology thus restricted editors and mixers to a narrow range of options when designing a motion picture soundtrack.

Frequency Characteristics

Engineers took several measures that addressed these shortcomings. They began by codifying a visual language for discussing the quality of each sound technology. The acoustical

ranges for microphones, loudspeakers, and other equipment were translated into line graphs that were intended to quickly communicate the device's strengths and weaknesses. The x-axis plotted its frequency range (measured in cycles-per-second), while the y-axis plotted the signal-to-noise ratio of each frequency (measured in decibels). These visualizations were known as frequency responses or frequency characteristics, and they often exhibited a mountain-like shape.[206] The downward slopes on the left and right sides of the graph represented the decrease in decibel range for the sound system's low and high frequencies. The flattened section in the center of the graph represented the constant decibel range for the mid frequencies. Known as a flat response, this middle section was considered a sound system's sweet spot. The wider the flat response, and the higher its decibel range, the more options studios felt they had when producing their talking pictures.

Studios and manufacturers subsequently innovated a number of recording technologies designed to widen each sound system's flat response. Among these innovations were directional microphones, which reduced the audibility of on-set echo; two-track "push-pull" noise cancellation, which silenced mechanical hiss; and ultraviolet light exposure, which minimized high-frequency distortion by sharpening each soundtrack's photographic image.[207] The new equipment collectively widened the industry's signal-to-noise ratios, and in turn increased the number of sounds that could be added to the final soundtrack. The new technologies also led filmmakers to redefine what constituted a proper sound design. As Lea Jacobs argues, with the adoption of noise removal processes during the 1930s, "the final release track came to be considered a multi-layered assemblage in which any given sound was precisely placed, and its volume controlled both in relation to the image and in relation to a complex array of other sound elements."[208] In other words, films were no longer confined to a narrow range of options. The

expansion of cinema's flat characteristics encouraged studios to explore new types of acoustical effects that could punctuate dramatic action with considerable power.

Examples of these effects can be heard throughout MGM's *The Great Ziegfeld*, one of the first films recorded entirely onto push-pull tracks.[209] The picture features abrupt shifts in volume that heighten Ziegfeld's many ostentatious stage performances. For instance, "A Pretty Girl is Like a Melody" boasts musical orchestrations that extend across the entire recordable frequency range. The lower noise levels and wider decibel ranges also allowed select moments to become extremely quiet, such as when Audrey Dane angrily confronts the titular producer. Following Audrey's emotional speech, she throws Ziegfeld's glass elephant to the ground and storms out of his room. The crash brings the scene's rapid line delivery to a halt and is followed by over ten seconds of silence. The sudden loss of sound punctuates the sequence and highlights the stark distinction between Ziegfeld's private life and his louder and lavish public persona.

Similar sound designs can also be heard throughout *Naughty Marietta*, one of the first films recorded with directional microphones.[210] During the final measures of the comedic "Italian Street Song," for example, there is a considerable amount of acoustical clarity as Jeanette MacDonald's Marietta holds a double-high C for more than eight seconds. In adherence to the genre's conventions, Marietta's confidence when cruising the high C's—as was often described—establishes her dominance over Captain Warrington, and conveys her comparable talents as a lover.[211] The scene's sound design thus amplifies story information that serves to motivate Warrington's subsequent pursuit of the talented songbird. As one of several operettas released throughout the decade, *Naughty Marietta* was not the only film to deploy these types of acoustical accents. The use of wide-range recording equipment merely made these effects easier for MGM to implement. As a result, by the mid-1930s an increasing number of studios were

widening their recording characteristics in order to enhance the fidelity and expressiveness of their soundtracks.

New Theater Horns

These changes to the industry's acoustical practices were not limited to sound stages and dubbing rooms. The new recording equipment also required exhibitors to upgrade their loudspeakers in order to play distortion-free soundtracks. To help meet these demands, exhibitors turned to two prominent manufacturers. One was ERPI, the motion picture office of Bell Telephone Laboratories, American Telegraph & Telephone (AT&T), and Western Electric (collectively known as the Bell System or the Telephone Group). The other was RCA Photophone, a division of the Radio Corporation of America, Westinghouse, and General Electric (collectively known as the Radio Group).[212] During the early 1930s, both ERPI and RCA Photophone established themselves as leaders in high-quality sound technology, and in turn they were able to exert considerable control over the marketplace for theater systems.

Such success was not accidental. As historian Steve Wurtzler argues, the Bell System and RCA together operated as an economic alliance that limited competition and consolidated power within the growing field of telecommunication.[213] During the 1920s, the two conglomerates created several patent pools that allowed their respective engineers to innovate new equipment without legal repercussions. Through its high licensing fees for transducers, amplifiers, and various other technologies, the patent pools simultaneously created barriers to entry for independent manufacturers who wished to sell their own acoustical products to the telephone and radio industries. This alliance continued into the 1930s as the Telephone and Radio Groups began developing sound equipment for cinemas. Although the two corporate entities were now in

direct competition with each other, their arrangement nonetheless worked to prevent other companies—such as International Projector or Vocafilm—from servicing a substantial share of the market.[214] In turn, ERPI and RCA Photophone became Hollywood's preferred manufacturers of talking picture technology.

And as reputable companies, the two manufacturers developed sound reproduction equipment that complemented the industry's ongoing adoption of new recording devices. In 1932, ERPI and RCA unveiled twin loudspeaker systems that markedly expanded the flat characteristics of cinemas. ERPI branded their system "Wide Range" and RCA called theirs "High Fidelity," but both were arguably based off the same electrical patents.[215] In each system, the playback range was split in half and directed to two sets of horns: "tweeters" for the high frequencies and "woofers" for the low frequencies. This two-way bandpass design allowed projectionists to control highs and lows independently. High-frequency hiss, for instance, could be minimized without quieting an orchestra's bass section, and low-frequency hum could be silenced at select moments without sacrificing the fidelity of operatic vocals. Such affordances proved attractive to exhibitors, who purchased the new loudspeakers in droves. By 1934, *Variety* reported that every major first-run theater had installed either Wide Range or High Fidelity systems, and that ERPI and RCA were aggressively marketing their equipment to independent venues.[216]

Over the next several months, the two manufacturers regularly issued small improvements to their systems, often in concert with upgrades to their respective recording processes.[217] These improvements, however, were soon overshadowed by the Shearer Two-Way Horn System, introduced by MGM in 1935.[218] In the wake of the studio's many advances in noise reduction, MGM sound director Douglas Shearer hired engineer John Hilliard to design a

loudspeaker that could flaunt MGM's wider playback ranges.[219] Of concern to Shearer was how poorly ERPI's and RCA's sound systems reproduced the vocal performances of mezzo-sopranos like Jeanette MacDonald. The sound waves for these performances, being high frequencies, travelled in a straight line; they did not spread throughout the auditorium like low frequencies did. As a result, filmgoers sitting on the sides of the theater—and to the sides of the loudspeakers—heard these vocal performances at lower volumes.[220] The common solution was to boost the high frequencies during post-production, but doing so distorted the playback signal (and risked deafening those seated in the center of the theater).

Hilliard's solution, in contrast, was to appropriate the special high-frequency horn that Bell Laboratories developed for Harvey Fletcher's famed "Auditory Perspective" concerts in 1933.[221] Unlike standard tweeters, Bell's multicellular horn consisted of a cluster of small openings pointed in multiple directions to form an arc-shaped face. This design allowed high-frequency sounds to emanate at louder volumes to the sides of theaters, thus eliminating the need to reproduce singers at unpleasant levels. Hillard's use of this arc-shaped design enabled MGM's sound systems to offer flat responses between 50 and 8,000 cycles, a span of roughly seven octaves.[222] The loudspeakers therefore reproduced motion pictures at an impressively wide range that promised to be an entirely new experience for filmgoers. MGM installed the first Shearer Two-Way Horns in select venues for the premiere of *The Great Ziegfeld*. The studio then wired them into hundreds of Loew's theaters for the release of *Romeo and Juliet*—which coincidentally starred Norma Shearer, Douglas's sister.[223] By the end of 1936 both RCA and ERPI had incorporated arc-shaped multicellular horns into the designs of their own systems.[224] To further alert audiences of these acoustical changes, ERPI even rebranded their entire recording and reproduction process Mirrophonic Sound.[225] According to *Variety*, every major

theatrical circuit was expected to have installed some variant of the Shearer Horn systems by the first three months of 1937.[226]

Playback Standards

Although the new loudspeakers greatly improved the playback characteristics of Hollywood soundtracks, not every exhibitor was willing to pay for the upgrade. As *Motion Picture Herald* reported in September 1936, "Some of the amplifiers still in use in theatres date back to 1928 and the days of the wax record."[227] Indeed, a film like *The Great Ziegfeld* might have sounded perfect in one of Loew's downtown palaces, but in smaller neighborhood cinemas *Ziegfeld* might have sounded not-so-great. Consequently, systems like the Shearer Two-Way Horn and ERPI's Mirrophonic Sound did not simply widen frequency characteristics in flagship theaters; the new systems also exaggerated the acoustical differences between the largest and smallest venues. These differences presented engineers with a dilemma: either studios could mix their films for the characteristics of their flagships, or they could mix their films for the characteristics of smaller screens. Either way, a great number of audiences would hear either distorted or low-quality soundtracks.

SMPE Test Films

This lack of uniformity was difficult for technicians to ignore. As early as 1932, the SMPE formed a special Sound Committee to investigate playback acoustics across the nation's theaters.[228] Its goal was to establish a set of standards that could guarantee that a single film print would be of equally high quality no matter the venue. But arriving at standards proved to be easier said than done. For one, the extensive variation among theaters made it hard for engineers

to agree to a single characteristic. More so, a theater's flat response was not determined solely by the sound system but by the architectural make-up of the auditorium. The height of the ceilings, the physical material on the floors and walls, and the number of people in the audience could change reverberation times, resonant frequencies, and thus the acoustical characteristics of the film's soundtrack.[229] A single playback standard was thus not only difficult to agree upon, but seemingly impossible to measure and implement.

The SMPE pressed ahead regardless. In 1933 its Sound Committee determined the first step in standardization was to eliminate the variation in each studio's dubbing rooms.[230] Accordingly, if studios mixed their films in rooms with comparable acoustical conditions, then release prints would feature uniform characteristics and engineers could begin to measure the differences between theater systems. The Committee thus began to distribute test reels to every studio.[231] The reels consisted of a series of tones—between 30 and 10,000 cycles—as well as a set of instructions for setting the appropriate decibel levels for each tone.[232] By following the instructions that came with each film, studio technicians could recalibrate their dubbing rooms to SMPE specifications. The test film, in turn, became a yardstick that measured variations among the studios and that enabled engineers to correct for such variations.

At least that was the plan, but as the Committee's many published reports document, the test films proved difficult to administer. Studios disagreed as to the proper decibel levels of each test print, and they complained that the levels of each print changed after repeated use.[233] In short, the characteristics for the test films were not clearly set, and their measurements were not properly implemented. The SMPE responded to this news with palpable frustration.

> It was hoped that it would be possible to present copies of these curves at this time, but a study of the results seems to arouse considerable doubt as to whether certain studios followed precisely the procedure laid down by the Sound Committee in obtaining the data.[234]

As the engineers concluded, the difficulty in creating an acoustical standard was not with using the test film as a yardstick *per se*, but with relying on studios to follow directions.

The SMPE was not incorrect in its assessment. Each studio branded itself as offering high-quality acoustics, and every sound department developed unique methods for mixing high-frequency effects. Instead of releasing films with a flat response, studios often boosted these effects to compensate for their attenuation in theaters.[235] Such boosting, known as "pre-emphasis", accentuated musical overtones and enhanced a soundtrack's overall fidelity. But studios treated pre-emphasis like a secret recipe. The better the recipe, the more successfully each studio could market their films as the highest quality titles in Hollywood. If studios were to have complied with the Committee's call for standardization, they would have put an end to this practice. As a result, studios seemed reluctant to fully cooperate. The SMPE's attempts to regulate acoustics thus lacked the necessary support from industry leaders. Absent any major disruption to studio mixing practices, future efforts to standardize playback were likely to fail as well.

Two Prints for Naughty Marietta

In lieu of adopting a standard characteristic, several studios developed their own temporary fixes to the problem of theatrical variation. Films that featured extensive high-frequency vocals would no longer receive a one-size-fits-all sound mix. Instead, operettas like *Naughty Marietta*, RKO's *I Dream Too Much* and Columbia's *Love Me Forever* were distributed via two different types of prints.[236] Class A prints were optimized to play through wide-range loudspeakers. Sound departments mixed these prints with a flat characteristic and with minimal pre-emphasis in the upper frequencies. Class B prints, in contrast, were designed to play through

older loudspeakers. These systems were capable of handling only a few watts of power, which caused upper frequencies to play at significantly lower volumes. To counteract this electrical limitation, sound departments added extra pre-emphasis to the high frequencies when mixing Class B prints, thereby neutralizing the narrow playback range of older loudspeakers.[237] In theory, two sets of prints allowed a film to feature a similar acoustical design no matter the sound system.

Naughty Marietta was arguably the more significant of these dual-print releases. Its box office success indicated to producers that such a distribution strategy could address acoustical variations without the need for a playback standard. The operetta's dual-print distribution, however, was far from ideal. The extra pre-emphasis to Class B prints introduced varying amounts of electrical distortion into the playback signal.[238] Because these prints were designed to play through sound systems that already introduced hiss, hum, and crackle into the theater, such distortion may not have been noticeable to all filmgoers. Nonetheless, it was noticeable to exhibitors.

Moreover, Class B prints were not just being sent to the industry's smaller theaters. As was later revealed, film exchanges were also processing and sending these prints to several theaters wired for wide-range loudspeakers.[239] Many higher quality sound systems that were developed by independent manufacturers were therefore being forced to play prints with audible distortion. Such distribution mishaps do not appear to have been accidental either. As I detail below, evidence indicates that they were deliberate measures undertaken at the direction of ERPI in order for the company to retain its status as Hollywood's foremost supplier of sound technology.

At the time of *Naughty Marietta*'s release in 1935, ERPI was facing several set-backs that threatened its long-term viability. Its parent company, AT&T, was under investigation by the Federal Communication Commission (FCC), an arm of the federal government created through the Communications Act of 1934.[240] Part of the FCC's investigation concerned the legality of ERPI's contracts and dealings with Hollywood studios and theaters. That the FCC might recommend prosecuting the Telephone Group in the foreseeable future incentivized theater owners to conduct business with other companies, namely those that were not at risk of forfeiting long-term servicing agreements in the wake of an adverse government ruling.

Indeed, by the mid-1930s ERPI was no longer the premiere provider of theater technology. As Donald Crafton notes, many exhibitors were foregoing ERPI equipment in favor of loudspeaker systems that were easier and cheaper to install.[241] Moreover, these systems often were sold to theaters directly for a one-time fee. In contrast, ERPI required exhibitors to sign binding licensing agreements which gave the company full control over the maintenance of its equipment, and which enabled the company to collect money from theaters long after their sound systems were purchased.[242] There was thus an opportunity for competing manufacturers to make inroads among exhibitors who looked to avoid the costs and contractual obligations associated with ERPI's sound systems. As a result, ERPI's share of the theatrical market slowly declined.

In addition to these financial problems, ERPI was facing increasingly negative publicity in the trade press. The company was in the midst of a multi-year legal battle against General Talking Pictures (GTP), wherein GTP alleged that ERPI collected fees for services never provided, that it bound theaters to only license ERPI equipment by means of strict and illegal contracts, and that it conspired to violate the Sherman Anti-Trust and Clayton Anti-Monopoly acts.[243] ERPI responded to GTP's accusations by filing a counter-lawsuit alleging that GTP

sound systems were using the Telephone Group's proprietary amplifier technology without a necessary license from ERPI.[244] Neither side was willing to settle, arguably to the detriment of ERPI President John Otterson. The drawn-out legal battle publicized the many ways that his company regularly coerced studios to engage in discrimination against other manufacturers—revelations which led to Otterson's resignation in 1935.[245]

The accusations against ERPI also corroborated what many in the industry had long suspected about the Telephone Group's operations in Hollywood. For instance, GTP's Max Schlesinger testified that Paramount Chief Adolph Zukor had been afraid to install GTP sound systems in its theaters for fear of battling ERPI in court over whether or not GTP technology violated the quality standard that Paramount agreed to in its contract with ERPI. According to Schlesinger, Zukor specifically felt that his studio "would be ruined in the event of an adverse ruling on any arbitration proceedings and that he was thus unwilling to take the chance."[246] Henry Behr of Paramount-Publix similarly testified that in 1929 Paramount's lawyers recommended its theaters uninstall over eight-hundred screens worth of non-ERPI equipment to avoid legal battles, while further testimony alleged that Otterson pressured Zukor not to hire Vocafilm president David Hochreich as Paramount's director of sound because this would have given a competitor considerable influence over the studio's decisions.[247] Despite ERPI's successful beginnings in Hollywood, these widely publicized testimonies further eroded the company's reputation a reliable and trustworthy name in talking picture technology.

According to additional testimony, ERPI's solution to this crisis was to employ questionable business tactics that sacrificed the quality of several Hollywood soundtracks. These tactics involved the strategic *mis*-distribution of Class A and Class B prints. As Vocafilm's Hochreich testified, and as other projectionists and independent theater owners corroborated,

ERPI was purposefully sending Class B prints of *Naughty Marietta* to theaters with non-ERPI sound systems, even though many of these systems had wide-range capabilities.[248] The wrong prints forced non-ERPI theaters to play the operetta with a great deal of distortion, thereby falsely suggesting that their sound systems were inferior to ERPI's. Exhibitors were subsequently required to replace their loudspeakers and amplifiers with ERPI-approved technology if they wished to receive Class A prints.[249]

This type of mis-distribution was possible as a result of the licensing agreements that MGM and other studios signed with ERPI.[250] Each contract granted ERPI the power to oversee the implementation of its proprietary recording equipment and, in turn, the encoding of soundtracks onto release prints. ERPI had the ability to dictate how each print was classified once it was encoded, and how each print was then categorized, or mis-categorized, when sent to regional exchanges. Thus, by overseeing the distribution of Class A and Class B prints, and by directing low-quality soundtracks to larger theaters with off-brand loudspeakers, ERPI could extort a number of these independent exhibitors into replacing their systems with ERPI-approved equipment. In so doing, ERPI could re-establish itself as Hollywood's foremost supplier of theater sound technology.

Few questioned ERPI's guilt. Even Judge John P. Nields—who presided over the lawsuit's appeal to the U.S. District Court in Wilmington, Delaware—found the accusations against ERPI convincing. After Hochreich testified to ERPI's strong-arm tactics, Nields agreed to project a Class B print of *Naughty Marietta* in his courtroom to serve as evidence of the plaintiff's allegations. (One can only imagine what any film might sound like when screened within the concrete walls of a federal court house, but such considerations did not seem to matter to the judge.) Following the screening, Nields reportedly remarked that he had seen the film at

his local Loew's, and that he too felt that "it had sounded better in the theatre."[251] But Judge Nields did not rule against ERPI. He instead argued that the difficult process of adding sound to motion pictures was inherently expensive, and it was reasonable for companies like ERPI to take extensive measures when both protecting their investments and maintaining the quality of their products, even measures that might prevent smaller manufacturers from competing for a share of the exhibition market.[252] That Hollywood's current efforts to create talking pictures succeeded where prior efforts failed was further evidence of just how necessary it was for ERPI to exercise extraordinary control over theatrical practices. In the eyes of Judge Nields, ERPI's tactics were justified.

The final appeal to the United States Supreme Court was similarly disheartening to the plaintiffs. In the majority opinion for *General Talking Pictures Corp. v. Western Electric Co.* (1938), Justice Louis Brandeis validated ERPI's countersuit against GTP.[253] According to Brandeis, GTP had no right to sell AT&T amplifiers to theaters, and the court therefore had "no occasion to consider what the rights of the parties would have been if the amplifier had been manufactured 'under the patent' and 'had passed into the hands of a purchaser in the ordinary channels of trade.'"[254] In other words, because GTP was using AT&T equipment without a proper license from the Telephone Group, the court would not litigate the legality of ERPI's tactics or if they infringed upon GTP's rights as a company. Brandeis's decision was a blow to the many manufacturers who wished to weaken ERPI's control over the industry.

Academy Mono

The Supreme Court's ruling, however, proved irrelevant to how studios reacted to the allegations against ERPI. The testimonies presented throughout the 1930s detailed ERPI's

willingness to sacrifice soundtrack fidelity in order to boost company profits. Though these testimonies were never fully verified, the allegations exposed a weakness that undermined the studios' institutional authority: If ERPI could override studio policy and encode low-range prints for theaters with high-range sound systems, then ERPI had more control over soundtrack quality than studios had. In effect, ERPI's tactics became the major disruption to acoustical practices that would reinvigorate calls for an industrywide playback standard. And unlike before, studios were now willing to cooperate.

In 1936, shortly after the exhibitor's testimonies were publicized in the trade press, the studio's Academy Research Council formed a Theatre Standardization Committee to investigate playback acoustics.[255] Chaired by John Hilliard, the Committee's work would ultimately curtail ERPI's power—both electrical and political. As its first major action, in March 1937 the Committee introduced the "Standard Electrical Characteristic," also known as Academy Mono.[256] [*figure 2*] The standard narrowed the frequency range of release prints with monaural (one-track) sound. It similarly narrowed the flat response of all sound systems—including ERPI's Mirrophonic sound system—that were modelled off Hilliard's initial Shearer Horn design.[257] When these measures took effect, each system's flat response decreased by fifty percent, from roughly seven octaves (between fifty to eight-thousand cycles) to three octaves (between two-hundred and fifteen-hundred cycles). The overhaul thus eliminated many of ERPI's acoustical advantages, and in turn, its market advantages over competing manufacturers.

The "Standard Electrical Characteristic" moniker arguably sounded innocuous, as did the technical vocabulary that described its use on two-way reproducing systems with multicellular horns. And it was the technical and confusing nature of these terms that hid the standard's economic consequences from many within the industry. The few trade articles that covered the

regulation suggested that it was merely a minor adjustment to a sound system's electrical filters.[258] *Variety*'s coverage went so far as to adopt the Research Council's rhetoric, which counterintuitively claimed that narrow playback ranges would improve soundtrack quality.[259] Most people in Hollywood would not have understood what a frequency characteristic was, let alone why an industrywide standard mattered. As a result, there was neither a sustained critique of the Academy's claims, nor much concern among filmmakers about the standard's impact on motion pictures.

Exhibitors, however, were conceivably less blasé about the new playback restrictions. Indeed, a number of theater managers had just recently been pushed, if not coerced by ERPI, to install wide-range loudspeakers. And these managers were now being forced to dramatically lower the aesthetic and financial value of their investments. In anticipation of pushback from theater owners, the Research Council commenced a campaign to encourage exhibitors to implement Academy Mono quickly and without objections. For instance, the Council announced that by the end of the year a handful of prestige titles—including Columbia's *Lost Horizon* (1937) and Paramount's *Swing High, Swing Low* (1937)—would be released in Academy Mono, and would therefore sound distorted if played through a seven-octave sound system.[260] The Council also distributed a new set of test reels to help ensure that each theater's conversion to the new playback characteristic was as painless as possible.[261]

Further, the Research Council worked to educate exhibitors about the long-term importance of theatrical uniformity. Hilliard publicly argued on behalf of studios that Academy Mono was just one piece of a larger effort to improve relations within the industry:

> We also realize that we in Hollywood are not without fault, so we have asked at the same time for criticisms from the field on current studio recording. To mix metaphors for a moment, we are not throwing rocks at glass reproducing systems, and we are attempting to clean up our own back yard at the same time.[262]

Hilliard's statement was ostensibly an admission that studios shared the blame for allowing ERPI's controversial recording and distribution tactics to occur in their "own back yard." Moreover, it helped to position the new playback standard as a means to "clean up" what had been, for many exhibitors, a toxic working environment. In effect, Hilliard was tasked with ending the era of malfeasance that he himself inaugurated, albeit inadvertently, when he developed the Shearer Horn for MGM. His message thus became a signal to theater owners that such malfeasance was no longer tolerated in Hollywood, for with Academy Mono in place, ERPI's tactics were technically no longer possible.

The Academy's electrical regulation was yet another blow to ERPI's wellbeing as the foremost supplier of Hollywood's theater technology. Its sound systems no longer held an acoustical advantage over those of its competitors, and it was increasingly unlikely that ERPI would ever retake its initial share of the theatrical market. Given the company's weakened state, it was impractical for AT&T to continue to support the full operational costs of its Hollywood division and still expect a substantial return on their investment. Thus, after a series of legal, technical, and financial setbacks, ERPI downsized its offices.

The restructuring began in 1938, shortly after the FCC published the results of its multi-year investigation into the telecommunications industry.[263] The Commission singled out the Bell System's dealings in Hollywood, namely how ERPI "plotted to dominate every branch of the picture business, and perfected a monopoly of the sound field."[264] In order to avoid prosecution, AT&T agreed to dramatically reduce ERPI's responsibilities. The company's manufacturing duties were transferred to two former ERPI competitors: Motiograph and International Projector.[265] Similarly, ERPI's servicing arm was sold to a new company known as All-Technical, or Altec for short.[266] ERPI, in turn, became little more than a license holder for the

Bell System's technologies. And it would remain as such until the Western Electric Exports Corporation, nicknamed Westrex, replaced ERPI as the motion picture arm of the Telephone Group in 1949.[267]

In contrast, Academy Mono remained the industry's soundtrack and loudspeaker characteristic for decades. During this time, the Research Council continued to impose its playback restrictions on every new sound system in order to make sure that each innovation complied with the Academy's directives. The Council, for instance, updated the standard in 1938 with specifications for both Motiograph and International Projector's Simplex systems following the release of their AT&T-licensed amplifiers.[268] The Council similarly revised the standard's specifications one final time in 1948 following the release of Altec's "Voice of the Theater" loudspeakers.[269] As long as Academy Mono remained in place, no other company exerted the same control over theaters that ERPI exerted during the 1930s. By these measures, the standard was a success.

New Stereo Systems

This enforcement of the playback regulations created a new problem for many within the industry. Producers wanted their films to feature the extended frequencies and decibel contrasts illustrated by *The Great Ziegfeld* and *Naughty Marietta*, yet the new acoustical restrictions made such contrasts difficult to achieve. It thus remains unclear whether and why studios also followed these guidelines. After all, the Academy was managed by studio heads. If they wished to continue releasing wide-range prints, then arguably there would have been no one to stop them. Nonetheless, evidence suggests that studios did follow their own guidelines, at least to a certain extent, for doing so reinforced the notion that these regulations were necessary. But rather than

allow the standard to constrain the creative freedoms of filmmakers, the industry's engineers found innovative ways to enhance motion picture acoustics without violating the Research Council's directives.

Among the more successful innovations was the implementation of stereophonic sound. The idea was simple: Academy Mono regulated the playback range of a theater's loudspeaker channel, which thereby restricted the acoustical characteristic for a release print's optical soundtrack. However, the standard did not govern the number of soundtracks and the number of loudspeakers that any one film could use when it played in theaters. Thus, if filmmakers wished to widen the decibel range of their pictures, they could mix their films for multiple playback channels. And with multiple Academy tracks designed to play simultaneously through an array of loudspeakers, acoustical engineers could boost the volumes of select frequencies and select scenes in order to bypass the industry's restrictions for individual loudspeakers. In other words, Academy Mono created an acoustical obstacle and stereophonic technology presented engineers with the ability to circumvent it.

Indeed, shortly following the initial announcement of the Research Council's "Standard Electrical Characteristic" in the Spring of 1937, a number of new multi-speaker technologies were designed and unveiled throughout the motion picture industry in order to aid in the ongoing pursuit of higher quality soundtracks. One such system, officially patented the following November by George Beers, allowed for two separate microphone signals to be transmitted to two loudspeakers—left and right—by way of a single channel.[270] Though the separate signals would ultimately be combined during transmission, a control-tone circuit would record the decibel levels of the initial microphone signals, and would reproduce these levels when the combined channels played through the left and right loudspeakers. The difference in signal

intensity between the two loudspeakers was thus intended to simulate what Beers called a "stereosonic" effect. And that December, John Israel of RCA developed a similar system in which two separate loudspeaker channels could be manipulated in order to create and enhance a three-dimensional stereo effect during playback.[271] Yet rather than adjusting decibel levels, Israel's system would adjust the phasing of the two signals. His experiments showed that if two identical sounds were played simultaneously through two loudspeakers, with the first loudspeaker time-delayed by several milliseconds, the resultant sounds would together produce a stereophonic image in front of the loudspeakers.

Additionally, a similar but less-complicated stereophonic sound systems was developed by William Offenhauser, Jr, formerly one of the engineers behind RCA's original Photophone technology.[272] Like Edward Amet's earlier sound localization equipment, Offenhauser's device fed a single track of sound to a special mixing console that enabled a technician to manually send that signal to any one of two or more loudspeakers behind the screen, if not also on the sides of the theater. This, Offenhauser argued, created a binaural effect. With the help of John Israel, who served as the system's live mixing technician, Offenhauser presented his binaural technology to the Society of Motion Picture Engineers in 1938. The response was positive—perhaps due to the industry's good will toward one of the inventors of Photophone—but much like Beers and Israel, Offenhauser had no luck selling it to studios and theaters. The failure of these engineers to find investors in their equipment had little to do with the quality of their inventions. Instead, each of these engineers chose not to promote their systems specifically as a solution to the narrow-range restrictions that the Academy imposed on motion pictures. As a result, their systems never progressed technologically beyond their initial prototypes.

Joseph Maxfield and Two-Track Stereo

The clearest example of this promotional failure was the two-track sound system that ERPI unveiled to the motion picture industry during the Fall of 1937, shortly before the company was forced to downsize its offices.[273] The format's inventor, Joseph Maxfield, was highly regarded within Hollywood's audio engineering community at the time. Along with Henry Harrison, he developed the highly successful sound-on-disk recording system at Bell Laboratories that Warners would license for such Vitaphone releases as *Don Juan* and *The Jazz Singer* (1927).[274] Several years later, Maxfield went on to innovate an even more advanced sound system, one involving multiple microphone channels fed to multiple loudspeaker channels.[275] He and ERPI would brand their system Stereophonic, the first multi-speaker system for motion pictures to be given this name.[276]

Much like Alan Blumlein in England, Maxfield was one of the strongest proponents of perspectival recording techniques following the industry's adoption of sound reproduction technologies during the early 1930s. Of considerable concern to Maxfield was the problem of audiovisual correspondence, particularly with respect to depth. As early as 1931, he was arguing that like a moving image, a sound track can and should cue filmgoers to the distance between an actor and a microphone.[277] Specifically, this distance can be thought of as the ratio between the signal, what Maxfield called "intensity of the direct sound," to the audible decay from that signal, what he simply called "reverberation."[278] The greater the intensity of the direct sound, and the lesser the reverberation of that sound, the closer the sound will appear to the filmgoer.

It was therefore important to Maxfield that the representation of depth in the sound track correspond with the representation of depth in the image. Microphones should be positioned so that their distance from the actors is equal to their distance from the camera. Similarly, recording

mixers should refrain from boosting signals that are deliberately recorded at longer distances, and reproduced at lower volumes. Mixers should instead allow these low-decibel sounds to remain quiet, perhaps even at the expense of clarity. As Maxfield argued, "One of the most important requirements for obtaining the illusion of reality is that the sound shall appear to come from the visible source on the screen," and to properly achieve this illusion both the image and the sound track must present complementary perceptual cues with respect to an object's or actor's distance from the screen.[279] Maxfield's stereophonic sound system was ultimately an extension of this philosophy, for it enabled audiences to perceive sounds as either close or distant, as well as either leftwards and rightwards.

To simplify the design of his multi-channel technology, Maxfield chose to re-appropriate the two-track prints that were initially developed for variable-density push-pull recordings.[280] Maxfield specifically adjusted the two tracks so that they were no longer 180-degree inversions of the same signal, but completely separate signals recorded by two different microphones: one for the left side of the staged action, the other for the right side. The two tracks would then remain separate as they were sent to loudspeakers behind the left and right sides of the screen. A sound intended to match an image in frame-left would therefore be recorded at a louder volume by the left microphone, then stored at a louder intensity on the left track, and sent to the left loudspeaker. Similarly, a sound intended for frame-center would be recorded at equal volumes by both microphones, and sent to both loudspeakers at equal intensities.[281] This channel arrangement thereby heightened Maxfield's "illusion of reality" through its correspondence of lateral cues between the image and sound.

Despite its new stereophonic namesake, this two-track format was similar to the binaural sound system developed by Blumlein several years prior. Both technologies transmitted two

audio channels to two separate loudspeakers, and both stored these channels as two narrow tracks printed side-by-side to the left of the 35mm picture. The one key difference was that Maxfield's transmission process was far simpler. Whereas Blumlein used a complicated sum and difference channel configuration to allow for the perception of lateral distance to vary according to the intensity of each channel, Maxfield's system used a left-right configuration not unlike a standard binaural headset. The potential downside of storing channels as left and right, instead of sum and difference, is that larger theaters would need to move the two loudspeakers further apart, perhaps to the wings of the theater, in order for those sitting in the very back to experience the stereophonic effect. Maxfield noted to the Society of Motion Picture Engineers that he never tested the system "in a big enough auditorium to lose the effect," and that therefore this problem was ostensibly inconsequential.[282]

Instead of worrying about the size of the theater, Maxfield focused his attention to selling his technology to as many theaters as possible. He designed his prints so that his system was easily adaptable to pre-existing theatrical equipment. For one, the system was backwards compatible. Both tracks of sound occupied the space typically reserved for a standard optical track, and theaters without special two-track sound heads could still read both the left and right channels and send them to a single loudspeaker behind the screen. His system therefore would not require studios to maintain a dual inventory of single-track and two-track release prints. The two-track prints could potentially play in any theater, regardless of its sound head.

Such theatrical concerns, however, were arguably less of a problem that Maxfied initially imagined. Upwards of 300 theaters had already installed two-track sound heads by the time that Maxfield unveiled his format.[283] Following the industry's adoption of push-pull noise reduction, several studios began distributing theatrical prints with push-pull tracks in place of a single track

of sound. For instance, MGM released acoustically ornate titles like *The Great Ziegfeld* onto special push-pull prints that were designed to play in theaters wired with the Shearer Horn System.[284] Goldwyn similarly distributed push-pull prints for *The Hurricane* and *The Goldwyn Follies* (1938).[285] To read these tracks, theaters needed to install a special two-track sound head that could reinvert the pull track so that it played in proper phase with the push track. With only slight modifications necessary, Maxfield's stereo system was compatible with theaters that installed these two-track sound heads. In other words, the earlier ambitions of studio sound departments made his system easily adaptable for immediate use within the industry.

Maxfield premiered his invention to the Society of Motion Picture Engineers in October of 1937, roughly seven months after the Academy Research Council announced its new electrical standard.[286] The demonstration began with a presentation about the benefits of stereophony, after which Maxfield projected a series of films recorded and reproduced in two-track stereo.[287] One reel was of a short orchestral performance of selections from Wagner's *Lohingrin*.[288] The horizontal directionality of the strings and brass were reportedly so salient that one member of the audience even heard a sound's verticality, claiming that "the clashing of the cymbals was particularly noticeable as apparently arising from the upper left-hand corner of the screen, where the image of the performer playing them was located."[289] Another reel was of two men playing ping-pong, where the bouncing of the ball between the left and right sides of the frame would similarly bounce between the corresponding loudspeakers. The most notable reel consisted of actors comically trying to negotiate their way around furniture in a darkened room. The crashes from their many collisions with the furniture were localized to the left and right portions of the frame, as were the voices of these actors as they spoke to each other. At the end of the scene a third actor turned on the lights, which then allowed the audience to determine if their hypotheses

about the locations of the actors were correct.[290] By incorporating a variety of different types of uses, Maxfield's demonstration was meant to sell not just his system but the potential storytelling value of directional stereo effects.

Maxfield specifically argued that these effects should be added to Hollywood's arsenal of special tricks. He noted, for instance, stereophonic sound could be particularly useful in a film in which a character, such as a ghost, materializes on screen. "The location of the sounds could be noted before the ghost is materialized," Maxfield stated. "We can for the first time call visual attention to positions on the screen by the sound effect alone. The dramatic people can think of many things that could be done with such an effect."[291] Above all other uses, however, Maxfield showcased how stereo could be humorous, much as Blumlein did. Independently of each other, both inventors produced demonstration films that privileged the relationship between directional stereo effects and comedy. Though Maxfield developed his two-track stereo system to further his philosophy of proper audiovisual correspondence in cinema, his invention nonetheless furthered other philosophical questions. Namely, were directional stereo effects innately more humorous than were proportional stereo effects? Judging by the manner in which both Blumlein and Maxfield promoted their systems, there did appear to be a comedic quality innate to the lateral localization of sounds within the audio engineering community during the 1930s.

It was perhaps because of this focus on directional effects that the industry ultimately rejected Maxfield's system. Technologies that replicated our own binaural hearing, no matter how amusing, continued to be of little value to Hollywood. Studio sound departments were far more interested in the way contrasts in volume created dramatic effects. Though stereophonic sound had the ability to provide studios with wider playback characteristics, Maxfield's system did not address this matter. In fact, it made this matter worse. Maxfield specifically found that by

using smaller tracks, his system produced a far narrower playback range. As he admitted, "Personally, I would rather hear two-channel reproduction good to 6000 cps., than one-channel reproduction good to 15,000 cps. It is more pleasing, more realistic, more dramatic. I am not sure that all other engineers will agree with me."[292] Maxfield's gut was correct: very few engineers agreed with him, and few found dramatic value in his sound system. He not only failed to address the limitations of the Academy's frequency characteristic, he made matters worse by introducing even narrower restrictions. Such technical problems discouraged the industry from adopting the system, leading ERPI to shelve the technology for more than a decade.

Fletcher, Four-Track, and the Compandor

Despite the many failed attempts to promote multi-speaker sound systems to Hollywood, studios and critics did not lose interest in stereo as a concept. Instead, they largely directed their attention to inventors with considerably more experience in the field of multi-channel audio. And in the late 1930s, Harvey Fletcher remained the biggest name in that field. The acoustical showman had developed a reputation among industry personnel for his many accomplishments during the early 1930s. The multicellular high-frequency horn that he touted during his "auditory perspective" demonstrations, for instance, now served as a model for all two-way loudspeakers. Additionally, his theories of "auditory perspective" were themselves being turned into practice throughout the industry. It was now common for studios to record their orchestral scores with at least three microphones, much as Fletcher recommended, and many studios were adopting variations of Fletcher's three-track recording techniques to allow for greater control over the balance of the different orchestral sections during the rerecording process.[293] When Fletcher announced that he was working on a new multi-speaker sound system—one that boasted the

"stereophonic" moniker and that directly addressed the narrow frequency characteristics of motion pictures—studio engineers treated it as a major event in cinema sound.[294]

Much like his earlier "auditory perspective" demonstrations, Fletcher's new stereophonic system continued to use a left-center-right channel configuration, which it then stored as three separate optical tracks across a single strip of 35mm film.[295] The one change Fletcher made was the addition of a fourth track that was printed along the same strip of film. This control track was designed to address many of the inadequacies of sound-film acoustics with respect to musical reproduction. As Fletcher found, the frequency ranges of most orchestras were between 40 and 14,000 cycles, while their decibel ranges were generally between 30 and 110 decibels, or a total range of 80 decibels.[296] The acoustical characteristics of cinema was far narrower. The best sound systems offered frequency ranges only 5,000 to 8,000 cycles wide, while their decibel ranges were between 35 and 50 decibels wide, or about half the range of a live concert.[297] In theory, three playback channels could boost the volume of the extremely high and extremely low frequencies, which could allow the system's flat characteristics to widen in order to provide greater fidelity, clarity, as well as the potential for more dramatic contrasts. However, three channels effectively tripled the amount of noise present in the playback signal.

The use of a control track thus allowed Fletcher to address this problem. It automated several noise reduction processes that could enable three channels to play simultaneously without a significant increase in noise.[298] Each channel was given its own unique frequency within the control track, and as the decibel level of the frequency increased and decreased, so too did the volume of the playback channel.[299] As a result, the control track expanded the decibel and frequency ranges of Fletcher's system beyond anything Hollywood had yet to experience. These

expanded ranges made the system seem like the perfect solution to the industry's acoustical restrictions.

At the heart of the control track were two methods of signal compression and noise reduction developed at Bell Laboratories and used in other communication technologies as early as 1932. Their use in cinema, however, had yet to be fully explored. One was a process of frequency equalization initially devised in the 1920s, and first used widely by Halsey Frederick and Henry Harrison to improve the playback quality of disk recordings.[300] Much like the process of pre-emphasis used by studios later in the decade, Frederick and Harrison boosted high-frequency signals and simultaneously decreased low-frequency signals when cutting a record's grooves. During playback, a special equalizer would provide a comparable, but opposite, adjustment of the decibel levels for both the high-frequency and low-frequency signals. This pre- and post-equalization process provided two functions. Low-frequencies necessitated wider grooves, and by lowering the volume of low frequencies, Bell engineers could effectively store more soundtracks onto each side of a record.[301] Further, the small imperfections along the surface of each disk would introduce a great amount of high-frequency hiss into each recording. The act of lowering the decibel levels of high-frequency signals therefore reduced this surface noise to a less noticeable level. Equalization was just as useful to Fletcher's Stereophonic Sound-Film System. Because filmstrips were also prone to comparable surface noise, the application of pre- and post-equalization to the three-channel recordings enabled Fletcher's system to similarly boost a recordings signal-to-noise ratio in the higher frequencies, enabling the entire frequency range to widen to 15,000 cycles without causing a considerable decrease in playback quality.[302]

The second method of signal compression involved the use of companding. Itself a compression of the words compressing and expanding, the process of companding, and the use

of a compandor, functioned much like equalization in that it increased and decreased the volume of select portions of the signal in order to reduce electrical noise. However, instead of dividing the signal into high and low frequencies, it divided the signal by decibel level.[303] Louder sounds could mask noises that quieter sounds could not, thus additional noise reduction was necessary during quieter sections. The compandor worked by compressing the entire decibel range of a recording before its initial transmission. By forcing all sounds to exist within a mid-range of decibel levels, this act of transformation simultaneously raised the volume of very quiet sounds and lowered the volume of very loud sounds. During playback, the compandor then expanded the decibel range of the recording back to its initial levels. Louder sounds would increase in volume, as would their accompanying noise. However, because louder sounds were thought to naturally mask these noises, their increase in volume was not an issue. [304] Of greater concern were the quieter passages. These sounds would decrease in volume during playback, which meant that the noise that accompanies these sounds would also decrease in volume.

The scientific principle behind this companding process originated as early as 1924. Alva Clark, an engineer at AT&T, devised a volume compression and expansion system specifically to lower the noise levels of radio and public address signals that were transmitted across his company's telephone wires.[305] That same year, Clark's colleague George Crisson devised his own compandor system for the transmission of similar audio signals with wider decibel ranges.[306] The first documented use of a sound compandor, however, would not occur until July 1932, when Bell Laboratories applied the technology to reduce noise levels during transmissions along the long-wave radiotelephone circuit that extended from New York to London.[307] This same companding principle proved most important to Fletcher’s stereophonic sound film. It allowed for the 80-decibel range of orchestras to fit inside the 50-decibel transmission channel of a 35mm

filmstrip. The information stored on the system's fourth-track then expanded the signal-to-noise ratio back to and 80-decibel range during playback, and rest roughly 100 decibels above silence for the symphony's loudest sections.[308]

This unprecedented increase in decibel level become both the most impressive and the most notorious aspect of Fletcher's technology, as its April 1940 premiere demonstrates. The event took place at Carnegie Hall over the course of two nights, wherein politicians, artists, aristocrats, concert music aficionados, and audio engineers—including MGM's Douglas Shearer, Goldwyn's Tom Moulton, and Columbia's John Livadary—all filled the darkened auditorium and stared quietly at three loudspeakers for roughly two hours.[309] The concerts included a brief introduction by Bell Labs president Frank B. Jewett, as well as a reproduction of a scene from Eugene O'Neill's *Emperor Jones* that was performed by Paul Robeson and that, like other Fletcher concerts, played without motion picture accompaniment.[310] The bulk of the evenings, however, were spent reproducing performances of the Philadelphia Orchestra and Mormon Tabernacle Choir. Each of these performances were recorded in 1939 under the direction of Stokowski and were further "enhanced" by the maestro in order to create more stereo effects.[311]

Some attendees were in awe of the recordings, with one critic noting that "the sound of high-frequency instruments such as bells or violins was breathtaking in its clarity."[312] Most, however, were horrified by the decibel levels, which was just below the threshold of pain.[313] In an article title "Super-Volume Concert Records Scare Audience," one disappointed concert reviewer reported that the immolation scene from Wagner's *Götterdämmerung* was far louder than any live symphony, while the sudden jolts in volume from the loudspeakers not only made concertgoers recoil in terror as if kicked by a horse, the loudspeakers "all but blew the rear end of the auditorium into Fifty-seventh Street."[314] Composer Serge Rachmaninoff similarly called

the evening "unmusical" as a result of the loud volume levels.[315] In an attempt to showcase the powers of stereophonic technology and the virtues of his compandor, Fletcher—one of the world's experts in human hearing—was ironically accused of nearly deafening an entire auditorium. The evenings at Carnegie Hall were planned to create public demand for stereophonic sound ahead of ERPI's demonstration of the technology to Hollywood later that year. The plan failed.

Despite these mixed reactions from New York, the Hollywood concerts went ahead as scheduled. Later that June, Fletcher demonstrated his four-track system to studio heads and engineers at the Pantages Theatre on Hollywood Boulevard.[316] Several months later they demonstrated the system again to more executives and engineers at the United Artists screening room.[317] The film industry, much like the New York audiences, found flaws in the system's volume controls. *American Cinematographer* praised the system, but also warned that "there may be danger to individuals," and predicted that as a result of the decibel levels, "the proportion of the audience who would be moved to attend a similar concert and face a parallel ordeal" is minimal.[318] If Maxfield's invention was faulted for not providing enough proportional capabilities, Fletcher's invention was seen as providing too much proportion and not enough pleasure. For some, the results were an indictment of Fletcher's broader concept of auditory perspective. Through its attention to three-channel amplification, Fletcher seemed to believe that louder volumes resulted in greater fidelity and more pleasurable sound reproductions. This belief was not unanimously held. It was therefore hard to envision studios investing in a system estimated to cost $30,0000 per screen, particularly if interest in the system was limited only to studio engineers.[319]

Of greater concern to studios, however, was that ERPI was reportedly planning on licensing and manufacturing Fletcher's system despite having undergone substantial restructuring — including the closing of its manufacturing facilities — as a result of the FCC's ruling against its parent company AT&T.[320] It was unclear if ERPI could adequately handle these duties without engaging in the same malfeasance that once plagued the company's earlier business relationships. The Bell System's structural changes might not have completely undermined ERPI's ability to equip and service the industry with a new sound system, but these changes nonetheless gave studios and theaters further reason to refrain from signing contracts with a company that many were still unwilling to trust. Although Hollywood's interest in stereophonic sound was steadily increasing, the technical issues with Fletcher's system, in combination with ERPI's own corporate baggage, ultimately made Fletcher's four-track system undesirable.

Nevertheless, Fletcher's innovations greatly affected the history of sound reproduction. Though it is difficult to imagine that audiences at Carnegie Hall were aware of any three-dimensional auditory illusion taking place, they certainly understood that multiple loudspeakers meant louder music. Thus, Fletcher attempts to recreate authentic concert volumes, and brand such aesthetics as stereophonic, further established stereo's association with decibel range. And in the wake of Academy Mono's adoption, this association gave studios a reason to continue investigating stereo technology in the years that followed. As a result, his system would not suffer the same fate as Maxfield's two-track technology. Instead, Fletcher's theories about proper stereo reproduction would go on to inform the decisions of Hollywood engineering communities as they addressed the Academy's acoustical restrictions and developed their own multi-speaker systems. In other words, Fletcher's decade-long battle to promote his sound systems to

Hollywood may have ended in defeat, but thanks in large part to the use of a volume compandor, his Waterloo was not a whimper; it was a thunderous bang that continued to resound throughout the industry.

Conclusion

Following Hollywood's transition to talking pictures, studio technicians innovated a number of new recording technologies that lowered noise levels and widened the flat characteristic of soundtracks. The implementation of these new technologies triggered comparable innovations in the field of loudspeaker systems. However, not every movie theater was willing to install wide-range sound systems, and in turn there was enormous acoustical variation between the industry's movie palaces and its smaller neighborhood venues. As a result, the Academy established to a playback standard narrowed the electrical characteristic for all wide-range sound systems. This standard created acoustical uniformity among movie theaters, but in doing so it also limited the sound designs of motion picture. In order to address these limitations, engineers like Harvey Fletcher unveiled stereophonic technologies that could widen the decibel range of motion pictures.

Though studios ultimately rejected these specific technologies, the work of Fletcher and his colleagues redefined stereo as more than a three-dimensional novelty; it became a tool that was associated with enhancing the cinema's volume. In the next chapter, I chronicle how studios like Disney, Warners, Fox, and Selznick continued to bolster this association when developing their own stereophonic formats during the 1940s. In so doing, I detail how the concept of stereo that emerged in response to Academy Mono would remain an integral part of the technology's use in motion pictures.

Citations

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[196] "Double Bill Due Tonight," *Los Angeles Times*, August 17, 1936, A12.
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[198] A. R. Soffel, "Sound Reinforcing System for Hollywood Bowl," *Bell Laboratories Record* 15, no. 7 (1937): 225-28.
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[210] Bob Rypinski,"An Afternoon with: John K. Hilliard," *Journal of the Audio Engineering Society* 37, no. 7/8 (1989): 607.
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[213] Steve J. Wurtzler, *Electric Sounds: Technological Change and the Rise of Corporate Mass Media* (New York: Columbia University Press, 2007): 19-69.
[214] Wurtzler, *Electric Sounds*, 46-56; For additional background, see Janet Wasko, *Movies and Money: Financing the American Film Industry* (Norwood, NJ: Ablex Publishing Corporation, 1982): 60-69.
[215] "'Wide Range' vs. 'Fidelity' Sound Starts This Week," *Variety*, November 1, 1932, 14. For examples of patents used to develop these systems, see William H. Martin [AT&T], "Sound Reproducer," US Patent 1,536,116 (Filed: Apr. 1, 1924); John Preston Minton and Abraham S. Ringel [RCA], "Filter System for Loudspeakers" US Patent 2,084160 (Filed: June 9, 1925).
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[284] Theaters that received push-pull prints included the Astor Theatre in New York and the Carthay Circle in Los Angeles. "The Cinema Spoiled Babe," *New York Times*, June 21, 1936, X4; Schutz, 16. Interestingly, the article refers to these push-pull prints as "a forerunner of 'three-dimensional sound', indicating that perhaps ERPI was already marketing Maxfield's two-track sound system as an extension of push-pull reproduction.
[285] "Five Studios Adopt Push-Pull Recording," 16.
[286] "M. P. Engineers' Conv. Unveils 3D Dimensh," *Variety*, Oct 13, 1937, 21.
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[311] M. Q. Jr., "Range of New Sound System Demonstrated," *Motion Picture Herald*, April 13, 1940, 12.
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[316] “Three Sponsoring Sound Recording Demonstration,” *BoxOffice* , June 15, 1940, 24; "Stereophonic Recording Adds Dimension to Tone," *Los Angeles Times*, Jun 21, 1940, 24.
[317] "Demonstration Given," *Los Angeles Times*, Jan 12, 1941, C5.
[318] “Hollywood Hears Stereophonic Reproduction… It Is Good,” *American Cinematographer* (July 1940), 325-26.
[319] "Hollywood Considers 3-Dimensional Sound," *Motion Picture Herald*, June 29, 1940, 18.
[320] "New Sound Race Is On; Millions Are At Stake," *Motion Picture Herald*, April 13, 1940, 12.

Chapter 3: The Pursuit of Viability, 1940-1948

During the liberation of Europe in 1945, Allied forces in Germany stumbled upon a multi-channel recorder that was said to reproduce three simultaneous audio signals, each with an extremely wide frequency characteristic. The device was also claimed to have achieved this characteristic this using only a narrow strip of film. This German-made machine was the Stereophon.[321] According the U. S. Naval Lieutenant H. B. Lee, author of the military intelligence sub-committee's technical report on the discovery, the Stereophon was a three-channel recorder where each signal was encoded as a pair of optical push-pull tracks and printed onto 35mm film in an area that was 2.65 millimeters wide, roughly the width of a standard sound track.[322] It was invented by German physicist Dr. Carlheinz Becker in 1938, and—due to its high-quality signal—it was later commandeered by Nazi officers for recording the power of extremely loud military explosions beginning in 1942.[323] Indeed, the Stereophon's playback signal was wide enough to reproduce the sound of carnage with considerable detail. It reportedly could record frequencies between 23 and 10,000 cycles, and intensities at a range of 60 decibels.[324] Moreover, its materially efficient design reproduced a three-dimensional effect that was comparable to the stereophonic illusions reproduced through the esteemed, though cumbersome, systems developed at Bell Laboratories during the 1930s. If Lee's report was accurate, Allied forces discovered a device that was far ahead of anything invented this side of the Atlantic.

Such communication technologies were treated as spoils of war by American troops during the liberation. The publication of the Stereophon's technical specifications subsequently became part of a much larger effort on behalf of the Department of Commerce to increase the

productivity of American engineers by freely disseminating the research and innovations of German competitors.[325] Perhaps the most famous of these technological exploits was the magnetic tape recorder known as the Magnetophon; its unveiling to the Institute of Radio Engineers in 1946 has been defined by engineers as a turning point for American audio reproduction, and it has since become the *de facto* birthday of modern day tape recording.[326] By comparison, the Stereophon had a less successful trajectory in America. To this day little has been written about the device, its inventor, or its use by Nazis during the war. The Stereophon nonetheless remains significant to the history of motion pictures, for its value to Hollywood in 1945 reveals the extent to which the motion picture industry at the time had failed to adopt its own, respectable multi-channel sound system.

This failure was not due to the industry's lack of interest in pursuing stereophonic sound. The adoption of Academy Mono created an opportunity for engineers to develop multi-speaker sound systems that could expand the decibel ranges of motion pictures. The problem was that the stereophonic systems at the time were all inherently flawed. As the previous chapter detailed, Joseph Maxfield's system was geared to showcase directional effects, and thereby introduced more unwanted noise into the playback signal. Similarly, Harvey Fletcher's system was capable of recreating the decibel ranges heard at live concerts, but such volumes—when played through an array of loudspeakers—introduced decibel ranges and distortion that audiences found unpleasant. Indeed, if Hollywood were to adopt a viable stereophonic technology, it would need to provide filmmakers and mixers with total control over the volume of its effects, and by the end of the 1930s there was no single system that was capable of meeting these demands.

Hollywood's pursuit of a stereophonic technology nonetheless continued. In the pages that follow, I chronicle the many attempts of studio engineers to create a viable multi-speaker

sound system that could enhance the volume of motion pictures, and that could provide filmmakers with the ability to integrate such proportional effects into the industry's broader storytelling toolkit. I specifically trace the many economic and technological problems that impeded the development and implementation of several sound systems, including Disney's Fantasound, Warners' Vitasound, Fox's 50mm Stereophonic Sound, and Selznick's Multi-Sound. In so doing, I explain why studio engineers failed to create a manageable and high-quality stereo system. Further, I offer reasons for why these engineers continued their costly and unpopular stereophonic research despite indications that their acoustical innovations might never become widely adopted throughout the motion picture industry.

The RCA Stereo Systems

The stereophonic sound formats that Hollywood initially developed were similar to Fletcher's, and—for many filmgoers less attuned to acoustical quality—they were at times even indistinguishable from Fletcher's. The key distinction of these new systems was that they were co-designed and manufactured by engineers at RCA. During the late 1930s, RCA was promoting itself as a leader in multi-channel audio. At times RCA engineers even insinuated—perhaps in a deliberate jab at Fletcher, ERPI, and Bell Labs—that their stereo systems were the only multi-channel technologies that could produce a true "illusion of reality."[327] Such rhetorical tactics proved successful. In 1936, ERPI was forced to end its exclusive licensing contracts with studios, thereby enabling studios to install a greater number of RCA recording technologies in sound stages and dubbing rooms.[328] And by 1940, Disney and Warners would specifically enlist RCA, rather than ERPI and Bell Labs, for help when developing their own proprietary multi-speaker formats.[329] Disney would call theirs Fantasound and Warners dubbed theirs Vitasound,

but both technologies were essentially based upon of Fletcher's stereo system. The difference was that Disney and Warners added stylistic and electrical flexibility to their formats in order to render them more appealing to the industry.

Disney in Fantasound

The most famous of the RCA systems was Fantasound, a three-channel stereo system developed by Disney engineers William Garity and John Hawkins for use on special showings of *Fantasia* (1940).[330] In many ways the film was a perfect vehicle for the new sound system. It featured an episodic structure consisting of eight works of classical music where each piece was set to a different style of hand-drawn animation. *Fantasia* originated as a Silly Symphonies cartoon short starring Mickey Mouse and set to Dukas's *The Sorcerer's Apprentice*.[331] Disney hired Stokowski to conduct the music, and to record the performance using an experimental multi-track technique. After several months of development, the animated short soon expanded into a full-length animated feature, Disney's third.

It was during this time that the studio also determined that the film should not only feature multi-track recording, but multi-channel playback as well. Garity was the logical choice to oversee the technological development. As Disney's chief engineer, Garity had invented several filmmaking technologies, most notably a four-layer multi-plane camera, and before joining Disney he had helped Lee de Forest invent the variable-density Phonofilm format.[332] Stokowski was similarly a logical choice to oversee the multi-track recordings, given his ongoing work with Fletcher in stereophonic sound reproduction. The final result was a concert film intended to promote the virtues of classical music to audiences of all ages. Between each of the animated shorts, famed music critic Deems Taylor spoke to filmgoers about the music, and at

times discussed the novelty of the Fantasound sound system. In so doing, the film also promotde the studio's technical ingenuity.

Disney's multi-channel playback system was heavily informed by Fletcher's stereophonic designs. Like his four-track technology, Fantasound used a left-center-right channel configuration along with an additional control track.[333] The four channels were printed onto a single filmstrip, each with a width of 200 mils and each encoded into push-pull sound tracks using ultraviolet light exposure for optimal noise reduction.[334] And much like Fletcher's system, Fantasound also used volume compansion and equalization to further limit noise levels and to widen the film's frequency characteristics.[335] The four-track filmstrip was then designed to play in synchrony with a separate 35mm filmstrip that housed the picture. Despite the similarities between Fantasound and Fletcher's stereophonic sound system, RCA and Disney did little to credit the innovation of Bell Labs in the many technical articles about the new stereo system. Instead, Garity and Hawkins would promote an alternative history of Fantasound's many loudspeaker configurations, wherein they revealed that more intricate designs—including two rear channels and ceiling speakers—were abandoned for a more common three-channel set-up.[336] Their discussion of past models was likely meant to indicate to the industry that Fantasound's design was a product of Disney's research, and not Bell's.

The most illustrative example of this competitive tactic can be found in discussions of Fantasound's Tone-Operated-Gain-Adjusting-Device, or "Togad" for short.[337] The Togad, arguably the heart the Fantasound system, was the name that Garity and Hawkins gave to the control track's ability to raise and lower playback volume. The process used three control tones, each one corresponding to either the left, center, and right channel, and as the decibel level of these control tones increased and decreased, so too would the volume of the three channels. The

Togad process was ostensibly a new application of Fletcher's control-track, where the playback volume of the signal would increase and decrease according to the level of compression applied to the signal before its transmission. Yet by giving the system a new name, Disney could conceal this lineage from the industry and claim its stereophonic sound technology as its own proprietary invention.

Disney's appropriation of Bell's technologies in some ways made Fantasound aesthetically comparable to Fletcher's sound systems. Specifically, the Togad process and the extra channels were each designed to intensify small adjustments in volume so that they would be much more salient to filmgoers. The technology, as a result, encouraged Disney and Stokowski to employ a great number of proportional effects throughout the feature in order to increase the dramatic payoff for each of the eight animated sequences. Such effects were most apparent as Mickey Mouse struggles to stop a team of mindless brooms from flooding his employer's basement in *The Sorcerer's Apprentice*. Too tired to fill a cauldron of water himself, Mickey, the titular apprentice, casts a spell on a broom in order to bring the object life so it could carry the water in Mickey's absence. Mickey, however, casts the wrong spell, and too many brooms are brought to life causing too many buckets to be poured. To Mickey's horror, he soon finds himself struggling to keep his head above water as the brooms show no sign of quitting their robotic behavior.

For this sequence, the stereophonic sound system accentuated the size of the flood by featuring a corresponding proportional effect: as the level of the water rises and rises, so too did the volume of Dukas's music. This use of stereo as a proportional tool was therefore not unlike Fletcher's stereophonic designs at Carnegie Hall and Pantages. *Fantasia*, however, was never accused lacking appropriate control over its playback volume. Disney's engineers instead

restrained their creative team, particularly Stokowski, from creating the types of aggressive stereophonic effects that the stereophonic technology encouraged. Such restraint helped Disney further construct the value of its technology as a marked improvement upon Fletcher's.

Pan Pots and Surrounds

Of greater consequence, Disney's engineers chose to deviate from the principles of auditory perspective. Garity and Hawkins specifically supplemented their Fletcher-inspired system with several innovations that enabled the studio to create dramatic effects that were antithetical to true concert fidelity. Such supplements expanded the film's stylistic toolkit and freed Disney from having to rely only upon proportional effects to enhance each animated story. Further, they increased stereophonic sound's appeal within an industry that remained skeptical that the new format would offer studios anything more than volume enhancements. To achieve such effects, Garity and Hawkins drew upon recording and reproducing technologies that had been developed by RCA in preceding years but that were never successfully marketed to audiences as cutting-edge innovations. By being the first system to publicize these technologies, Disney could then further position itself as the leader in multi-channel audio technology.

The first of these innovations involved the addition of more salient directional effects. Instead of relying upon only a left, center, and right microphone configuration to record the musical performances, *Fantasia* used as many as eight separate channels.[338] Engineers staged microphones throughout the orchestra, many pointed at different instrument sections and each encoded onto a different sound track. This technique allowed Stokowski and other mixing engineers to re-balance the orchestra during re-recording in accordance with onscreen actions. If a more menacing character were to appear onscreen, the brass channel could perhaps be boosted.

Similarly, if a more serene setting were depicted, violins and woodwinds might similarly increase in volume.

This inventive recording and mixing technique necessitated the adoption of mixing consoles that RCA developed several years prior, specifically for Stokowski's multi-track recording experiments during the making of Universal's *One Hundred Men and a Girl* (1937)—a film which, not coincidentally, also stars the famed maestro.[339] For each of the film's musical numbers, Stokowski and a team of technicians—including Universal's re-recording engineer Bernard Brown and the studio's supervising sound engineer Homer Tasker—enlisted RCA to devise multi-channel equipment that could accommodate Stokowski's interest in stereophonic mixing. The result was a nine-channel recording system, likely the first of its type.[340] One channel was dedicated to actress Deanna Durbin's vocals, while six additional channels were dedicated to six individual sections of the orchestra. These tracks were specifically recorded with RCA's directional ribbon microphones placed at a very close proximity to the instruments. An eighth channel was devised by down-mixing the six orchestral channels during the performance. This served as a back-up track in case any one of the six orchestra channels failed to properly register as a sound track. Finally, a ninth channel recorded the entire orchestra with two microphones at a distance. This last channel served as a reference for the orchestra's actual balance during each take.

In theory, this multi-channel technique gave re-recording engineers and Stokowski a number of options for re-balancing the orchestra in the final mix, options that were important if any one section of the orchestra became too loud and masked the important melodies played on quieter instruments. The technique was also designed to open up new creative possibilities during post-production. For instance, one notable sequence depicts Stokowski himself

conducting a performance of Liszt's famous *Hungarian Rhapsody* while the orchestra sits along the many steps of a spiral staircase. Throughout the performance, director Henry Koster cuts to close-ups of each section of the orchestra in order to show their faces as they intently follow the maestro's cues in a non-traditional stage. When Koster cuts to the violin section, for instance, the sounds of the violins increase in volume.[341] Tasker argued that the six separate orchestra channels allowed him to create a strong correlation between visual perspective and sound perspective in the final film.[342]

In actual practice, however, the benefits of the multi-channel recording were unclear. As Tasker later admitted to the Society of Motion Picture Engineers, despite each section of the orchestra being closely miked, there remained a notable amount of signal leakage across the six close-up channels.[343] In other words, the violin channel might still contain a large amount of percussion, and the percussion channel might contain a large amount of brass. This lack of audio separation would have then undermined Tasker's efforts to achieve the close audiovisual correlation that he desired. It is therefore likely that any pronounced change in sound perspective during the performance of *Hungarian Rhapsody* was less a result of the multi-channel recording and mixing and more a result of the orchestration itself. Though Tasker might have played with the final mix to boost the volumes of the onscreen instruments, the orchestration of the music, in combination with Stokowski's interpretation of it, was what largely created any apparent change in sound perspective in the final mix. Due to signal leakage, the multi-track recordings may have contributed less to the film's sound design than initially intended.

Stokowski nonetheless appropriated this recording and mixing technique in *Fantasia*. The film provided him with the opportunity to adapt his new technique for a three-speaker sound system. Further, it became a means for him to improve upon the technique's noted shortcomings.

With the exception of *The Sorcerer's Apprentice* and *Ave Maria*, each performance was recorded onto eight separate channels: one channel for the entire orchestra, six close-up channels, and one down-mix of the close-up channels.[344] Disney then needed the ability to mix its eight microphone channels into three loudspeakers. In response, Garity invented and patented a special mixing console with a dial for each of the eight input channels.[345] When turned during rerecording, each dial could send its corresponding input channel to any of the three output channels. This mixing device became known as either the "differential junction network" or the "panoramic potentiometer" ("pan-pot" for short).[346] The stereophonic effects afforded by the pan-pot became a major selling point of the film in the press. *Scientific American* even rhapsodized about the many possibilities of the new mixing device:

> By proper control of the recording equipment the sound can be made to follow the characters on the screen with uncanny fidelity or even to 'creep down the aisle' of the theater, if such a procedure should be desired. […] Suppose for example that the sound of a violin is to accompany the flight of a shooting star across the screen. The record of the violin sound will then start, say, on the sound track that feeds the right-hand speaker on the stage, will pass to the track for the center speaker, and end on the track for the left speaker.[347]

Consequently, the use of the pan-pot to achieve such aisle creeps and shooting stars meant that the auditory perspective of a live performance could be changed in the final mix for dramatic purposes. The stereophonic reproduction of Fantasound was no longer intended to improve musical fidelity, as Fletcher's system was. Instead, the eight-channel recording technique, in combination with the new mixing consoles, enabled the creation of directional effects where the music could move across the stage in a manner that earlier stereo systems reserved for airplanes and gunfire. In other words, Disney sacrificed auditory perspective and acoustical fidelity in order to create the type of emphatic effects that Howard Hughes and Abel Gance flaunted during the early 1930s.

Much like this increase in the number of microphones, *Fantasia* also deviated from Fletcher's initial left-center-right configuration to increase the number of loudspeakers. Specifically, Fantasound required theaters to mount tens of additional loudspeakers on the rear and side walls of the theater.[348] The three-channel signal could then feed into the rear loudspeakers to create what is more commonly known today as surround sound effects. Such effects were limited to select moments throughout the film, namely the several minutes of Schubert's *Ave Maria* that closes the picture. As the line of monks walk past a lake, through a forest, and into a cathedral, the left and right channels were both sent to the rear loudspeakers at a quieter volume, simulating the effect of hearing music reverberate through a concert hall or, more appropriately, a cathedral. Sound emanated from every side of the audience, not just from the direction of the concert stage.[349] The overall effect was to increase the size or the proportion of the sound track. Quieter, religious music like *Ave Maria* could therefore reach as far as the back row of the theater without necessitating a decibel level increase that could undermine the sublimity of the music, or worse, cause the front row to recoil in terror.

These surround sound capabilities, though still novel in the cinema, were an extension of the stereophonic and surround sound effects developed by RCA's Glenn Dimmick for use in the Manhattan Opera House's live performance of the stage show *The Eternal Road* in 1937.[350] Directed by Max Reinhardt and composed by Kurt Weill, the oratorio/play told the story of a rabbi and his congregants who hide in their synagogue during a violent pogrom and who retell a series of stories to one another about the history of Jewish persecution, all of which are simultaneously performed on stage.[351] Dimmick's off-stage effects were thus a way for audiences to experience being surrounded by the sounds of the pogrom, much like the

congregants who were surrounded by the angry mob. And like the angry mob, this sound design was intended to incite an emotional response within audiences.

The show was developed by Polish-immigrant and activist Meyer Weisgal. He conceived it to function an allegorical warning of the growing anti-semitism in Europe, and it turn it would become one of the more notable stage pageants to combine art and propaganda during the 1930s and 1940s.[352] Weisgel's concept called for elaborate sets of more than two-hundred performers. Further, he required a much larger stage than the Manhattan Opera House could provide. Reinhardt's solution was to gut the orchestra pit and replace it with a stage extension.[353] In its place many of the smaller musical numbers would be performed in the basement of the theater, where it was then mixed with other live sound effects and transmitted to loudspeakers located throughout the stage as well as along the walls located behind the audience.[354] At the same time, *The Eternal Road*'s orchestral music was pre-recorded and printed as four push-pull sound tracks that were then simultaneously sent to the auditorium's many loudspeakers.[355] Special vocal effects were even sent to loudspeakers that were installed onto the ceiling of the theater. As God spoke to Moses during one of the many Biblical stories told by the rabbi, his voice emanated from the ceiling, simulating God's location within the heavens.[356]

The reviews of the spectacle were generally positive. The elaborate production was praised for its grandeur, and a young Sidney Lumet was especially commended for his role as the Estranged One's son.[357] However, while Reinhardt initially estimated that the orchestral recordings would keep musicians' costs low, he was soon proven wrong. The production budget doubled from $250,000 to roughly $500,000 by the time *The Eternal Road* premiered.[358] The show was never capable of recouping its initial expenses, and after a series of lawsuits filed

against its producers, the show would close several months after it opened, with no opportunity for the sound system to be reused in other cities.[359]

Fantasia would thus serve as an opportunity for RCA to reuse many of these stereo innovations.[360] Like *The Eternal Road*, *Fantasia* consisted of push-pull recordings in four-channel playback, and like *The Eternal Road* it too featured additional loudspeakers on the rear of the auditorium to enable the playing of surround sound effects. Further, it shared with *The Eternal Road* the special selection of sounds sent to the rear channels. It is perhaps no coincidence that the extra loudspeakers that surrounded the audience were reserved for the performance of a Latin prayer directed to the Virgin Mary. Like God speaking to Moses, when the heavens open up and the sun emerges on *Fantasia*'s screen, the music of *Ave Maria* grows louder and the vocal harmonies play from every side of the filmgoers, as if the audience were suddenly surrounded by singing angels. The rear channel in *Fantasia* has been typically associated with the film's broader concert-hall aesthetic, specifically the way that the sound of a symphony echoes off the side and rear walls of a concert venue.[361] But its placement within the film and its similarities to *The Eternal Road* suggests a religious association as well, one that can be conceived of as a temple aesthetic.[362]

Fantasia opened at the Broadway Theatre on November 13th, 1940, and was quickly lauded by the press.[363] Music critic Olin Downes argued that Fantasound brought "unprecedented effectiveness" to the picture, and "that "tone-color" of which every musician speaks, and which is particularly the attribute of orchestral music, is here reproduced with a completeness and sumptuousness," for which Downes argued there was no precedent.[364] Bosley Crowther similarly opined, "that the sly and whimsical papa of Mickey Mouse, Snow White, Pinocchio and a host of other cartoon darlings has this time come forth with something which

really dumps conventional formulas overboard and boldly reveals the scope of films for imaginative excursion."[365] Such praise was directed at Disney, but the Fantasound system was largely indebted to Fletcher's accomplishments at Bell Laboratories, as well as the many innovations of RCA's engineers, such as the multi-track recording techniques for *One Hundred Men and a Girl* and the multi-track sound system for *The Eternal Road*. These experiments afforded Disney the ability to expand *Fantasia*'s storytelling toolkit beyond the initial conception of stereo, specifically to include pan-potting and surround sound. The result of this refinement of auditory perspective, and indeed the intention of Garity and Hawkins, was a sound system that could showcase not only Mickey's wizardry but Disney's as well.

Warner's Vitasound Experiment

The Broadway Theatre was the first of several venues wired to play *Fantasia* in stereophonic sound during the film's initial road show.[366] Because Fantasound was a dual system requiring four projectors — one for the picture, one for the four sound tracks, and two more for reel changes — the film's multi-channel effects were only able to play in theaters which had larger projection booths, or which were willing to renovate their booths to house the extra projectors. Additionally, by requiring venues to install extra loudspeakers on the rear and side walls, Fantasound could only be played in theaters capable of powering the additional equipment.[367] These technical demands raised the cost of the system to estimates ranging between $15,000 and $85,000 per screen, which greatly limited Fantasound's road show only to the industry's larger and more profitable theaters.[368] As a result, Fantasound could not replace Academy mono so much as it could, at best, become an alternative sound system for special screenings and select venues.

In order to provide a stereophonic format for the rest of the industry, RCA and Warners developed a sound system that was intended to widen frequency characteristics in smaller theaters without exerting considerable technical demands upon these theaters. The result was Vitasound. Developed by Warners' sound director Nathan Levinson, and aided by Warners' Lloyd Goldsmith and RCA's Hillel Reiskind, the format was ostensibly a smaller version of Fantasound, one that was a better fit for neighborhood theaters than for downtown palaces.[369] In theory, the same film could therefore receive a Fantasound mix for flagship theaters and a Vitasound mix for smaller theaters, a distribution model that would allow for a studio to extend the reach of a film's enhanced sound design beyond just a few specialty theaters. Vitasound's design borrowed many features of Fantasound's stereo technology. These included the use of a control-tone track and the use of a variable-gain amplifier to increase the system's overall volume by up to 10 decibels (roughly twice as loud).[370] Vitasound, however, was not a multi-channel sound system. It was instead a single-channel sound system with multi-speaker playback, much like Vitaphone and Perspective Sonore. Indeed, Warners developed the technology during the early 1930s and quietly tested it on select releases including Reinhardt's adaptation of *A Midsummer Night's Dream* (1935).[371] According to *Variety*, Warners agreed to withhold the sound system's inauguration until after the premiere of Fantasound "to permit Disney to gain the full advantage of his elaborate expenditures in time and coin."[372] The plan was for Fantasound's unveiling to cause enormous excitement within the industry, and for this excitement to in turn generate comparable buzz for Vitasound simply due to its association with Fantasound.

This plan was not a terrible idea, for Vitasound's technical specifications were not conducive to sensational theatrical effects. Unlike most uses of a left-center-right configuration,

Vitasound's left and right loudspeakers were small. This gave theaters the flexibility to install them either behind the screen or on the sides of the theater.[373] Additionally, Vitasound films all used standard 35mm single-track optical prints, making the prints compatible with theaters not equipped with the new technology. The one distinction between a standard print and Vitasound print was the addition of a variable-width control track located in the small spaces between the left sprocket holes.[374] The control track was designed to emit a tone that had a frequency of 96 cycles (4 sprocket holes per frame, multiplied by 24 frames per second) and that could be read by a special sound head.[375] As this control tone varied in track width, the sound system varied in volume. For instance, if the track were not present at all (or zero mils wide), the film would be given a 10-decibel boost and would play from all three loudspeakers. As the width of the track increased, the film's decibel boost would similarly decrease, as would the intensity of the sounds that played through the side speakers. If the control track were as wide as 40 mils, the extra loudspeakers would turn off and the film would play at a standard volume from only the center loudspeakers. As a result of this design, Vitasound could not allow for any directional stereo effects; like the original Vitaphone sound system, Vitasound could only offer proportional effects.

On November 19th, 1940, just six days after *Fantasia*'s premiere, Warner's Levinson unveiled the system with a special demonstration to critics, theater owners, and representatives from other studios.[376] His intention was to sell the technology to the Hollywood community, and Levinson did so by detailing the format's ability to expand and contract the volume of a film's soundtrack for the sake of dramatic emphasis. He presented several scenes taken from recent Warners features that the studio re-mixed for Vitasound. Such effects-driven action scenes included the earthquake sequence from *The Sisters* (1938), the "gusher" sequence from *Flowing*

Gold (1940), and the battle sequence from *Fighting 69th* (1940), while such music-driven moments included the performance of "Symphony Moderne" from *Four Wives* (1939) and Jean Negulesco's musical short *Henry Busse and his Orchestra* (1940).[377] Warners soon followed its demonstrations with the release of two pictures for the new Vitaphone format in several first run screens across the country. The first was the western *The Santa Fe Trail*, which appropriately saw its premiere in Sante Fe, New Mexico on Dec 13th 1940.[378] The second film was the melodrama *Four Mothers*, the third installment in Warners' *Four Daughters* trilogy, which premiered at Warners' Hollywood Theater four days later.[379] Warners' release of its other films in Vitasound continued throughout 1941, beginning with *Affectionately Yours*, *Shining Victory*, and *The Sea Hawk*.[380]

For most Vitasound mixes, the proportional effects were reserved for action sequences or for extended musical sequences, often to provide greater punctuation to the single-track sound designs. In the war film *Dive Bomber* (1941), for instance, rerecording mixer George Groves recalled that the additional loudspeakers were "sparingly used, but [implemented] for important aerial maneuvers of the aircraft, to enhance it and give it more dramatic impact and more excitement to the audience."[381] In effect, the extra loudspeakers in *Dive Bomber* served a similar stylistic function to those used in *Hell's Angels*, but they did so without the need for multiple projectors. Further, Warners often reserved the Vitasound system's proportional effects for less spectacular sequences in order to enhance the dramatic importance of subtle, emotional moments. For *Sergeant York* (1941), Groves recalls:

> ... they didn't want to overwhelm the audience with sound by enhancing the score, but certain things—gunshots that were particularly important: when Sergeant York wipes the gunsight on the end of the barrel of his gun, at a turkey shoot. This is an important thing. And during the battle sequences, they were enhanced. But it was held to a minimum so it was effective when it happened.[382]

Such reserved uses of Vitasound effects were generally well-received. Industry critic Philip K. Scheuer praised the format, writing that "'Vitasound' will impress even the layman by its increased fullness of tone, so to speak—the sound is 'spread,' more spatial."[383] He specifically singled out the way that additional speakers in *Four Mothers* created "a more balanced tone and a fuller-recreation of high, low and intermediate notes."[384] Similarly, *New York Times* critic Douglas W. Churchill wrote that compared to Vitasound, traditional single-speaker soundtracks "seemed muffled and dead."[385] In other words, though Vitasound only offered proportional effects, such limited uses did not seem to initially matter to the press.

The question was whether or not such technological limitations would matter to theater owners and studios. Without knowing the answer, RCA and Warners set the cost of a Vitasound installation to a competitive $1,500 per screen, less than one-tenth the cost of Fantasound.[386] Additionally, following the premiere of *Four Mothers*, they decided to rebrand the system RCA Panoramic Sound.[387] Although the Vitasound moniker worked to associate the new technology with the historically successful Vitaphone format, it remained possible that—like Vitaphone—competing studios and theaters would be unwilling to invest in a proprietary Warner format. Nonetheless, such pricing and branding strategies were not enough to market the new sound format to the industry. For one, Vitasound was not as adaptable to as many theaters as Warners and RCA suggested. Smaller venues in particular would have had a hard time justifying the added pleasure from a substantial volume increase when the extra loudspeakers were only a few feet from the heads of filmgoers. Theaters would have also likely needed to install additional power sources to account for the extra loudspeakers and decibel boosts, and the cost of these upgrades would have greatly exceeded the initial estimates.[388] More significantly, the format was designed to offer theaters the same type of proportional effects that both Fantasound and

Fletcher's system offered, yet these effects were not accompanied by additional noise reduction nor wider signal-to-noise ratios. In other words, Vitasound did not solve the acoustical problems of Academy Mono; by amplifying a sound track's hisses and hums the format instead accentuated these problems. As a result of such aesthetic limitations, only a handful of theaters installed the multi-speaker system.

Fantasound's Decline

Despite its generally positive reception among critics, Fantasound suffered a similar fate within the industry. RCA was slow to supply theaters with equipment, and theaters were therefore slow to invest in a system that appeared to still be in a state of development. In April 1941, *Variety* reported that RCA had only equipped eleven theaters, causing some insiders to estimate that the film's nationwide road-show would take seven years to complete.[389] Ironically, many of the technical problems that plagued Fantasound stemmed from what many at Disney considered to be strengths. Its variable-gain amplifier, designed to automate the system's compandor, reportedly failed to reduce noise to the desired levels. *Fantasia*'s music editor, George Adams, specifically recalls that before the film played in Los Angeles's Carthay Circle, the studio hired assistants to manually paint over the print's physical sound tracks in order to remove the bubbles and other imperfections that would increase the level of surface noise reproduced in the theater.[390] Much like Vitasound, the increase in noise that accompanied the music's boost in volume undermined its ability to substantially improve upon the acoustical characteristics of Academy Mono.

Similarly, the technical demands of the Fantasound system necessitated that theaters remain closed for long periods of time as engineers renovated auditoriums and projection booths

for the new system. In response, theater managers chose to install the system on their smaller screens, allowing the more profitable screens to continue to sell tickets and concessions during the long installation process.[391] However, because *Fantasia*'s three-channel mix was initially designed for larger auditoriums, the installations in these smaller theaters at times required the sound track to be re-recorded to better fit the size of the venue. According to Garity and RCA's Watson Jones:

> If the low-level portions of the music were below the theater noise-level, the volume-range was reduced by changing the ratio of the control-tone level to the variable-gain amplifier output. The music was re-recorded with a one-to-one ratio; however, in some theaters it was necessary to use a ratio of eight-to-five.[392]

These readjustments in turn lengthened the installation process and increased the sound system's total costs, with one theater reporting that the total price of equipment, renovations, and labor amounted to roughly $85,000, more than five-times Disney's initial estimates.[393]

More significantly, the release of *Fantasia* in smaller venues with fewer seats, in combination with additional labor costs, meant that it would take longer before Disney and RCA would profit from their stereophonic innovations, which when added into the cost of the film's budget amounted to more than two million dollars.[394] In Spring of 1941, RKO announced that it would begin distributing *Fantasia* to a wider number of screens, allowing for a faster return on the animation studio's investment.[395] Instead of distributing the feature in four-track stereo, RKO promoted the release as a "modified" Fantasound system that did not require the installation of new theatrical equipment.[396] In actuality, however, the modified release was merely the single-track down-mix that was printed next to the picture to serve as a back-up during Fantasound screenings. Modified was just a fancier name for monaural.

Of greatest concern to Disney and RCA, however, was that its famed pan-pot system worked less well than they initially suggested. In a presentation to the Society of Motion Picture

Engineers in 1942, Garity and RCA's Watson Jones admitted that what plagued the multi-channel recording system was the same issue that plagued the similar recording system during the making of *100 Men and a Girl*: a lack of separation among the six individual close-up channels. The two engineers described attempts to physically separate each individual section of the orchestra during each take, but because it was difficult for the isolated sections to play in time with each other, this idea was soon abandoned.[397] Disney composer Edward Plump further claimed that the orchestral staging resulted in significant leakage across each section's channels:

> In the material on the woodwind channel, the woodwinds usually predominated, but material from other section of the orchestra was definitely present. Many times, because of differences in performance level, the material from adjacent sections would be as loud as, or louder than, the woodwinds directly picked up. This lack of complete separation was not an insurmountable obstacle in creating an artistic balance for ordinary reproduction, but it greatly limited the dramatic use of orchestral colors in Fantasound.[398]

Accordingly, the leakage between channels meant that if woodwinds were to pan from the left loudspeaker to the right loudspeaker during screenings, so too would the brass, percussion, and perhaps also the rest of the orchestra. The directional effect would become inaudible.

Garity similarly complained in his diary that the six recordings also suffered from synchronization issues, making it difficult for individual channels to sound pleasant when mixed together. As he described one rerecording:

> ...the over-all result is pretty bad. The sustained tones, particularly of the brass and the strings, have a bad low-frequency resultant wobble. This, we believe, is due to the fact that the six sound tracks were not accurately registered in synchronism to within plus or minus a few thousandths of an inch, and at the moment I don't see how we could synchronize them any more accurately than we have done.[399]

The solution to this problem was to discard a great number of tracks from each take. According to Plumb:

> ... only one-third of the material recorded on chosen performances was used in the final dubbing. The unused film contained sound that was too repetitious of other channel, too poor in quality, or, during a long section, too unimportant in the design of the composition to help the total result.[400]

This decision to throw away many of the individual tracks suggests that Disney's vaunted eight-channel recording technique, and the directional effects that this technique and pan-pot were designed to demonstrate, worked less well than Disney initially claimed. Further, it calls into question many critical accounts of the Fantasound process. William Stull of *American Cinematographer*, for instance, even claimed to have heard directional effects during *Ave Maria* emanating from loudspeakers that were never installed:

> When the solo voice enters, it is first played only on the rear speakers, then faded to the ceiling speakers, and finally to the downstage speakers on one side only. The effect is that the voice begins at the rear of the auditorium, floats gradually across the top of the house, and finally comes to rest at the front side of the stage.[401]

Because Fantasound did not include ceiling speakers, Stull's review can only be taken as a hyperbolic account of Fantasound's achievements, perhaps an indication that the press wanted the sound system to succeed at all costs. The technology, however, did not live up to its glowing reputation.

Following *Fantasia*'s road show, Disney's sound and music department continued to experiment with multi-channel recording in an attempt to resolve its separation and synchronization problems. The studio specifically applied new staging and microphone techniques to five new sequences. These techniques included the use of playback for Sibelius's *The Swan of Tuonela* when recording the English horn solo. The isolation of the horn from the rest of the orchestra not only prevented unwanted leakage into the microphone channel, but it also allowed for the horn to be recorded at a greater distance and with more audible echo, which reportedly "gave the tone of the English horn brilliance, but also lent a feeling of mystery in

character with the subject."[402] Disney's plan was for *Fantasia* to run in theaters for years, with new sequences like the Sibelius piece replacing older sequences over time.[403] Disney also planned to release additional films, like *Bambi* (1942), in Fantasound.[404] Neither of these plans materialized.

The studio would not release another film in stereophonic sound for another ten years.[405] RCA would similarly turn its attention away from its stereophonic innovations to instead focus on developing communication devices to aid the U.S. during the war.[406] As a result, the technological shortcomings of both Fantasound and Vitasound, much like those of Fletcher's sound system, would never be adequately addressed by engineers. RCA's intention to provide the industry with a viable alternative to Academy Mono proved to be more difficult than initially imagined.

Fox's 50mm Stereo Films

Such difficulties nonetheless did not dissuade Twentieth Century-Fox from constructing its own sound system that could enhance motion picture acoustics. Between 1944 and 1946, Earl Sponable, Lorin Grignon, and other engineers at the studio developed a 50mm film format designed to widen the appeal of stereophonic technology within the industry. Unlike Fantasound and Vitasound, however, the format and its associated techniques specifically addressed how studios could apply principles of auditory perspective to more typical Hollywood releases. As previously noted, Fletcher designed his four-track stereo system so that it could accentuate the proportional qualities of an orchestra. This design, in turn, limited its appeal to most Hollywood studios as very few movies consisted entirely of orchestral performances. RCA and Disney addressed this limitation by adding directional effects and surround sound, but because these

effects were still only relegated to orchestral music they did not substantially increase the value of multi-channel sound within the industry. Fox's 50mm stereo system addressed this shortcoming. It specifically improved upon Fletcher's initial principles not only by adding more effects into the technology's stylistic toolkit, but by adapting these principles for a wider number of uses. Stereophony would no longer just enhance orchestral music, it could enhance the drama in a dialogue sequence as well. By increasing the number of applications of stereo effects across a motion picture, Fox intended to increase stereophony's appeal within the industry both as a valuable storytelling tool and as a viable solution to the acoustical restrictions imposed by Academy Mono.

Although Sponable would promote 50mm film prints as a new way of presenting stereophonic sound in the cinemas, by the 1940s the wider gauge was itself not a new technology. Fox initially proposed the format to the motion picture industry as early as 1930 in an attempt to solve the problems associated of Fox's other widescreen format, its 70mm "Grandeur" system.[407] 70mm prints created two adaptability issues for motion picture theaters: standard balcony cut-offs limited the height of the projected image, and 70mm prints were incompatible with 35mm projectors.[408] According to John Belton, theaters wishing to project 70mm films needed to install a separate set of film projectors, and many projection booths were not large enough to store this extra equipment.[409] As a solution to both of these problems, Fox proposed a 50mm format.[410] The dimensions of the image increased to roughly 1.3 inches wide, while it remained four perforations high. This allowed the picture area to increase (from 1.37 to 1 to roughly 1.77 to 1) and it simultaneously prevented the balcony cut-offs (and the heads of filmgoers) from obstructing the image during projection, as was reportedly the case with 70mm prints.

Further, the 50mm film gauge was just narrow enough to fit within the limitations of standard 35mm projection equipment. All that was necessary was a separate set of parts, such as sound heads, aperture plates, and sprocket teeth, which could be easily swapped out between screenings of 35mm and 50mm prints.[411] The conversion to 50mm film, however, was met with skepticism among theater owners who remained concerned by the cost of the new equipment and by Fox's insinuation that the installation of larger screens would work in the vast majority of venues. Following a contentious debate about the new format at the SMPE's Spring 1931 meeting, it was decided to hold off on any hypothetical discussion of 50mm's benefits until Fox was able to physically demonstrate the value of the format to the SMPE at a later date.[412] When such demonstrations did occur in 1932, enthusiasm for 50mm remained low, and the industry remained unconvinced that 50mm was a valuable alternate to 35mm or 70mm.[413]

Though the discourse that surrounded 50mm largely focused on its screen size, the benefits of the format extended beyond its improvements to image quality. The larger film gauge also allowed the size of the optical sound track to widen to 200 mils, a width could increase a film's signal-to-noise ratio during playback by three decibels. It is therefore no coincidence that in 1939, shortly after the Academy's decibel restrictions were imposed, Fox's chief of engineering, Earl Sponable, attempted to revive the 50mm format by selling the format's wider frequency characteristics. In a letter asking for assistance from International Projector's Herbert Griffin, Sponable not only stressed the three-decibel boost but argued that the industry failed to see many of the format's other acoustical benefits:

> The 200 mil width also enables one to use a double 100 mil push-pull track where the signal to noise ratio can still further be increased without undo distortion. If the squeezed track method of printing is used with the 200 mil track the volume range on the film can be made great enough to take care of most sound that one is concerned with.[414]

What Sponable did not mention to Griffith, but what would later be of immense value to using 50mm prints, was that the 200 mil width track could also house multiple playback channels. And unlike Maxfield's two-track system the multiple channels would be wide enough to not necessarily introduce more hiss, hum or static.

Sponable returned to developing the studio's 50mm technology in 1944. That November, he and production manager Ray Klune oversaw the filming of three short test films, each shot in New York and each comprised of actuality footage designed to showcase the improvements in picture quality that 50mm prints afforded.[415] One film featured the Washington Bridge, another featured the Manhattan Skyline, while the final film starred the more photogenic Niagara Falls. In June of 1945, Sponable and Klune began pre-production on two more films that would showcase the film's 200-mil sound track. One was a short consisting of musical performances conducted by Alfred Newman.[416] The other was a dialogue-heavy civil war playlet called *The Clod,* written by Dorothy Bennett.[417] Henry King agreed to work for free as director of the playlet in order to keep production costs low.[418] By this point, the studio's engineers had also decided to take advantage of the acoustical potentials of the 200-mil sound track. Instead of using the space to house two push-pull tracks like Sponable initially imagined, the studio divided the optical track into three separate stereo channels — left, center, and right — each 58 mils wide.[419] This decision effectively sacrificed the substantially lower noise floor for a three-dimensional soundscape, one that offered a significant expansion of the film's decibel and frequency range through the addition of two extra loudspeaker channels.

The three-channel format was readily adaptable to Fox's musical short. Engineers would simply need to place the microphones in a left, center, right arrangement near the edge of the sound stage, a three-microphone orchestral staging that was common in Hollywood and that was

not unlike Fletcher's microphone placement used during his 1933 transmission of the Philadelphia Orchestra. The use of a three-channel recording technique in *The Clod*, however, was much more difficult for technicians to engineer. If King were to film the playlet from a single camera angle, then engineers would merely need to stage the three microphones in a line above the action and adjust them minimally as the characters moved around the stage and delivered their dialogue. This aesthetic would perhaps replicate many of the three-channel experiments conducted at Bell Laboratories during the 1930s, wherein dialogue sequences were recorded with a left, center, and right microphone and with minimal consideration given to each sequence's photographic representation.[420]

The problem was that by the mid-1940s this single-camera set-up was far from the accepted convention. Directors were expected to cover a scene from many different angles, and these angles would generally place the actors in different parts of the frame, if not outside of the frame entirely during close-ups, inserts, or eye-line matches. Fox's engineers in turn needed to develop a series of microphone configurations that could correspond to each camera angle without creating distracting shifts in audio in the process. That is, if the film cut between two camera angles, such as a two-shot where the actor sits in frame-left and a wide shot where that same actor now sits in frame-right, the actor's voice could not simply jump from the left channel to the right channel, especially if the cut were to occur while the actor was speaking. Initially, the studio planned to employ an aesthetic where monaurally recorded dialogue would be pan-potted to different playback channels during rerecording.[421] Sponable nonetheless opted for another solution to the problem. His colleague at the studio, sound engineer Lorin Grignon, had developed a series of stereophonic techniques for the filming of dialogue sequences that avoided many of the directional problems inherent to dialogue editing, but that nonetheless adhered to

Fletcher's principles of auditory perspective. In turn, Sponable called upon Grignon to oversee the application of these techniques during filming.

As Grignon would later detail in a paper delivered to the Society of Motion Picture Engineers in 1948, these stereophonic techniques were in fact a combination of recording and rerecording practices.[422] The microphones were tacitly governed by a principle of three zones: left, center, and right. The left microphone, for instance, needed to be free to move throughout the take so as to remain pointed in the direction of every actor speaking from frame-left. If an actor walks from the background to the foreground, the boom operator would need to follow that actor. If the actor turned her head away from the left microphone and spoke in the direction of the center microphone, the left microphone would need to move toward the center in order to prevent the center microphone from recording her voice at the higher volume. Otherwise, the voice of an actor seated in frame left might accidentally pan from the left loudspeaker to the center loudspeaker for no apparent reason.

In addition to these guidelines for microphones, Grignon also proposed a series of rerecording techniques that allowed for filmmakers to correct recording mistakes and the aforementioned directional jumps in the final sound track. Grignon specifically argued that the best way to maintain proper auditory perspective was for rerecording mixers to adjust the volume levels of the three channels throughout the rerecording.[423] If the voice of an actor accidentally pans to the center channel while the actor remains situated in frame-left, the mixer can lower the volume of the center channel and simultaneously raise the volume of the left channel. This adjustment in volume would enable the voice to emanate at a higher volume from the left channel and, in turn, it would prevent filmgoers from hearing a voice pan across the frame. Similarly, if two consecutive shots were to move an actor from frame-left to frame-right, a mixer

could prevent the voice from jumping from the left loudspeaker to the right loudspeaker by merely raising the volume of the center channel so that her voice remains in the same location across the two cuts.[424] By not resorting to pan-potting, Grignon's stereophonic techniques provided Fox with the ability to maintain Fletcher's principles of auditory perspective in their application to dialogue sequences that specifically featured a great number of picture edits.

The Clod, however, featured long tracking shots and was perhaps less in need of many of the volume adjustments that Grignon outlined.[425] This was perhaps due to the difficulty in adapting Grignon's technical recommendations into actual practice. However, it was more likely due to the tight shooting schedule and the film's initially small $19,000 budget.[426] King ultimately filmed *The Clod* over four days in March 1946, and due to various technical problems regarding the 50mm negative stock the production cost the studio an extra $6,000.[427] The stereophonic sound system, though still a novelty on the film set, did not appear to contribute to these additional costs in any way. Western Electric provided Fox with special sound equipment that recorded the three microphone channels as three 200 mil variable-density push-pull tracks onto a single 35mm filmstrip.[428] The sound tracks were then rerecorded and printed as three narrow variable-density tracks on a special 50mm film provided by Eastman Kodak.[429] The stereo system's connection to an expensive and cumbersome film format, however, would help to undermine its value among those in the motion picture community who were looking for a low-cost upgrade to Academy mono.

Sponable held two private screenings of *The Clod* and his other 50mm demonstration films over the course of the year. The first was held on the East Coast at Fox's Grandeur screening room in New York City on the evening of June 24th.[430] In attendance were many of the industry's technical leaders, as well as representatives from Hollywood's leading sound

departments, including Paramount's Loren Ryder and Columbia's John Livadary. The second was held on the West Coast at Fox's Hollywood studio during the afternoon of October 25th.[431] For this second screening, Sponable sent a personal invite to Harvey Fletcher, who was reportedly in attendance alongside representatives from Western Electric, Eastman Kodak and Fox executives Spyros Skouras and Joseph Schenck.[432] Sponable's choice to hold private demonstrations instead of public screenings gave him the opportunity to characterize the 50mm format as a work-in-progress in case there were any major flaws with the system or any loud complaints that the system was not worth the cost of investment. And unlike Fletcher's Carnegie Hall concert, it was perhaps a means to conceal these flaws and complaints from the public and prevent the reputation of a new theatrical format from being tarnished before its feature-film debut.

Sponable's tactics were not unjustified, for those in attendance found a significant number of faults with the system. Many sent Sponable letters outlining their criticisms of the test films and of the 50mm stereophonic system more broadly. Livadary specifically thought that the system was a poor means of expanding the acoustical characteristics of motion pictures. Despite an increase in decibel levels, "the noise reduction was insufficient," Livadary wrote.

> Having three channels we no doubt have about four or five db more ground noise than we have in a normal channel and I believe therefore that we need at least ten db more noise reduction over what we have seen the other night. Frankly at the beginning of the first subject it took me a little time to determine whether it was actually raining on the roof or whether the noise was film background.[433]

Livadary was also quite critical of claims that the flat response was as wide as 9,000 cycles. "The frequency spectrum did not sound any wider than we have in normal releases…. I believe that the slight preponderance of bass was due to lack of extreme high to balance it."[434] Finally, Livadary was critical of Grignon's recording techniques, which made the overall soundscape

sound "exactly like three monaural channels with the ability of localization, which in itself is insufficient."[435] Not everyone agreed with Livadary. Ryder found Grignon's three-microphone designs to be a significant improvement over earlier attempts at multi-track recording:

> Your group are to be congratulated on the microphone technique which has been evolved and which for the most part avoided apparent movement of the characters when they looked right and left. This technique also minimized the echo effect which has been heard in most stereophonic pick up.[436]

Ryder, like everyone else in attendance however, found that the noise levels were a distraction: "the multi loud speaker reproduction of film background noise was both higher than normal and harder to discriminate against during listening."[437] Both Ryder and Livadary ended their letters stating that it would be wise for studio heads to keep investing in new theatrical technologies, even if the current experiments in stereophonic sound were still riddled with problems.

Fox's studio heads greatly disagreed. Both Skouras and Schenck were not impressed enough with the 50mm stereophonic sound format to willingly invest more money into its development as an alternative to 35mm.[438] The novelty of adapting auditory perspective for dialogue sequences was thus not enough to overcome the resistance to technological change within the industry, and the many acoustical problems with the system only exacerbated this resistance. The failure of Fox's stereophonic sound system to become the industry's solution to the Academy's restrictions once again called into question the value of Fletcher's principles of auditory perspective. Despite those who defended these principles, there were now engineers like Livadary and Ryder who questioned their practicality given the technical demands of optical sound tracks. Sponable and Grignon perhaps agreed. When the two engineers would return to the problem of stereophonic sound in the 1950s, particularly with four-track magnetic CinemaScope, they would show a greater willingness to abandon Fletcher's principles in order to develop

stereophonic sound technologies that were more flexible and efficient in allowing filmmakers to create stereophonic sound designs.

Auditory Perspective In Pieces

Fox's 50mm test films did little to reignite the industry's interests in auditory perspective. Instead, *The Clod*, *Fantasia*, and other earlier experiments in stereophonic sound would effectively function as an opportunity for studios and theaters to hear for themselves the many problems inherent to Fletcher's theoretical principles. As a result, by the late 1940s an increasing number of studio engineers began to reject the notion that stereo sound was a solution to the limited playback range of Academy Mono. Instead, the industry began promoting a number of monaural technologies—such as Altec Lansing's "Voice of the Theatre" sound system—that promised high fidelity reproductions despite their continued observance of the industry's Academy Mono standard.[439] For many in Hollywood, it was not worth the trouble to invest in stereophonic technology. Monaural sound may not have sounded as impressive as stereo, but it was good enough for most audiences, and thus good enough to most filmmakers.

Equalization Disseminates

The rejection of Fletcher's concept of auditory perspective however was not a dismissal of every idea that had become associated with the Bell System's stereo technologies. Indeed, Fletcher might have sold his Stereophonic Sound-Film System as a package, but studio engineers saw his system as a tray of options that could be implemented *a la carte*. And among these options was frequency equalization. As discussed in the previous chapter, the acoustical process had been available to engineers since the transition to talking pictures, but it was never widely

implemented in studios until the Academy placed a limit on the decibel range of motion picture soundtracks. At that point, the electrical procedure suddenly become more valuable. Along with volume compression, Fletcher's concerts specifically illustrated that pre-and post-equalization could be extraordinarily effective at both removing noise and offering cleaner audio signals in the high and low pitch registers. The process could thereby allow studios to expand the signal-to-noise ranges of their soundtracks while continuing to abide by the electrical limitations set by the Academy's Research Council. In turn, more and more studios started to regularly implement equalization in the recording and rerecording of their motion pictures.

This widespread implementation, however, led to a great deal of variation in the ways that studio technicians were equalizing soundtracks. In response to this variation, the Academy Research Council circulated a technical bulletin in December 1943 that proposed a standard for creating uniformity across the industry.[440] At issue for the Academy was that the process of boosting high frequencies and suppressing low frequencies during recording (and the process of returning of these frequency bands back to their original levels during playback) had a different effect on each element of the soundtrack, and thus it could overload the electrical circuit if not performed carefully. According to Paramount's Y. Frank Freeman, who authored the seven-page bulletin, equalization greatly improved the reproduction of music, as Fletcher's concerts illustrated, but they often had adverse effects on speech given the frequency and decibel ranges in which dialogue is often performed. As a result, Freeman recommended that studios adopt a rather conservative approach to equalization, one that made sure that its implementation did not simply replace surface noise with distortion. His recommendations were substantial. They promised to reduce as many as ten decibels of noise from individual audio tracks, a decrease that was comparable to the Bell System's own equalization results demonstrated several years prior.

In the years that followed, a number of studio engineers began promoting their own equalization methods throughout the industry in order to recommend procedures and equipment that further enhance the quality of motion pictures soundtracks, if not also promote themselves as Hollywood's the top technicians. Wesley Miller and Harry Kimball, for instance, publicized their own accomplishments at MGM when applying pre-and-post equalization to the studio's multi-track recording consoles.[441] They particularly showcased their newfound ability to control the equalization setting with incredible precision in order to ensure that the final down-mix of the multiple tracks would not sound distorted or acoustically uneven as a result of raising and lowering the high and low frequency bands.

Several engineers even detailed their own experiments in dividing the entire recordable frequency range into more than just high and low bands. Fox's Grignon, for instance, demonstrated to the SMPE that instead of raising and lowering the acoustical levels of two bands, he could remove even more noise from dialogue recordings by equalizing a third frequency band specifically for the mid frequencies.[442] Additionally, William Thayer showed how at Paramount he and his colleagues used a special rerecording console with a built-in five-band equalizer that a technician can monitor and adjust with only one hand, leaving the other hand available for more global adjustments of dialogue volume.[443] By the end of the 1940s, and largely as a result of this public exchange of ideas, most if not every studio was employing their own equalization recipes in the production of their motion pictures.[444] In so doing, studios could creatively circumvent some of the acoustical limitations of Academy Mono, without having to invest in costly and unwieldly stereophonic equipment.

Portrait of Jennie *in Multi-Sound*

There also remained a handful of industry technicians who continued to pursue the idea of stereophonic sound. They merely questioned the efficacy of Fletcher's specific theories and requirements of proper auditory perspective. Accordingly, if all that was necessary to widen the decibel range of motion pictures was the installation of multiple loudspeakers, then engineers could jettison the restrictive methods used in creating the illusion of a three-dimensional soundscape. This way, technicians would have more freedom to stage loudspeakers anywhere around the audiences in order to boost dramatic action and create thrilling soundscapes. In other words, the rejection of auditory perspective had the potential to usher in alternative ways to structure a soundtrack within the space of a movie theater.

One such experiment in multi-speaker design was the Cycloramic Screen and Multi-Sound technology developed by James G. Stewart for the road show of *Portrait of Jennie* (1948).[445] The format boasted two separate soundtracks, an arrangement of loudspeakers on the sides of the audience, as well as a re-appropriation of the Magnascope lenses and screens previously used on such action-driven pictures as *Wings* and *Hell's Angels*. The slow and oneiric storyline for *Portrait of Jennie* was anything but action-driven. It was therefore a curious choice to debut the new audiovisual format. The story followed artist Eban Adams (Joseph Cotten) and his obsession with Jennie Appleton (Jennfer Jones), a woman who drowned in a sea storm many years prior but who, unbeknownst to Jennie, is mysteriously living out her life for a second time in New York City. Adapted from the popular Robert Nathan novel, this supernatural romance posited existential questions about mankind and its relation to the cosmos, questions raised by Eban's voice-over at the beginning of the film and routinely made manifest in each reel through images of clouds, storms, and other meteorological iconography.

Such themes were made present by the sound track. Instead of a typical film score, *Portrait of Jennie* was comprised almost entirely of Claude Debussy's music, most notably his slow and moody *Nuages* (or *Clouds*) for orchestra, which functioned as a leitmotif for the film's depiction of foreboding storms and weather more broadly.[446] A stereophonic rendering of Debussy's music in proper concert-hall fidelity could have had the potential to punctuate the piece and enhance its thematic role with the narration. This type of rendering, however, did not occur. Though Stewart designed the film's multi-channel playback system so that it was capable of producing the type of proportional effects found in earlier stereo systems, the film reserved its stereophonic effects for atmospheric sounds only.

This unique acoustical design was reportedly inspired by a call for greater sensationalism from the film's producer, David O. Selznick. Like Selznick's designs for his other large-scale productions, namely *King Kong* (1933) and *Gone with the Wind* (1939), Stewart recalled that the producer was interested in making the picture "much more for spectacle. Things had to be big—and loud."[447] And things were, especially at the climax as Eban sails through a turbulent storm off the shores of Massachusetts in order to save Jennie from drowning a second time. The sequence begins once Eban looks up from his sailboat and stares at the gray clouds above him. Following this brief eye-line match, the green-tinted fifth and final reel begins. Two animated lightning bolts crash downward across the screen. We next rest on a massive storm cloud that slowly inhales an atmospheric fog into its expansive, circular orifice. Images of crashing waves follow, as do shots of Eban as he desperately fights to stay alive amidst the violent squall. To enhance this sequence, Selznick wanted this final reel to be enlarged with a 1930s Magnascope lens and projected onto a taller and wider Magna screen, now branded Cycloramic, which in

some theaters was as large as thirty feet by forty feet.[448] The effect of this reel change was intended to be awe-inducing for filmgoers. As the theatrical instructions indicated:

> The screen should open up IMMEDIATELY on the change-over to reel 5, and, if possible, should be opened fast enough to be fully open when the first shot of the storm comes on the screen…. Under no condition, should any portion of the picture, other than reel 5, be run on the big screen.[449]

Thus, much like in *Hell's Angels*, reel changes would occur in concert with the beginnings of dramatic sequences, and these changes would allow for the size of the picture to increase as a means of punctuating the onscreen drama.

This same type of punctuation effect was created by the sound system. Stewart called for additional loudspeakers to be installed along the side walls of the auditorium in order for the screams and howls of the climactic storm to blast the audience from multiple directions.[450] In many ways, this sound design was reminiscent of the climactic sequence that was meticulously constructed by Thomas Moulton and others in Goldwyn's sound department for specialty screenings of *The Hurricane*. The one difference was that instead of merely releasing films with two push-pull tracks, Stewart mixed the film's final reel for two separate channels: one for the front of the theater that contained dialogue, music, and sound effects, and one for special loudspeakers mounted to each theater's side walls that contained only sound effects.[451] This effects track then was printed onto a separate 35mm filmstrip, and was read by a second sound head mounted onto the projector and played in synchrony with *Portrait of Jennie*'s main filmstrip. As a result of Stewart's design, the dual system technology used for *Portrait of Jennie* was almost identical to that used by Howard Hughes for select showings of *Hell's Angels*.

Their aesthetics were also comparable. Both systems used additional speakers to heighten the suspense when protagonists battle their way through a clouded atmosphere. The proportional effects in *Hell's Angels*, however, expanded the size of the sound track laterally behind the

frame. With *Portrait of Jennie*, this expansion occurred sagittally into the space of the theater. As a technical pamphlet for each theater stated, "an entirely separate sound system will be used to reproduce, from all sides of the audience, the sounds of a real hurricane. In this way, the audience will feel as though they, themselves, are going through the storm with the characters on the screen."[452] In this regard, the surround sound effects were a simpler means to spread the sounds to all sides of the audience, not unlike the vocal harmonies during *Fantasia*'s "*Ave Maria*" segment. The onscreen rapids and the corresponding proportional effects in the sound track perhaps even made the sequence more congruent with Mickey's near-death experience during *The Sorcerer's Apprentice*.

Stewart's Multi-Sound process, in combination with the Cycloramic screen, premiered on Christmas Day simultaneously in two Los Angeles theaters. One was the famed Carthay Circle on San Vincente, and the other was the much smaller Picwood Theatre on Pico, a theater which, coincidentally, was owned by Phil Isley, the father of Jennifer Jones and the soon-to-be father-in-law of Selznick.[453] Following its run in Los Angeles the Multi-Sound system was installed in a limited number of additional theaters—including the Apollo Theatre in Chicago and the Rivoli Theatre in New York.[454] Despite the audiovisual effects, reviews of the film were mixed. Bosley Crowther called it "deficient and disappointing in the extreme."[455] The *Showmen's Trade Review* was kinder, albeit only slightly:

> Because it is essentially appealing to certain feminine moviegoers, with little appeal for the average male, "Portrait of Jennie" will undoubtedly make money in some situations (especially in metropolitan situations or where discriminating patronage predominates), but in others (average communities and small towns) its drawing power is problematical.[456]

The film's box office performance, however, was not what the *Trade Review* predicted. *Motion Picture Daily* reported that even in New York its opening-week gross of $41,000 fell short of

what would be expected of a high-profile release.[457] Selznick would soon ask theaters to boost ticket prices, but not because the cost of installations were enormously high; at about $2,000 per screen they were roughly the same cost as the Vitasound system.[458] Instead Selznick was asking theaters to "tilt the price just slightly to give the connotation to the public that this is an out-of-the-ordinary picture."[459] In other words, the film's use of novel theatrical technology was not enough to sell tickets, Selznick had to manufacture demand.

The largest issue limiting profits, however, was that while the installations of multi-sound equipment were easy — with RCA, Western Electric, Altec Lansing, and other manufacturing companies helping to provide said installations — there was a very limited supply of Magna screens and Magnascope lenses still in existence. The Selznick Releasing Organization sent letters across the country to every known exchange asking if they knew of any theaters that had these screens and lenses in storage. Very few theaters replied with a yes.[460] One letter specifically notified Stewart that not only was there no Magna equipment to be found in Washington or Oregon, but that all of Fox West Coast's older Magna screens in the region "have been completely dismantled, the mattes have been used and discarded for various display purposes, and the motors used for their control have been taken out."[461] Such a problem was foreseeable, but arguably not fully planned for by the studio.

According to Stewart, Selznick had difficulty accepting certain truths regarding the use of technology in his films. Selznick, for instance, "always insisted" that *Portrait of Jennie* was the first picture to employ wider screens and multi-track sound, despite consciously reusing theatrical equipment that was designed for Hollywood features more than fifteen years prior.[462] Stewart would similarly bemoan, "[Selznick] kept insisting that something could be done for 250 dollars that would cost 4000. And he called in other people to prove this, but they were never

able to do so."[463] The film's distribution problems were perhaps another instance of Selznick not recognizing the limitations of his own cinematic showmanship, specifically the difficulties involved in widely distributing a motion picture with a forty-foot screens and two-track surround sound. Selznick's subsequent financial problems as a result of his many technical investments led Stewart to leave the studio soon after *Portrait of Jennie*'s release and to find employment at Glen Glenn, one of many independently owned post-production sound facilities in Hollywood.[464] The lack of sufficient screens and Stewart's departure from Selznick hindered any future uses of the Multi-Sound format.

Stewart's sound system for *Portrait of Jennie* therefore illustrates the decreasing value of auditory perspective, and the broader concept of stereophonic sound, by the end of the 1940s. Following what had been a series of failures to adapt the Harvey Fletcher's soundtrack ideals to motion pictures, engineers and technicians pursued methods of simplifying the idea of stereophonic sound and rendering it more flexible to the needs of filmmakers. Whereas some studios reduced Fletcher's technology to a mere a noise-reduction process, Selznick and Stewart similarly repurposed the technology so that it became little more than an immersive arrangement of loudspeakers that generated thrills and surprises during a film's climax.

Yet even this simplification of multi-speaker sound was not enough to save the concept of stereo from its decline by the end of the 1940s. The decade began with a sizable community of audiophiles interested in the potentials of multi-channel formats. Concertgoers were willing to buy tickets just to see and hear three loudspeakers, and studios were willing to invest considerable time and money to produce stereophonic films that could be played through those loudspeakers. But such enthusiasm toward stereo gradually disappeared. By 1949, the trade press was no longer covering multi-channel sound as if it were a special and important event, and—as

Selznick's promotional strategies illustrate—the price of a movie ticket conveyed more about a film's prestige than did its theatrical technology. Critics and filmgoers were presumably losing interest in the novelty of stereophony, and any further attempts to develop a multi-speaker format for motion pictures would need to solve such dwindling enthusiasm for the technology's loud and abrasive soundscapes.

Conclusion

Following the premiere of Harvey Fletcher's Stereophonic Sound-Film System, Hollywood's acoustical engineers saw stereophonic technology as a means to widen the decibel ranges of motion pictures. In turn, Disney, Warners, Fox, and Selznick developed unique stereophonic systems that could enhance their more acoustically adventurous soundtracks, but none of these systems were used beyond a select number of titles. Although there was a strong desire to improve the playback levels of motion pictures, there were significant acoustical and financial limitations to sound technology at the time, and these inherent limitations made it difficult for stereo engineers to generate three-dimensional reproductions that could be of acceptable quality.

In the years that followed, such obstacles would nonetheless diminish in scale. In the following chapter, I chronicle the rise of magnetic recording, a technology that improved the cost and quality of motion picture soundtracks, and that therefore reinvigorated studio engineers to continue their acoustical research and develop a series of viable stereophonic formats for the cinema.

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[322] H. B. Lee, "Stereophon Sound Recording System Developed By Dr. Carlheinz Becker," Combined Intelligence Objectives Sub-Committee, Item no. 9, File no. XXVI-46 (July 1945), 1-7.
[323] "German Film Sound Recording System Offers Depth Illusion," *Broadcasting*, Nov. 26, 1945, 85. Why exactly the German military wanted hi-fi stereo recordings of explosions remains unclear.
[324] Lee, 5.
[325] Reveal New German Sound Track Process," *Variety*, Nov. 28, 1945, 11.
[326] For instances, see John T. Mullin, "The Birth of Tape," *Billboard*, July 4, 1976, MR-13, 38, 46; Harold Lindsay, "Magnetic Recording Part I," *db* (December 1977), 38-44;
[327] H. F. Olson and F. Massa, "On the Realistic Reproduction of Sound With Particular Reference to Sound Motion Pictures," *Journal of the Society of Motion Picture Engineers*, vol 23 (Aug. 1924), 80.
[328] Helen Hanson, *Hollywood Soundscapes: Film Sound Style, Craft & Production in the Classical Era* (London: BFI, 2017): 28-29.
[329] It is also possible that both Disney and Warners preferred RCA's variable-area systems because these systems were believed to be of higher quality than variable-density systems. However, because many Hollywood engineers continued to record motion pictures onto variable-density tracks during the 1940s, claims that variable-area was better than variable-density were likely a matter of opinion.
[330] William E. Garity and John N. A. Hawkins, "Sound Reproducing System," US Patent no. 2298618 (July 31, 1940).
[331] Michael Barrier, *Hollywood Cartoons: American Animation in its Golden Age* (New York: Oxford University Press, 1999), 242-46.
[332] William E. Garity, "Control Device for Animation," US Patent no. 2198006 (Nov. 16, 1938); W. E. Garity and W. C. McFadden, "The Multiplane Camera Crane for Animation Photography," *Journal of the Society of Motion Picture Engineers*, vol. 31 (Aug. 1938), 144-56; Lee de Forest, "Pioneering in Talking Pictures," *Journal of the Society of Motion Picture Engineers*, vol. 36 (Jan. 1941), 41-49. On page 42, de Forest humorously described Garity's recording made with de Forest's sound-film technology, that "today Garity is chief factotum for Walt Disney; possibly because that primitive recording was chiefly suggestive to him of the squeaks of Mickey Mouse."
[333] WM. E. Garity and J. N. A. Hawkins, "Fantasound," *Journal of the Society of Motion Picture Engineers*, no. 37 (Aug. 1941), 127-46.
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[336] Garity and Hawkins, "Fantasound," 140-43.
[337] Garity and Hawkins, "Fantasound," 131-35.
[338] Garity and Hawkins, "Fantasound," 143-44.
[339] "Why '100 Men and a Girl' Makes a Hit on Screen," *American Cinematographer* (Nov. 1937), 453, 58-60.

[340] H. G. Tasker, "Multiple-Channel Recording," *Journal of the Society of Motion Picture Engineers*, vol 31 (Oct. 1938), 381-85.
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[344] Garity and Hawkins, "Fantasound," 143-44. A ninth-channel contained the Garity-designed "click-track" that could allow for greater synchronization between the music and picture. William E. Garity, "Method of and Means for Scoring Motion Pictures," US Patent no. 1919364 (May 9, 1930); James J. Finn, "'Fantasia' Technical Data," *International Projectionist* (Oct. 1940), 21.
[345] William E. Garity and John N. A. Hawkins, "Method of Recording and Reproduction of Sound and Apparatus Therefore," US Patent no. 2247554 (Apr 12, 1939).
[346] Garity and Hawkins, "Fantasound," 129-30.
[347] A. P. Peck, "What Makes 'Fantasia' Click," *Scientific American*, vol. 164 (Jan. 1941), 29.
[348] William W. Garity and Watson Jones, "Experiences in Road-Showing Walt Disney's Fantasia," *Journal of the Society of Motion Picture Engineers*, vol. 39 (July 1942), 9-10.
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[353] "Reinhart's Pitless Musical Score Idea," *Variety*, Jan 15, 1936, 1.
[354] Grover C. Mueller, "Novel Sound System Brings New Realism to the Theater," *Popular Science Monthly*, April 1937, 30-31.
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[359] "Actor Sues Equity for Salary Alleged Due from 'Eternal' Bond, *Variety*, March 4, 1936, 69; "B'way's Two Spectacles Doubtful Of Paying Off Production Costs," *Variety*, Mar 24, 1937, 69; "'Eternal Road' Files Counter Claim in Suit," *Variety*, Mar. 31, 1937, 65; "'Road' May Fold Before May 15, Needing Coin to Tour, If and When," *Variety*, April 14, 1937, 69; "'Eternal Road' Closes with Benefit For Meyer W. Weisgal; May Reopen," *Variety*, May 10, 1937, 56.
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[361] See, for instance, Tim Anderson's analysis of *Fantasia* with respect to a concert-hall aesthetic in Anderson, *Making Easy Listening: Material Culture and Postwar American Recording* (Minneapolis: University of Minnesota Press, 2006), 117-20.
[362] It is worth mentioning that this temple aesthetic was not unique to music, nor to the production of *The Eternal Road*. In 1924 art director Norman Bel Geddes constructed the interior of New York's Century Theatre to look like the interior of a cathedral for Reinhardt's production

of *The Miracle*. William Paul, *When Movies Were Theater: Architecture, Exhibition, and the Evolution of American Film* (New York: Columbia University Press, 2016), 16. Reinhardt's later work with RCA's Dimmick seems to have merely provided the director with an opportunity to extend this aesthetic of visual immersion to one of auditory immersion.
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[364] Olin Downes, "'Fantasia' Discussed From the Musical Standpoint—Sound Reproduction Called Unprecedented," *New York Times*, Nov. 14, 1940, L28.
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[368] This wide price range was likely due to each theater having unique installation needs. "Pix Sound Revolutionized," *Variety*, Nov. 13, 1940, 25; "Films' Technical Advances in '40," *Variety*, Jan 8, 1941, 36; Peck, 30.
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[382] Groves, interview with Irene Atkins, 198-99.
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[393] Peck, 30.
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Chapter 4: The Transition to Magnetic Recording, 1946-1952

May 16, 1946 has long been considered a turning point for the history of sound technology, for it was on this day that United States Army engineer John Mullin gave the first public presentation of the German-made Magnetophon K-4 to the San Francisco chapter of the Institute of Radio Engineers (IRE).[465] The Magnetophon was a tape recorder, among the first ever made. It was invented by the German electrical company, Allgemeine Elektricitäts-Gesellschaft (AEG), in co-operation with engineers at the Badische Anilin und Soda Fabrik (BASF) tape manufacturing plant, a division of the I. G. Farben chemical company. The Magnetophon K-4 was also portable. The "K" in the name stood for "Koffer," the German word for "portable case," and the dimensions of the device were in fact no bigger than a suitcase.[466] The Koffer series had been in development since the 1930s, and the K-4 differed from its predecessors in its boasting of an extraordinarily wide frequency characteristic for a machine its size.[467] The machine reproduced sounds ranging from twenty-five cycles to ten-thousand cycles, with a flat response between thirty and nine-thousand cycles. More, it reportedly achieved a signal-to-noise ratio as wide as eighty decibels.[468] Despite its origins in Nazi Germany, those who attended Mullin's demonstration were stunned by the Magnetophon K-4's impressive sound quality.[469]

The May 1946 meeting of the IRE, however, was not the first time the famed magnetic tape recorder played for American engineers. According to BASF historian Friedrich Engel, AEG sent an earlier model of the Magnetophon to its New York office as early as 1937 in the hopes of enticing General Electric (GE) to market the machine in the United States.[470] GE, however, balked at the opportunity. Their reasons were reportedly due to the Magnetophon's

poor acoustical quality, although Engel suggests that GE's rejection was also because the device was invented outside of America. Regardless of GE's reasons, the Magnetophon was not the closely held "state secret" that historians have since claimed it to be.

Similarly, and contrary to popular accounts of audio history, Mullin was not the only person actively promoting the German-made tape recorder to American engineers. Much like the collective effort by the Signal Corps and the Commerce Department to disseminate the Stereophon technology to various businesses, the American government began distributing pamphlets that provided engineers with technical details about the Magnetophon K-4 as early as November 1945.[471] By the time Mullin presented the device to the San Francisco chapter of the IRE, there were a number of American businesses who were already informed of AEG's and BASF's innovations.[472]

Mullin's contribution to history involved a level of showmanship that was largely absent from magnetic recording industries at the time. His presentations to the IRE and to other engineers were peppered with stories of his own heroism during the war, tales that he would later publish in *High Fidelity* and *Billboard*.[473] It was he, Mullin proclaimed, who stood face to face with Nazi officers while rescuing the device from a German castle forty-five miles north of Frankfurt, and it was he—the quasi-Indiana Jones of magnetic recording—who then smuggled the Magnetophon out of Europe. Although hyperbolic, Mullin's stories were no doubt effective tools in establishing the value and importance of magnetic tape recording to the American recording and broadcasting industries. Unlike the Stereophon's reception in North America, which fizzled more than it wowed, the Magnetophon was exceedingly popular. Its stateside arrival in 1946 led to the boom in magnetic recording equipment not only within the professional arenas, but within the consumer marketplace as well. It allowed for suburban households to own

professional grade audio equipment, and it further engendered the formation of publications, such as *Audio Magazine*, *Audiocraft*, and *Tape Recording*, which routinely informed amateur hobbyists about the latest technologies and techniques associated with magnetic media. Indeed, the rise of a post-war audiophile culture was just as indebted to turntables and home speaker systems as it was to portable tape recorders, namely those that were mass-produced in response to the Magnetophon as well as the ongoing research in magnetic media at Ampex in San Francisco, the Armour Research Foundation in Chicago, and the Brush Development Company in Cleveland.

And Mullin was not alone. By the late 1940s, there emerged a host of influential audio engineers who extolled the virtues of magnetic tape recording over previous forms of sound reproduction, namely sound-on-disk (mechanical) and sound-on-film (photographic or optical). Marvin Camras, an engineer at the Armour Research Foundation, was especially effective at selling the possibilities of magnetic recording to the film industry.[474] He argued that magnetic media could help widen the recording and playback characteristics of motion picture sound tracks, and that its material efficiency could lower the costs and streamline the process of multi-track recording. More, Camras argued that the low noise floor of magnetic media could solve the many problems that had plagued stereophonic sound systems in prior decades. Thus, magnetic media could allow Hollywood to finally create and install a viable stereo format in studios and theaters, thereby ending the string of failures that had prevented Fletcher's theories of auditory perspective from becoming a viable option for the cinema.

Hollywood, however, was not enticed by magnetic recording's ability to improve upon the problems of the past. Following what was one of the most productive waves of stereophonic experimentation in Hollywood—a period that extended from Disney's Fantasound in 1940 to

James G. Stewart's Multi-Sound in 1948—the motion picture industry appeared to no longer have any interest in three-dimensional audio. Studio engineers instead would construct the new sound technology merely as a means to refine their old and well-established recording and mixing techniques. Though magnetic recording would have dramatic effects on other industries and on American audio culture more broadly, the transition to magnetic recording in Hollywood was historically and conspicuously unremarkable.

This chapter accounts for why the industry's conversion to magnetic sound all but ignored the new format's ability to enhance multi-channel sound systems. I argue that Hollywood's construction of magnetic media was not caused by any sudden loss of interest in stereo. Though there would always be some skepticism toward multi-channel sound as a practical investment, the absence of almost any stereo experimentation during the industry's transition to magnetic recording was largely due to economic uncertainty as well as to structural inertia that kept studios locked into pre-existing workflows. The new technology was valued by studios more for its ability to reduce costs, and less for its ability to improve motion picture aesthetics. In turn, studios constructed their magnetic recording technologies in a manner that prevented it from seriously disrupting established production and postproduction practices, disruptions that might increase a studio's overhead expenses. The larger aesthetic benefits of magnetic media—namely those pertaining to multi-channel sound systems—were subsequently excluded from the equipment's designs. As a result of these economic concerns and their technological consequences, Hollywood delayed the development of a viable stereo format that took advantage of magnetic recording's acoustical capabilities.

Optical Sound and Path Dependence

The conservative manner by which Hollywood constructed its magnetic equipment during the late 1940s and early 1950s was a consequence of the many technological decisions that Hollywood made during the early 1930s. Following the transition to talking pictures, studios relied upon two photographic systems for the recording, rerecording, and reproducing of motion picture sound tracks: RCA's variable-area system, and Western Electric's variable-density system. This adoption of only two formats lowered the financial risks associated with technological investment. Studios and theaters could install optical sound equipment without fearing that they would need to replace this equipment within a few years. Similarly, audio engineers could donate time and money into developing noise reduction processes that were optimized for optical sound systems—such as push-pull recording, ultraviolet light exposure, and fine-grain film stock—without fearing that these processes would become obsolete with the adoption of different recording formats. The lowered risks that resulted from Hollywood's standardization of optical recording therefore increased economic stability within the industry, particularly the long-term stability of talking pictures.

However, optical technology was far from perfect. Photographic sound recording required filmmakers to use both negative and positive film stocks for a single take, requirements that increased the material costs of motion pictures. The light sensitivities of negative stock also required sound departments to construct cumbersome equipment that prevented any unwanted exposure when filming outside or under bright studio conditions. Further, the process of developing negative prints prevented actors, musicians, and other filmmakers from reviewing the quality of a recording until after the lengthy photographic development process, which at times took up to a full day.[475] The cost, material, and time constraints of optical sound encouraged

engineers to develop different encoding technologies that might correct several of the undue burdens associated with the photographic inscription of sound tracks. However, studios rejected each of these competing inscription processes due to costs associated with technological change. In other words, the studio system was not a free market. Though competing sound formats offered Hollywood producers a solution to the problems associated with variable-area and variable-density sound tracks, there were economic disincentives that dissuaded the industry from considering the adoption of such formats.

Economists refer to such inertia within the marketplace as path dependence.[476] Accordingly, when an institution adopts a new technology—as Hollywood did with optical sound—it can then become difficult for the institution to replace its technology when a more efficient or higher quality competitor becomes available. The institution's bias toward an inferior product is often the result of two phenomena. For one, the older technology has likely undergone several upgrades, whereby the manufacturers received feedback and made several changes to remove design flaws that might impair functionality. Such changes—known as increasing returns—can render the older technology more attractive within the marketplace, despite the new technology's many benefits.[477] For another, the institution itself has likely made several changes, whereby it invested in several business operations, such as infrastructure and labor contracts, that are designed to increase the efficiency and use of the older technology. The adoption of an entirely new set of technological protocols might disrupt these business operations and require the industry to invest more capital in new infrastructure, the cost of which could outweigh the benefits of any technological improvement.

With respect to motion picture audio, Hollywood's decision to adopt optical sound as the recording and playback standard led to the formation of economic structures that were designed

to help support the new optical standard. These structures included microphone techniques, rerecording practices, photochemical processes, divisions of labor, post-production workflows, and the design of theatrical sound systems. In effect, Hollywood's financial investment in infrastructure and labor practices that were optimized for optical sound would create disincentives for the industry to consider replacing the format with non-photographic sound processes. Accordingly, studios were "locked-in" by historical events to the photographic sound standard.[478]

Mechanographic Film

James Miller's "Millerfim" process offers the clearest example of how the industry's lock-in incentivized studios to reject competing recording technologies that were designed to correct the shortcomings of photographic sound inscription.[479] Miller specifically devised a way for studios to eliminate the need for both positive and negative film stocks during sound recording, as well as the subsequent need for lengthy development processes. To achieve this, Miller appropriated the mechanical recording systems associated with sound-on-disk media. Though instead of cutting an up-and-down "hill-and-dale"-type track onto a record's groove, an angled stylus cut small vertical bumps onto a special strip of film. This film consisted of a thin layer of opaque material that rested on top of a transparent base. When the triangular stylus moved up and down, it would cut through the opaque material and expose the base. And because the stylus would cut through the film at an angle, the vertical movement of the stylus created an optical sound track with varying widths.[480] Miller's mechanical encoding process could subsequently allow for a variable-area sound head to read the track as if it were recorded photographically. He thus called his system "mechanographic" recording.

Because Miller's process eliminated the need for photographic development, he argued that it would reduce a film's material and labor costs.[481] Further, the precision with which it cut a sound track was suggested to be far greater than that achieved with photographic exposure. Miller specified that mechanographic recording could increase the signal-to-noise ratio of sound tracks by as many as twenty decibels, allowing tracks to boast a range of seventy-five decibels.[482] Despite these benefits, Hollywood dismissed Millerfilm as an alternative to its standard optical processes. The industry's rejection was partly due to an unfortunate roll-out. Miller first demonstrated his system to the Society of Motion Picture Engineers on May 24th, 1935, the same day that Douglas Shearer unveiled MGM's push-pull noise reduction process. Although *Variety* would later refer to Millerfilm and push-pull collectively as "two revolutionary methods," Shearer's demonstration likely eclipsed Miller's spotlight among studios.[483] More significantly, Miller did not effectively convince the industry that the benefits of his system outweighed the price of conversion. Radio historian Sean Street notes that the recording process had the potential to be expensive due to the costs of the film material, and perhaps as a result of the lower noise levels—the cuts and splices of Millerfilm were reportedly more audible than those of other recording material.[484]

However, Miller's inability to sell his Millerfilm within the Hollywood marketplace was not simply a matter of Miller's poor announcement timing and the design flaws in his equipment. Indeed, any shortcomings of a working prototype presumably could have been solved with small refinements made to the filmic material and sound heads, refinements that were unlikely to have strained the bank accounts of studios and manufacturers willing to make the investment. More likely, what hurt Miller's chances in the marketplace were the demands that his invention would have placed upon the technological and economic structures that supported photographic

formats. Studios and theaters would have needed to invest in new recording, re-rerecording, and playback equipment that was specifically optimized for Millerfilm's frequency characteristics. Similarly, manufacturers like Dupont and Eastman Kodak would have needed to begin mass production of Miller's mechanographic film stock, an endeavor that would have likely necessitated the costly overhaul of their many manufacturing plants.[485]

Further, and perhaps most damaging to the industry, RCA's and ERPI's patents for light-based sound inscription processes would have lost their value, as would the two companies' licensing agreements with studios and theaters. The loss of revenue for the industry's leading manufacturers of production and theatrical equipment would have risked slowing down the research and development arm of the industry as a whole, consequences that would have potentially outweighed any aesthetic or short-term financial benefits of Millerfilm. Such economic factors relating to technological change meant that—likened to a game of poker—Hollywood was ostensibly "pot-committed" to optical sound, even if optical was at times aesthetically flawed and materially inefficient.

Precursors to Magnetic Soundtracks

This economic lock-in also led Hollywood to initially reject magnetic sound recording as an alternative to photographic sound. Like Millerfilm, magnetic recording eschewed a need for positive and negative stock, and it enabled immediate playback once a signal was recorded. Yet instead of physically cutting a track onto a strip of film, magnetic recording was a touch-free process. As historian Mark Clark notes, the scientific principles behind this process originated as early as 1878, when New Jersey iron manufacturer Oberlin Smith was said to have visited Thomas Edison's laboratory in Menlo Park.[486] Smith wanted to hear what was, at the time, a

brand-new invention: the phonograph. However, after seeing how the technology worked firsthand, Smith concluded that Edison's machine was highly flawed. Of particular concern to Smith was the way the phonograph required a needle to scratch the surface of the track in order to record and reproduce sounds. For Smith, these scratches not only degraded the quality of the equipment, but they also introduced unwanted noise and distortion into the signal.

To address this matter, Smith devised a touch-free method by which signals were encoded into magnetic charges. According to Smith's article in *The Electric World*, published in 1888, individual tracks of sound could in theory be coated with microscopic particles—such as iron filings—that had positive and negative magnetic charges.[487] And in place of a sharp stylus, an engineer could use a small magnet that rested just next to the filings, and a metal wire could be coiled around this magnet. Thus, when an electrical signal was sent through the wire, the subsequent electromagnetic field would cause the magnet to rock back and forth, and thereby translate the pulses of the electrical signal into a series of positive and negative polarities on the surface of the soundtrack. The use of a magnet in place of a needle allowed recordings to be erased and reused with little difficulty. If the engineer did not like the recording, he could simply send a different electrical signal to the magnet, thus re-orienting the polarity of the iron particles. The destructive nature of mechanical, photographic, and mechanographic processes did not allow for any erasure and reuse of individual tracks. As a result, magnetic recording had the potential to be of immeasurable value to the motion picture industry.

The Blattnerphone

That said, the theory of magnetic recording was not easily put into practice. The process of actually finding the right material to serve as the physical base for the magnetic filings to rest

upon was much easier said than done. This process led to a series of experiments in which various types of flexible and no-so-flexible media were tested. Many of these experiments even led to the development of technological prototypes that were sold to entrepreneurs and other businessesmen were hoped to cash-in on the new sound technology. However, many of these early attempts to market magnetic recording ended in failure.

Among the most notorious of these systems was the steel based technology known as the Blattnerphone. According to historian William Lafferty, the concept of recording sounds onto flexible steel originated with Curt Stille, a German inventor who by the 1920s had acquired the patents for the many failed magnetic recording technologies that were developed following the publication of Smith's theories.[488] Using these patents, Stille constructed his "System Stille," a new device that stored sounds onto a six-millimeter wide steel ribbon, and that could hold up to twenty minutes at a time at a recording speed of five feet per second. Following its initial construction, Stille licensed his technology to Ludwig Blattner, a German-born British film producer and theater owner who wished to produce his own talking pictures while simultaneously circumventing the costly patents of RCA's and Western Electric's optical sound formats. Indeed, Blattner believed that steel ribbons were a practical alternative to optical tracks, and that he would have much success promoting steel ribbons to studios and manufacturers.

He was wrong. Blattner rebranded Stille's device the Blattnerphone and proceeded to demonstrate it to the film industry to middling results. By the early 1930s Blattner's failed attempts to convince producers to convert to Stille's invention resorted in Blattner demonstrating his device in between double features at select movie theaters, recording filmgoers as they told jokes to each other, and reproducing these jokes for the entire auditorium. As Lafferty further notes, "these novelty shows appear as pathetic parodies of the grandiose film production schemes

envisioned by Blattner three years before."[489] Blattner was sadly never able to convince filmmakers to use his device, and soon after declaring bankruptcy on his new business venture, he committed suicide.

Blattner's death notwithstanding, the Blattnerphone's fate was sealed when the costs of converting studios to the System Stille were seen as outweighing any potential advantages introduced by the new recording process. Although the Blattnerphone was capable of recording up to twenty minutes at a time, the machine needed to hold up to a mile of steel ribbon, a requirement that caused great strain on each of the machine's spools.[490] The weight of the spool would interfere with the speed of the motor, which introduced distortion into the audio signal during playback. Stille initially solved this problem by creating sprocket holes down the center of the ribbon, but because the sprocket-driven motor was run on conventional batteries, the intensity of the motor speed continued to remain uneven when recording and reproducing the audio signal.[491] Further, Stille's steel ribbon used a charcoal-iron base that was only made in Sweden, a limitation that further hindered the Blattnerphone's potential adoption throughout the motion picture industry. These defects were perhaps why Blattner himself decided not to use his magnetic recorder when adding an orchestral score to rerelease prints of the silent film *A Knight in London* (1928). He instead recorded the music onto a standard optical track.[492]

The Telegraphone

Not all early magnetic technology was as difficult to use as the Blattnerphone was. Indeed, many sound engineers saw greater commercial success when they replaced cumbersome steel ribbons with much smaller and lighter weight recording media. Among the more successful of these devices was the portable Telegraphone. The magnetic recorder became a popular

dictation machine among businesses, and due to its relative ease of use, it was also seen as a necessary investment for many motion picture studios.

Invented in 1898 by Danish engineer Vladimar Poulsen, the Telegraphone encoded magnetic signals onto a thin wire that was similar in shape to piano wire.[493] The machine came with a microphone and a small speaker system, not unlike the more popular phonograph dictaphones at the time. Arguably, however, the narrow wire and its ease of reuse made the Telegraphone more materially efficient than phonographs were. Seeing an opportunity to capitalize on the new invention, in 1903 Poulsen licensed his device to American lawyer John Lindley. Lindley in turn founded The American Telegraphone Company (ATC) with the purpose of expanding the potential market for the new technology, and of manufacturing the device for commercial use.[494] ATC made several innovations that enabled the steel wire to store up to thirty minutes of sound, and by the 1910s Lindley was promoting his device to businessmen and stenographers as a vast improvement upon standard dictation equipment.

Lindley's business also benefited from the device's prominence in motion picture melodramas. The eleventh episode of the serial melodrama *The Exploits of Elaine* (1914), for instance, typecasts the Telegraphone as the story's Deus ex Machine. In the middle of the episode, the megalomaniacal villain, known only as The Clutching Hand, records his evil scheme to murder the titular Elaine onto magnetic wire. Once the recording is discovered by the heroic scientist Craig Kennedy, The Clutching Hand's fiendish plot can be deciphered, and Kennedy can subsequently save Elaine yet again from her premature demise.[495] Such product placement, though inventive, was not enough for Lindley's corporate ambitions to materialize. In 1919, ATC would fall into bankruptcy, leaving Poulsen's machines to become technological curiosities and vestiges of a road not taken for the communication industry.[496]

Hollywood would nonetheless rediscover the Telegraphone during the industry's transition to sound beginning in the late 1920s. Specifically, studios re-identified the machine as a tool to aid in the construction of proper vocal techniques and in vocal pedagogy more broadly. By the late 1920s, science professors at the University of Southern California began using the Telegraphone to study characteristics of the human voice.[497] These professors even coined new terms such as "dynaphonic", "plasmaphonic", "diaprusophonic", and "eudynoacousmophonic," words intended to bolster the significance of their scientific findings.[498] Further, the professors invited MGM stars like Norma Shearer to their labs, where there voices could be studied, and where the actresses could therefore be taught how to speak into microphones with greater aesthetic yield.[499]

It remains unclear if these experiments at USC actually had any affect on Shearer's acting quality. Nonetheless, MGM chose to continue such uses of Telegraphones on their sound stages. For the production of the Grace Moore vehicle *New Moon* (1930), MGM recorded select scenes with the Telegraphone in order for the actors to review their vocal performance immediately after each song.[500] Actors could then make the necessary adjustments to their performances while on the set, as opposed to waiting several hours to hear the recordings after they were developed onto positive stock. Thus, though Telegraphones were not initially tied to the recording, rerecording, or playback of motion picture soundtracks, they were still valuable tools for singers and other actors who wished to perfect their line deliveries during the early years of talking pictures.

It was because of these initial experiments that the industry's Society of Motion Picture Engineers commenced a series of discussions as to whether or not the device could become a viable alternative to photographic sound recording.[501] It was noted, for instance, that the

Telegraphone did not require the duplication of sound tracks on both positive and negative film stock. It was further highlighted that the Telegraphone's immediate playback made the device inherently useful to actors wanting to know how they sounded in each take. None of these discussions of the Telegraphone's viability, however, were met with serious consideration. Of utmost concern to engineers were the machine's limited frequency characteristics. Engineers felt that the sound reproduction on the machine was simply not wide enough to warrant further investment into improving the technology so that it could replace RCA's and ERPI's optical formats.[502] Instead, the use of magnetic encoding remained limited to spot-checking of an actor's performance.

Devices like the Telegraphone and derivative wire recorders continued to be used as on-set dictation devices in the decades that followed. Alfred Hitchcock, for instance, used portable recorders on the set of *Rope* (1948) in order to allow actors to review their performances once each take was complete, an affordance that made it easier for actors to deliver their lines with fewer mistakes over the course of the film's production and its staging of numerous long takes.[503] As a result of such uses, portable magnetic recorders were valued as tools for actors to make small, cosmetic changes to their performances. As sound engineer Semi Begin would argue, magnetic technology was simply a mirror for the voice, not unlike the dressing room mirror that reveals lipstick smears and uncooperative cowlicks.[504] It was not, by any means, seen by the industry as a technology that could dramatically improve the quality of motion pictures as a whole.

The Magnetophon

Hollywood nonetheless revised its opinion of magnetic recording following the series of financial setbacks that took place after World War II. The end of the 1940s saw the combined profits of the ten major studios begin to fall by as much as seventy-four percent.[505] This decline in revenue was due in part to a steady decline in film attendance, but it was also due to the rising prices of 35mm film stock and the ongoing strikes among below-the-line studio workers, many of which delayed productions and swelled motion picture budgets.[506] Additionally, the relatively lower tax rate for companies, as compared to individuals, encouraged filmmakers to form their own production houses in order to avoid taxes and absorb more of the profits from film grosses.[507] Though intended to save money, these newly formed independent companies led to more competition among producers for onscreen talent, which inflated the salaries of actors and further trimmed away at the studios' profit margins.

In order to address these adverse conditions, studios looked to cut production costs. One proposed solution was to change the product itself. In 1946, Louis B. Mayer ordered that MGM shorten the running times of all of its feature-length releases, as doing so could save his studio labor and material expenses.[508] Other solutions addressed the costs of filmmaking technologies. For instance, in order to reduce the expense of impressive camera movements like craning and tracking shots, studios encouraged filmmakers to use zoom lenses that simulated such visual flourishes without actually moving the camera.[509] By and large, these solutions were all small in scale, but when added together they could conceivably save studios on overhead costs in order to make up for the steady decline in box office receipts.

It was within this economic context that studios also re-identified the value of magnetic recording. It was no longer merely a cosmetic device, but a cost-effective substitute for variable-

area and variable-density optical recording. Of particular interest to studios was magnetic technology's material efficiency, namely the ability for recordings to be immediately reviewed and—if so desired—erased and reused without the need for expensive photochemical processes. Moreover, the late 1930s and early 1940s saw several innovations to magnetic encoding, each of which greatly improved upon the frequency characteristics and labor demands that had plagued earlier recording equipment.

It was discovered, for instance, that much of the distortion that marred early magnetic recordings were due to the fact that iron filings could move around, albeit slightly, after the recording process stopped.[510] Engineers found that if they encoded an inaudible, high-frequency signal—known as a bias—alongside the audio recording, then they could essentially lock these filings into position and subsequently lower distortion and extend the frequency range of the playback signal.[511] Additionally, engineers developed a new type of recording material that was both cost-effective and light-weight: magnetic tape.[512] The portability of tape recorders, in combination with the extended signal range produced by a high-frequency bias, made magnetic technology that much more attractive to those in Hollywood who were looking to invest in more efficient filmmaking technologies.

The machine that would serve as the model for such investments was the German-made Magnetophon K-4. Though not the first tape-based magnetic recorder ever invented, the suitcase-sized Magnetophon was the first tape recorder to achieve considerable influence within the entertainment industry due to the promotional campaign that accompanied its arrival in North America. The device became a technological curiosity after it was discovered that Nazi officers were using the machine to broadcast high-quality concerts to their front lines without the need for live musicians. As previously noted, the Department of Commerce disseminated technical

pamphlets about the Magnetophon soon after the war in order to encourage manufacturers to exploit the accomplishments of German engineers. The machine also benefited from being personally promoted by John Mullin. His 1946 presentation to the IRE in San Francisco was notable for the stories he told as well as for the machine's acoustical quality.

In many ways, Mullin's demonstration emulated the type of stereophonic demonstrations that Harvey Fletcher routinely delivered in the 1930s. The most salient similarity was Mullin's emphasis on volume. Magnetic tape had extraordinarily wide frequency characteristics—far wider than the characteristics of optical recordings—and Mullin accentuated these differences by opting to play his Magnetophon recordings through a giant Western Electric loudspeaker, affectionately nicknamed "the tub."[513] Despite long-established claims by equipment manufacturers that their machines were capable of reproducing "noiseless" signals, hiss and hum remained a serious problem for radio and electrical engineers.[514] Mullin's demonstration did not just acknowledge this problem; its pairing of a high quality tape recorder with an equally powerful loudspeaker provided the industry with a practical solution.

The success of the Magnetophon's unveiling to the IRE triggered a series of responses from the entertainment and recording industries that inaugurated the post-war tape recording boom during the years that followed. Ampex's Alexaner Poniatoff and Harold Lindsay began developing consumer-grade magnetic recording equipment largely modeled after the Magnetophon, equipment that would eventually lead to the release of Ampex's popular Model 200A tape recorder and its subsequent use in the music and broadcasting industries.[515] Other inventors, including Marvin Camras of the Armour Research Foundation and Semi Begun of the Brush Development Company began developing similar tape recorders, and soon called upon companies like Shellmar, the makers of bread wrappers, and Minnesota Mining and

Manufacturing (3M), makers of scotch tape, to begin mass producing magnetically coated paper tape that could support the growing marketplace for new audio technology.[516]

Mullins himself would continue to demonstrate the Magnetophon to radio engineers in an attempt to reinvigorate the possibility of broadcasting "canned" recordings over airwaves. Such attempts would prove successful. Mullin's expertise and charisma landed him a job as the head of engineering for Bing Crosby Enterprises, and gave him the opportunity to oversee the first broadcast of ABC's Philco Radio Time, recorded in 1947 with the specially ordered Ampex's Model 200A with BASF magnetic tape.[517] By the end of the 1940s, mechanical and photographic sound recording was slowly being phased out and replaced with more materially efficient magnetic equipment, which—alongside the rise of other home sound equipment—would commence a period of audiophilia that has since been dubbed the age of high fidelity.

Studios Adopt Magnetic Recording

The Magnetophon demonstrations and the growing popularity of tape recording more broadly prompted the Society of Motion Picture Engineers to discuss the similar prospects of replacing their recording, rerecording, and reproducing equipment with new magnetic technology. In October of 1946, the Society convened in Hollywood to debate this issue. As engineer Loren Ryder of Paramount remarked, the purpose of the meeting was for studios to better understand the current state of magnetic sound, and for manufacturers to learn the needs of filmmakers in order to design more desirable equipment.[518] The speakers included Begun, Camras, as well engineers from Magnecord and Indiana Steel.[519] Camras's talk was notable for generating considerable interest among attendees as to the viability of the new recording technology. During the talk he presented on a new four-track 35mm filmstrip that was fully

coated with a thin layer of iron oxide. The film produced a signal-to-noise ratio that was noticeably lower than standard motion picture sound tracks. However, what piqued the audience's interest was not the specific capabilities of the equipment, but the way that Camras spoke of the potentials of magnetic recording with respect to the concept of increasing returns:

> It appears that film recording techniques have approached closely to theoretical limits of perfection, and there is no reason to expect revolutionary changes in the near future. On the other hand, we have by no means reached the ultimate in magnetic recording heads or media. Theoretically a magnetic track can be at least as good as an optical one, and the magnetic record should give a greater dynamic range without resorting to artificial noise reduction schemes.[520]

In other words, though 35mm magnetic sound was not yet capable of producing the frequency characteristics of optical sound, Camras asserted with continued innovations the new technology would be able to surpass the quality levels achieved with push-pull, equalization, and other photographic sound recording techniques.

Though open to the idea of magnetic recording, Hollywood engineers initially responded with skepticism toward the promises made during each of the presentations. George Tallian of Paramount, for instance, wondered if magnetic splices were audible, Lawrence Brunswick of Bardwell & McAllister production equipment questioned if metallic sprockets demagnetized magnetic tracks, and John Crabtree of Eastman Kodak asked if magnetic signals would interfere with adjacent tracks stored on the same 35mm filmstrips.[521] The consensus of the Society's members was that if studios wanted to replace optical recording equipment with less-expensive magnetic media, then there would need to be several requirements imposed upon the new technology in order to prevent any costly changes to postproduction workflows. [522] These requirements included a frequency range between fifty and ten-thousand cycles and a signal-to-noise ratio of fifty-five decibels.

Additionally, magnetic equipment needed to allow for visual markers, edge numbers, lossless duplication of recordings, lossless reproduction up to 500 plays, non-flammable base, perforations to maintain synchronization with the picture, quick rewind times, three-second start-up times for motors, and the ability to record continuously for up to eleven minutes. Furthermore, all of these demands would need to be met for the four standard print sizes—35 mm, 17.5 mm, 16 mm, and 8 mm—and the studios would need full ownership of the patents used on the sound equipment in order to protect themselves from lawsuits. By and large, the industry wished to design magnetic recording equipment so that it would be non-disruptive to each studio's economy, particularly its pre-existing modes of optical sound production. Simply put, studio engineers wanted magnetic recording to be indistinguishable from optical recording.

In turn, the industry's manufacturers developed conversion kits that could allow studios merely to upgrade their sound systems in place of installing entirely new equipment. RCA's conversion kits included new sound heads and demagnetized inner components that enabled its PR-23 optical recorder to also store sounds onto magnetically coated tape.[523] Western Electric similarly provided studios with conversion kits for its RA-1231 recording units.[524] By the early 1950s, both RCA and Western Electric were also developing a new line of magnetic recorders that were compatible with the larger production needs of the industry. RCA introduced their PM-62 two-channel recorder and PM-63 three-channel recorder, both of which boasted a signal-to-noise ratio of 57 decibels between 30 and 10,000 cycles.[525] Likewise, Western Electric unveiled their Westrex 1035, a portable two-channel magnetic recording unit, which was said to produce a signal-to-noise ratio as high as seventy decibels between thirty and ten-thousand cycles.[526]

As a result of their having met the demands established by the Society of Motion Picture Engineers, the new magnetic recording technologies were quickly adopted by Hollywood.[527]

Columbia, under the direction of John Livadary, became among the first studios to install multi-track magnetic recording equipment for their scoring stages.[528] Warners similarly collaborated with RCA to develop their own magnetic recording apparatus, which the studio first used during King Vidor's production of *The Fountainhead* (1949).[529] Moreover, MGM and United Artists became two of the earliest studios to use the Westrex 1035 recorder to save production costs during foreign location shoots, such as those for Fred Zinnemann's *Teresa* (1951) and Jean Renoir's *The River* (1951).[530] According to the Society's Journal, by 1952—six years after the Magnetophon's initial premiere—magnetic recording had become the "established medium" for original dialogue and music recordings at each of the major studios.[531]

In addition to satisfying the Society's acoustical requirements, magnetic technology saved studios a considerable amount in production costs. Instead of photographically recording and processing all production takes, many studios recorded scenes on magnetic stock and transferred only the good takes to direct-positive optical stocks. The bad takes, in turn, could be erased and reused by studios, thus greatly reducing studio overhead. Universal's Leslie Carey and Frank Moran, for instance, reported in 1950 that they had begun using magnetic recording and direct-positive transfers for a handful of films including *Iron Man* and *Fiddler's Green* (renamed *The Raging Tide*), both released in 1951.[532] Notably, Carey and Moran manipulated Western Electric's RA-1231 unit so that it could record onto 35 mm magnetic filmstrips, and transfer the magnetic recordings to standard push-pull tracks. This technical workaround allowed filmmakers to cut and splice an optical track in post-production without destroying the 35mm magnetic film stock.

The cost of this process was reportedly one quarter of the total cost of comparable all-optical productions. For *Iron Man*, Carey and Morgan estimated that an optically recorded film

would have cost $4,100 in film materials, including 104,000 feet of negative stock, 29,000 feet of positive stock, and the cost of processing the optical tracks. With magnetic recording, the total material costs dropped to $968 once it became routine for all films to be recorded with this method.[533] Such stories of lowered expenses no doubt helped to popularize the new technology among the budget-conscious studio heads.

Refined Editing Techniques

Magnetic recording was similarly vaunted by studio technicians, though such praise was not immediate. Editors and mixers originally criticized the physical appearance of magnetic tape. Variable-area and variable-density tracks were photographs, and thus they allowed practitioners to see the sound and make editing decisions without necessarily running the track through a sound head. As MGM sound editor Milo Lory recounted:

> … any sound effects editor can look at an optical sound track, particularly the variable density type, and read it pretty accurately. You can say, "Well, that's a pistol shot." [...] I've put lots of gunshots in, in the optical days, without even putting them in the moviola. I pick up the gunshot, and I can see the flash in there, and I know where it goes and put it in.[534]

Lory further noted that the photographic nature of optical tracks allowed for creative work-arounds when technicians needed to quickly add sound effects to a scene: "I've even seen people put a door slam in by taking a pencil and putting a bump on the sound track. It's crude, but it works."[535]

In contrast, the sounds on magnetic tracks were not visible to the human eyes, and thus the technology prevented editors from exercising the same type of short-cuts. According to technology historian David Morton, "magnetic recording was not without its critics. Many editors in the early 1950s refused to work with it, complaining that unlike optical recordings, it

was impossible to edit the film visually by looking at the undulations on the sound print."[536] Indeed, it was not uncommon for technicians to complain about magnetic recording and to exaggerate its deficiencies in order to emphasize the difficulties of postproduction sound labor (or, to simply tell a good story). Rerecording mixer Murray Spivack would even insinuate that the ease to which magnetic tracks could be erased ultimately caused his assistant to drop dead during the music recording for *Oklahoma!* (1955). As Spivack recalled, the assistant was so used to degaussing (erasing) bad takes that he accidentally erased a good take:

> I made a take that took me a day and a half to make, and the recorder immediately went over and degaussed the tape. So it took me another day to try and get a comparable take. And this fellow grieved about that so much, you know, and he had a weak heart. [...] And he died.[537]

For Murray Spivack, magnetic recording may have been materially inexpensive, but such costly mistakes came at a deadly price.

Of course, tales of the technology's fatal flaws were not representative of how it was typically used. During the early 1950s, engineers developed machines that allowed for pen lines and variable-area tracks to be written next to a magnetic track, thus alleviating the concerns of many editors and mixers about their being unable to see sounds.[538] At the same time, many other technicians were reportedly becoming so comfortable with editing magnetic tape that such cumbersome visualization machines were discarded in favor of simply making a small tick mark on the film wherever a sound began. According to Warners' George Groves, "because the editors got so used to playing mag track in a reproducing machine, with the fast forward and backward motion, that you could easily spot a mark with a grease pencil where cuts should be made."[539] Spivack's complaints about magnetic recording being too easy to erase also appear to have been greatly exaggerated. According to Lory:

> In the optical days, you'd have several rehearsals, and then you'd make a couple of takes. Then the film has to go to the lab to be developed that night. You can't hear it again until the next day. Whereas the mag, you can immediately play it back. So you know right away whether it's right or not. You don't have to wait. This is a tremendous advantage. Or you can have a take, and you might say, "The music is too loud for the first 200 feet." So, erase it and do it over again. But the rest of it is still intact, still good.[540]

In other words, there may have been some resistance to magnetic recording during its initial implementation—especially among the below-the-line laborers who had no say in the cost-saving decisions of the studio. However, like the studio heads, editors and mixers soon found the new technology to be advantageous with respect to simplifying the post-production process. As a result, any reservations about magnetic recording all but disappeared.

Curiously, there were few incentives for these technicians to alter their craft in order to take advantage of magnetic technology's acoustical potentials. Indeed, though sound practitioners—much like anyone else in Hollywood—were not opposed to showcasing their recording and mixing talents, there were few opportunities to do so. This was largely because studios continued to distribute release prints to theaters that adhered to the Academy Mono playback standard.[541] In the ten years since the acoustical standard was created, it had proved to be beneficial to the industry's technical needs, for its standardization of decibel levels meant that studios and theaters could invest in new recording, rerecording, and reproducing equipment without worrying about any major changes in acoustical quality subsequently devaluing these investments in the near future.

But Academy Mono also placed severe restrictions on the playback ranges of motion pictures. While the frequency characteristics of magnetic recordings were capable of extending well beyond the Academy's restrictions, Hollywood's reluctance to update its acoustical standard with a wider characteristic meant that the new technology's extended ranges would never be

audible in theaters. As a result, there was little to no reason for technicians to experiment with these ranges and thereby overhaul the aesthetics of motion picture soundtracks.

There were nonetheless places where the craft of magnetic recording and mixing differed from optical, even if only for only a short period of time. Indeed, perhaps the most notable change that magnetic recording made to filmmaking was not with respect to acoustical range, but with respect to dialogue dubbing, or looping. Magnetic recording's lighter weight equipment encouraged studios to leave the sound stage and shoot films on location. These location shoots would not take place in a controlled acoustical environment, and as a result the roar of an airplane or the honk of a distant car horn might mar a line of dialogue, especially during the making of westerns and historical dramas. In response, sound departments felt that they needed to dub over individual lines of dialogue during post-production more frequently than they needed to during earlier decades.

The re-usability of magnetic media made was seen as a solution to this problem, for it was easy for actors to simply record the marred lines over and over again in a tape "loop."[542] However, this process required an actor to time their delivery in order for the words to remain in synchrony with the movement of their lips onscreen. Such looping was therefore difficult. In turn, location shoots that took place in noisier environments often hid the mouths of the actors who were speaking. Sometimes this meant shooting actors from a distance so that the movement of their lips were not clear. Sometimes this meant shooting conversation scenes with the actors turned away from the camera as they speak. Any of these methods would conceal synchronization issues between images of the on-set performance and sound recordings later made during post-production.

Case Study: The Sleeping City

Instances of this staging phenomenon can be found in select scenes throughout the late 1940s, particularly in the films *The Fountainhead* and *Intruder in the Dust* (1949).[543] That said, the most salient examples are found in Universal's semi-documentary noir, *The Sleeping City* (1950). The film follows Detective Fred Rowan (Richard Conte), a former medical specialist who goes undercover at a public hospital to investigate the murder of an intern and who, in the process, uncovers a narcotic-smuggling racket among the hospital's employees. In addition to being among the first all-magnetic features made at Universal, *The Sleeping City* was also among the first films shot entirely on location in New York City.[544] The choice to use Bellevue Hospital as the location setting proved especially controversial. The setting prompted producers to begin the film with a short disclaimer to assure audiences that the film was indeed the work of fiction, as opposed to a documentary, and that the illegal activities in the film were not based on actual events that took place at the famed medical center.[545] The film's sound aesthetic only added to this controversy. The location recordings that were made with magnetic tape were perhaps so realistic sounding that Universal felt compelled to add this disclaimer.

According to Corson Jowett, the film's head of production sound, magnetic sound not only lent itself to easier location recordings, it also decreased production expenses:

> We send a day's take out to the Coast on the night plane, and out there the sound is transferred to sound film, the tape is erased, and they send it back to us, ready to use again. We've used the same twenty thousand feet of tape about two hundred times now, and it gets better all the time.[546]

Universal's desire to keep costs low also informed many of the film's stylistic decisions, particularly as they pertained to dialogue recording. Specifically, and strangely, many of the scenes were shot with characters mouths fully covered. At one moment Steve (Alex Nicol), engages in a conversation with his head face down on a table. Though this staging decision is

motivated by Steve's highly depressed state, the hiding of the actor's face meant that the producers could change Steve's lines to clarify his emotional struggles during post-production, and Nicol could then perform them onto a tape loop in a recording booth without the need for expensive reshoots. Indeed, while Steve has his face down into the table, his voice changes dramatically with respect to frequency range and clarity, indications that during this moment his voice was dubbed, and was not the original production recording. Thus, the act of covering actor's mouths, though strange, became another way to maximize the cost-efficiency of magnetic media.

The looping of dialogue in post-production would also prevent unwanted environmental sounds from slowing down a film's production. During one scene in the middle of *The Sleeping City*, Fred and Ann (Coleen Gray) continue their ongoing courtship of each other by sneaking a cigarette break on the hospital's rooftop. For much of the scene the characters speak with their mouths fully in view of the camera, but this changes toward the scene's end, specifically when as Ann says "There's no law that says we can't go out for a cigarette, there's no law that says we can." Much like the conversation between Steve and Fred, it is possible that this staging allowed for the producers to change Ann's lines during post-production. One can perhaps imagine a number of ways that Ana's dialogue can be jazzed up with one or two scintillating innuendos about smoking a cigarette. However, I have found no evidence to suggest that issues of censorship explain the film's mise-en-scène.

Instead, it is likely that this specific scene was part of a larger strategy to employ cost-effective solutions to the acoustical problems inherent to location shooting. For instance, when reporters from *The New Yorker* visited the set to profile the film's Manhattan production, they witnessed the shooting of a similar rooftop scene. Jowett, at the time, was exhilarated by fire

trucks, foghorns, police whistles, and other sounds of the city that were audible during the shoot and that were thus available for his sound effects collection. According to the magazine, however, these noises and Jowett's enthusiasm for them greatly interfered with each shoot, particularly during the film's climax. "A plane flew over Bellevue and Jowett looked up, delighted. 'What a City!' he said. 'Noise, noise, noise!'"[547]

Whereas it is common for filmmakers to delay shoots in order to wait for the plane traffic and other distractions to stop, director George Sherman appears to have filmed these scenes regardless of the background noises in order to save time and money. Knowing that the dialogue would need to be replaced during post-production, he was then able to stage actors like Coleen Gray so that their mouths were covered, a decision that planned ahead for the difficulties of synchronizing looped dialogue to the picture. In other words, it wasn't just magnetic media that lowered production costs. The new technology made looping easier, which then allowed directors to make more cost-efficient decisions during productions, particularly during location shoots.

That said, such staging practices were unique but also short-lived. By the 1950s, the tendency to cover an actor's mouth all but disappeared as the practice of looping lines of dialogue became more routine and as technicians refined their ability to synchronize dubbed dialogue with onscreen lip movements. For the greater part of the decade, the looping of dialogue had only a minimal effect on the visual designs of motion pictures as studios returned to their usual recording practices. In other words, magnetic recording did not engender a new soundtrack aesthetic in Hollywood. Despite a brief period of experimentation, films that were recorded onto magnetic tracks remained virtually indistinguishable from those that were previously recorded onto optical tracks. Put another way, as of a result of various economic,

aesthetic, and technological constraints that were imposed upon the new soundtrack technology, Hollywood constructed magnetic recording so that it was merely a cheaper and more versatile version of optical recording.

Conclusion

By the late 1940s, magnetic recordings could boast lower noise levels than optical recordings, and the material efficiency of magnetic media meant that these recordings were often cheaper to produce than optical recordings were. The new technology therefore offered studios the ability to correct many of the aesthetic problems that had plagued the development of stereophonic sound systems in preceding years. Hollywood, however, did not pursue magnetic technology as a means to improve sound reproduction. It pursued magnetic technology as a cost-saving measure. Studios were hoping to cut production expenses in response to the sharp decrease in box office returns. The reusability of magnetic media was seen as an effective means to lower overhead and budgets. Further, studios were economically dependent upon older technologies, so much so that it became financially beneficial for engineers to build magnetic recording equipment that was indistinguishable from optical equipment. As a result, the new technology was implemented by studios in order to merely refine old techniques and continue the soundtrack designs that Hollywood established in earlier decades.

Such economic conditions, however, did not last very long. Much like the standardization of Academy Mono, the construction of magnetic technology would soon set the stage for a period of immense stereophonic experimentation in the years that followed. Hollywood's decision to render magnetic technology in the image of optical technology would engender competing industries to distinguish themselves from the major studios specifically by engaging

in a completely different conception of magnetic recording. This competition would lead to greater exploitation of magnetic media's wider frequency characteristics, both in the recording studio and in theaters, as well as to an entirely new playback format: magnetic stereo.

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Chapter 5: Cinerama, the Seven-Track Blockbuster, 1952-1955

"*Quiet!*" "*Quiet!*" "*QUIET!!*" Those who saw *This is Cinerama* (1952) in theaters returned to their seats following the film's intermission and proceeded to get yelled at by renowned broadcaster Lowell Thomas. The demands, which emanated from every corner of the theater, gave the impression that Thomas was calling for silence at the start of the second act, but this was not the case. His requests were instead part of a pre-recorded demonstration of the film's seven-track sound system. For the entire demonstration, the curtains over the screen remained closed, which allowed audiences to turn their heads and notice the system's localization effects without missing any onscreen attractions. The demonstration also showcased the system's decibel range by reproducing a brief symphonic performance. "Please note the enormous power without distortion when the full orchestra plays," Thomas commented. The two-minute demonstration was just one piece of the film's impressive display of audiovisual technology, and—despite Thomas's earlier objections—it was anything but quiet.

This is Cinerama became the first of five features released throughout the 1950s to promote a new motion picture format branded as Cinerama. Much like the Polyvision technology developed for Abel Gance's *Napoléon* (1927), Cinerama's picture was a composite of three separate strips of film that were projected simultaneously to produce a large, contiguous image. Its sound system was just as expansive. The seven-track sound design—which was stored entirely on magnetic media—reproduced sounds through five separate loudspeaker channels behind the screen, and through three banks of loudspeakers on the side and rear walls of the theater. The magnetic sound system built upon the experiments in stereophonic sound developed by engineers at Bell Laboratories and studios like Disney and Twentieth Century Fox. Indeed,

the film's pre-recorded demonstration recalled Harvey Fletcher's stereo concerts at Constitution Hall and Carnegie Hall almost twenty years prior. Yet, Cinerama was strikingly different from these earlier experiments. Whereas prior technologies were designed to further the realistic reproduction of sound in auditory perspective, the sound tracks for Cinerama's features were more concerned with the idea that sound was a thrill-inducing tool, one that could cause audiences to not only hear, but feel a motion picture.

Such phenomenological experiences were encouraged in part by the many advances made to magnetic recording technologies after World War II. As discussed in the preceding chapter, these innovations greatly lowered noise levels across the entire frequency spectrum, and thereby widened a recording's response characteristic and boosted the decibel levels of a signal's extreme registers. Thomas's stereophonic demonstration called attention to these extended characteristics: "For those who are interested in the technical aspect," he remarked, "the upward range goes as high as fifteen-thousand cycles, and the downward range to below thirty cycles per second." This frequency response was dramatically wider than standard motion picture sound tracks, which in 1952 were still restricted to Academy Mono's acoustical constraints. Instead of following the industry's lead by constructing the magnetic media merely as a means of lowering production costs, Cinerama's engineers saw the new recording technology as a tool that could also improve sound reproduction in theaters. The magnetic material prevented signals from being compressed into an optical track's limited acoustical range, and it simultaneously allowed for more tracks to fit within a single strip of film without any loss in playback quality. In sum, Cinerama constructed magnetic recording technology so that its differences from prior recording technology could be readily noticed by all audiences, not just audio experts.

The premiere of *This is Cinerama* at New York's Broadway Theater on September 30, 1952, in combination with the film's touring road show throughout the following year, was a critical moment in the history of stereophonic sound. The film would encourage studios like Fox and Warners to re-open their investigations into multi-channel playback and develop magnetic stereo formats that could imitate the sounds produced by Cinerama's seven-track technology. The popularity of the new technology would similarly lead to a boom in stereophonic content, with more than one hundred Hollywood films receiving multi-track release prints throughout the 1950s. As a result of Cinerama's unveiling, stereophonic reproduction was no longer defined solely by the failed experiments of the past. Its identity was now associated with the seven-track soundscapes that had the ability to shake theaters and filmgoers. In effect, it was the success of these sensational film-going experiences that would cause many within the industry to completely re-conceive of stereo's value to cinematic storytelling.

This chapter traces the conceptual and technology development of the stereo practices that lead to this reevaluation of multi-channel audio. To do so, I provide a detailed account of Cinerama's sound aesthetic as well as the historical factors that led to its genesis. I argue that the competitive marketplace for motion picture technology incentivized Cinerama's engineers to generate stereo effects that demanded filmgoers to pay attention to the sound technology itself. Further, I show how these stereo effects were largely pursued as solutions to Cinerama's financial problems. Its engineers did not have the resources to correct many of their sound system's technical flaws. In turn, the films' technicians created practical workarounds when building their seven-track mixes. In other words, Cinerama's unique multi-channel aesthetic was not merely the result of its use of magnetic recording technology. Though magnetic recording was integral to the stylistic effects heard in each Cinerama release, the sound system's broader

acoustical aesthetic was more accurately a product of the economic constraints that governed the construction of its own magnetic technology.

The Marketplace for Auditory Sensations

The many filmgoers who saw *This is Cinerama* in theaters lauded the show's visual and auditory thrills. As *New York Times* critic Bosley Crowther described after attending its Broadway premiere, the sound system offered an "assault upon the eardrums" from "sensations that are rousing, intoxicating—and unique."[548] It is hard to dispute the role that technological innovation played in enabling audiences to experience these acoustical sensations. After all, Cinerama's engineers built their thrill-inducing sound system using the latest advances in magnetic media, many of which were still new to the entertainment industry. Innovations like high-frequency bias and magnetic tape greatly lowered the noise levels contained in a magnetically recorded signal, thereby enabling engineers to store more acoustical information on a single strip of film without a discernible loss of quality. Drawing upon these innovations, Cinerama engineers could then simplify multi-track recording and playback equipment so that mixers could explore auditory sensations that Hollywood studios had only struggled to create in prior decades. What Crowther and other filmgoers were experiencing was arguably a style of acoustical reproduction that had yet to be widely heard.

Though these cinematic thrills were tied to the new recording medium, they were not solely prescribed by the technology itself. As Hollywood's construction of magnetic tape demonstrates, the new medium inspired a variety of uses, including those that were far less exhilarating and that merely refined pre-existing techniques. Instead of magnets alone engendering this broader reconceptualization of motion picture sound, the creative decisions that

shaped Cinerama's multi-channel effects were fueled by a host of historical factors, namely those pertaining to product differentiation.

According to art historian E. H. Gombrich, artists regularly compete for attention within a highly populated marketplace of art dealers, critics, and patrons. Such intense competition can, in turn, compel these artists to engage in a game of "watch me" and one-up-manship—what Gombrich calls "the logic of vanity fair"—wherein unique and controversial stylistic decisions function rhetorically as demands for audiences to take notice of the artwork.[549] Cinerama's filmmakers were no different. They engaged in similar one-up-manship with Hollywood through their own stylistic decisions, ones that ostensibly said "hear me" to a community of producers, critics, and filmgoers. These mixers in turn created stereophonic sound designs that called attention to the seven-track technology, for doing so promoted their sound system as a valuable alternative, if not also a necessary upgrade, to standard monophonic sound tracks. The new sensory effects that Cinerama exploited and that audiences applauded were not technologically determined so much as they were conceived and created out of market-driven needs.

The Festival of Britain

Hollywood's earlier decision to construct its own magnetic recording equipment in a manner that hid the technology from audiences made Cinerama's attempts at differentiation that much more pronounced. A film like *This is Cinerama* and later features like *Cinerama Holiday* (1952) and *South Seas Adventure* (1958) merely had to accentuate the wider frequency characteristics and localization effects that magnetic media afforded but that the major studios had yet to pursue. Hollywood, however, was not the only concern of Cinerama's mixers. There were a handful of other filmmakers working in adjacent industries who were also exploring the

possibilities of magnetic recording and magnetic stereo. Though many of these ongoing explorations would fail to become as successful as Cinerama, they nonetheless increased competition and created theatrical experiences that made Cinerama's sound designs harder to distinguish within the motion picture marketplace.

Among the first of these non-Hollywood films to exploit the aesthetic potentials of magnetic recording were those that premiered at the 1951 Festival of Britain. The internationally renowned event coincided with the hundred-year anniversary of The Great Exhibition in London, a world's fair designed by the government to promote Britain's superiority as a leader in modern industry and technology. The 1951 Festival was similarly designed to showcase the nation's continued leadership in science and innovation, and to demonstrate that the British Commonwealth as a whole had rebounded from the adverse economic conditions during World War II.[550] Of additional concern to the Festival's programmers was the matter of repositioning United Kingdom as a leader in world entertainment and culture. As part of the fair, engineers erected a special motion picture auditorium—known as the Telecinema (or Telekinema)—that would serve as a venue for British filmmakers to assert their status as cinematic innovators.[551] The programmers, for instance, commissioned English filmmakers Michael Powell and Emeric Pressburger to premiere their forthcoming adaptation of *The Tales of Hoffman* (1951) at the Telecinema.[552] Similarly, director John Boulting used the Festival as a space to premiere *The Magic Box* (1951), his biopic about the many contributions that English-born photographer William Friese-Greene made to cinema's development during the late nineteenth century. The Telecinema further served as the venue for a host of experimental films made by British and Canadian directors. These experimental films would become some of the first publicly screened motion pictures to feature four-track magnetic sound designs.

This program of surround sound experiments was overseen by Raymond Spottiswoode, a British filmmaker and documentary producer at the National Film Board of Canada (NFB).[553] Spottiswoode conceived of the Festival's experimental program to be shot and screened entirely in stereoscopic three-dimensions, a visual novelty that could function as a means to illustrate the Commonwealth's technological prowess and its continued innovations in the field of motion picture engineering. Among the films that were shown were Leslie Dudley's *A Solid Explanation*, which depicted a gentleman humorously explaining stereoscopic cinema to the audience, and *The Distant Thames* (later known as *Royal River*), a short travelogue about London's aquatic landmark that Spottiswoode and his brother Nigel both directed. The Festival's stereoscopic program also included two shorts by Spottiswoode's Scottish-born colleague Norman McLaren: *Around is Around* and *Now is the Time (to Put on Your 3D Glasses)*. Both films featured McLaren's signature abstract animation, yet this time the colorful patterns not only moved sideways across the screen but also toward and away from audiences.[554]

Shortly before their premiere at the Festival, each of these films were mixed in the Telecinema for four-channel playback.[555] Three channels corresponded to the left, center, and right loudspeakers behind the Telecinema screen. The fourth channel corresponded to the array of smaller loudspeakers located along the rear and side walls of the theater.[556] Similar to the making of *Fantasia*, the film's surround sound designs were generated with a special pan-pot console that allowed any one sound to travel to different loudspeaker channels during the films. The key difference from *Fantasia* was that the sound tracks were not formatted as four separate push-pull tracks but rather four magnetic tracks stored on single strip of film. The use of magnetic sound technology enabled the films to boast a frequency response that was wider than Hollywood releases. Thus, this novel use of magnetic recording enabled Spottiswoode to

distinguish his experimental program an example of Britain's many groundbreaking technical achievements.

Such distinction, however, was lost on the Festival's audiences. Like many of Hollywood's earlier experiments in stereophonic and surround sound design during the 1930s and 1940s, Spottiswoode's four-track films suffered from a series of unforeseen equipment problems. For one, the stereophonic sound system at the Telecinema did not always function as intended. The four-track technology reportedly broke during screenings, which forced the projectionists to play each film with only monaural sound accompaniment.[557] Additionally, when the stereophonic system did work as intended, the architectural design of the auditorium nonetheless made it difficult for all audience members to hear the rear-channel sound effects. The problem was that the Telecinema was comprised of three levels: ground, mezzanine, and balcony. To spread the effects channel throughout the theater, technicians had to install loudspeakers on the ceiling and in the rear of each level.[558] And this special orientation of loudspeakers failed to adequately send the rear effects to every seat in the theater. One critic, who saw the program of experimental films several times, reported:

> On the occasion of one visit I had a downstairs seat on the left-hand gangway, about one quarter or less from the back wall. By dint of knowledge and conscious effort I could hear sounds coming from the rear and side, but only when I decided that I ought to be hearing them in that manner.[559]

As a result of these technological and architectural problems, it remains unclear just how effective Spottiswoode was at promoting Britain and its Commonwealth as leaders in the field of motion picture acoustics.

The absence of any sonic distinction in these films, however, was not due to the acoustical design of the theater but the way Spottiswoode conceived of the value of magnetic recording more broadly. Spottiswoode developed a novel use for the new technology that could

further differentiate his program of experimental shorts from standard Hollywood fare. Whereas studios like MGM, Warners, and Universal all identified magnetic media merely as a tool that could lower the industry's production costs, Spottiswoode identified the new technology as a means to further aesthetic innovations, particularly with respect to multi-channel sound.[560]

That said, the multi-channel innovations that he demonstrated at the Telecinema were often inaudible. During one scene in *The Distant Thames*, for instance, a series of quiet bird calls were sent to the rear loudspeakers while the film's louder orchestral score played through the front three loudspeakers. Consequently, the musical score overpowered the diegetic sounds so much that even those seated as near as ten feet from the rear speakers were reportedly unable to hear the birds chirping at the back of the theater.[561] In effect, the mixing decisions were too subtle to be noticed. Like with many other attempts to introduce stereophonic sound to cinemas, those who failed to hear the multi-channel effects also failed to see the point of the technology.

The Festival's surround sound designs became a double-edged sword for competing stereo formats like Cinerama. On the one hand, the problems with Spottiswoode's technology meant that it was unlikely to compete for screens west of the Atlantic. Indeed, the stereophonic effects designed for the Telecinema were not only quickly forgotten soon after the Festival, but when the films screened in the States as part of a touring program of three-dimensional films, there is little evidence that theaters were compelled to install four-track sound systems to accommodate Spottiswoode's original surround sound designs.[562] Spottiswoode's experiments thus never became a genuine threat to Cinerama's long-term success as an alternative theatrical format.

On the other hand, the response to Spottiswoode's films posed a risk to the value of Cinerama technology more broadly. If magnetic stereo was associated with the aesthetic failures

of the Telecinema, then Cinerama's brand of magnetic stereo might be defined as a similar failure before the technology even reached theaters. To a certain extent, this problem was far from new. During the 1930s and 1940s, stereophonic sound was largely associated with failed formats like Fantasound and 50mm three-track. The Festival of Britain was simply one more stereophonic sound system to collapse shortly after its unveiling. Cinerama's success as a magnetic stereo format was therefore predicated on its ability to address the negative associations that the industry had with stereophonic sound. In other words, the company would need to redefine stereo's value to motion pictures.

The Cinerama Ideal

The manner in which Cinerama's manufacturers promoted their stereophonic sound system proved to be extremely effective. Not only did its technicians differentiate their sound designs from those produced in Hollywood, they created a unique theatrical experience that they could market as a pleasurable augmentation of the standard film-watching routines to which audiences had grown accustomed. Of particular concern to the Cinerama engineers was the concept of proportion; by increasing a motion picture's size and scale, filmmakers could create more awe-inducing thrills in theaters. This belief dictated the format's dimensions. Its picture was a composite of three different strips of 35mm film, each projected separately and in synchrony to form a combined aspect ratio of roughly 2.59 to 1, on a screen that was about fifty-one feet wide and twenty-six feet high.[563] Likewise, its sound was stored on a separate (fourth) strip of magnetically coated film, which was essentially magnetic tape with an acetate base. The low noise floor of magnetic tape was specifically exploited to allow for seven tracks of sound to be housed on a single strip of film without noticeably increasing noise and distortion. The stereo

system was thus seven times the size of standard motion picture sound tracks, and nearly twice the size of Spottiswoode's four-track system. Although it is unclear if Cinerama's engineers were aware of Spottiswoode's work, their unique construction of magnetic recording technology—particularly this focus on proportion—nonetheless corrected many of Spottiswoode's earlier decisions.

Vitarama and the World's Fair

Cinerama's attention to the scale of cinematic representation had been at the forefront of the technology's design since its inception. According to architect Ralph Walker, in 1937 the American petroleum industry hired the firm of Vorhees, Gmelin, and Walker (later Vorhees, Walker, Foley and Smith) to develop a large-scale exhibition venue, titled "A World Without Friction," for the 1939 World's Fair [564] Walker had become fascinated with theatergoer perception and cognition while tasked with improving the acoustical properties of symphony halls. In turn, he envisioned this frictionless world as a "contrapuntal montage" of imagery. As he recalled in 1953, "I wanted a huge room, spherical in shape, on the walls of which would be thrown a constant stream of moving pictures from an entire battery of projectors."[565]

In order to build the exhibit's motion picture component, Walker teamed with Fred Waller, who was previously a special effects supervisor at Paramount, and who later directed a number of musical shorts at the studio, including *Cab Calloway's Hi-De-Ho* (1934) and Duke Ellington's *Symphony In Black: A Rhapsody of Negro Life* (1935).[566] Waller shared Walker's interest in peripheral vision, and in 1938 the two developed a new motion picture apparatus that projected a seamless image onto a dome-shaped screen that was 165-degrees wide and 75-degrees tall—just shy of the 180-degree-wide and 90-degree-high field of vision of human

perception. The apparatus worked by recording moving images onto eleven individual filmstrips that ran through separate 16mm cameras. It then reproduced these pictures through a battery of projectors pointed to the front, sides, and over the heads of filmgoers.[567] Walker and Waller called their invention "Vitarama," and subsequently formed the Vitarama Corporation to finance the construction and testing of the new technology.[568]

The immense scope of the Vitarama process would have surely impressed 1930s audiences as well as the petroleum executives who wanted their exhibit to attract as many fairground attendees as possible. That said, the Vitarama process never made it as far as the World's Fair.[569] Following attempts to produce a series of test films for the eleven-camera system, the petroleum industry pulled their support of Walker and Waller's innovarion. The exact reasons for their decision are not fully known, although we can surmise that the difficulties involved in shooting and editing the films, in addition to the costs of building and maintaining a working architectural prototype, were potentially too much work for the oil industry to oversee.[570] The oil industry would instead promote its world without friction with a puppet film, crudely titled *Pete-Roleum and His Cousins* (1939), co-directed by a then-unknown Joseph Losey, and scored by Oscar Levant and Hanns Eisler.[571] *Pete-Roleum* was notable for its three-dimensional effects as well as for its use of four-channel stereophonic sound, one of the first of its type to be screened for public audiences.[572] In effect, the oil industry found four-track sound to be far less cumbersome than an eleven-projector picture.

Despite its cancelled appearance at the World's Fair, the Vitarama Corporation remained a holding company for the invention's patents while Waller worked to attract new investors. One such patron was Laurence Rockefeller, son of oil tycoon John D. Rockefeller, who offered his carriage house on West 55th Street as a venue for all future demonstrations.[573] Another such

patron was the United States military. In 1940, the Air Force licensed the device to use for machine gun training exercises.[574] Installed in more than seventy different locations, the "Waller Flexible Gunnery Trainer" was a simplification of the original Vitarama design.[575] It consisted of only five 35mm cameras and projectors that reproduced images of moving targets on a dome-shaped screen. Waller intended to include a three-channel stereophonic sound system so that the sounds of the moving targets would more realistically pan across the three loudspeakers located behind the screen.[576] Very few specifics are known about this three-channel sound technology aside from the fact that the military opted not to use it.[577] Instead, trainees wore headphones that played several high-pitched tones after they successfully fired at each target.[578] In place of stereo, the Gunnery Trainer boasted only monaural sound.

Hazard Reeves's Sound Ideas

Following World War II, Waller returned to the prospect of creating a stereophonic sound system to complement the immense scale of his multi-projector picture. As the Vitarama Corporation retooled its invention for future use, and perhaps at the suggestion of Rockefeller, Waller invited Hazard "Buzz" Reeves into his studio to view the some of the early test footage and to offer his own insights into developing the format's multi-channel sound tracks.[579] Reeves was a sound engineer and entrepreneur who by the 1940s had made a name for himself within the music industry as a leader in sound-on-disk recordings. The Reeves Sound Studio in midtown Manhattan served as the preferred East Coast studio not only for singers, but for documentary producers in need of orchestral scores and voice-over narration.[580] It was through his studio that Reeves would develop working relationships with personalities like Lowell Thomas, the future narrator of *This is Cinerama*, as well as Vitarama investor Nelson

Rockefeller.[581] Rockefeller's Standard Oil Company commissioned Reeves's studio to record several promotional documentaries for the company, and would ask the studio to record and mix the soundtrack for its production of Robert Flaherty's *The Louisiana Story* (1948).[582]

In addition to an entrepreneur, Reeves was a renowned inventor of sound technology. During World War II he worked alongside the United States Signal Corps to innovate piezoelectric ("crystal sync") technology, a device that used the standard frequency of a vibrating quartz crystal to allow portable recording equipment to maintain a constant motor speed.[583] Reeves had also developed a line of magnetic recording tape, which the studio would use when recording the all of the dialogue, music, and effects for locally produced features, including Joseph Lerner's semi-documentary noir *C-Man* (1948).[584] Incidentally, Reeves's Soundcraft manufacturing plant in Danbury, Connecticut would become a leading supplier of magnetically striped film for the motion picture industry following the transition to magnetic recording.[585] Fully engrossed in the business of motion picture engineering, Reeves agreed to construct a sound system that complemented Waller's multi-projector picture.

Reeves's system, however, would not simply be the outgrowth of an unorthodox and visionary approach to aesthetics. His technological experiments also benefited from an exorbitant amount of financial capital. In 1947, a business team that included Reeves, Laurence Rockefeller, and *Time Magazine*'s Henry Luce founded a new company with the intention of refining Waller's technology—now rebranded "Cinerama."[586] The Cinerama Corporation promoted the format to film producers and theater owners in the hopes of licensing the equipment for commercial use. The company also acquired a private tennis court in Oyster Bay, Long Island to serve as Cinerama Corporation's lab, studio, office space, and screening facility.[587] It was during this period that Waller simplified the scope of the Cinerama process to a

146-degree wide and 55-degree tall field of vision, which could be achieved with merely three 35mm projectors, each with a film speed of twenty-six frames-per-second and an individual frame width of six perforations.[588] It was also during this period that Reeves—alongside Walter Hicks, Karl Vogel, and Wentworth Fling—began construction on Cinerama's stereophonic technology.

The engineering team envisioned their sound system to build upon Harvey Fletcher's original three-channel loudspeaker configuration, while offering far more expansive stereophonic effects.[589] Instead of Fletcher's three loudspeaker channels, Reeves and his team initially called for six: five for the front of the theater and one for the theater's rear and side walls.[590] This system was also to include a seventh channel to function as a control track, not unlike the fourth track used by Fletcher to further accentuate the proportional capabilities of his format.[591] These initial ideas for Cinerama's sound system, though already quite expansive, would only grow in size as engineers continued perfecting its technology. By the early 1950s, Cinerama was further refined to boast a row of seven channels that collectively formed a 180-degree curve around the front and sides of the audience.[592] Five loudspeakers were situated behind the expansive screen, while two more banks of loudspeakers were located beyond the edges of the screen and mounted onto the theater's side walls. This 180-degree arrangement of speakers complemented Waller's and Walker's initial interests in peripheral vision, as it effectively reproduced a filmgoer's entire field of audition. Finally, Reeves's sound system included additional loudspeakers on the very back wall of the theater. These speakers formed the sound system's eighth playback channel. According to Fling, this eighth channel was designed with a specific purpose in mind:

> You don't need any more than 180 degrees between all the sound is coming out where the picture is, and all you need is the sound going into the picture and the sound coming out of the picture from either side. The only time you'd need

> anything in the rear would be if you had something coming straight over your head.[593]

In other words, the eighth channel had little to do with the reproduction of sounds in auditory perspective, and had more to do with creating the thrilling flyover effects of airplanes or helicopters.

The limited functions of this rear channel, in combination with the low noise levels found in magnetic media, enabled Cinerama's rerecording engineers to store the sound system's eight playback signals onto a single strip of 35mm film. Each strip, however, only contained seven sound tracks. Brush Industries, the designers of Cinerama's multi-track sound heads, argued that seven tracks were necessary because eight would cause the magnetic signals to bleed into each other, an unfortunate occurrence that would introduce noise and distortion.[594] To address this problem, Fling divided the loudspeaker channels across the magnetic tracks as follows: tracks one through five corresponded to the five loudspeakers located behind the screen, and tracks six and seven corresponded to the two side loudspeaker channels. During moments when the filmmakers wished to activate the rear loudspeakers, two changes would occur. First, the rerecording mixers would preemptively store the signals for the two side loudspeakers onto track six while they would store the rear loudspeaker effects onto track seven. The mixers would also create cue sheets that detailed when tracks six and seven corresponded to the two side loudspeakers and when they corresponded to the side and rear loudspeakers.[595] Second, projection engineers would then refer to these cue sheets during screenings and manually redirect channels six and seven to the appropriate bank of loudspeakers at the designated moments.[596] This creative solution to the format's technological limitations meant that Reeves's sound system was almost triple the size of Fletcher's system. The unprecedented scale of Cinerama could

therefore be recognizable even to those familiar with Hollywood's earlier experiments in stereophony.

The "Hear Me" Effects

The sound system's scale, though unprecedented in motion pictures, would easily be lost on filmgoers whose attentions were paid almost entirely to the expansive, three-panel screen. Indeed, by the early 1950s terms like "stereophonic sound" and "high fidelity" were not yet common parlance, and the innovations of Reeves, Hicks, Vogel, and Fling were unlikely to have been the main attraction for the majority of Cinerama's patrons. In other words, the sound system did not speak for itself. Rerecording mixers needed to actively draw attention to the system's presence in order for the company's investment in sound technology to be a key selling point to audiences and to the industry more broadly. With respect to Gombrich's concept of vanity fair, Cinerama's sound system needed to shout "Hear me!" or suffer the same fate as Spottiswoode's films.

The short demonstration of stereophonic sound that followed *This is Cinerama*'s intermission was one way that the filmmakers directed the focus of audiences to the system's wider frequency and decibel ranges. Because the sequence was designed to play without any visual accompaniment, it gave audiences the opportunity to turn their heads in the direction of the loudspeakers, feel the effects of stereophonic sound, and even learn how to be active listeners during the remainder of the motion picture. This demonstration, however useful, was not a regular attraction in Cinerama releases. Most of the time the company's rerecording mixers simply chose to integrate the sound system's proportional capabilities into the narratives. *This is*

Cinerama and *Cinerama Holiday*, the format's first two features, offer some of the clearest examples of how such strategies were achieved.

In terms of plot, *This is Cinerama* consists of short vignettes that advertised Cinerama's aesthetic distinction over typical Hollywood releases. To help weave these scenes together, Thomas provided voice-over that spoke of the format's ability to magnify the majestic imagery found in every corner of the globe, from Niagara Falls to the canals surrounding the Piazza San Marco in Venice. *Cinerama Holiday* differed in that it followed two couples—Fred and Beatrice Troller of Zurich and John and Betty Marsh of Kansas City—who travel to opposite sides of the globe to experience a variety of visual delights. Despite this premise, *Cinerama Holiday* remained a collection of disconnected sequences tied together by voice-overs, this time provided by the traveling couples.

These voice-overs did little to showcase the seven-track sound system, for they emanated only from the center loudspeaker. Further, the orchestral accompaniment that bellowed from all four walls of the theater helped to raise the decibel levels of the motion picture, but it arguably did little to draw the audience's attention to the sound system once they became accustomed to its volume. The films instead called attention to Cinerama's stereo technology by drawing upon the emphatic, mimetic, and three-dimensional effects that had at one time formed the identities of multi-speaker sound designs during the 1930s. By the early 1950s, these stereo effects had all but been removed from Hollywood's storytelling toolkit, for they called too much attention to the loudspeakers and thereby distracted audiences from the onscreen narrative. And it was perhaps for this very reason that the mixers of Cinerama's nearly plotless travelogues found such effects to be of considerable value.

At times Cinerama's sound tracks would seem to assault the audience with a sudden jolt of sound, not unlike the emphatic effects found in *Hell's Angels*. For instance, *This is Cinerama* begins with a brief lecture from Thomas projected in standard Academy aspect ratio, during which Thomas's voice plays through only the center loudspeaker. Once Thomas concludes his lecture by announcing "Ladies and gentlemen: This is Cinerama!" the curtains that were covering the left and right sides of the screen suddenly open to reveal the full scope of Cinerama's three-projector image. The audience's point of view is now from the first row of the "Atom Smasher" roller coaster, a fixture of Rockaway's Playland in Queens. The abrupt change from the narrow lecture to the widescreen amusement ride is arguably a thrilling moment for audiences, yet it is the sound design that perhaps induces a larger reorientation of the senses. As the curtains open, Thomas's monaural lecture becomes eclipsed by a brass fanfare that erupts from every loudspeaker along the front and side walls of the theater. Following this fanfare, the creaks of the carriage, the screams from its riders, and the melodies from a distant calliope all blast from these seven loudspeaker channels. Much as a roller coaster's unexpected turns offer thrills to its riders, the shift from a subdued single-track lecture to a seven-track fanfare calls attention to the new acoustical technology, and simultaneously jolts the audience into recognizing the system's power.

At other times, the large scope of the sound technology was designed to wow audiences with the precise localization of sound, not unlike the mimetic effects found in Alan Blumlein's binaural films. One such example occurs during *Cinerama Holiday*, when noted humorist Art Buchwald converses with Fred and Betty Marsh in their Paris hotel room. During this exchange they each sit in different sections of the frame: John in frame-left, Betty in frame-center, and Buchwald in frame-right. In correspondence with this onscreen arrangement, their dialogue

emanates from the left, center, and right loudspeakers, and bounces back and forth between the speakers in the process. Much like Buchwald's visit itself, this localization of sound animates an otherwise mundane conversation.

Another example of mimetic effects can be found in *This is Cinerama*, shortly after the amusement ride concludes. We return to Thomas's office—now in widescreen and stereo—and hear him talk about Fred Waller's role in the development of Cinerama. When Thomas delivers the line: "On Long Island at an indoor tennis court, Mr. Waller established a laboratory and a studio," he walks from frame-right to frame-center, seamlessly crossing from the right filmstrip to the center filmstrip in the process. And as Thomas moves across the screen, his voice noticeably travels with him, from the right loudspeaker to the center loudspeaker. It is perhaps only a coincidence that Thomas shows off the precision of the system's multi-projector and multi-speaker synchrony at the same time that he lauds Waller's ingenuity. That said, one can read this use of a mimetic stereo effect as a means to call attention to the capabilities of the sound system at the very moment that Thomas traces the technology's development.

Lastly, rerecording mixers ambitiously showcased the aesthetic potentials of its eight-channel sound system by creating three-dimensional illusions that rivaled those associated with earlier experiments in multi-channel sound. One example of this illusory sensation occurs just before the performance of Handel's "Hallelujah Chorus" in the first act of *This is Cinerama*. The scene begins as four altar boys light candles inside a grandiose cathedral while bells play a slow rendition of the hymn "Abide With Me." Following these actions, we hear an off-screen choir begin to sing, their voices emanating from only the surround speakers. This song grows in volume, and soon after rows of singers enter into the foreground and walk down the cathedral's center aisle toward the left and right sides of the stage. When these singers pass by the camera

and walk into the background, their voices pan from the rear loudspeakers, to the side loudspeakers, and finally to the front loudspeakers. With respect to the scene's acoustical design, the panning of the singers across each channel creates an illusion that the singers are walking down the cathedral's center aisle and through the space of the theater at the same time.

The sequence was among the very first experiments in stereophonic sound that Reeves conducted during his tenure as Cinerama's chief sound engineer. In 1947, Reeves, Waller, and their team of technicians drove to Garden City, New Jersey, where they had set up five microphones at the front of the Garden City Cathedral as well as "roving microphones" beside the pews.[597] As the Long Island Choral Society sang, they approached the five stage microphones, passing the roving microphones along the way. Upon playback, the signals recorded by these roving microphones were sent to the surround speakers, while the row of stage microphones were directed to the five channels located behind the screen. As Reeves would recall during the 1980s:

> After several takes and playbacks, the first seven-channel magnetic stereo recording was a thrilling reality. We couldn't wait to get back to the tennis court to listen over our large theatre system. The sound was equal in excellence to any recording today and realistic beyond belief. It gave me goose pimples![598]

Curiously, this early test of stereophonic equipment was conducted without any visual accompaniment. It was only after hearing the seven-track recording that Reeves and Waller would construct a mock cathedral in their Oyster Bay tennis court and record a handful of singers as they move through the court while lip-synching to the earlier recording. This separation of sound and picture proved to be quite practical. The noises produced by Cinerama's three-motor camera did not mask the quieter passages of the music. Similarly, the presence of microphones in front of the singers' faces did not mar the sepia-toned images of the choir and the cathedral.

This three-dimensional effect was repeated in *Cinerama Holiday* during the Troller's long excursion in New Orleans. For this new sequence, however, the sound and picture appear to be recorded simultaneously. The scene begins in Lafayette Cemetery, following what was presumably a funeral service. In the background we hear yet another rendition of "Abide With Me" played in the style of a Dixieland band. As the camera slowly tracks forward, a long line of trumpeters, clarinetists, and other musicians march and dance toward the camera, now performing "When the Saints Go Marching In." During their slow approach, their music expands from the center channel to all five front channels. And when they pass the camera one by one, their improvised ornamentations pan from the front channels to the rear of the theater, creating the illusion of hearing musicians joyfully shuffle through the auditorium on their way out of the cemetery. The seven-track sound designs thus did not simply emulate the emphatic, mimetic, and three-dimensional effects of earlier multi-speaker formats, these designs dramatically improved upon them. The extra loudspeaker channels for the rear of the theater made it easier for filmmakers to send sound objects to specific locations around the audience, and do so with a precision that had yet to be achieved in motion pictures.

An Imperfect Business Model

The Cinerama aesthetic, however, was more than just a collection of effects that were intended to call attention to the seven-track sound system. The stylistic ambitions of Cinerama's filmmakers were often compromised by technical and financial limitations. Indeed, one cannot overstate the difficulties involved in both the design of a sound system that was as much as eight-times the size of standard systems, as well as the implementation of a set of recording and rerecording routines for such a large-scale sound system. Moreover, these difficulties were never

fully solved nor addressed by its producers at the time that Cinerama features were being filmed and distributed. Cinerama's sonic aesthetic reflected these broader constraints.

As historian Thomas Erffmeyer argues, one of Cinerama's biggest problems was that it was not a single studio like MGM or Paramount. More accurately, it was a collection of companies connected by shared stockholders and complicated licensing agreements.[599] Waller's Vitarama Corporation held the patents for the initial inventions, while Cinerama Corporation was the licensee of the Vitarama patents as well as the designer and manufacturer of Cinerama equipment. Neither of these companies were responsible for producing or distributing Cinerama films. Instead, these companies had to license the equipment to producers who were responsible not only for shooting a full-length Cinerama film, but also for installing the equipment in enough theaters to generate revenue. And given the cost of the equipment, as well as its demands among filmmakers and theaters, such licensing deals were difficult to arrange. Both companies therefore risked never turning a profit.

At least investors felt there was considerable risk. In July 1950 Rockefeller and Luce sold their shares in Cinerama Corporation as a result of the company's financial arrangements.[600] Reeves responded by reforming the technology's manufacturing arm as Cinerama, Inc. with he and his Soundcraft plant serving as majority shareholders.[601] Further, he and Waller aggressively began to sell their product to potential filmmakers. In December 1950, they successfully licensed the equipment to Thomas-Todd Productions, a newly formed production company led by Lowell Thomas and noted theatrical showman Michael Todd.[602] Thomas-Todd became the production and distribution arm of Cinerama, and soon began work on the first film to be made entirely with the new exhibition format. That film would become *This is Cinerama*.

Michael Todd in Europe

An immediate problem that resulted from this decentralized structure was that there was neither a stable of filmmakers nor a company of technicians that worked together to establish studio routines and specific norms of use for the new equipment. The camera and sound teams for each picture were largely contract hires who discovered the proper ways of using the equipment "on the fly." As a result, Cinerama's engineers lacked many of the resources needed to incorporate or implement the new technology within a pre-existing mode of production.

For instance, Thomas-Todd initially hired Robert Flaherty to direct *This is Cinerama*.[603] The filmmaker had worked previously with Reeves on *The Louisiana Story*, and his direction of *Nanook of the North* (1922) several decades prior helped to establish his reputation for an adventurous spirit that was an ideal match for the technological difficulties innate to the Cinerama format. When Flaherty died before production would officially begin on *This is Cinerama*, Thomas-Todd was then left without a director and, subsequently, with the possibility that more investors might pull out from the project altogether.[604] With options limited, Todd took it upon himself to serve as the feature's lead artistic director.[605] He rounded up a crew of camera and sound operators and soon left for Europe with the intention of collecting as much footage as possible, enough to save the production from cancellation.[606] Todd's decision was a risk. He had no real filmmaking experience, and his crew had only limited experience using the three-camera and multi-microphone format. And while the crew ultimately shot a great deal of footage during their overseas excursion, Todd's own misunderstanding of basic filmmaking protocols undermined much of what they recorded.

One of the stories to emerge from Todd's European trip involved his attempt to film the changing of the guard at Vienna's Federal Palace.[607] In 1951, the city was still co-governed by

England, France, Russia, and the United States, and this specific changing of the guard was going to depict the Russian military lowering their flag and the United States military raising the American flag in its place. The event was thought to have incredible symbolic meaning for American audiences, but Todd needed permission to film it. His strategy to gain access was supposedly to cozy up to Russian military officers by drinking with them the night before the ceremony. The strategy worked. He and his crew were ultimately granted a permit to film the ceremony, but at a cost: Todd was reportedly too drunk to wake up the next day. After spending much of the following morning struggling to carry Todd out of his hotel room, the crew arrived at the Federal Palace after the Russian flag was already lowered. They were therefore only able to film the second half of the ceremony. Additionally, the hung-over and tired producer allegedly ruined the sound recordings by shouting "ARE YOU GETTING THIS?" throughout each take.[608] As a result of the crew's late arrival in combination with the now unusable sound tracks, the sequence was not included in the final film. Though stories of Todd's drunken behavior are perhaps exaggerated for comedic effect, it stands to reason that a more established studio would not have allowed someone with as little motion picture experience as Todd to have ever led a costly location shoot. Given Cinerama's economic situation as well as its somewhat disorganized corporate structure, Reeves and Waller seemed to have no other choice.

A much more significant problem for Cinerama's corporate structure was that it created incentives for Cinerama, Inc. to misinform filmmakers about the technology itself. And given Todd's inexperience, this misinformation only compounded his problems with shooting on location. Such complications were perhaps most apparent while filming selections from Verdi'a *Aida* at the La Scala Opera House. Although Todd had successfully convinced the theater to let the crew record several takes from a performance, the footage was reportedly dark and

distorted.[609] According to Michael Todd, Jr., one of the crew's many camera operators, each take required serious manipulation in processing to save the material from being thrown away. He further suggests that these technical problems were the result of Waller willful mischaracterizing the capabilities of the technology when it licensed the camera to the Thomas-Todd Productions. As Todd, Jr. recounted:

> After seeing the distortions in some of the footage we shot, Todd took Waller aside and complained to him about not being forewarned that there were severe limitations to the camera angles that could be used. Waller told Mike that he *had* explained. However, Waller had always played down the various flaws in the process.[610]

In other words, Cinerama, Inc.'s growing need to license its product may have encouraged Waller to be less than forthcoming about the technology's design flaws during meetings with producers like Todd. It is also reasonable to infer that Todd's enthusiasm for the format compounded the situation by clouding his ability to fully understand that the untested format might have a few technical problems.

Problems By Design

Indeed, Cinerama's technology had problems. For one, its sound system was quite expensive. The extra microphones, recording channels, and mixing stations, in combination with increased production times and labor costs as a result of the additional equipment, would have undoubtedly increased production budgets.[611] Likewise, the use of as many as fourteen loudspeakers for each theater dramatically increased the price of installation. The total costs for wiring the Broadway Theater for the format for *This is Cinerama*'s premiere was initially reported to be as much as $85,000 dollars for parts and labor.[612] Later reports even estimated that the total equipment and labor costs could reach $200,000 per screen.[613] These numbers would

not have included the reduction in ticket sales caused by removing as much as a third of the auditorium's seats to make room for the sound system and projection equipment, nor would it have included the additional projectionists and technicians to run the sound system, nor even the increase in electrical costs simply to power the system. The loss of seats and the simultaneous increase in labor and utility bills would have made it even more difficult for theaters to match their overhead expenses in box office receipts. Like a set of dominos, these expenses dissuaded theaters from installing the system, which led to fewer people buying tickets, as well as smaller profits for Cinerama's producers and manufacturers.

In addition to the high costs associated with material and labor, there were considerable issues with how smoothly the technology actually functioned, especially during postproduction. The films' rerecording mixing sessions, for instance, were at times plagued with technical issues due to the seven-track sound system's complexity as well as the absence of experts who could easily solve technical mishaps. Cinerama's production sound director, Richard J. Pietschmann, Jr., documented the many mechanical malfunctions that he experienced while remixing *This Is Cinerama* in 1953.[614] Despite its strong box office performance on Broadway, Pietschmann felt that the film might still be riddled with acoustical mishaps, including audible cuts and uneven frequency characteristics across the individual channels.

The 1953 mixing sessions, however, introduced additional mechanical problems that needed to be solved. Among them were the build-up of magnetic oxide on the rerecording studio's sound heads, the presence of abnormally high electrical hiss (the source of which was often difficult to pin-point), and the operational failures of entire stereo channels. On April 13, for instance, Pietschmann documented the following:

> Arrived Studio at 8:30 A.M. Made gain checks on the three channels. Rehearsed Aida at 10:00 A.M. Started second rehearsal and had to shut down. No sound on

> #5 theatre monitor. Found broken lead to #5 theatre horn. Experienced static pick-up on tracks 4 and 5. After lunch, ran Aida rehearsal again. Had to stop rehearsal because of no sound in #3 theatre horn. Found broken leads to #3 theatre horn. Made two takes of Aida. Second take good except for high hiss level. After running A - B checks, it was decided to roll A Channel on the high end to cut down hiss. This was at 6:00 P.M. Finished for day at 6:30 P.M.[615]

Such technical glitches were common during the film's rerecording sessions, and to make matters worse, the projection engineers who were hired to aide in these sessions were reportedly incompetent and disorganized. On April 9, Pietschmann, for instance, noted, "We made our first picture run at 9:30 A.M. The next run was at 11:30 A.M. We made the run without a projectionist in one booth. Very bad organization of projection crew. Today there was no one to cover the operating console."[616] Two days later, Pietschmann recorded a similar incident with the crew. "Were ready to roll at 9:15 A.M. One projectionist was missing. He did not arrive until 10:30 A.M. Had to call in another man. First rehearsal at 9:30 A.M.; next at 11:45 A.M. Again evidence of no organization."[617] Pietschmann's dissatisfaction with the quality of Cinerama's sub-contracted labor, compounded by the many equipment malfunctions, resulted in these rerecording sessions being rushed to meet deadlines. In turn, the rerecording engineers had less time to fix many of the acoustical problems in the original tracks.[618]

Perhaps the largest hindrance to the viability of Cinerama's seven-track sound system was Cinerama's corporate structure and the economic uncertainty that it created. There simply was not enough investment capital to address the very design flaws that were rendering the system unattractive to filmmakers and theaters. These financial problems were largely rooted in the licensing deals that Cinerama, Inc. established with producers. Cinerama, Inc. received up to only twenty-five percent of the total box office gross until the film accrued one million dollars, at which point the company received as little as ten percent of the gross.[619] Such agreements awarded producers with a larger share of box office receipts due to the high costs of each

production. That said, the license did not provide for the financial stability of Cinerama, Inc. and the company subsequently operated at a net loss. At the end of 1952, following what was a record-breaking box office performance of *This is Cinerama* at the Broadway Theater, Cinerama, Inc. specifically reported a loss of more than forty-thousand dollars.[620] It was therefore hard for the company to justify further investment in correcting many of the sound system's shortcomings when these fixes were unlikely to lower the company's larger operating costs.

Further, Cinerama's corporate structure failed to incentivize outside investments. For instance, in January 1951 Cinerama, Inc. had its first public offering.[621] The goal was to create a funds that could pay for the manufacturing of more equipment. However, because Waller and Reeves wished to retain their status as majority shareholders, they only sold $200,000 worth of stock, arguably not enough money to overhaul the seven-track sound system.[622] Additionally, there were questions among private investors about the efficiency of company operations. Chief among these concerns was Michael Todd himself. Though Todd had achieved a reputation for being a successful theatrical producer of such stage shows as *The Hot Mikado* (1939), *The Naked Genius* (1943), and *Michael Todd's Peepshow* (1950), his time as a producer also garnered him considerable debt and a bankruptcy that defined his reputation by the time *This is Cinerama* commenced production.[623] According to Lowell Thomas, there was incredible difficulty in trying to find investors and bankers willing to work with Thomas-Todd Productions to secure funding for the film's Broadway premiere.[624] As a result of this crisis, Todd was forced out of the company in 1952.

In response, Thomas-Todd was dissolved into Cinerama, Inc., while Cinerama's production arm was re-established as Cinerama Productions Corporation, with noted film producers Louis B. Mayer and Merian C. Cooper replacing Thomas and Todd as heads of

operations.[625] The combination of Todd's exit, new leadership, and the successful premiere of *This is Cinerama* all helped to restore confidence in the Cinerama process. Investment activity increased dramatically following the film's Broadway debut, with the cost of each share of Cinerama, Inc. doubling from $4 to $8 by the end of October.[626] Most investors nonetheless thought they were buying shares of Cinerama's production arm, as opposed to its manufacturing arm, and were therefore unaware that they were buying shares of a company that would not receive the bulk of the film's box office revenue.[627] With insinuations mounting that Cinerama's owners were misleading Wall Street into investing in the cash-strapped Cinerama, Inc., traders in turn cautioned their clients from continuing to buy Cinerama stock altogether.[628] The public offering and the subsequent changes made to attract more investment capitol into the company ultimately had little effect in helping Cinerama, Inc. out of its financial predicament.

The public offering did, however, limit Reeves's control over Cinerama, Inc. His decisions now had to be defended to a board of investors, and like Todd he could be removed if his decisions were thought to be adversely affecting the company's bottom line. Although Reeves's business history was far less controversial than was Todd's, Reeves did have one major liability: his sound system. It was mechanically imperfect, it was expensive, and—as a result—it was at risk of preventing the broader Cinerama format from being used as effectively and as widely as possible. In other words, Reeves's sound system was creating a ceiling on the company's profits. With no resources to invest in a redesign, if the company were to jettison the sound system and replace it with something simpler, then Reeves too might get jettisoned along with it; the sound system was, after all, his idea. It was therefore in Reeves's best interest to protect the reputation of his invention.

Reeves's solution was to limit the amount of details Cinerama, Inc. would provide to the industry in press releases.[629] This tactic would differ dramatically from how the company marketed its three-projector picture, its screen, and its lenses.[630] Furthermore, any articles that detailed the seven-track sound system were conspicuously vague if not also inaccurate. Instead of discussing the eight playback channels, or the switching device that allowed for seven-tracks to expand into eight different channels, reports of the sound system spoke mostly of its use of magnetic media and the concept of stereophonic reproduction in broad terms. Some articles even hid the costs of the sound system by arguing that the seven-tracks need not be used for sound. For instance, Cinerama's Director of Exhibition reported to *Variety* in 1953 that the seventh-track's control functions could raise and lower a theater's lights, thereby automating a projectionist's duties and potentially saving the theater labor costs.[631] Such reporting appeared to only encourage further mischaracterizations of the seven-track sound system in other journals. Early descriptions in *International Projectionist*, for instance, claimed that Cinerama was a six-channel system with a seventh channel reserved for control functions, and these claims continued into the mid 1950s, well after the system grew in scale to eight channels.[632] Despite the large readership of journals like *International Projectionist*, Cinerama, Inc. appeared to do little to resolve the confusion.

Reeves's strategy was arguably intended to prevent the industry from asking too many questions about his sound system. If he were to actively promote the system as an eight-channel technology, then he might raise more doubts about the system's viability, namely that it was too big to work properly, or that it was too demanding of filmmakers and theaters. In response, Reeves essentially made sure that his sound system kept a relatively low profile. The consequence of his strategy, however, was that it made it difficult for the system's weaknesses to

ever be honestly addressed, even if Cinerama, Inc. were to suddenly acquire more capital, which occurred in August 1953. At that time, Stanley Warner theaters purchased a thirty-five percent stake in Cinerama, Inc. as part of a larger deal gave the theater company control over Cinerama Productions as well as an exclusive license to exhibit all Cinerama content.[633] Stanley Warner's tenure as the de facto operating head of the entire Cinerama enterprise resulted in the release of four Cinerama features. Additionally, this rearrangement of leadership garnered more than a million dollars to Cinerama, Inc., not including its share of box office returns that were generated by the new Cinerama releases.[634] That said, Cinerama, Inc. did not use the money to correct any of the major flaws in its eight-channel sound system.[635] In effect, the absence of any serious acknowledgment regarding the design of its stereo technology might have secured Reeves's position as the chief of Cinerama, Inc., but it simultaneously helped to ensure that the format would continue to have serious problems for the remainder of the decade.

Stereophonic Workarounds

The many economic problems that plagued Cinerama, Inc. and its adjoining companies were not entirely unprecedented. Studios like Disney, Fox, and Selznick each suffered their fair share of financial difficulties and equipment malfunctions as they attempted to design and promote their own multi-channel sound systems in prior decades. What was unprecedented about Cinerama, however, was how the company's engineers addressed these problems. Many of the issues caused by the high price or the cumbersome nature of the sound system were solved stylistically.

One quick and easy solution was for technicians to simply remove any unusable location recordings from the mix, and to replace these takes with voice-over narration and non-diegetic

orchestral music. We hear this solution during *This is Cinerama*'s famed Niagara Falls sequence and during the many gondola rides that comprise the film's excursion to Venice. The best illustration of this mixing strategy, however, is the film's extended sequence in Florida's Cypress Gardens. During the canoe rides, the water skiing shows, and the humorous situations involving the people who perform at the Florida resort, the mix is almost exclusively comprised of Lowell Thomas's storytelling and a musical score provided by Max Steiner and Roy Webb. Indeed, any corresponding synch points that are formed between the picture and sound are largely the result of the music, which—in the tradition of Steiner's other compositions—draws upon the controversially named "Mickey Mousing" technique where humorous glissandos and percussive crashes accentuate onscreen events.[636] In effect, the solution was to essentially imitate certain types of cartoon aesthetics.

Cinerama Holiday similarly emulates this cartoon-like style. The Swiss Alps episode, for instance, contains several musical ornaments and decorative gestures that correspond to the many onscreen falls and tricks and that skiers perform as they race down the snow-covered slopes. Often, however, the film's orchestral music merely provided a seven-track stereo accompaniment for scenes that could not be recorded in stereo, or that were corrupted by each location's unpredictable acoustics. The film's New England episode offers the best illustration of this practical workaround. As we view the picturesque landscapes and the portraits of the region's farmers as they walk through the countryside, we hear only Morton Gould's score and the occasional line of voice-over narration.

This audiovisual design persists even during moments when characters engage in conversation. The fairground sequence, for example, includes a medium shot of several people as they wait by a concession stand and speak to one another. Oddly, we do not hear what the

characters are saying, despite our close proximity and our unobstructed view of their moving mouths. It is likely that the recording of the conversation was unusable due to the location's uncontrolled atmosphere, yet instead of throwing away the scene entirely the rerecording mixers merely replaced the location recording with a mix of music and background sounds. Though Cinerama's shoot reportedly cost as much as two-million dollars, the resultant effect of this musical design causes the sequence to resemble a low-budget picture that was shot silent to keep production costs low, and that uses score as an affordable alternative.[637]

That said, *Cinerama Holiday*'s acoustical design was economical for reasons well beyond the constant use of Gould's music. The film not only included visual attractions, but also aural attractions such as The Great Organ at the Cathedral of Notre Dame. It therefore became a necessity to document the sounds of each location, as opposed to replacing these naturally occurring sounds with score and voice-over. For a live musical performance, one solution to the problem of poor audio was for technicians to record the music separately from the picture, and to then combine both parts during rerecording. An example of this strategy can be found during the film's excursion to New Orleans as the Trollers watch Oscar "Papa" Celestin and his band perform the jazz standard "Tiger Rag." The performance takes place inside a nightclub with relatively narrow walls, a set that may have limited the degree to which the recording mixers could have arranged the microphones in proper auditory perspective. Similarly, the room's narrow shape, high ceilings, and stone walls would have likely introduced unwanted echo and other acoustical compromises into the recording.

The solution to the room's acoustical problems was for the technicians to record an entirely different take of Celestin's performance of the rag, one that may have even taken place outside the narrow quarters of the nightclub.[638] The tempo of the separate sound recording

matched that of the onscreen performance, but this unique mode of production is nonetheless curious. Given the nature of improvisatory jazz, the recording often fell out of synchrony with the timing of many of the musician's virtuosic licks. The most salient examples of asynchrony occur as Celestin delivers a series of growls in response to his band's calls to "hold that tiger." The band's vocals are mostly in time with the picture. Celestin's roars are not. In turn, the sequence becomes a bizarre moment when the film appears to flaunt its lack of technical precision. The choice to use a completely different recording of the song highlights the very staged and constructed status of the performance itself, one that is almost Brechtian in its disregard for the fourth wall. In lieu of providing audiences with a demonstration of the sound system's technical capabilities, the recording of "Tiger Rag" rendered any flaws with the new technology so obvious that they might even be read as intentional.

Despite the salience of these curious moments, the most common solution to the format's technical problems was for engineers to simply record more acoustical coverage for each location. Often, this meant the production crew would generate their own collection of sound effects that rerecording technicians could then use to mix the film during postproduction. The roller coaster sequence from *This is Cinerama* provides an early example of this technique. The calliope, the occasional screams of riders, and the roar of the carriage as it dips and rises were all sound effects recorded separately from the image and added to the film during rerecording. A similar example occurs in *Cinerama Holiday* as we careen down Switzerland's icy Cresta Run from the point of view of the bobsled. Given the inherent difficulty—if not the impossibility—of staging a row of five microphones in proper auditory perspective inside the narrow space of the bobsled track, the sounds that play over the image are those that needed to be recorded separately.

Such attention to acoustical coverage, however, was not only reserved for fast-moving tracking shots or other action sequences. Similar techniques were common even during the episodes that depicted everyday tranquility. During *Cinerama Holiday*'s New England episode, for instance, we find numerous examples of sound effects that were clearly recorded separately and subsequently added to the scene to enhance its audiovisual synchrony. As the camera tracks forward through a busy fairground, for example, we hear the atmospheric noises from the crowds of people as well as a calliope that plays a rendition of Strauss's "By the Beautiful Blue Danube." Following this tracking shot we cut to a man helping two people into a Ferris wheel's carriage, during which we continue to hear the atmosphere and the music. Like the other scenes at the fairground, we do not hear the people speak, nor do we hear their footsteps. It is only when the Ferris wheel operator turns the large lever to begin the ride that we hear the shot's first synch-point: a loud crank. The placement of this ear-catching effect during such an uneventful sequence indicates the extent to which technicians were comfortable with adding extra sounds to the films' less remarkable scenes. Further, it was perhaps an attempt to make these less action-heavy sequences more exciting for audiences.

This attention to acoustical coverage also had ramifications for Cinerama's stereophonic effects. To save on production costs, many of these effects were not recorded with the full array of six to eight microphone channels, but with only one or two channels.[639] As a result, technicians needed to pan these effects manually to individual loudspeakers in order to spread the sounds across the seven-track sound system. This process subsequently increased the number of directional effects in each of the films.

The Cyprus Gardens episode in *This is Cinerama* is one example of this increased attention to localization. Its motorboat race through the Florida marsh not only features fast-

moving boats that race across the screen, it also includes of the roar of their engines as they jump across the waves along the lake's shores. In some instances, we only hear these motorboats from the center of the screen. In other instances, however, the single-channel sounds pan to the left and right loudspeakers in correspondence with the onscreen action. During the brief sequence in which water skiers perform a medley of stunts, several motorboats enter the background of frame-right and bounce along the water toward frame-left. At the same time, we hear the engines pan from the right loudspeaker to the center loudspeaker in synchrony with this movement in the picture. During another instance, a motor boat races from the background of frame-center and zooms by to exit the foreground of frame-right, ejecting its driver in the process. To accompany this shot, the roar of the boat pans from the center loudspeaker to the right loudspeaker. Further, the sound of the driver splashing into the water plays from the right loudspeakers, matching its location in the picture.

Not unlike the added sound effects at the New England fairground, *Cinerama Holiday*'s thrilling stereo effects often occur during the film's more quotidian and relaxed moments. The Paris episode, for instance, includes a long take of an outdoor cafe where its patrons drink their coffee and admire the ambiance of a grand boulevard. The scene is accompanied by leisurely paced orchestral music and voice-over narration. As in many other scenes, we do not hear the conversations taking place at the cafe in screen left, nor do with hear the sounds of the street traffic in screen right. There is, however, one striking exception. In the middle of the scene, the cafe's patrons sit up to look toward the boulevard in screen-right. A fire engine then enters the picture from the center background and quickly travels toward the right foreground where it exits the frame. At the same time, its single-channel siren pans from the center loudspeaker to the right loudspeaker in correspondence with the engine. Much like the motor boats, the panning of the

siren accentuates the salience of its onscreen source. In this particular instance, the absence of any diegetic sound might have led audiences to misunderstand why the patrons suddenly turned to look at the boulevard during their relaxing afternoon at the cafe. The stereo effect thus helped to provide clarity to the otherwise confusing moment. And much like the loud crank of Ferris wheel, the scene's stereo effect illustrates how the localization of sound was becoming increasingly embedded within every type of Cinerama sequence, even those in which nothing spectacular happens.

This increase in directional effects throughout Cinerama's features meant that action sequences required even more acoustical salience in order to maintain their dramatic importance to audiences. It was during these more thrill-inducing scenes that engineers would activate the sound system's eighth channel. However, the process of redirecting the seventh playback track to the eighth loudspeaker channel was not easy. The effect would have required time for the projectionist to manually switch the cables for tracks 6 and 7 to new output channels. It was therefore inefficient for the rear channel to become activated and de-activated for short-lived fly-by effects, as Wentworth Fling initially intended, for it might take more time for the engineer to patch the cables than for the sound effect to play. In order to address this matter, engineers designed the eighth channel to play not just for one-off effects but for entire sequences.

The most noticeable instance of the eighth channel's activation occurs throughout *Cinerama Holiday*'s finale, when the Blue Angels fly their jets near the coast of Jacksonville, Florida. As a result of this decision to leave the rear channel activated for several minutes, rerecording mixers designed the finale for numerous fly-by effects. The jet engines not only pan across the five loudspeakers located behind the screen, but as we see the jets continuously fly over the camera, the roar of the jets pan from the front loudspeakers, to track six (repurposed for

the side loudspeakers) to track seven (repurposed for the rear loudspeakers). The soundtracks were thus constructed in a way that invited filmmakers to think that these planes were flying over their heads and into the space of the theater. By boasting such extraordinary stereo effects, the film's eighth channel allowed for the finale to distinguish itself from the rest of the feature.

In sum, the sound system's cumbersome recording techniques led to an increase in the number of localization effects throughout each Cinerama travelogue. As a result, the films helped encourage Hollywood to re-define its concept of proper multi-channel aesthetics. Unlike the earlier stereo experiments that privileged the realistic reproduction of sound in auditory perspective, such as *Fantasia* and Fox's 50mm test films, Cinerama demonstrated how directional effects and other thrills could be successfully integrated within a motion picture. For many filmmakers, the question now was how to incorporate these kinds of effects within the narrative structure of a typical Hollywood release.

Cinerama in 70mm

Cinerama's three-strip picture and seven-track sound system were never seen as a realistic alternative to the standard theatrical formats used by the motion picture industry at the time. After years of promoting the technology to Hollywood, MGM became the first studio willing to produce films with the experimental picture and sound system. It also became the last. Both of MGM's Cinerama releases—*The Wonderful World of Brothers Grimm* (1962) and *How the West Was Won* (1962)—performed well at the box office during their national road shows, yet neither performed well enough to counter the technology company's equipment costs and other operating expenses. Cinerama, Inc.'s first foray into narrative features was estimated to have resulted in a ten-million-dollar loss for the company.[640] This loss ultimately encouraged its

remaining investors to abandon their belief that Cinerama was in fact a viable motion picture technology. Its many technical and stylistic innovations simply did not outweigh its weaknesses in the marketplace. Cinerama's three-picture, seven-track apparatus would in turn become another technological curiosity in the history of cinema, not unlike Polyvision, Fantasound, and 50mm stereophonic film.

Though the motion picture industry rejected Cinerama's technology, it did not outright dismiss its aesthetics. Engineers working both inside and outside of Hollywood would harness the sensory experiences of Cinerama's large-scale format, and repackage them within less cumbersome equipment. By the late 1950s there were a number of alternatives to Cinerama that were being promoted to studios as more affordable options for providing audiences with large-scale cinematic experiences. Among the most popular of these alternatives was 70mm film, a large-picture format that had been developed in the 1920s by Fox for a limited number of features—including *Happy Days* (1929) and *The Big Trail* (1930)—but that had since fallen out of use.[641] Following the release of *This is Cinerama*, 70mm would be rediscovered and refurbished with added stereophonic sound, largely as a result of Michael Todd.

Shortly after his dismissal from Cinerama, Todd began work with Brian O'Brian of American Optical—as well as with sound engineers at Ampex and Westrex—to develop a single-lens system that could directly compete with Cinerama as a large-picture technology for the industry's prestige releases.[642] His format was relatively simple. It recorded images onto a single strip of 65mm stock in an aspect ratio that was roughly 2.2:1. These films were then released onto 70mm prints, a slightly wider gauge that provided space for six tracks of magnetically encoded sound. Two stripes of iron oxide placed directly onto the far edges of the print housed two tracks each, while slightly narrower stripes located between the picture and the

perforations held one track each. These six tracks corresponded to six loudspeaker channels; like Cinerama there were five behind the screen, but unlike Cinerama there was only one channel for the rear and sides of the auditorium.[643] Todd promoted his 70mm six-track technology as "Cinerama out of one hole" and branded it Todd-AO.[644]

Todd was far more successful at selling his format to the industry than were Waller and Reeves. Initially Todd-AO features were recorded and projected at thirty frames-per-second, a frame rate that increased onscreen details and that exceeded the twenty-six frames-per-second of Cinerama.[645] The frame-rate, however, also raised production costs due to the twenty-percent increase in film stock needed to record every minute of film. The pictures produced with the Todd-AO process—*Oklahoma!* (1955) and *Around the World in 80 Days* (1956)—were each filmed and road showed in this higher frame rate, but there appeared to be little acknowledgment in the trade press that the increased speed was necessary. To simplify the format for wider use, Todd-AO eventually lowered the film speed to the standard twenty-four frames-per-second, a reduction that simultaneously lowered film stock needs.[646] Studio productions filmed in the Todd-AO format—such as *South Pacific* (1958), *Porgy and Bess* (1959), and *The Alamo* (1960)—were thus all recorded at this standard twenty-four frames-per-second.

More measures were soon introduced to dramatically reduce the cost of Todd-AO productions. During the early 1960s, engineers at Technicolor and Panavision innovated an optical "print-up" process that converted a film shot on traditional 35mm film into a 70mm six-track release print that was compatible with Todd-AO projection equipment.[647] This process allowed studios to record films—such as *The Cardinal* (1963) and *The Carpetbaggers* (1964)—onto less-expensive picture stock, and still have the ability to distribute the finished product to theaters that were equipped with wide screens and stereophonic sound systems. This meant that

Hollywood no longer needed to budget for costly Todd-AO production stock in order to charge filmgoers for pricier Todd-AO theatrical experiences. By the end of the 1960s this cost-saving tactic would become the standard means of producing and distributing wide-gauge, stereophonic sound films to the industry's flagship theaters.[648]

That said, this tactic was not universally adopted. In the mid 1950s MGM and Panavision collaborated to produce an alternative 70mm process that could compete both with Cinerama and Todd-AO. MGM branded it Camera 65 (later known as Ultra Panavision-70).[649] Like Todd-AO, the process recorded pictures onto 65mm film stock and distributed completed films to theaters on 70mm release prints striped with six-track magnetic stereo. The one important distinction was the size of the picture. Instead of a 2.2:1 aspect ratio, MGM Camera 65 used a special anamorphic lens to squeeze the picture onto the 65mm film at a compression rate of 1.25 to 1. In theaters, a similar lens would un-squeeze the picture back to its proper size, creating an aspect ratio of 2.76:1, a ratio that was wider than both Cinerama's and Todd-AO's.[650] Several titles, including *Ben Hur* (1959) and *Mutiny on the Bounty* (1962), were shot and released in the Camera 65 format. This extraordinarily wide aspect ratio even enabled MGM to use the system at various points during the production of *How the West was Won* (1962).[651] The decision to eschew three cameras during production offered the filmmakers greater flexibility with respect to mobility, depth of field, and visual contrasts. Ultimately, 70mm film eliminated the need to use three filmstrips to create the theatrical spectacles associated with Cinerama.

Such theatrics included stereophonic sound designs. Seventy-millimeter six-track prints afforded studios the ability to replicate Cinerama's sensational acoustical effects without the need for a separate filmstrip to run simultaneously with the picture. These auditory effects can specifically be heard throughout *It's a Mad Mad Mad Mad World* (1963) and *Battle of the Bulge*

(1965), both of which were co-produced under the brand of Cinerama but that were nonetheless filmed and distributed with anamorphic 70mm six-track technology. *Battle of the Bulge*, for instance, begins with a series of aerial stunts in which American Col. Daniel Kiley, flies over the head of Nazi Col. Martin Hessler. And much like the Blue Angels sequence in *Cinerama Holiday*, the humming of Kiley's plane pans between the five speakers at the front of the theater, as well as between the front and rear speakers each time it flies over the head of Hessler. Equivalent localization effects are even found in comedies. After Dingy and Benjy steal a plane in *It's a Mad Mad Mad Mad World*, they fly past the air traffic controllers, barely missing the tower at every turn. Throughout this sequence, the roar of the plane pans from the front speakers to the rear speakers, as if to suggest that Dingy and Benjy are recklessly flying not only around an airport's runways but, humorously, though the space of the theater. Thus, though Hollywood did not adopt seven-track, eight-channel technology, Cinerama's stereophonic aesthetics nonetheless continued to inform the industry's six-track sound designs.

The adoption of this aesthetic in select films suggests the extent to which Cinerama had altered the industry's concept of proper multi-channel sound designs. Reeves intended for his eight-channel system to expand the size and scope of motion picture sound, much as earlier multi-speaker designers did during the 1930s. However, the size of the sound system opened up a host of new stylistic options for sound mixers and engineers. Eight channels were no longer just a means to expand the size of a recorded sound, they became a tool to create more compelling directional effects and other theatrical thrills that had yet to become conventions of motion picture mixing practices. In sum, Cinerama's development resulted in a new attempt to create the very assaults on the senses which Howard Hughes, Abel Gance, and André Debrie tried but failed to market to the film industry. Cinerama would not only succeed in selling the

value and pleasure of such auditory sensations to Hollywood, it would lead filmmakers to normalize such practices over the next several years.

Conclusion

When Hollywood studios constructed its magnetic recording technology to be indistinguishable from optical recording, they created an opportunity for peripheral industries to explore alternative functions of magnetic recording, and thereby differentiate their own soundtracks from those produced in Hollywood. Chief among these differentiation strategies was the re-investigation of multi-channel audio. Magnetic technology lowered the noise levels of recorded signals and enabled engineers to store more tracks onto a single strip of film. In turn, the new recording technology could address many of the technical problems that had undermined the quality of earlier optical stereo formats. Cinerama's seven-track magnetic stereo system was marketed to the industry as a viable alternative to optical monophonic sound specifically because of the way the system was said to improve upon earlier alternatives to single-channel playback. It not only featured wider frequency and decibel ranges, it also stressed a new conception of proper stereophonic reproduction, one that placed less emphasis on natural auditory perspective, and greater emphasis on thrill-inducing directional effects.

Although only two Hollywood films would ever receive Cinerama's seven-track stereo mixes, the industry did not hesitate to adopt the technology's more sensational auditory techniques. Beginning in the mid 1950s, a handful of Hollywood films were released onto 70mm prints and distributed to the industry's largest theaters as traveling road-show entertainment. These prints were all striped with six magnetic stereo tracks, which allowed them to manifest the same types of directional capabilities that once played from Cinerama's sound systems. Though

Cinerama was unable to convince the industry that its seven-track technology was a necessary component of motion picture, it nonetheless established a new aesthetic ideal to which studios adhered when mixing the sound tracks for their large-screen attractions.

Cinerama's impact on 35mm releases was even more profound. The arrival of seven-track magnetic stereo would cause a boom in multi-channel content across all genres of motion pictures, from the A-status productions of major studios to the B-grade programmers of independent producers. These stereo releases dominated 35mm screens during the 1950s and in turn 35mm became the format wherein Hollywood negotiated the value of multi-channel effects to its broader storytelling practices. In the following chapter, I trace the origins of this negotiation to a short-lived theatrical format known as triple-track stereo. I show how the market problems provoked by triple-track releases, and formed in response to Cinerama's popularity, would set the stage for Hollywood's codification of multi-channel aesthetics by the end of the decade.

Citations

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[550] Sarah Easen, "Film and the Festival of Britain," in *British Cinerma of the 1950s: A Celebration*, eds. Ian MacKillop and Neil Sinyard (Manchester: Manchester University Press, 2003), 51-63.
[551] Wells Coats, "Planning the Festival of Britain Telekinema," *British Kinematography*, vol. 18 (Apr. 1951), 108-19.
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[553] Raymond Spottiswoode, "Progress in Three-Dimensional Film at the Festival of Britain," *Journal of the Society of Motion Picture Engineers*, vol. 58 (Apr. 1952), 291-303; Ray Zone, *Stereoscopic Cinema and the Origins of 3-D Film, 1838-1952* (Lexington: University Press of Kentucky, 2007), 176-79.

[554] Norman McLaren and Chester Beachell, "Stereographic Animation—The Synthesis of Stereoscopic Depth From Flat Drawings and Art Work," *Journal of the Society of Motion Picture Engineers*, vol. 57 (Dec. 1951), 513-20; Zone, 172-76.
[555] Spottiswoode, "Progress in Three-Dimensional Film," 300.
[556] A. Bowen, J. Moir, and H. Turner, Sound Film Equipment in the Festival of Britain Telekinema," *British Kinematography*, vol. 18 (May 1951), 142-49.
[557] Norman Jenkins, "The Cash Customers at the Festival of Britain Telecinema," *Journal of the Society of Motion Picture Engineers*, vol. 58 (Apr. 1952), 303-04.
[558] Coats, "Planning the Festival of Britain Telekinema," 117.
[559] Jenkins, "Cash Customers," 310.
[560] Spottiswoode, "Progress in Three-Dimensional Film," 294.
[561] Jenkins, "Cash Customers," 310.
[562] The films were repackaged as the *Stereo Techniques* program of shorts that Raymond and Nigel Spottiswoode distributed throughout England after the Festival. In the United States *Stereo Techniques* was distributed by Sol Lesser, who used the program to promote his "Tri-Opticon" three-dimensional process. "Lesser Acquires Rights to British Tri-Opticon," *Box Office*, Oct. 25, 1952, 21; "Sol Lesser's 3-D, Tri-Opticon, In Socko Chi Teeoff," *Variety*, Dec. 31, 1952, 6; Keith M. Johnston, "Now is the Time (to Put on Your Glasses): 3-D Film Exhibition in Britain," *Film History*, vol. 23 (Jan. 2011), 95-98.
[563] Crowther, "Looking at Cinerama," X1.
[564] Ralph Walker, "The Birth of an Idea," in *New Screen Techniques*, ed. Martin Quigley, Jr. (New York: Quigley Publishing Company, 1953), 112-17.
[565] Walker, "Birth of an Idea," 114.
[566] Richard Koszarski, *Hollywood on the Hudson: Film and Television in New York from Griffith to Sarnoff* (Piscataway, NJ: Rutgers University Press, 2008), 56; For specific details on *Symphony in Black*, see Jennifer Fleeger, *Sounding American: Hollywood, Opera, and Jazz* (New York: Oxford University Press, 2014), 107-14.
[567] To achieve this, the eleven projectors were divided into three rows: two at the bottom that were pointed toward the ceiling, four in the middle that were pointed just above the audience's eye-lines, and five at the top that were pointed toward the bottom of the screen. Fred Waller, "The Archaeology of Cinerama," *Film History*, vol. 5 (Sept. 1993), 290.
[568] Walker, "Birth of an Idea," 116.
[569] Waller nonetheless successfully designed other venues for the World's Fair, including the "Time and Place" exhibit for the American Museum of Natural History, as well as the "Hall of Color" for Eastman Kodak. Waller, "Archaeology of Cinerama," 291-92.
[570] Surviving panels from the eleven-camera film were re-assembled for *Cinerama Adventure*, directed by David Strohmaier (2002; Los Angeles, CA: Flicker Alley, 2012), Blu-ray.
[571] Koszarski, *Hollywood on the Hudson*, 369-70. Ironically, and despite their bona fide credentials on the oil industry's capitalist propaganda film, both Losey and Eisler would later be investigated for their ties to the Communist Party,
[572] Johannes C. Gall, "An 'Art of Fugue' of Film Scoring: Hanns Eisler's Rockefeller Foundation-Funded Film Music Project (1940-1942)," in *Patronizing the Public: American Philanthropy's Transformation of Culture, Communication, and the Humanities*, ed. by William J. Buxton (Plymouth, UK: Lexington Books, 2009), 124-25.
[573] Walker, "Birth of an Idea," 117.

[574] Fred Waller, "Cinerama Goes to War," in *New Screen Techniques*, ed. Martin Quigley, Jr. (New York: Quigley Publishing Company, 1953), 118-26.
[575] Fred Waller, Willis Robert Dresser, and Henry Martyn Baker, "Gunnery Training," US Patent no. 2,406,574 (Oct. 17, 1941); Fred Waller, "The Waller Flexible Gunnery Trainer," *Journal of the Society of Motion Picture Engineers*, vol. 47 (July 1946), 73-87.
[576] Waller, "Cinerama Goes to War," 124.
[577] During the 1930s Waller had developed a stereophonic sound system that recorded and reproduced a stereophonic signal using three-tracks of sound, each stored as parallel grooves on a single disk. Although the format was abandoned shortly after the beginning of World War II, it is possible that the three-channel sound system initially intended for the Waller Gunnery Trainer was a continuation of this three-track stereo disk. Waller, "Archaeology of Cinerama," 292-93. See also Waller, et. al., "Gunner Trainer," 7.
[578] Waller, "Waller Flexible Gunnery Trainer," 80-83.
[579] Hazard E. Reeves, "Adding the Sound to Cinerama," in *New Screen Techniques*, ed. Martin Quigley, Jr. (New York: Quigley Publishing Company, 1953), 127-32.
[580] Hazard Reeves, "Bootstraps," in *Nine Lives and More* [unpublished manuscript; no date], Alex Reeves papers, Port Haywood, Virginia.
[581] Lowell Thomas, "The Cinerama Show," in *New Screen Techniques*, ed. Martin Quigley, Jr. (New York: Quigley Publishing Company, 1953), 135.
[582] Eva Orbanz, "Step by Step," in *Filming Robert Flaherty's* Louisiana Story*: The Helen van Dongen Diary*, ed., Eva Orbanz (New York: Museum of Modern Art, 1998), 113; Thomas Fine, "Less is More: The Mercury Living Presence Recording Technique," *Tape Op* (July/Aug. 2012), 23.
[583] Hazard Reeves, "A Little Bit of Luck," Alex Reeves papers.
[584] Reeves, "Adding the Sound to Cinerama," 128-29; William Lafferty, "The Early Development of Magnetic Sound Recording in Broadcasting and Motion Pictures, 1928-1950" (PhD diss., Northwestern University, 1981), 194-97. See also, Richard Koszarski and Joseph Lerner, "Joseph Lerner and the Post-War New York Film Renaissance," *Film History*, vol. 7 (Winter, 1995), 456-476.
[585] Edward Schmidt, "Commercial Experiences with Magna-Stripe," *Journal of the Society of Motion Picture Engineers*, vol. 60 (Apr. 1953), 463-69; Hazard Reeves, "Parlay Two," Alex Reeves papers.
[586] Waller, "Cinerama Goes to War," 126; Waller, "Archaeology of Cinerama," 294.
[587] Reeves, "Adding the Sound to Cinerama," 129.
[588] Waller, "Archaeology of Cinerama," 294-95.
[589] Reeves, "Adding the Sound of Cinerama," 127-28.
[590] Alden P. Armagnac, "Super-Movies Put You in the Show," *Popular Science* (Aug. 1950), 74-78; Aaron Nadell, "Cinerama—A Step in the Right Direction," *International Projectionist* (Oct. 1952), 11, 24.
[591] George R. Groves, "Progress Committee Report," *Journal of the Society of Motion Picture Engineers*, vol. 60 (May 1953), 535.
[592] Scott Marshall, "Interview With Dr. Wentworth Fling, the Man Who Brought Cinerama Out of the Laboratory," *Film History*, vol. 15, no. 1 (2003), 61-63.
[593] Marshall, "Interview With Dr. Wentworth Fling," 62.
[594] Marshall, "Interview With Dr. Wentworth Fling," 62.

[595] Cue sheets were provided to all the projectionists, as they told theaters not only when to patch track seven to the rear loudspeakers, but when to open the curtain and—like early Vitagraph releases—when to change reels. Surviving stereo cue sheets for *This is Cinerama*, *Cinerama Holiday*, and *Search for Paradise* are located in the David Strohmaier papers in Van Nuys, California. The cue sheets for *Search for Paradise* are also republished in Robert E. Carr and R. M. Hayes, Wide Screen Movies: A History and Filmography of Wide Gauge Filmmaking (Jefferson, NC: McFarland & Company, 1988), 20-21.
[596] Marshall, "Interview With Dr. Wentworth Fling," 62.
[597] Hazard Reeves, "Cinerama I: Labor Pains," 7-8, Alex Reeves papers. The description was posthumously republished in Hazard Reeves, "This is Cinerama," *Film History*, vol. 11, no. 1 (1999), 87-88.
[598] Reeves, "Cinerama I: Labor Pains," 7-8; Reeves, "This is Cinerama," 87.
[599] Thomas Erffmeyer, "The History of Cinerama: A Study of Technological Innovation and Industrial Management," (PhD diss., Northwestern University, 1985), 53-56.
[600] "Cite Intricate Structure of Cinerama Co.," *Variety*, Nov. 19, 1952, 5, 21.
[601] "Cite Intricate Structure of Cinerama Co.," 21.
[602] "Todd-Thomas Eyes N.Y. Legit Theatre for Bow Of New Cinerama Pic," *Variety*, Dec. 27, 1950, 4.
[603] "Broadway," *Variety*, Apr. 18, 1951, 74; Thomas, "The Cinerama Show," 137.
[604] "Passing of Pioneers," *Educational Screen* (Sept. 1951), 296.
[605] Art Cohn, *The Nine Lives of Michael Todd* (New York: Random House, 1958), 328.
[606] Michael Todd, Jr. and Susan McCarthy Todd, *A Valuable Property: The Life Story of Michael Todd* (New York: Arbor House, 1983), 218-19.
[607] Cohn, 330-31; Todd and Todd, 221-25.
[608] Todd and Todd, 224-25.
[609] Reeves, "Cinerama II: A Star is Born,", 5, Alex Reeves papers; Reeves, "This is Cinerama," 91.
[610] Todd and Todd, 229-30.
[611] The budget for *This is Cinerama* was reportedly $1,250,000, arguably well above the cost of a traditional documentary at the time. "Todd-Thomas Eyes N.Y. Legit Theatre for Bow Of New Cinerama Pic," 4. The budged for *Cinerama Holiday* was reportedly as high as to $2,000,000. "'Holiday, Thus Far, Grossed $4,600,000," *Variety*, Sept. 28, 1955, 6.
[612] Erffmeyer, 80.
[613] Erffmeyer, 91-92.
[614] Richard J. Pietschmann, Jr., Letter to Ed Evans, "Considerations for remixing 'This is Cinerama'," Mar. 27, 1953, David Strohmaier papers.
[615] Richard J. Pietschmann, Jr., "Remix of 'This is Cinerama' From April 6, 1953 to April 25, 1953 Inclusive," David Strohmaier papers.
[616] Pietschmann, "Remix of 'This is Cinerama'," 1.
[617] Pietschmann, "Remix of 'This is Cinerama'," 1-2.
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[619] Harold Walsh, "Despite Big Box Office Cinerama Is Losing Money," *Los Angeles Times*, Feb. 6, 1953, A8.
[620] "Cinerama Shifting On Broadway After Snarl With Shuberts," *Variety*, Mar. 5, 1953, 7.

[621] Erffmeyer, 46.
[622] Erffmeyer, 55.
[623] "Michael Todd Ruled Bankrupt in U. S. Court," *New York Herald Tribune*, Sept. 26, 1947, 25; Todd also had a considerable gambling problem that may have exacerbated his financial situation. "Mike's Venice," *Time*, July 21, 1952, 44; Cohn, 319;
[624] Erffmeyer, 51-53.
[625] Thomas remained with the company, becoming Vice-Chairman of the company's board of directors. "Merian Cooper to Manage Cinerama Productions," *Box Office*, Aug. 16, 1952, 22; Cohn, 335; "Mayer Board Chairman Of Cinerama," *Motion Picture Daily*, Oct. 20, 1952, 1, 4.
[626] "Heavy Trading In Cinerama As Mayer Heads Bd.," *Variety*, Oct. 22, 1952, 3, 18.
[627] Erffmeyer, 77-78.
[628] According to Cohn, Todd knew about the stock manipulation and had used it as leverage when brokering his severance package following his removal from the company. Cohn, 334-35.
[629] For an illustration of this lack of transparency, see "Cinerama: Prepared from Material Supplied by Cinerama, Inc.," *International Sound Technician*, vol. 1 (Mar. 1953), 4-7, 18.
[630] For instance, see "In Sync," *New Yorker*, May 5, 1951, 23-25; John W. Boyle, "And Now... Cinerama," *American Cinematographer* (Nov. 1952), 480-81, 998-500; Joseph Brun, "The Cinerama Technique," *American Cinematographer* (June 1954), 291-2, 301-2.
[631] Lester Isaac, "Hi-Fi Trix in Pix," *Variety*, Oct. 14, 1953, 46.
[632] "Cinerama: Super Movies of the Future," *International Projectionist* (Nov. 1950), 10-11; Jack Gieck, "Backstage at Cinerama," *International Projectionist* (May 1954), 15-16, 30-31.
[633] "SW Mulling Production Plans; To Make 5 Pix in 5 Yrs. in Cinerama," *Variety*, July 8, 1953, 3, 14; "D. of J. Greenlights SW-Cinerama Deal With Strings; Await Court O.K.,"*Variety*, Aug. 5, 1952, 3, 18; "Court Approves Sale of Cinerama Rights," *New York Times*, Aug. 13, 1953, 17.
[634] Stanley Warner's shares in Cinerama, Inc. were reported to cost about $1,600,000. "SW Mulling Production Plans," 14. Erffmeyer notes that the final purchase price for Stanley Warner to produce, distribute, and exhibit Cinerama films was $2,562,637. Erffmeyer, 100.
[635] The changes that Cinerama, Inc. made to its sound system were limited to a system upgrade that eliminated hum during theatrical playback as well as several small-scale recording improvements including a new seven-channel production mixer. Charles R. Daily, "Progress Committee Report," *Journal of the Society of Motion Picture and Television Engineers*, vol. 64 (May 1955), 228.
[636] Kathryn Kalinak, *Settling the Score: Music and the Classical Hollywood Film* (Madison: University of Wisconsin Press, 1992), 115-16; Lea Jacobs, *Film Rhythm After Sound: Technology, Music, and Performance* (Berkeley: University of California Press, 2015), 58-108.
[637] "'Holiday, Thus Far, Grossed $4,600,000," 6.
[638] The one exception occurs during the drummer's brief solo, which is filmed at a close distance and which plays in close synchrony with the sound. There is an audible cut just before and] after the solo, which suggests that the sounds of the solo were likely recorded at the same time as the image, and that the take was then spliced into the sound track, albeit somewhat haphazardly, during rerecording. It is reasonable to infer that the difficulty of this splice discouraged the technicians from attempting other moments of close synchrony throughout the rest of the sequence.
[639] For instance, the sound effects log book for Cinerama's *Seven Wonders of the World* (1956) indicates that the vast majority of location recordings were made with only one or two microphone channels. "Sound: Seven Wonders," David Strohmaier papers.

[640] Erffmeyer, 225-26.
[641] John Belton, *Widescreen Cinema* (Cambridge: Harvard University Press, 1992), 48-50.
[642] "Prep Special Sound for Todd-AO Process," Variety, May 6, 1953, 3; "Todd-AO Methods and Equipment," Motion Picture Daily, Oct. 7, 1955, 12-18; John Gow, "The Todd-A.O. Process," Cine Technician (Oct. 1955), 150-51.
[643] James Morris, "The Todd-AO System: A Projector for Both 70- and 35-mm Film," *International Projectionist* (Oct. 1955), 7-10, 34.
[644] Todd and Todd, 245.
[645] Morris, "The Todd-AO System," 9-10.
[646] Robert A. Mitchell, "'Low-Powered' Projection Ruled Out By 'High-Powered' American Standard," *International Projectionist* (Feb. 1961), 6.
[647] Charles Loring, "Breakthrough in 35mm-to-70mm Print-Up Process," *American Cinematographer*, vol. 45 (Apr. 1964), 204, 224-225.
[648] Belton, 179-80.
[649] "Board Shown 'MGM Camera 65' Process," *Motion Picture Daily*, Apr. 13, 1956, 1, 6; Morgan Hudgins, "Return to 'Paradise' Aboard the 'Bounty'," *New York Times*, Feb. 19, 1961, 123.
[650] Initial reports stated the aspect ratio was 3:1. This was likely in reference to measurements taken before considering the width of the sound track, which reduced the width of the picture track slightly. A. E. Jeakins, "More Wide Screen Systems," Cine Technician (Sept. 1956), 134; "Panavision Enters Independent Production," *International Projectionist* (Nov. 1957), 11.
[651] "Second MGM-Cinerama Film Now in Planning Stages," *Box Office*, Mar. 13, 1961, 15; Erffmeyer, 199.

Chapter 6: The Triple-Track Alternatives, 1953

Who is Dr. Terwilliker? The eponymous and acoustically conscious antagonist from Columbia's *The 5,000 Fingers of Dr. T* (1953) has continued to puzzle scholars ever since the film's release.[652] So has the film. The surreal musical for which Dr. Terwilliker was invented tells the story of Bart Collins, a young boy who refuses to practice the piano, and who falls sleep and awakens in a world where he and 499 other children are forced to play on a large, grotesque keyboard that curves around the walls of an immense concert hall inside the macabre Terwilliker Institute. And Dr. Terwilliker himself is by many accounts the story's most compelling element—a tall order given how the musical offers a bouquet of psychoanalytic catnip, including a Kurt Weill-inspired number about torture and bondage accessories, not to mention a pair of roller-skating Sigmund Freud look-a-likes who boast lengthy beards that are conjoined at the tips (and that are eventually snipped by a pair of elongated scissors).

On one hand, we might understand Dr. Terwilliker to be a tongue-in-cheek stand-in for the film's screenwriter, Theodor "Dr. Seuss" Geisel. Both are ostensibly whimsical pied pipers who seduce children through fantastic tales and who encourage them to partake in an enigmatic, yet imaginative, worldview. On the other hand, the historical context of the film's release invites Dr. Terwilliker be read as an agent of audiophilic satire. Like Dr. Seuss's commentaries on capitalism and Nazism, *5,000 Fingers* functions as a parody of multi-channel sound systems. The film began its production in 1951, before the premiere of Cinerama, and in the wake of several stereophonic failures, including Harvey Fletcher's concert at Carnegie Hall and Disney's short-lived Fantasound.[653] For Dr. Seuss, stereophonic sound was perhaps no different than a piano that curves around an auditorium and plays music from all sides of the listener—poor music at

that. As the film's climax reveals in a dissonant rendition of "Chopsticks," the stereophonically designed sinusoid piano hurls noisy melodies from every which direction without any consideration for acoustical pleasure.

Dr. Terwilliker—the promoter of these technologies and the man who implores children to value their cacophonies—is then, by proxy, a caricature of Leopold Stokowski, the European conductor who aided Fletcher in the design of his multi-speaker sound system, who in Disney's *Fantasia* (1940) educated children about how to listen to classical music, and who even orchestrated concerts during which hundreds of musicians performed on stage at the same time.[654] As stereo's cultural reputation remained one of eccentricity, there was perhaps no one associated more with its historical trajectory than Stokowski, and there was similarly no better comment on its cultural value than Columbia's bizarre musical. To Stokowski's likely chagrin, Dr. Seuss reduced stereo technology to a deafening punch-line peddled by a crazy megalomaniac with a penchant for preening and commercialized cacophonies.

That said, the film's theatrical release would inadvertently undermine this acerbic commentary. After the premiere of *This is Cinerama* in September 1952, the value of stereophonic sound underwent a remarkable transformation in Hollywood. It became not only a tool to bolster motion picture quality but a means to boost box office revenue. And during a period when the studio-system economy was fractured by theatrical divestiture and the continued rise of independent productions, such boosts were a matter of necessity, even at Columbia. Though it initially poked fun at Stokowski and his musical apparatus, the studio would nonetheless release *5,000 Fingers*, ironically, in stereophonic sound—the very technology that its design had ridiculed.[655] Like dozens of Hollywood films released in 1953, *5,000 Fingers* played in magnetic stereo in select theaters as a means to cash-in on audiences' newfound

interest in multi-channel sound. The result of such conditions was a significant uptick in stereophonic content, arguably the first time that Hollywood valued multi-channel sound systems as more than merely technological curiosities, but as acoustical necessities that were worthy of considerable financial investment.

This chapter looks at this first attempt by Hollywood studios to take financial advantage of magnetic stereo's newfound popularity. In the immediate wake of Cinerama's premiere, studios haphazardly designed a multi-channel theatrical format that could quickly add three-dimensional soundscapes to 35mm releases without the burdensome costs of a seven-track system. This format was triple-track stereo. Throughout 1953, Hollywood mixed and distributed dozens of films for this new stereo technology, including *5,000 Fingers*. And yet triple-track stereo fell out of use by the end of the year almost as quickly as it rose to prominence. I argue that such a short-lived trajectory was partly due to the economic conditions that led to its rushed design. More, through a close analysis of several triple-track releases—including Universal's *It Came From Outer Space* (1953), Columbia's *Miss Sadie Thompson* (1953), and Warners' *House of Wax* (1953)—I contend that the format was ultimately riddled with a host of acoustical flaws that prevented it from ever becoming a cost-efficient alternative to Cinerama's vaunted sound system. Triple-track, however, was not historically insignificant. Despite the format's many technical problems, the inventive ways that technicians used the system to design multi-channel soundscapes continued to inform the many multi-channel formats that were developed in Hollywood throughout the remainder of the 1950s.

The Conditions for Innovation

In 1953, Hollywood valued stereophonic sound not because of its storytelling possibilities per se, but because it promised to provide studios with a much-needed financial boost during a time of considerable economic uncertainty. As historians note, the late 40s and early 1950s saw a dramatic decline in ticket sales due to several changes to American society following World War II.[656] The G.I. Bill encouraged American soldiers to enroll in schools when they returned home, a moment of mass matriculation that lowered cinema attendance during evenings and weekends. Additionally, suburbanization led to a rise in a greater number of leisure activities beyond simply going to the movies.

Chief among these activities involved staying home to take in radio and television entertainment. According to Tino Balio, in 1947 only fourteen-thousand households had television sets, but this number drastically increased to four million in 1950 and thirty-two million by 1954.[657] At the same time, the number of commercial television stations increased, and with it so did the amount of television programing that families could watch for free in lieu of attending the cinema. By the mid 1950s, Balio even suggests that "television had grown to replace the movies as the dominant leisure-time activity."[658] This increase in competing forms of entertainment encouraged studios to raise ticket prices in order to mitigate any profit losses. Such tactics, however, only exacerbated the problem. Between the mid-1940s to mid-1950s box office receipts continued to drop 26%, from 1.7 billion to 1.3 billion. As a result, studios had fewer financial resources at their disposal.[659]

Hollywood's adverse economic conditions were compounded by the 1948 Supreme Court decision, *United States v. Paramount Pictures*.[660] The landmark ruling found that the major studios were in violation of federal antitrust laws with respect to their theater ownership, their

methods of preventing independent distributors from gaining access to many high-end theaters, their price fixing and block booking of releases to independent theaters, and their creation of an anticompetitive run-zone-clearance system to maximize profits at the expense of independent companies.[661] The Court ruled that these practices were unconstitutional, and in response it decreed that studios needed to divest from their theater chains in order to avoid further prosecution. The mandated economic shake-up meant that studios were unable to maintain their highly beneficial distribution deals with the leading first-run theater chains. Instead, studios would have to compete for access to these venues, a process that would effectively lower rental costs and curtail the ability for studios to pawn off low-quality pictures to independent theaters at inflated prices.

The decrees nonetheless did not dramatically disrupt the balance of power in Hollywood. Before the Court's decision, the industry was dominated by eight studios: five majors (Fox, RKO, Warners, Paramount, and MGM) and three minors (United Artists, Columbia, and Universal). Following the decision, the majority of profits in Hollywood continued to be shared among these same eight studios, with two more companies—Republic and Allied Artists (formerly Monogram)—operating at a distant ninth and tenth place.[662] The problem for studios, however, was that there were now fewer profits to be had. No longer able to exploit the theatrical marketplace for financial gain, studios now had to split the smaller box office grosses among a larger number of companies.

The studios initially responded to this predicament by cutting budgets and overhead. Among these cuts was a decision to replace optical recording equipment with magnetic recording technology. As I discuss in chapter four, the adoption of magnetic was estimated to save studios on material and labor costs, not only on sound stages in Hollywood, but also on location in cities

like New York, where films like *The Sleeping City* (1950) could be made with smaller crews and smaller budgets. However, the transition to magnetic technology had only a limited effect on the yearly earnings. The savings to material and labor costs could not, by themselves, outweigh the loss of revenue from theatrical divestiture.

Studios also responded to declining profits by downsizing contracted talent and salaried workers by nearly 50%, from 24 thousand to 13 thousand employees by the mid-1950s.[663] Such attrition was particularly felt among the industry's sound personnel. As studios dismantled their in-house sound departments, editors and mixers—those who maintained stable job security at studios in the 1930s and 1940s—now found themselves working as freelance practitioners.[664] Many even opened up postproduction facilities in and around Los Angeles to service motion picture, television, and independent productions around Hollywood. Paramount's Loren Ryder opened Ryder Sound Services in 1948.[665] James G. Stewart, formerly of RKO and Selznick Releasing, became a leading sound engineer at Glen Glenn shortly following the 1948 release of *Portrait of Jennie*.[666] And by the 1950s Reeves Sound Studios had become a leading postproduction house for New York productions, with Cinerama engineer Dick Vorisek serving as the sole re-recording mixer for many New York filmmakers, including Robert Wise, Sidney Lumet, and Elia Kazan.[667]

Although the many cuts to overhead offered short-term savings for the studios, their long-term effects were far less beneficial. The rise of an independent post-production industry meant that former salaried technicians were now competing against studios for clients, at times successfully stealing away business and driving down the price of each studio's technical services in the process. Such economic changes removed the barrier for entry for many independent filmmakers who could now pay to have their films professionally edited and mixed.

However, it meant that studios were producing a smaller share of annual releases, and that studios themselves were at risk of decreasing their control over the theatrical market. Though the majors may have retained their status as the industry's financial leaders following the 1948 Paramount decision, this increase in intra-industry competition meant that such a status was arguably disappearing.

Old Technologies Reintroduced

In response to these economic problems, studios redirected their efforts away from cost-cutting measures and toward new strategies designed to increase ticket sales. One such tactic was to exploit the Production Code Administration's weakened authority over the industry, and to include more sensational and controversial content in each picture—as Otto Preminger successfully demonstrated by including a few lines of salacious dialogue throughout the comedy *The Moon is Blue* (1953).[668] Another such tactic—and one adopted by the vast majority of studios—was to release pictures in audiovisual formats that de-familiarized audiences with cinema's sensory entertainment. The formats included stereoscopic 3D, larger pictures, and stereophonic sound.

The three technologies had been available to studios since the 1920s, though none of them proved to be exceptionally popular with filmgoers until the releases of *This is Cinerama* and Arch Oboler's *Bwana Devil*, both of which premiered in Fall of 1952.[669] As I discuss in chapter five, *This is Cinerama* boasted an extremely wide three-strip picture that curved around the sides of the audience, as well as a seven-track stereo system that emanated from speakers located on all four walls of the auditorium. *Bwana Devil* was similarly sensational. It featured a two-strip 3D process called Natural Vision that required filmgoers to wear special disposable

glasses in order to experience its screen-bursting, three-dimensional visual effects. Largely as a result of these two films, the concept of 3D, widescreen, and stereo sound increased in popularity with audiences. In turn, the technologies were soon valued by the studios as profit generators that had the potential to lure suburban audiences back into theaters in numbers that rivaled pre-War attendance rates. All that studios needed to do was find a cost-efficient means of incorporating these technologies into their modes of production.

Such was specifically the intention of Natural Vision's owner, Milton Gunzberg. Following *Bwana Devil*'s premiere, Gunzberg commenced an aggressive campaign to market its product to studios. By the end of 1952 he had successfully convinced Warners to license Natural Vision for their production of *House of Wax*.[670] Gunzberg's campaign was accompanied by other 3D merchants hoping to cash-in on Hollywood's newfound interest in stereoscopic technology. Sol Lesser, for instance, promoted his Tri-Opticon technology to the industry by road showing a program of 3D shorts, titled "Stereo Techniques," which consisted of films that premiered at The Festival of Britain.[671] At the same time, studios including MGM and Paramount were busy developing their own proprietary 3D technologies that could be easily licensed to filmmakers who wished to experiment with visual effects. The Pine-Thomas productions of *Sangaree* (1953) and *Those Redheads from Seattle* (1953) were among the many films made with Paramount's 3D "Paravision" process, while Richard Fleischer's *Arena* (1953) would become the first film released in MGM's "Metrovision" process.[672] As a result of a perceived demand for 3D content, stereoscopic formats saw a relatively high rate of use by Hollywood studios between 1952 and 1954.

In contrast, Cinerama's three-strip widescreen picture and seven-track stereophonic sound saw far more resistance among the studios. Both processes were cumbersome and

expensive and were thereby an immeasurable burden on commercial theaters. Though MGM would in 1962 release two films—*The Wonderful World of the Brothers Grimm* and *How the West Was Won*—produced for the three-picture and seven-track Cinerama technology, during the 1950s most studios balked at the prospect of releasing a film in a theatrical format that would not screen in the vast majority of flagship theaters.[673] In lieu of adopting Cinerama proper, filmmakers looked to develop a type of Cinerama-lite, a format that could simulate the enormous screen and stereo sound of Cinerama without the requirement of costly theatrical renovations.

Many studios did opt for such formats. During the early months of 1953, several producers began releasing motion pictures in an image format that John Belton dubs "ersatz" widescreen.[674] Unlike Cinerama, these films were shot in Academy Ratio and simply matted at the top and bottom of the frame in a manner that ostensibly recreated Cinerama's wide picture dimensions. That said, the aspect ratios were noticeably smaller, generally between 1.66 to 1 and 1.85 to 1. Paramount's *Shane* (1953) became the first film released in the ersatz format that Spring, and in the weeks that followed other prestige titles also premiered with matted frames, including Universal's *Thunder Bay* (1953) and MGM's *Julius Caesar* (1953). *The 5,000 Fingers of Dr. T* was perhaps among the most notable of these releases, for Columbia would go so far as to brand its matted picture as the new "Wonderama" technology in a ploy to convince audiences that the wider screen was not simply an afterthought for filmmakers.[675] Such gimmicks, though silly in retrospect, were deemed economically necessary. The major studios needed to increase the market value of their many unreleased titles that had been recorded in 1.37 to 1. Due to the widening of theatrical screens, there was a fear that these films were suddenly at risk of being shown only on television.[676] Matted widescreen, and their subsequent promotional campaigns,

became a quick and affordable means to secure box office revenue and transform these titles into the big-picture sensations that audiences were now craving.

Triple-track stereo was ostensibly the acoustical analogue to ersatz widescreen. Like the seven-track stereo system that accompanied Cinerama releases and the four-track stereo system that accompanied Raymond Spottiswoode's three-dimensional films at the Festival of Britain, triple-track stereo was a dual system. This meant that the picture and soundtracks were stored onto two separate sets of prints. The picture was housed on standard 35mm film, complete with a narrow optical track that held a monaural version of the movie's sound mix. Its stereo tracks were stored on a second strip of 35mm film that was fully coated in magnetic oxide.[677] These fully coated prints featured three soundtracks—each 200 mils wide (0.2 inches)—which corresponded to the movie's left, center, and right playback channels.[678] The stereo prints were designed to play in theaters wired with three loudspeakers behind the screen, typically Altec-Lansing's "Voice of the Theater" speakers.[679] However, if stereo system were to break-down during screenings, or if the film were distributed to venues without a stereophonic playback system, projectionists could simply send the film's monaural optical soundtrack to the theater's center loudspeaker.

Just as projectionists could quickly transform Academy Ratio titles into widescreen releases, studio engineers could up-mix Academy Mono prints for triple-track sound systems. Such up-mixing was made possible with the advent of new stereophonic rerecording machines, such as Westrex's line of RA-1500 mixing units.[680] Dialogue, music, and sound effects that were recorded in monaural could now be directed to any single playback channel or spread to multiple channels at the discretion of the rerecording technician. Furthermore, the triple-track medium was itself already being used by studios for the recording of larger orchestral scores as well as

for storing dialogue, music, and effects onto separate tracks during each film's re-recording stage.[681] The up-mixing of monaural soundtracks into stereophonic releases merely involved the repurposing of 35mm triple-track magnetic media as a playback format. In turn, the three-channel technology was not a costly endeavor with respect to post-production overhead.

Many ersatz widescreen features received triple-track stereo up-mixes in 1953, including *Thunder Bay*, *Shane*, *Julius Caesar*, *The 5,000 Fingers of Dr. T*, as well as lesser known releases such as MGM's *Young Bess* (1953), United Artists' *Melba* (1953), and Columbia's *Let's Do it Again* (1953). Many 3D pictures also featured triple-track up-mixes, including *Those Redheads From Seattle*, Columbia's *Fort Ti* (1953), Universal's *The Great Sioux Uprising* (1953), Allied Artists' *The Maze* (1953), and two sound-centered thrillers that have come to define Hollywood's golden age of 3D: *It Came From Outer Space* and *House of Wax*. Like matted widescreen, triple-track was ostensibly a jerry-rigged technology. It gave studios the means to boost the value of their library titles at a time when traditional monaural sound was perceived to be losing steam at the box office, and it did so without a considerable overhaul of studios' production and post-production facilities.[682] In other words, the adoption of the triple-track format was more about ticket sales and yearly revenue than it was about enhancing a story.

Standard Up-Mixing Procedure

As a result of these financially centered decisions, it is perhaps no surprise that the industry's triple-track technology was far from problem-free. Indeed, the cost-efficient and, at times, rushed manner in which triple-track films were made led to acoustical mishaps that were neither motivated by the films' narratives nor informed by theories of aural fidelity. Rather, these mishaps often detracted from the film-watching experience. As *Variety* noted in its review of

Thunder Bay, "Exhibs will have to be careful of the stereophonic sound, however, because, as used at the preview, it can become a major distraction that greatly lessens a viewer's ability to stay with the story."[683] The paper's review of *Julius Caesar* similarly noted, "The use of stereophonic sound, however, is sometimes intrusive and draws attention away from the story in scenes with few characters."[684] Reviews consistent complained about many triple-track releases. However, there remain very few clues as to why stereophonic designs routinely distracted from the filmwatching experience.

Case Study: It Came From Outer Space

The triple-track up-mix for *It Came From Outer Space*—perhaps one of the more sonically adventurous films released in 1953—offers some clarity as to what these distractions were, and how the up-mixing process might specifically be to blame for such acoustical mishaps.[685] Like many other Universal releases at the time, the film's dialogue and effects were recorded in monaural and then rerecorded onto triple-track tape using a Westrex mixing console.[686] The console allowed single-channel dialogue to be directed to any or all of the three playback channels in order to create a three-dimensional soundscape. The equipment also allowed engineers to adjust the volume of the playback channels in order to simulate directional stereo effects. During each reel's mixing sessions, technicians manually raised and lowered the production dialogue in accordance to where actors were positioned in the frame. A character speaking in screen-left, for instance, might lead sound technicians to raise the volume of his voice in the left channel, and lower its volumes in the center and right channels. This mixing technique gave audiences the impression of stereophonic sound, when in fact it was merely an adjustment in volume.

The beginning of *It Came From Outer Space* illustrates how these types of adjustments were often integrated into the three-channel mix. Following John and Ellen's romantic dinner together at the beginning of the film, the two lovers step onto John's patio to look through a giant telescope. As they each peek through the eyepiece, they discuss astrological signs and, later, witness an alien spaceship crash-land off into the distance. For the majority of their conversation, director Jack Arnold frames John and Ellen in a two-shot. John begins in frame-left, next to the telescope, while Ellen begins in frame-right. After the two almost kiss, they swap places within the frame, so that Ellen can peer through the optical device. During this sequence, the voices of the two characters emanate from all three loudspeaker channels, yet they do so at different volumes. When John speaks from screen-left, the left-channel is louder than the right channel. Likewise, when Ellen speaks from screen-right, her voice is loudest in the right channel. Though subtle, these volume characteristics were intended to align the voice of each character with their respective position within the frame in a manner that is neither obtrusive to the story nor unpleasant for filmgoers.

The problem, however, was that this manual mixing process was prone to user error. Technicians ostensibly had to adjust the volume of each track in real time while rerecording each picture-locked reel. Although some of the adjustments could be anticipated in advance, evidence suggests that for the majority of each mixing session the rerecording engineers would raise and lower the volumes of the vocal deliveries only after the dialogue switched to a different onscreen speaker. At these times, the volume of each vocal performance would audibly change just after the actor began to speak, often in the midst of a sentence. For instance, after John and Ellen witness the spaceship fly across the sky, they ask their friend Pete to drive them to the site of the crash. While at the site, John walks into the crash-zone and sees what he believes to be an extra-

terrestrial. John escapes the predicament and proceeds to inform Ellen and Pete of what he witnessed. Their conversation is filmed in three-shot, with John in the center, Ellen in screen-left, and Pete in screen-right. When John speaks, he is loudest in the center channel. When Pete interjects his skepticism toward John, the right channel grows in volume. However, this adjustment in volume occurs in the middle of Pete's line "I let maniacs drag me out in the middle of the night," which gives the impression that Pete's voice is traveling between different sides of the screen. A similar mishap occurs when Ellen tells John to keep what he witnessed a secret. Specifically, when she says "Oh please, don't tell them what you told us" the left channel increases in volume while the other channels decrease, yet this abrupt shift in volume awkwardly takes place right as she says the words "them what." In turn, the triple-track mixing procedure provides an acoustical accent to two words that seem to carry no actual importance to the story.

Though such mishaps were common throughout the film, it is reasonable to infer that these sorts of errors were also a product of the rerecording equipment itself. For instance, when John returns to the scene of the crash the following day, he and Sheriff Warren converse about what John witnessed. The conversation is filmed as a series of two-shots in standard shot/reverse-shot, and as a result we might expect the volume of their dialogue to be adjusted according to their placement within the frame, but such adjustments do not occur. Instead, the volume of the dialogue often goes up and down in the left channel rather abruptly, at times in the middle of a shot. This specifically occurs when the sheriff makes it clear that he doesn't care much for John. While standing in screen-left, he states, "Yeah, I know Ellen. Also knew her father. I was his deputy. Now I mean to keep an eye on her. Trouble is, she keeps trailin' after you. See, this town doesn't understand you—pokin' around out here in the desert, squintin' up at the stars—and now you come up with this story." Despite the fact that the sheriff remains

relatively motionless in screen-left, the volume of his voice is continually raised and lowered in the left channel, first when he says “See, this town…” and again when he says “and now you come up…”

It is difficult to imagine that these mishaps were caused by the technicians deliberately manipulating the volume of the recording in the left channel. Rather, because Westex’s mixing consoles were relatively new, it is likely that they suffered from several technical flaws at the time of their installation at Universal. The close proximity of different electrical circuits inside of the machine may have simply enabled electrical energy from one circuit to leak into an adjacent circuit. In this case, the signal being sent to the left channel was mis-amplified not by the technician but by a nearby electrical pulse. Though there would be no way to tell if this was the case, it seems plausible that the film’s more bizarre acoustical issues were the result of some sort of electrical problem, if not a design flaw, with the mixing equipment—though this is pure speculation.

More importantly, these acoustical errors would have been heard by audiences at the time of the film’s release. Because volume adjustments to each of the three playback channels were meant to give the impression that sounds were emanating from different sides of the screen, when the adjustments occurred in the middle of the actors’ performances, their voices would bounce from one side of the theater to another. In other words, when Ellen says, “Oh please, don’t tell them what you told us”, or when the sheriff says, “See, this town doesn’t understand you,” their voices bounce between the left and right side of the theater without narrative motivation. If Universal’s goal was to simulate a coherent and unobtrusive stereophonic sound design, it failed.

The film's strangest acoustical designs, however, occurred with respect to sound effects. Like production dialogue, the many sounds of gunshots, punches, door slams, and car engines were recorded in monaural, as they would have been largely culled from the studio's sound effects library. Yet unlike production recordings, effects were not spread to all three playback channels at the same time. Instead, they would either be directed to one of the playback channels, or they would be panned across the three channels. For instance, as the alien spaceship crash-lands in the desert, it flies across the screen from right to left. To accompany this movement, the whistling of that aircraft pans from the right loudspeaker channel, to the center, and finally to the left. Similarly, whenever a car or truck travels across the frame, the roar of its engine is often panned across the three loudspeaker channels in conjunction with the onscreen movement.

However, this mixing practice for sound effects often become distracting, if not illogical, when they play alongside production recordings. For example, when John and the sheriff brawl in the police station toward the end of the film, their quiet grunts are sent to all three channels, yet the loud smacks are sent only to the center channel. In terms of a stereo mix, the violent punches are given less priority than the breathing and grunting of the characters, a stereo design that is largely atypical of Hollywood's storytelling norms.

Perhaps the most interesting examples of this kind of curious mixing effect occur each time Ellen screams. As was the practice in Hollywood at the time, her high-pitched shrieks were themselves pre-recorded sound effects performed by professional screamers in controlled environments to prevent unwanted distortion. And as sound effects, Universal's technicians chose to direct them to only one playback channel at a time. This mixing strategy made logical sense for when Ellen was off-screen. For instance, when she and John are startled by a silhouette along the road, Ellen screams before realizing that the silhouette is just a tree. Her scream occurs

during a close-up of the tree where Ellen stands off-screen left. To complement this staging, Universal sent the piercing sound effect to the left playback channel only.

However, this mixing strategy made less sense when Ellen was onscreen. Toward the end of the film, as she drives through the desert by herself, she picks up Joe Sawyer from the side of the road. The two converse and Joe soon reveals himself to be an alien, causing Ellen to scream in terror. Throughout this scene, the voices of the two actors are sent to all three playback channels. However, when Ellen screams, her piercing cry for help only emanates from the center channel. As a result, the triple-track sound design appears to contradict the narration. At the moment when Ellen yells at her loudest volume, her voice plays from the fewest number of loudspeakers. In effect, the film's stereo design undermines the emotional moment.

These many acoustical mishaps throughout the triple-track mix of *It Came From Outer Space*, as well as the patchwork aesthetic of up-mixing more broadly, can largely be attributed to the jerry-rigged nature of the triple-track format. Titles mixed and released in this format were designed to simulate multi-channel recordings, but they simultaneously sacrificed the quality of these recordings in order to simplify the production of multi-channel mixing. Often this meant vocal recordings would inadvertently bounce between the left and right sides of the theater, and the acoustical relationship between sound effects and dialogue would audibly clash. In effect, the soundscapes of these films were likely to call attention to the triple-track up-mixing process itself.

As a result, many producers appeared cautious about quickly up-mixing their films for triple-track stereo. RKO, for instance, released only two titles in triple-track stereo in 1953, *Second Chance* and *Devil's Canyon*. Republic Studios eschewed releasing any of their titles in

stereo, instead opting to release John Ford's *The Sun Shines Bright* and other prestige pictures in Academy Mono only.

Other studios attempted to address, if not solve, the problems associated with triple-track up-mixing. Columbia, for instance, paired the stereo format with a three-channel recording system—dubbed the Vitascope—in order to create more natural-sounding directional effects. Warners, in contrast, eschewed such natural ideals entirely and instead sent dramatic effects to a special surround sound channel. Warners dubbed this unique stereo system WarnerPhonic Sound. Both variations off of the standard triple-track stereo process solved many of the format's acoustical issues. However, these revisions were marred by their own technical problems that proved to be just as distracting to audiences, if not more so.

The Columbia Vitascope

The Vitascope was a combination of a stereophonic sound recording format and a three-dimensional picture recording format.[687] Its visual process utilized two different 35mm Mitchell cameras that recorded two separate picture tracks simultaneously. Its stereophonic process similarly encoded three separate audio signals onto a single strip of triple-track film. An arrangement of three or more microphones would record the production dialogue as three separate channels—left, center, and right—and these channels were then stored onto three separate tracks. The greater value of the triple-track recording process was that it could avoid many of the acoustical mishaps that plagued up-mixes like *It Came From Outer Space*. Instead of requiring technicians to manually adjust the volume of the dialogue in order to simulate a stereophonic soundscape, Columbia's sound technicians merely needed to transfer the original three-channel recordings to the final triple-track mix in a manner that preserved the separation of

each channel. Vitascope was thereby a means to simplify the process of rerecording triple-track releases without sacrificing their acoustical quality.

Columbia wanted their Vitascope technology valued as an important contribution to film history. The moniker itself recycled the name of the Vitascope projector that Edison famously promoted during the early years of motion pictures.[688] At the same time, Vitascope was a portmonteau of two filmmaking technologies with which Columbia likely wished to be further associated. The Vita- recalled the Vitaphone, the first talking picture technology to be used by a major Hollywood studio. The -scope was a reference to CinemaScope, a competing stereo and widescreen format that—despite extensive trade coverage—remained in development at Twentieth Century-Fox for most of 1953.[689] In effect, Columbia wanted the industry to value Vitascope as an alternative to the forthcoming and much-discussed CinemaScope that would simultaneously revolutionize motion pictures the way that Vitaphone did. However, the format's name made little reference to the one person who had the greatest influence on its design: Harvey Fletcher. Like Fantasound and 50mm stereo, Columbia's three-channel stereo recording process was an extension of the principles of auditory perspective that Fletcher and his colleagues at Bell Labs promoted throughout the 1930s. Vitascope was yet one more attempt to put Fletcher's theories into actual practice.

Fletcher's influence on Columbia's recording technology can be attributed to John Livadary, one of Vitascope's chief inventors.[690] As I discuss in chapter three, Livadary had been an avid supporter of Fletcher's work since the 1930s, having attended several of Fletcher's early stereophonic concerts, and having worked to incorporate Fletcher's ideas into practice at Columbia's facilities. It was Livadary, for instance, who oversaw the renovations of the studio's recording stage in order to enable three-channel recording.[691] Livadary was also one of the few

people who Earl Sponable invited to the 50mm stereophonic sound demonstrations during the 1940s, and who Sponable then solicited for feedback regarding the quality of Fox's three-channel reproductions.[692] Livadary's comments in response to Sponable's demonstrations were critical. He complained about the system's proclivity for noise, arguing that "you expect a greater quietness out of a wide screen than an ordinary film because it more closely resembles the legitimate stage.[693] That Livadary would later help develop a three-channel stereo recording process at Columbia suggests the extent to which Livadary remained interested in Fletcher's ideas and wished to improve upon Fox's earlier attempts to adapt them for the cinema.[694]

The difference between Vitascope and Fox's 50mm stereo format was ultimately a matter of scale. Instead of pairing its stereo reproductions with a large-screen format, Columbia paired the soundtracks with stereoscopic images stored on standard 35mm prints. The smaller film size perhaps precluded what Livadary felt was the expectation of quietness associated with the large screen. Further, the addition of three-dimensional visual effects would have the potential to pull the audience's attention away from the stereophonic technology. The directional effects associated with the technology might thereby seem subtle in comparison. Ostensibly, Vitascope was not designed to accentuate any one moment of drama. Instead, it would function as an acoustical upgrade to all aspects of cinematic reproduction, not unlike the way that the adoption of panchromatic film once offered a similar upgrade to the visual quality of motion pictures. The use of left, center, and right channels specifically widened the frequency and decibel ranges of motion pictures, and it allowed filmmakers to create more realistic directional effects in the cinema. Simply put, Columbia posited its three-channel recordings not only as an improvement upon triple-track up-mixing, but also as a step forward for an industry that, up until that point, had largely relied upon the narrow Academy Mono standard for acoustical reproduction.

Case Study: Miss Sadie Thompson

Columbia announced its Vitascope process to the industry in April 1953.[695] As part of the announcement, Columbia listed a handful of titles being filmed in the new format, including the westerns *The Stranger Wore a Gun* (1953) and *Gun Fury* (1953), as well as several films listed as forthcoming Vitascope pictures, including *Pal Joey* (released in 1957), *The Franz Liszt Story* (released as *Song Without End* in 1960), *The Wild One* (1953), and Fritz Lang's *The Big Heat* (1953).[696] Among the most significant of these titles, however, was the Rita Hayworth musical *Miss Sadie Thompson*.[697] The film was based on a popular W. Somerset Maugham story about a singer in the Pacific whose livelihood is threatened once a missionary exposes her to be a former prostitute. More, Hollywood had adapted the story twice before, once as a vehicle for Gloria Swanson, the second time as a vehicle for Joan Crawford. Columbia would specifically cast Hayworth as the famous, titular character as part of the studio's broader attempt to reinvigorate Hayworth's career following her brief marriage to Pakistan's Prince Aly Khan, a marriage which ended in 1953.[698] Along with *Affair in Trinidad* (1952) and *Salome* (1953), Columbia promoted *Miss Sadie Thompson* as a return to form for the redheaded actress. The use of Vitascope became a way to further endow the film with historical importance and cultural value.

Many of the film's sequences boasted an acoustical improvement to frequency and decibel range as a result of studio's three-channel recording process. These sequences include musical numbers—such as "The Blue Pacific Blues," "Hear No Evil, See No Evil," and the sultry showstopper "The Heat is On"—wherein the instrumental accompaniment was capable of extending into the low and high registers without any major roll-off in volume. Of particular note, however, were the many dialogue sequences. By adapting Fletcher's multi-microphone

recording process to conversations, Columbia was able to create localization effects wherein the voice of a character in frame-left would emanate from the left loudspeaker, and do so without any of the jarring changes in volume that riddled *It Came From Outer Space*.

For instance, shortly after Sadie arrives in Hawaii she's driven to a popular bar where she conversed with marines about life on the military base. Despite the quick back-and-forth between the many characters in the scene, the voices of each actor always emanate at their loudest volumes from the left, right, and center loudspeakers in correspondence with their onscreen location. In a similar sequence later in the film, Sadie visits the office of the governor in an attempt to reverse her expulsion from the island. In each shot, both characters move back and forth between the left and right sides of the frame, and their voices follow the location of the actors by emanating from different loudspeakers behind the screen. In effect, Vitascope's acoustical stereo aesthetic strengthened the lateral correspondence between the sound and picture.

Such quality improvements, however, were not without drawbacks. The addition of two more microphone channels effectively increased the amount of acoustical detail present in each scene. And though more acoustical detail is generally thought to be preferable in a musical performance, it was not preferable during dialogue sequences. For one, three microphones could amplify the textures of sounds that are best left quiet. Such amplification proved to be an issue during the story's more romantic episodes. As *Variety* reported in May 1953, film's sound recordist, George Cooper, had issues applying triple-track techniques to the sounds of Rita Hayworth and Aldo Ray kissing. "With three sensitive 3-D mikes magnifying the customary screen kiss," Cooper told *Variety*, "it sounds like a horse pulling its foot out of the mud."[699] Columbia's solution was simply to remove the equine smooches from the final soundtrack. That

said, not every problem could be solved so easily. The multi-track recordings also amplified the atmospheric details present on each set. These atmospheres included the resonant frequency of each room, as well as the sound of a vocal performance as it decays and reverberates between the walls of the set. Such acoustical details meant that a simple instance of looped dialogue might sound artificial.

Take, for instance, the dinner conversation where Dr. McPhail, Davidson, and Margaret discuss Sadie's highly sexualized behavior as she entertains a handful of marines in the room next door. During this scene, the vast majority of Margaret's lines are looped in post-production, as is evident by the momentary losses in synchrony between her voice and lips. This is especially clear when she says, "It's that awfully cheap girl from the Orduna who kept playing her phonograph to attract the sailors." In addition to being out of synchrony with Margaret's mouth, the looped lines are also acoustically different from the rest of the scene's dialogue. Whereas the production recordings are closely miked and contain little reverberation, Margaret's looped recordings appear to have been recorded at a different microphone distance. This distance adds slightly more reverberation and decay to her voice, yet strangely it does so at random times throughout the scene.

These acoustical differences are most obvious at moments when only segments of sentences are looped. For instance, as Margaret clarifies her opinions of Sadie, she says the following: "She made certain of that from the very first moment she came on board, behaving so outrageously, having all those wild parties at her cabin." Judging by the acoustical details and the audiovisual synchrony, the first part of this sentence—up until the words "came on board"—was very clearly looped during post-production. The remainder of the sentence contains different levels of atmosphere, and was thus likely taken from the production recordings. In turn, the

quality of Margaret's voice changes mid-sentence. This acoustical mishap not only calls attention to the film's post-production process, it also punctuates random pieces of Margaret's dialogue and, thereby, it can distract audiences from paying full attention to the more important narrative information being conveyed throughout the conversation.

There is little to no evidence to suggest that Columbia cared much about these looping problems. Brazen examples of similar mistakes were common throughout the studio's triple-track output, even *From Here to Eternity*, arguably the most prestigious Columbia picture to receive a stereophonic mix. In one particularly jarring moment, Sgt. Milton Warden interrupts a bar fight between Angelo Maggio and James "Fatso" Judson. And as Warden chastises the two privates, his voice contains slightly more reverberation than his costars, an indication that his lines were the only lines looped during post-production. Yet at one point during the scene, Warden's dialogue vacillates between production recordings and post-production looping. For instance, as Warden turns away from the camera, he tells Angelo, "Out for blood, huh? You'd puke your guts out at the sight of a dead man. Put down that stool... put it down!" The entire line was looped, except for the words "Put down that stool... put it down," which were instead recorded live during production and which are thus defined by a sudden drop in volume, reverberation, and decay. This abrupt acoustical shift from the looped recording to the production recording is quite noticeable, and the three-channel sound system only accentuates the mistake to the point where it can distract audiences from the story.

And yet despite this rather jarring bit of post-production craftsmanship, the film would go on to win several Academy Awards, including Best Picture, Best Direction, and Best Editing.[700] Remarkably, Livadary even won the Oscar for Best Sound.[701] This recognition of artistic and technical excellence illustrates the extent to which the film's acoustical errors were immaterial to

the industry at the time. Instead, Columbia's stereophonic practices were largely celebrated. Their praise in the face of such aesthetic issues is perhaps due to the continued high regard for Harvey Fletcher and his principles of proper auditory perspective throughout Hollywood's sound departments during the early 1950s. In a sense, because the stereo designs of *Miss Sadie Thompson* and other Columbia releases were informed by respectable aesthetic ideals, many producers, filmmakers, and craftspeople were willing to overlook the number of audible problems that riddled the studio's stereophonic technology, at least during its first few months of use. But such good will toward Vitascope was not enough to keep the format on Columbia's sound stages. By 1954, the studio abandoned its triple-track and stereoscopic experiments entirely, opting instead to release its multi-channel content through competing stereo and widescreen technologies, namely Fox's four-track CinemaScope and six-track Todd-AO.[702]

WarnerPhonic Sound

Fletcher's principles may have been popular among most Hollywood's sound engineers, but not every studio felt that triple-track stereo should function as an extension of his ideas. WarnerPhonic Sound, in particular, was designed as a full-on rejection of the theories of proper auditory perspective that Fletcher promoted and that many in the industry had adopted as gospel. In lieu of treating stereo as a tool that could provide an acoustical upgrade to all elements of the motion picture, Warners situated their own triple-track technology within the tradition of the emphatic stereophonic effects found in such films as *Hell's Angels* and *Portrait of Jennie*. Accordingly, multi-channel thrills were reserved for dramatic sequences only, while—unlike in *Miss Sadie Thompson*—conversation scenes were rendered with more subdued sound designs.

What made WarnerPhonic Sound even more unique was its incorporation of a fourth channel for surround sound effects.[703] Like all triple-track stereo technologies at the time, Warnerphonic Sound stored its left, center, and right loudspeaker channels on a separate strip of triple-track magnetic film, and it stored the monaural down-mix of the film next to the 35mm picture track. Moreover, like *It Came From Outer Space*, Warner recorded the film monaurally, after which it up-mixed the production recordings onto triple-track film. The one significant change to this four-track design (triple-track magnetic plus single-track optical) was afforded by WarnerPhonic Sound's pairing with Natural Vision's three-dimensional picture technology. Natural Vision required theaters to project not one but two separate strips of 35mm film to create the stereoscopic images, and this second filmstrip had room for an additional optical track. Columbia, Paramount, MGM, and other studios that relied upon similar three-dimensional technologies did not utilize this extra space on the second filmstrip to house an additional channel of sound, but Warners did. And this second optical track was what contained surround sound effects, those that were specifically directed to the loudspeakers installed onto the rear and side walls of each theater.

Case Study: House of Wax

This idea of a surround sound channel recalled the four-channel stereo effects heard during the Festival of Britain. Warners' sound department, led by veteran engineer George Groves, specifically envisioned this rear channel as an extension of the three-dimensional picture effects. Just as an on-screen object can appear to burst out of the screen and enter into the space of the theater, so could the sound of that object. Such effects occur throughout WarnerPhonic Sound's inaugural feature, *House of Wax*. The film begins inside the museum, where wax

sculptor Henry Jerrod is busy finishing his latest uncanny creation. His business partner, Matthew Burke, pays Jerrod a visit during which he burns down the museum in order to collect fire insurance. Jerrod resists Burke's attempts to destroy the wax figures, and the two begin to brawl. At one point during this action Burke stands in the background of a shot and holds a chair high above his head. He throws it toward Jerrod, who stands in the foreground. Jerrod ducks, sending the chair toward the camera. As the chair flies off-screen, the stereoscopic process sends the chair flying into the auditorium. And as the chair then lands off-screen, its crash plays from the rear loudspeakers, an effect that suggests the chair has landed behind the audience. WarnerPhonic Sound was thus less about subtly preserving the fidelity of a performance between actors—much as Fletcher and Livadary each hoped to achieve—and more about creating memorable thrills that could enhance the emotional payoff to the film's many moments of suspense-driven action.

The incorporation of a surround sound channel, however, introduced a creative problem for Warners regarding its use of rear channel effects. Was there a way to integrate such effects into the motion picture without distracting audiences from the story? This question was largely directed toward William Mueller, the technician in change of overseeing Warners' use of the technology during screenings of *House of Wax*.[704] Mueller's answer to this question would help establish the value of WarnerPhonic Sound to an industry that remained skeptical of its usefulness. Moreover, his solution would set a precedent for future WarnerPhonic releases. Interestingly, Mueller acted conservatively. Instead of using the new soundtrack at every conceivable moment, he opted to employ the rear channel as little as possible. The studio's sound department sent fewer than fifteen sound effects to the rear channel for the duration of the

movie.[705] Despite calling the track an effects channel, it mostly contained David Buttolph's musical score.

Although there are no records that account for why Warners would use its new technology only a small handful of times throughout their tent-pole release, there are three reasonable explanations. First, it seems likely that the minimal usage was thematically driven. Every surround-sound effect occurs at moments when characters face life-threatening peril. For instance, each time Sue is about to be murdered, she lets out a blood-curdling scream. And unlike the screams in *It Came From Outer Space*, which play from only the center channel, Sue's screams are sent to loudspeakers on every wall of the auditorium. When the mystery man crawls into Sue's bedroom, she sits up in her bed and lets out a piercing howl that blasts from the rear loudspeakers. Similarly, when Sue is chained to a laboratory table and is moments away from drowning in boiling wax, she screams at a similar volume that is once again amplified from all corners of the theater.

In addition to screams, the noises made by the film's many deadly weapons are also sent to the rear channels. The wax that bubbles and curdles from a container just above Sue's head, for instance, also bubbles and curdles from loudspeakers along the rear of the theater, just above the audiences' heads. Similarly, the fire that burns down the wax museum at the beginning of the film crackles not just from behind the screen, but from the rear and side walls of the theater, perhaps giving audiences the impression that the theater itself is erupting in flames. Arguably, the most powerful surround-sound effect in the film occurs during the murder of Burke. As the mystery man wraps a rope around Burke's neck and throws his body down an elevator shaft, the abrupt crack of the rope and concurrent snap of Burke's spine echo from every loudspeaker, a thrilling moment designed to rattle the theater, if not also the audience. *House of Wax'*s

surround-sound design is thus highly structured around a narrative pattern: the moments of greatest violence are simultaneously the moments that receive rear-channel effects. And by limiting these effects to only a small handful of scenes, Mueller prevented audiences from growing numb to the new technology before the film's climax.

At the same time, the limited number of surround-sound effects throughout *House of Wax* may have also been because Warners had only a limited amount of time to mix the film for four playback channels. Though Warners had promoted the film's 3-D release in December 1952, it did not announce its decision to mix the film for stereo until the middle of March, just days before Warner was scheduled to demonstrate its new sound system to exhibitors, and just weeks before the film's April 10th premiere.[706] The late announcement of a multi-channel release likely required Warners sound department to move quickly through the post-production process, a process which would have included the rerecording of the film and the subsequent quality check of its surround sound acoustics in commercial theaters.

As a result of these constraints, Warners may have simply played it safe with respect to sending sounds to the rear channel. For instance, when the mystery man chases Sue through the dark and foggy streets of New York, they both listen to each other's footsteps to determine how close they are to one another. Hypothetically, these off-screen stomps and pats could have been sent to the rear loudspeakers, as this stereo effect could have punctuated the suspense and further called attention to the studio's theatrical technology. However, there may simply not have been enough time or resources to implement such an effect and make sure that it sounds pleasurable and realistic in theaters.

Further, the majority of the rear-channel effects are limited to the first and last reels: the burning of the old wax museum, and the rescue of Sue from the museum's basement. Although

both reels perhaps contain two of the more action-driven scenes, these were likely the same two reels that Warners chose to showcase when demonstrating the WarnerPhonic Sound system to exhibitors. It is thus reasonable to infer that the majority of the film was largely without rear-channel effects because Warners opted to dedicate their limited resources to sprucing up the film's pre-release demonstrations rather than its final theatrical release. In other words, the decision to dress the film with only a small number of surround sound effects was not only a matter of narrative design, but also a matter of time constraints and the studio's limited resources.

Lastly, the design of the surround-sound technology itself would have also limited Mueller and Warners to the types of stereophonic effects that could be sent to the rear loudspeakers. As a triple-track format, the front three loudspeaker channels were stored on magnetically coated film, and were thus privy to the wider frequency and decibel ranges that magnetic soundtracks afforded. The rear channel, in contrast, was stored as a standard optical track, and was thereby subject to the limited frequency characteristics of Academy Mono. Further, the system's rear channel was designed to play from multiple loudspeakers at once—at times, more than twenty—whereas the left, center, and right channels played from only one loudspeaker at a time.[707] As a result of such technical designs, a voice sent to any one of the front playback channels would sound acoustically different from that same voice if it were sent to the rear channel. This meant that if dialogue were to pan from the rear channel to the front channels, the timbre of that sound would audibly change in the middle of the sentence, thereby exposing the artifice of the stereophonic process, if not also the artifice of the film's narrative.

As a result of these limitations, Warners made two concessions with *House of Wax*'s stereo design. First, any sounds that were sent to the rear loudspeakers would also be sent to the

three loudspeakers behind the screen simultaneously. This mixing decision concealed the acoustical differences between the front and rear channels. That said, it also meant that the surround sound track was constructed to function as a mere amplifier of soundtrack elements. This may help to explain why louder effects, such as screams and crashes, were exploited by the rear channel, while softer sound effects—like Sue's footsteps—were kept to the front channels. Second, in order to hide the narrow acoustical range of the rear-channel's optical track, Warners made sure to boost the decibel levels of surround sound effects. Thus, the crackling of the wax museum's fire did not simply emanate from the four walls of the theater; it roared from them. In effect, WarnerPhonic's design encouraged the studio to treat the sound system as an emphatic technology, one which privileged proportional effects over directional effects, and which limited the fourth channel to louder climactic actions over quieter moments of cinematic suspense.

House of Wax proved to be popular among audiences. The campy horror film was hailed as a box office triumph upon its initial theatrical run, leading Warners to release several more titles in WarnerPhonic Sound later that year—including *The Charge at Feather River* (1953), *Blowing Wild* (1953), *Island in the Sky* (1953), and *Calamity Jane* (1953).[708] More, as *House of Wax* toured the country during its initial road show, it was celebrated by small-town filmgoers much like millennials would one day fete the release of the latest iPhone. The Laemmle-affiliated Kenosha Theatre, located just outside of Milwaukee, was particularly joyous when it premiered the film in WarnerPhonic Sound's full thirty-two-speaker array.[709] Theater owners Bud Nelson and F. B. Schlax promoted their $25,000 investment by encouraging Kenosha's City Manager, H. R Custer, to turn the thriller's May 6th release into an official city holiday.[710] In response, Custer published the following statement in the *Kenosha Evening News* on the morning of *House of Wax*'s release:

> PROCLAMATION!
>
> Whereas, One of the technical advances for which our country is noted has been taking place in the entertainment field with the development of three-dimensional motion pictures, and
>
> Whereas, On May 6 the city of Kenosha will become the first city in Wisconsin where theater patrons can enjoy the advantages of the latest and most modern development in this field, known as stereophonic sound
>
> Therefore, I, as city manager, declare Wednesday, May 6, as "Stereophonic Three Dimension Day" in Kenosha and express best wishes to the local theater which has brought this unique entertainment experience to our citizens.
>
> H. R. CUSTER
> City Manager[711]

It is perhaps worth noting that Custer likely declared May 6th "Stereophonic Three Dimension Day" before he or anyone else had seen or heard *House of Wax* screen at the Kenosha Theatre. Nonetheless, the town's celebration illustrates the extent to which *House of Wax*'s use of surround sound was treated to be a major cultural event—if not a cinematic milestone—for many audiences, in spite of the stereo format's technical limitations and the film's limited use of rear-channel effects.

In contrast to such celebrations, *House of Wax* received a much colder reception throughout the industry. Unlike Livadary's work on *From Here to Eternity*, Mueller's and Groves' design failed to receive recognition by the Academy for its technical innovations and historical achievements. Additionally, reviewers attacked the film's stereophonic sound design for undermining the filmgoing experience. Otis L. Guernsey of the *New York Herald Tribune* specifically criticized Warners choice to boost the volume of the rear channel, wryly arguing that the decision "tends to detract from the central screen illusion, rather than add to it; but if you enjoy being overwhelmed with decibels during the moments of high melodrama, the multiple-speaker system is the one that can do it."[712]

A particularly hostile review came from *New York Times* columnist Bosley Crowther, who referred to the film's stereo design as an all-out cacophony.

> ... the stereophonic sound with which 'House of Wax" is dubiously endowed causes strain on the ears in a measure which may give some auditors actual pain. […] Turned on full blast when the fire is roaring or when the villain is about to plunge the girl in boiling wax, the effect is not only near-deafening but appreciably exhausting to the nerves.[713]

Crowther further ridiculed those who celebrated such stereophonic sound technologies.

> But the most frightening thing about this picture is the thought of the imitation it will encourage, if it proves to draw customers to the theatre, which it more than likely will do. Some may accept this dismal prospect with the same casualness they accord the idiocies and eventually comical monstrosities of the film. But not so this reviewer. It's a prospect we view with alarm. Dimly we foresee movie audiences embalmed in three-dimensional wax and sound.[714]

For Crowther and many other industry critics, *House of Wax* posed an existential threat to the very concept of tasteful sound design. As such, the harsh reviews were an attempt—albeit a failed one—to persuade audiences to refrain from patronizing the film and its sound system, and from indulging themselves in its tasteless excess. And Warners' sound department perhaps took these criticisms to heart. Although Jack Warner had once lambasted the industry for mocking his studio's technological accomplishments, like Columbia his studio ultimately abandoned its unique triple-track technology less than a year after its unveiling.[715]

Conclusion

Following the premiere of *This is Cinerama*, Hollywood studios worked to develop similar stereophonic sound systems for 35mm releases that were cost-effective, popular among audiences, and thus capable of bolstering yearly profits. Triple-track stereo was Hollywood's first attempt to create such Cinerama-lite. The jerry-rigged, dual-strip technology provided studios with a quick and easy means of providing stereophonic content to filmgoers. However, it

was not without its technical problems. The process of up-mixing Academy Mono releases for triple-track stereo created acoustical mishaps in theaters. Moreover, multiple attempts to address such problems only created more issues for filmmakers. As a result, triple-track ended its short-lived tenure as a viable stereo system within a year. In the following chapter, I look at Hollywood's second attempt at creating a Cinerama-lite format. This new format was Fox's four-track CinemaScope. I show how CinemaScope was designed in response to triple-track stereo's failure, and as a result Fox was able to more effectively market its technology throughout the industry as a practical and reliable system for 35mm prints.

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Chapter 7: CinemaScope, the Four-Track Solution, 1953-1955

During the Spring of 1953, several members of New York's Projectionist Union, Local 306, spent their off-hours lighting stink bombs inside a number of prominent movie palaces, including Radio City Music Hall and Loew's State on Broadway.[716] The bombs were not intended as an homage to Roxy's sulfur-burning experiments that once buried audiences under the malodorous smells of Mount Vesuvius's eruptions.[717] Nor were they intended as a commentary on the quality of stereophonic and three-dimensional content being shown at these venues. The lighting of stink bombs was instead far more consequential to the future of stereophonic sound in Hollywood: they were the negotiation tactics that the local Projectionist Union deployed as part of their ongoing contract disputes with theater owners. The contentious debate between the two parties concerned unpaid overtime and the quantity of labor needed to properly project three-dimensional movies. The union claimed its members were being exploited; management claimed its exhibitors were being extorted. And as box office revenue continued to decline throughout the industry, both parties grew increasingly unwilling to forfeit shares of their earnings.

Triple-track stereo was developed as a solution to the industry's financial troubles, but in reality, its complicated technical designs only made matters worse. Films like *It Came From Outer Space*, *Miss Sadie Thompson*, and *House of Wax* stored their picture and stereo tracks on separate prints, and they therefore required the use of additional projector systems in each theater. Unions demanded that extra projectors necessitated extra men in each projection booth, whereas exhibitors disagreed and refused to pay for additional labor.[718] The impasse led to a series of theatrical disruptions across the country. In some cities, movie palaces were forced to

go dark until these contractual disagreements were settled. In other cities, such as Manhattan, the projectionists fought with pungent weaponry until exhibitors acquiesced.

The stench bombs were a symbol of triple-track stereo's many problems. As the previous chapter noted, the rush to release stereo pictures led to acoustical mishaps and other problems that studios failed to address before their pictures were sent to theaters. Such issues, however, were only the tip of the iceberg. Triple-track's reliance on multiple prints proved to be an even greater threat to the format's longevity. Had studios allotted enough time to address the aesthetic shortcomings of their triple-track sound designs, it seems likely that exhibitors would have still sunk the technology once it arrived in theaters. The format exacerbated ongoing battles between unions and theater management, so much so that any boost in ticket sales afforded by the new technology was soon undermined by the costs of labor, litigation, and—once the smoke cleared—new air filters. These unforeseen expenses not only threatened the viability of triple-track technology, they threatened the broader value of stereophonic sound in Hollywood.

Yet despite the industry's clamor to release triple-track films, not every studio was on board with the format when it arrived in theaters that Spring. Twentieth Century-Fox specifically spent the greater part of 1953 constructing an alternative magnetic stereophonic format, one that would recreate the acoustical power of seven-track Cinerama without simultaneously shouldering its exorbitant installation costs nor its potential for inciting tension between projectionists and exhibitors. Fox's format was four-track CinemaScope, and unlike triple-track stereo it was far from a short-lived experiment. Instead, CinemaScope stereo would grow to become a popular stereophonic format throughout the 1950s and 1960s, continuing into the 1970s and 1980s.[719] It was, by all accounts, the first truly viable multi-channel sound format for 35mm venues.

The following pages trace the historical factors that led to the development of Fox's stereo technology and that established its esteem throughout the industry. I argue that as the second of two Cinerama-lite technologies, CinemaScope benefited from its fortuitous timing in following triple-track's troubled theatrical roll-out. Fox actively positioned its format as a solution to triple-track's technical failures, and such posturing not only shaped the design of the format but its norms of use. By drawing upon four-channel analyses of several early CinemaScope releases including Henry Koster's *The Robe* (1953) and Samuel Fuller's *House of Bamboo* (1955), I show how CinemaScope's sound engineers designed their four-track soundscapes with considerable restraint. Their conservative approach to stereophonic mixing underplayed directional effects, which all but concealed the stereophonic technology from audiences.[720] And this approach yielded a stereo aesthetic that sold CinemaScope both as an attractive alternative to triple-track and, more importantly, as a reliable, burden-free multi-channel technology.

The CinemaScope Package

From the perspective of projectionists and theater managers, CinemaScope hardware was demonstrably less cumbersome than triple-track hardware was. Like WarnerPhonic Sound, Fox stored its stereo designs onto four discrete tracks. Three corresponded to the left, center, and right loudspeakers located behind the screen, while a fourth track directed music, sound effects, and other atmospheres to the banks of loudspeakers located on the rear and side walls of the auditorium.[721] Unlike WarnerPhonic Sound, however, all four tracks were stored onto the same strip of film that also housed the picture track. This single-strip design necessitated only one

projector to run at any given time. It thus mitigated the need for special motors to maintain synchronization. More significantly, it was less demanding of projectionist labor.

The four-track print design was largely the invention of three Twentieth Century-Fox engineers—Earl Sponable, Herbert Bragg, and Lorin Grignon—the same team who co-developed Fox's 50mm stereo system during the 1940s. And similar to the earlier three-channel format, the newer four-track process was part of a larger technological package that Fox intended as an across-the-board upgrade to theatrical equipment. Its stereo unit was built to improve the acoustical range and fidelity of theaters that used Altec's "Voice of the Theater" loudspeakers for single-channel reproductions.[722] Likewise, its new lenses and special screen material were designed to enlarge and brighten the moving image itself.[723] In this regard, the 1953 premiere of CinemaScope might be best understand as an extension of Fox's earlier ambitions. And it would be sold as an affordable, immersive alternative to those exhibitors that who were unwilling to undergo the costly renovations that Cinerama's multi-projector system required. Just as 70mm Todd-AO would later be referred to as "Cinerama out of one hole," CinemaScope was ostensibly Cinerama out of one hole for the 35mm market.

The Slow Roll-Out

Fox's "one-hole" design was possible due to an optical process—known as anamorphosis—which enabled standard prints to reproduce widescreen images simply by installing an ovular lens to 35mm cameras and projectors. During production, this lens would record a widescreen image and squeeze it horizontally into the narrow space of a standard 35mm picture track. During projection, a complementary lens would un-squeeze the narrow picture track back into its original widescreen aspect ratio.[724] Fox's anamorphic lenses were specifically

defined by a compression ratio of 2 to 1. This meant that standard prints with a picture ratio of 1.33 to 1 were able to store and reproduce moving images as wide as 2.66 to 1, screen dimensions that exceeded the 2.59 to 1 ratio of Cinerama. More, Fox could achieve this ratio without relying on wide-gauge stock, such as 70mm or 50mm prints, and without requiring multiple filmstrips to store a different portion of the widescreen image, much as Cinerama required.

The problem for Fox, however, was that these special anamorphic lenses were neither widely available nor easy to make. The patents for the optical technology were held by Professor Henri Chrétien, a French astronomer who innovated the process shortly after the turn of the century, and who had developed its first lenses as early as the 1920s.[725] The unveiling of the CinemaScope package thus necessitated that Earl Sponable and Fox President Spyros Skouras travel to Chrétien‘s home in Europe to secure the rights to produce and market their own anamorphic process around the globe.[726] Fox then hired Bausch and Lomb to mass produce their anamorphic lenses for studios and theaters, but the manufacturing process took several months to complete. Indeed, when Fox announced its CinemaScope process to the industry in January 1953, the studio anticipated that its inaugural CinemaScope release—the biblical epic *The Robe*—would begin filming on January 19, but it was later postponed to February due to various delays involving the studio’s readiness to begin using the new widescreen process.[727] Futher, the studio anticipated that theaters would not be able to begin screening CinemaScope films until as late as October.[728] Fox’s CinemaScope roll-out was therefore diametrically opposed to those which defined earlier Cinerama-lite formats. Whereas studios had the ability to quickly release prestige titles in such jerry-rigged technologies as matted widescreen and triple-track stereo, Fox

chose to delay the premiere of CinemaScope for almost a year, until there were enough anamorphic lenses available to properly service the entire industry.

The announcement that *The Robe* and other CinemaScope titles would play in theaters no earlier than October seemed to give triple-track technology a major advantage in the exhibition marketplace. Many theaters that were willing to pay for one expensive upgrade of their sound system might be less likely to pay for a second upgrade several months later. These market disadvantages were not lost to Fox executives. In March 1953, just weeks before the premiere of *House of Wax*, Fox scheduled a series of demonstrations of their new format at their Hollywood screening room, to which the studio invited major exhibitors and studio heads to witness the forthcoming CinemaScope process firsthand.[729] The demonstrations featured clips from both *The Robe* and the romantic comedy *How to Marry a Millionaire* (1953), both of which were currently being filmed and recorded in CinemaScope. Several weeks later, Fox held a similar demonstration of their system at Manhattan's Roxy Theater.[730] In addition to clips from the two CinemaScope productions, the studio showcased footage of aerial flights, car races, and a musical number from Howard Hawks's *Gentlemen Prefer Blondes* (1953), all of which were reproduced in stereophonic sound.[731] The medley of attractions featured in Fox's one-hour show was arguably reminiscent of the narrative structure for *This is Cinerama*.

The similarities between the two formats were not coincidental. The West and East Coast demonstrations were orchestrated to reassure filmmakers, investors, exhibitors and even critics that CinemaScope would provide audiences with sensory thrills, and that its debut in theaters would be worth the long wait. Such orchestrations worked. *Times* critic Bosley Crowther, who had ridiculed four-channel WarnerPhonic Sound several weeks prior, was particularly impressed by the Roxy screening, calling it "effectively demonstrated" and noting how "the sound came

naturally and clearly from the sections of the orchestra where it was produced."[732] By successfully screening CinemaScope to industry leaders, Fox was not only selling the virtues of the new theater format, the studio was also undermining the technological wonderment that would otherwise accompany triple-track premieres in the weeks and months that followed. In other words, Fox was communicating to investors, critics, exhibitors, and filmmakers alike that CinemaScope was superior to triple-track, and that it would behoove the industry to refrain from placing all their eggs in the competition's basket.

Triple-Track Equipment Shortages

Fox's worries about CinemaScope's market disadvantages were arguably overblown. Soon after the studio's bi-coastal demonstrations, triple-track films were beset with a host of distribution problems. And these problems only undermined the format's ability to claim technological and aesthetic dominance over CinemaScope. For one, studios unveiled triple-track stereo before making sure that there were enough sound heads and synchronization motors to wire theaters for the new format. Following Jack Warner's March announcement that *House of Wax* would be released in 3-D and stereophonic sound, a number of exhibitors immediately ordered triple-track sound heads, synchronization motors, and new loudspeaker systems.[733] Each exhibitor seemed hell-bent on becoming one of the first to screen the film in stereophonic sound during its highly anticipated road show. These exhibitors included the studio-friendly Interstate Theater circuit of Texas, as well as the former Paramount-owned chains in New York and Los Angeles. Other notable venues were the Fox theaters of St Louis and Phoenix, the Warner Theatre in Washington, D.C., the Balaban and Katz theaters in Chicago, and—to local acclaim—the Kenosha Theatre in Southeastern Wisconsin

However, not every theater was given the opportunity to purchase the necessary stereo technology. After a substantial number of urban palaces placed their orders for new sound equipment, Altec-Lansing and RCA each issued statements claiming that they would not be able to supply a stereophonic sound system to every theater, at least not in the near future.[734] Other exhibitors—the majority of which were independent chains—were suddenly forced to wait until after August before triple-track sound heads and interlock motors would be made available, thereby preventing these venues from playing *House of Wax* and other triple-track releases in their preferred format during their initial theatrical roll-outs.[735] In effect, the rush to become among the first theaters wired for magnetic stereo took manufacturers by surprise. The result of this high demand for stereophonic sound was a bottleneck at each site of production, and it would affect every subsequent triple-track release.

Many independent theaters that were forced to wait for official stereo equipment found other ways of improving the sound systems in their theaters. For instance, Albert M. Pickus, manager of the Stratford Theatre in Connecticut and secretary of the Theater Owners of America, developed a widescreen and stereo system that he installed himself for a cost of eight thousand dollars.[736] He dubbed the system "Amp-O-Vision" based on his own initials. The eighteen-by-thirty-foot screen boasted a 1.66 to 1 aspect ratio as well as a newly furnished loudspeaker system, which he unveiled for his May screenings of John Huston's *Moulin Rouge* (1952) and the MGM musical *Small Town Girl* (1953). Pickus's do-it-yourself solution inspired similar constructions from other theater owners, such as L. J. "Bucky" Williams, manager of the Peerlex theater in Oakland, California. Dubbed "Magnavision," the total installation of Bucky's system cost $3,500 dollars and was debuted with the 1953 re-release of MGM's *Show Boat* (1950).[737] Such DIY installations also took place at the Luciann Theatre in Memphis. Theater

manager Augustine Cianciola expanded his fifteen-by-twenty-foot screen and upgraded his loudspeakers for a cost of only 500 dollars.[738] Like other theater managers, he named the system "AugusteScope," after himself.[739]

Most independent exhibitors however did not develop their own custom-made multi-speaker formats to compete with Hollywood stereo technology. Instead, they turned to smaller, regional manufacturers to produce low-cost triple-track sound equipment. Chief among these new manufacturers was the Ballantyne Company of Omaha, Nebraska. In May, the company announced the development of a projection package for theaters that could accommodate all of the new sound and picture formats for a price of only six-thousand dollars.[740] Ballantyne also offered to service the equipment and provide updates, such as new lenses and loudspeakers, if theaters wished to eventually add more bells and whistles to the base package. Additionally, Ballantyne offered managers the opportunity to finance the purchase of any of their equipment, thereby further easing the financial pain of doling out thousands of dollars in theater technologies. Because there was no guarantee that triple-track stereo sound was going to become any more than a passing fad, the option to finance became one of the stronger selling points of the Ballantyne system. Regardless of these selling points, the company—much like Altec-Lansing and RCA—could not begin to service many theaters until well after the triple-track releases premiered across the country.[741] In effect, smaller neighborhood theaters remained largely out-of-luck when it came to projecting triple-track titles in stereo.

Continued Favoritism

In addition to the long wait to install triple-track technology, many independent exhibitors began to question if triple-track stereo was even worth the cost of installation. After

all, there was no guarantee that the new technology would create higher box office returns for neighborhood chains. Similarly, there was no guarantee that neighborhood chains would be able to compete for better distribution deals with studios. Indeed, many smaller exhibitors that were able to wire their screens for the newest theatrical technologies were still treated as third-, fourth- and nth-run venues. For these exhibitors, it was unclear if there was any benefit to paying the thousands of dollars for a triple-track system if studios continued to routinely favor downtown palaces, even those that had not yet installed stereo technology.

The concerns of independent exhibitors were not misguided. Despite the 1948 Paramount decision promising to change the way Hollywood distributed its movies to theaters, the decisions did not change the hierarchy of power and status across the American exhibition industry. For one, the prestige associated with the industry's most profitable screens were arguably more valuable to box office gross than any one sound system. And by 1953, many of the industry's first-run palaces had so successfully solidified their reputations for quality movie-going that they could retain their status as a profitable first-run theater regardless of their technology.

Radio City Music Hall, for instance, did not need a stereophonic sound system to bolster its renown. As historian Emily Thompson notes, the venue's 1932 design represented "a culmination of the modern soundscape," wherein "the age-old 'mysteries of the acoustic' were finally and fully revealed by modern acoustical technologies."[742] A multi-channel loudspeaker installation would not only have cost the theater upwards of fifteen-thousand dollars in equipment and labor, it would have also interfered with the auditorium's impressive architectural and electro-aesthetic construction. Radio City president Russell V. Downing suggested as much to *Variety* when he indicated that he would only install stereo "when we get the right picture for it."[743] And several studios did not seem to mind the logic behind Downing's business plan.

Paramount, for instance, opted to premiere *Shane* (1953) at Radio City in April, and despite having spent several hundred dollars on its triple-track up-mix, the western played in Academy Mono.[744] The same was true for MGM's release of *Young Bess* (1953), a biopic of Queen Elizabeth I. The costume drama boasted a triple-track mix at its May premiere in London, but not during its simultaneous showings on Downing's screen.[745] Indeed, for the major studios it was more important to see their films play at respectable, quality theaters than it was for them to open their films to state-of-the-art sound technology.

Even more consequential to a venue's reputation was its location. A neighborhood theater that boasted the latest technology would rarely be able to outbid a downtown palace for an early run of the latest studio release. Instead, studios routinely showed preferential treatment toward city-center circuits, particularly those that already had established themselves for offering high-profile openings. Such favoritism even became the subject of several lawsuits that ended with the 1954 Supreme Court decision, *Theatre Enterprises vs. Paramount*.[746] According to the suit, Theatre Enterprises alleged that their newly built Crest Theatre in Baltimore's suburban neighborhood was routinely bidding for studio content at a higher rate than downtown venues were, but that the studios were still choosing to distribute their titles to the Avalon Theatre and to other urban venues before sending them to the Crest.[747] In effect, Theatre Enterprises was accusing studios of continuing to collude with theaters despite the 1948 Paramount decision declaring these practices illegal.[748]

The studios countered these allegations of collusion by claiming that releasing a film downtown builds word of mouth and leads to larger revenue as the film progresses to second- and third-run theaters. In a near unanimous decision, the Court ruled in favor of the majors, arguing that studios had the right to protect their investment anyway they saw fit. This included

choosing to premiere films at any theaters that were thought to accrue the highest box office receipts, even if other theaters were willing to outbid the first-run palaces.[749] The Court's decision was controversial. It protected the studios' right to engage in anti-competitive distribution practices, but more importantly it codified such practices into law. And in doing so, it also cemented the growing skepticism toward new cinema technologies among the industry's independent chains. If these technologies were unable to help exhibitors secure better distribution deals, as well as the higher ticket sales associated with such deals, then arguably there was no reason to install them.

CinemaScope's delayed roll-out therefore afforded Fox with an opportunity to reach out to the many exhibitors who felt disenfranchised by the industry when triple-track and 3-D formats first premiered. To promote its four-track system specifically to these independent venues, Fox and Altec held stereophonic sound demonstrations of CinemaScope throughout the summer in a number of cities, including Memphis, New Orleans, Toronto, Cleveland, Denver, and Dallas.[750] Much like Fox's bi-coastal demonstrations, the nationwide clinics were carefully designed to build confidence in the new technology, so that the entire exhibition industry would see CinemaScope as a reliable alternative to triple-track or 3-D. The clinics also allowed Altec representatives to speak directly to the second- and third-run managers who feared that there might not be enough four-track stereo equipment, or that studios would continue to ignore neighborhood theaters even after they installed CinemaScope's four-track technology. In effect, the holding of summer clinics was a way for Fox to shore up support for its new stereo format several months ahead of its theatrical premiere that Fall.

The clinics proved effective. By the end of 1953 roughly 1,200 screens were wired for Fox's four-track technology, with as many as 4,000 set to be wired in the following year.[751] The

sheer quantity of venues fitted for CinemaScope stereo ensured that *The Robe*, *How to Marry a Millionaire*, and subsequent CinemaScope releases including *Beneath the 12-Mile Reef* (1953) and *King of the Khyber Rifles* (1953) all received four-track premieres in several hundred theaters during their national runs. But beyond these promotional ploys, CinemaScope's slow roll-out gave Fox the ability to update their technology in order to avoid repeating triple-track's many controversial design failures. Indeed, Fox was soon packaging its format not only as a Cinerama-lite, but as a mechanical and aesthetic solution to the many problems that plagued triple-track stereo releases throughout 1953. By the time of *The Robe*'s premiere at the Roxy Theater on September 16, the concept and design of CinemaScope was markedly different from what Fox initially proposed to the industry in January.

The Single-Strip Technology

Among the most important of technological changes was the development of its single-strip construction. Up until the premiere of CinemaScope in 1953, stereophonic sound had largely been conceived as a multi-strip process. This was true of the Fletcher-inspired systems like Fantasound and Fox's 50mm stereo, as well as the many multi-speaker experiments of the 1930s, including ERPI's two-track system developed for *Hells Angels* and André Debrie's Perspective Sonore system developed for *Napoléon Bonaparte*. There were notable exceptions to this trend during the 1930s—namely Alan Blumlein's Binaural Sound and James Maxfield's Stereophonic Sound—but because both systems relied upon very narrow optical tracks, they were riddled with noise and thus were never valued as a realistic alternative to standard monophonic sound.

The transition to magnetic stereo did not immediately challenge this preconceived notion that stereophonic sound required a dual-projector design. Despite the lower noise floors achieved through the new encoding processes, stereo engineers at both the Festival of Britain and Cinerama, Inc. continued to store their multiple tracks of magnetic sound on separate media that played in synchrony with the picture track. Interestingly, it was not until the release of triple-track titles that such widespread conceptions of stereophonic sound began to change. Indeed, triple-track's rushed roll-out led to a host of problems that undermined its value. None were more damning than those caused by its cumbersome multi-strip design. Simply put, multiple projectors introduced a level of financial risk that made stereophonic sound less desirable for many within the industry.

Labor Disputes

One issue caused by its dual-projector construction involved the motors that kept the multiple prints in synchrony. During the 3-D and stereophonic premiere of Columbia's *Fort Ti* (1953) in Manhattan, these motors failed, undermining the three-dimensional illusion, and leading the Criterion Theatre to offer refunds to those filmgoers who complained of headaches.[752] Despite its promoted technological achievements, *Fort Ti* finished its run at the Criterion in only two-dimensions and monaural sound.

A more pressing issue with the dual-projector construction was that it exacerbated labor disputes between projectionist unions and theater management in many of the country's largest palaces. As alluded to earlier in this chapter, the problem concerned the number of projectionists who were needed to run a three-dimensional and stereophonic screening. By 1952, with the release of films like *Bwana Devil* and the announcement of forthcoming 3-D titles like *Man in*

the Dark, local affiliates from the International Alliance of Theatrical State Employees (IATSE) began to renegotiate their contracts with exhibitors in order to guarantee that theater managers hired multiple projectionists when screening a two-projector 3-D film.[753] These terms, however, did not clarify how many men were needed to screen a 3-D motion picture that required simultaneous projection of a third strip of triple-track film. IATSE affiliates demanded that exhibitors pay for additional labor, and theater management refused. Such disagreements over projectionists turned the industry's largest theaters into battlegrounds—some even besieged by stink-bombs—in the middle of a film's run.[754] The timing of such events was less than opportune for studios. Triple-track stereo was marketed as a solution to the industry's financial problems, but news reports merely associated the technology with continued headaches.

In several cities, the battle over projectionists led to lengthy and costly arbitration hearings between unions and theaters. In St. Louis, the Fanchon & Marco company sued the Moving Picture Operators, Local 143, accusing the union of forcing Fanchon & Marco's Fox Theatre into hiring a third projectionist during its run of *House of Wax*.[755] Fanchon & Marco demanded that the union return the $645 paid by Fox to support a third man in the projection booth.[756] Further, the company requested a federal injunction be imposed that would prohibit the requirement of a third projectionist during any future screenings, and that would even lift the twenty-year-old local ordinance that required two men in two-projector booth.[757] The battle between Fanchon & Marco and Local 143 would not be resolved until November 1954.[758]

In other cities, the labor disputes caused theaters to discard the stereophonic soundtracks entirely. Such is most clearly illustrated by the national run of *Fort Ti*. Columbia planned for their western to become the first widescreen, 3-D, and stereophonic title released by a major studio, but many audiences never experienced these attractions.[759] The film's West Coast

premiere at Hollywood's Paramount Theatre, for example, was immediately beleaguered by projectionist protests. To quickly resolve this impasse, the Paramount opted to play only the film's Academy Mono down-mix.[760] Similar disagreements between labor and management were reported when *Fort Ti* opened in Kansas City. IATSE's Motion Picture Operators, Local 170, even forced Paramount to shut down its flagship auditorium for six hours on a Thursday evening before both parties ultimately agreed, once again, to ignore the triple-track prints entirely.[761] Neither of these events could have been welcome news to Columbia Pictures, let alone to an industry that had invested in a stereo format that now risked becoming unplayable in many of the country's most profitable venues.

CinemaScope was thus a welcome change. The technology housed a film's picture track and stereo channels on a single 35mm print, which required only one projector and—more consequently—one projectionist during screenings. The single-strip format thus promised to curtail any further battles between unions and theater management over the number of men needed in the projection booth.

Design Compromises

Fox, however, did not initially conceive of CinemaScope as a single-strip format. When the technology was first announced, it was envisioned as yet another dual-system stereo process, not unlike Fox's earlier experiments in 50mm.[762] Presumably, the anamorphic picture would thus be housed on silent-era stock, which held a picture ratio of roughly 1.33 to 1 and thus an anamorphic widescreen image as wide as 2.66 to 1.[763] Fox's format could then boast a screen size that was slightly wider than Cinerama's 2.59 to 1 ratio, and it could do so without the need for multiple projectors to produce the enormous image. A second projector would only be

needed to reproduce the film's stereo tracks, which would be presumably housed on separate four-channel prints not unlike those developed for the Festival of Britain.

These technical designs were never fully realized. As triple-track films began to play in theaters—or in many instances, as they failed to play in theaters—Fox's Sponable, Bragg, and Grignon were at work altering CinemaScope's initial construction. In lieu of housing each film's stereo channels on separate media, the three engineers found ways of storing sound and picture on the same prints. Early designs show a handful of ideas for fitting everything onto a single filmstrip. One such design involved storing three tracks of sound on the right side of each print, and it even involved removing an entire column of perforations from the prints in order to make room for these channels.[764] The final design, which Sponable, Bragg, and Grignon unveiled to the SMPE in May, nonetheless found a way to keep both columns of perforations intact, while it simultaneously found enough space for four individual tracks of sound.[765] Unlike earlier designs, the new prints spread out the four narrow tracks of magnetic iron oxide across the entire width of a 35mm filmstrip.[766] Tracks one and three (the left and right loudspeaker channels) were placed on the sides of the print, in the narrow space between the perforations and the very outer edges. Tracks two (the center channel) and four (the surround channel) were placed on either side of the picture track, in the narrow space between the perforations and the image. This final design required that theaters install a new four-track sound head on each of their projectors, but it no longer required that theaters remodel their projection booths to make room for a second set of projectors.[767]

In order for Fox to achieve this single-strip design, however, the studio made several compromises to the material dimensions of standard 35mm prints. First, the picture track was narrowed by several thousandths of an inch. The .999 by .750 inch silent-era picture dimensions

were reduced slightly to .912 by .715 inches.[768] The new dimensions created a ratio of about 1.276 to 1, which expanded to a theatrical aspect ratio of roughly 2.55 to 1 when using a 2 to 1 anamorphic lens. The studio's 2.55 to 1 frame size was now smaller than the 2.59 to 1 aspect ratio of Cinerama, but only negligibly so. Of greater importance was that Fox now had an additional .087 inches of space for the stereo tracks.

Second, the perforations themselves were also reduced in size. At the time of CinemaScope's development, there were two standard sizes and locations for sprocket holes on 35mm film.[769] The first was developed in the 1910s by Donald Bell and known as Bell and Howell (BH) perforations.[770] Commonly used on negative stock, these perforations were .073 inches high by .110 inches wide. Further, the left and right sides of each hole were rounded in such a way so that the width decreased from .110 inches in the center to .082 inches at the top and bottom. The second type of sprocket hole was developed in the 1920s and known as the Kodak Standard (KS) perforation.[771] Commonly used on positive stock, the KS perforations were more rectangular in shape, though their corners were rounded with a radius of .0195 inches to prevent tearing. The KS perforations had a height of .078 inches, making them slightly taller and therefore less likely to clash with the projector's sprocket teeth should the nitrate film stock shrink with age.[772]

By the 1950s, however, the industry no longer used nitrate stock, which meant that film prints were no longer as susceptible to significant shrinkage. 35mm prints could therefore feature smaller sprocket holes without these holes ever changing in size in such a way that would prevent sprocket teeth from guiding the film through the projector. With this in mind, Fox developed its own sprocket hole—known as a CinemaScope (CS) or "fox-hole" perforation—that was narrower in width and which therefore allowed the studio to maximize the space on a

35mm filmstrip. The new CS perforation was rectangular in shape, much like the KS perforation, and it had a height of .073 inches, much like the BH perforation. However, its width was only .078 inches, and to achieve this much smaller size, its corners featured a rounded radius of only .013 inches.[773] These smaller holes subsequently widened the lateral distance between the two columns of perforations from .999 inches to 1.049 inches, thereby freeing up an additional .050 inches of space on each print filmstrip.

This seemingly minuscule amount of space was far from trivial. Fox had determined that in order to produce a high-quality sound signal, the left, center, and right tracks needed to be at least .063 inches wide. Similarly, the effects channel for the surrounds needed to be .027 inches wide.[774] The extra .068 inches of space derived from the narrower picture track, in combination with the extra .050 inches of space derived from narrower sprocket holes, proved to be just enough room to afford Fox engineers the opportunity to store four separate tracks comfortably onto CinemaScope prints.

In order to play these new prints, exhibitors merely needed to install smaller sprocket teeth, which—when combined with new sound heads—was still less expensive than the cost of renovating projection booths to make room for additional projectors.[775] However, the four CinemaScope tracks were considerably narrower than the .200-inch tracks found on triple-track tape, meaning that CinemaScope's left, center, and right loudspeaker channels were far noisier than the noise levels of competing stereo systems.[776] Fox nonetheless argued that the signal-to-noise ratio of CinemaScope's .068-inch tracks were still far greater than that produced by optical prints.[777] In other words, the single-strip design still remained a quality improvement over Hollywood's standard optical technology, and was thus a worthwhile investment for the industry.

Many studios agreed with Fox's assessments. Shortly after the unveiling of Fox's single-strip design, MGM announced that it would join Fox in releasing CinemaScope features of their own, beginning with *Knights of the Round Table* (1953) and *Rose Marie* (1954).[778] Universal, United Artists, Columbia, and Disney quickly followed MGM's lead, revealing that they too would license the single-strip technology for use on a number of forthcoming features, including Richard Fleischer's *20,000 Leagues Under the Sea* (1954), Douglas Sirk's *Sign of the Pagan* (1954), John Ford's *The Long Gray Line* (1954), and the animated feature *The Lady and the Tramp* (1955).[779] Warners similarly opted to abandon their proprietary four-channel WarnerPhonic Sound process and fully adopt Fox's single-strip system beginning with their 1954 western *The Command*.[780] In subsequent years, the studio even released their non-anamorphic widescreen content with four-track stereo sound, beginning with *Giant* in 1956.[781] The growing popularity of CinemaScope was attributable to its practicality. Triple-track was not as cost-efficient as the industry first thought, and though Fox's entire stereo and screen package may have carried a higher up-front cost—which some trades estimated to run as high as $15,000 per screen—the package dramatically lowered the financial risks associated with stereo.[782] It bypassed the need for multiple projectors, and in turn the price of wiring a venue for CinemaScope became a more reliable investment for studios and downtown palaces.

A Conservative Aesthetic

In addition to these technical distinctions, CinemaScope also introduced a new set of stereophonic mixing conventions that were arguably less controversial than those of triple-track releases. Indeed, perhaps the biggest reason that CinemaScope was so quickly adopted by the industry was that the technology enabled technicians to avoid many of the acoustical problems

that plagued films like *House of Wax* and *It Came From Outer Space*. As the previous chapter noted, triple-track's aesthetic malfunctions were almost entirely linked to volume control. The systems were not only too loud, they were prone to small decibel adjustments that were similarly distracting if not also unpleasant. CinemaScope was different. To prevent these sorts of mishaps, recording and rerecording mixers remained conservative when using its four-track equipment. In effect, stereo's ability to wow and thrill filmgoers appeared less important than its ability to enhance a film's acoustical and narrative clarity.

This new approach toward multi-channel technology is illustrated by the way Fox conceived of the format's three front channels. Much like Columbia's Vitascope process, the studio constructed its soundscapes upon the principles of auditory perspective that Fletcher introduced during the 1930s. Accordingly, a row of three microphones recorded each take into separate audio channels, and these channels then transmitted the signals to a corresponding row of loudspeakers during playback.[783] Ideally, the raw microphone tracks were to remain unaltered during the transmission and mixing phase, as any changes to the recorded channels might undermine the three-dimensional auditory effect. However, as Grignon noted several years prior, and as Columbia perhaps failed to recognize, such principles were developed for orchestral recordings and were thus not practical for dialogue-driven movies.[784] For example, an actor in frame-left might briefly turn away from the left microphone as he spoke, and this subtle movement might not only lower the volume of his voice in that microphone, it might subsequently move his voice to the right side of the frame, depending on the direction that he turned. In order to compensate for these mishaps, Grignon recommended that technicians temporarily raise or lower the volume of the affected microphone channels.[785] In theory, the final stereophonic mix would then continue to maintain its three-dimensional effect.

For many early CinemaScope productions, this three-channel recording technique proved to be quite practical. A number of films were recorded with three microphones and reproduced through a multi-speaker system so that the sounds recorded in front of the camera were assigned the correct location across the entire 2.55 to 1 frame.[786] During *How to Marry a Millionaire*, for example, as Pola, Loco, and Schatze lounge on a Manhattan rooftop, their voices appear to emanate from their own respective onscreen location: Pola from the left, Loco from the center, and Schatze from the right. Similar acoustical effects were also achieved with two-character scenes. In *There's No Business Like Show Business* (1954), during a sequence in which Molly and Terence Donahue spread out on a long train station bench and discuss how vaudeville is adversely affecting their children, they move their heads toward and away from the microphones as they converse and yet their voices continue to play at the loudest volumes from the same loudspeakers in accordance with the mise-en-scène: Molly on the left and Terence on the right. Moreover, Grignon's three-channel technique was also effective for scenes with four or more characters. For instance, at the beginning of the historical drama *Désirée* (1954), the titular character dines with her brother, sister, and mother, and tells them about her recent encounter with Napoleon Bonaparte's brother. Though her own brother and sister have their backs to the camera in frame-left and frame-right, each actor's voice is still given a clear acoustical location that corresponds to their on-screen location. As each of these films illustrate, Fox's technicians appeared to have little difficulty in adapting Grignon's three-dimensional principles for use inside the studio's sound stages.

The problem for Fox, however, was that several of their CinemaScope productions were shot on location and were therefore not as amenable to multi-track recordings. Many sequences from *The Robe*, for example, take place in the desert and thus needed to be filmed in

uncontrolled acoustical environments that made Grignon's prescriptions for three-dimensional stereo effects difficult to administer. Any background noise heard on an outdoor set—including airplane engines, gusts of wind, or the screeches of nearby trucks—would only amplify in volume when multiple microphones were pointed toward the vast landscape. Whereas Fox's post-production sound technicians had the ability to dub over any lines of dialogue that were marred by these noisy distractions, production sound mixer Bernard Freericks opted at times to forgo these dubbing procedures. For several sequences in which background sounds were especially loud, Freericks attached portable radio microphones onto the actors.[787] The close proximity between the microphones and the actors' mouths allowed Freericks to record the vocal performances with greater clarity. He could then mix the individual recordings to a lower decibel level and simultaneously reduce the volume of background noise on each track. Though a seemingly uneventful decision, this use of radio microphones indicates that mixers like Freericks were willing to ignore Grignon's stereophonic instructions, as well as the principles of auditory perspective more broadly, especially if doing so might improve the acoustical clarity of the final mix.

Track Positions and the Rear Channel

In addition to location noise, technicians also needed to negotiate the placement of tracks on CinemaScope release prints. Of particularly concern were the left and right channels. Sponable, Bragg, and Grignon chose to store these channels on the outer edges of each print, thereby ensuring that the channels were wide enough to boast a high signal-to-noise ratio.[788] However, this arrangement meant that both channels were likely to incur small tearing or bending to the edges during a print's theatrical circulation. In turn, information that was stored in

either the left or right channel had the potential to be lost after repeat screenings. As a preventative measure, signals that were sent to the side channels would also need to be duplicated in the center channel. This way, should the left or right track become completely unplayable, any dialogue stored in the left channel would remain audible to filmgoers.

This print design was not a significant problem for Fox. Because the studio recorded the vast majority of their early CinemaScope titles with three microphones, any dialogue recorded in the left and right channels were automatically picked up by the center microphone—albeit at a slightly lower volume. The print design was nonetheless a problem for studios which recorded CinemaScope pictures onto one microphone channel, and which up-mixed this channel by pan-potting the dialogue across the front three stereo channels. Warners, for instance, was forced to address this issue in several of their early CinemaScope releases. In *Track of the Cat* (1954), dialogue was routinely panned to the left and right channels during conversation sequences where characters were spread across the entire width of the frame. Yet whenever such pan-potting would occur, the dialogue was simultaneously sent to the center channel. Thus, in a sequence where Arthur, Harold, and Ma Bridges eat breakfast around the kitchen table, their entire conversation is sent to the center channel, while select lines of dialogue are sent to the side channels in accordance with the mise-en-scéne. Such mixing decisions prevented any loss of information from the side channels, but the time it took to pan-pot dialogue to the left and the right loudspeakers was potentially not worth the hassle. Sending all dialogue to the center minimized its lateral stereo effects. Further, any dialogue that was sent to two loudspeakers at a time subsequently received an unexplained boost in volume.

It is perhaps because of these shortcomings that Warners soon opted to change their up-mixing practices altogether. In lieu of pan-potting dialogue to the left and right loudspeakers,

mixers kept dialogue tracks in the center channel regardless of the mise-en-scéne. As *Rebel Without a Cause* (1955) demonstrates, dialogue was only sent to the side channels in order to punctuate onscreen drama. For instance, when Plato is attacked by three gang members outside of his home, their taunts and screams are sent to left, center, and right channels in order to heighten the emotional impact of the fight. Similarly, the gunshot that takes Plato's life at the very end of the film is sent to all three loudspeakers at the front the theater, whereas the climax's other sound effects emanate from the center channel. The sound design for *Rebel Without a Cause* therefore mitigated the problems of CinemaScope print design without burdening its audiences with excessive pan-potting. Further, it reveals how the mixers of early CinemaScope releases were often more concerned with using the technology to create subtle narrative emphasis, and less concerned with generating the types of three-dimensional effects that Fletcher and Grignon promoted throughout the industry.

This conservative approach to multi-track technology is also evident by the extent to which technicians were willing to send sound effects to the rear loudspeakers. Arguably such mixing norms were shaped by Fox's original conception of its four-track technology. Before it was fully unveiled to the industry, Fox envisioned CinemaScope to be a three-channel stereo system with a fourth track reserved only for acoustical controls.[789] The three-channel and four-track design mirrored Fletcher's earlier Stereophonic Sound Film System, which also boasted three playback channels as well as an additional track that was pre-programmed to raise and lower the sound system's volumes at designated intervals. Fox's sound department was likely attracted to Fletcher's control track because it could allow the studio to raise and lower its sound system's playback volumes in a manner that mimicked the startling proportional effects associated with Cinerama's seven-track technology. If properly mixed, CinemaScope could then

provide theaters with elements of the iconic Cinerama soundscape without requiring that these theaters undergo the costly loudspeaker renovations that were also associated with the seven-track format.

Fox nonetheless revised this design following the release of *House of Wax*.[790] For one, the 3-D thriller was skewered by the trade press for its deafening volumes. The idea that CinemaScope might include a control track that would provide similar decibel effects would arguably be a difficult sell in the wake of *Wax*'s release. At the same time, *Wax*'s implementation of four discrete playback channels posed a potential threat to CinemaScope's status as the most technologically advanced Cinerama alternative on the market. To retain its competitive advantage, Fox turned its fourth track into a rear-effects channel, much like WarnerPhonic Sound's rear-effects channel. Indeed, by reconstructing CinemaScope for four-channel playback, Fox essentially ended Warners' ability to promote its own stereo system as the only technology that could provide audiences with thrilling surround sounds.

Despite Fox's inclusion of a rear-effects channel, however, the studio's earliest CinemaScope titles generally refrained from sending sounds to each theater's rear loudspeakers. *How To Marry a Millionaire*, for instance, only features surround sound effects during the upbeat song about New York that underscores the opening montage of Manhattan. In contrast, the sounds of trains and plains that travel through the frame, as well as the symphonic performance of Alfred Newman's "Street Scene" that opens the film, are only present in the left, center, and right channels. Nunnally Johnson's *Black Widow* (1954) operates in a similar fashion. The murder mystery's sound design plays entirely through the front three loudspeaker channels with the exception of the opening credits, wherein Leigh Harline's orchestral score plays from every loudspeaker in the theater. The scarcity of rear loudspeaker effects in many of Fox's earlier

films is somewhat curious. It perhaps indicates that the studio by and large wished to avoid many of the acoustical problems that undermined *House of Wax*'s surround sound design. More, it suggests that Fox did not see these sorts of effects as essential components of motion picture storytelling.

Case Study: The Robe

The one major exception to this restrained approach to surround sound was *The Robe*. Like other early CinemaScope releases, Fox sent Alfred Newman's music to the surrounds during the film's main titles. Likewise, just before the film ends, as Marcellus and Diana walk to their executions, the orchestral score swells and plays not just from behind the screen but from every loudspeaker in the theater. Yet unlike *How to Marry a Millionaire* and *Black Widow*, the rear effects channel remains active throughout the narrative, specifically at moments when the physical and spiritual presence of Jesus moves people to epiphanies and other related emotional realizations. For instance, as Jesus arrives in Jerusalem on Palm Sunday, Demetrius becomes awestruck by the parade of palms and by the off-screen Jesus, who stares back into Demetrius's eyes. Demetrius admits to being physically moved by the religious leader's divine presence, and to punctuate his emotional reaction the music swells to a climax in every stereo channel, including the rear channel. This moment of spiritual awakening rhymes with a later scene in which Peter performs a miracle to heal the badly tortured body of Demetrius. As during the Palm Sunday sequence, the miracle receives an orchestral underscore that emanates from every loudspeaker in the theater.

Religious epiphanies also occur throughout the film for characters who aid in Jesus's crucifixion and who are later burdened by the gravity of their actions. And much like Demetrius,

the guilt-driven epiphanies of these characters are punctuated through surround sound effects. For example, as Demetrius runs to alert Jesus about his forthcoming arrest by Roman Soldiers, he stumbles upon a man grieving in the middle of the street. The man tells Demetrius that the Romans have already arrested Jesus, and that one of Jesus's closest followers is responsible for this arrest. As the grieving man walks away he reveals himself to be Judas, the friend who betrayed Jesus. Following this revelation, thunder suddenly explodes in all four stereo channels, and the orchestral score that had emanated from the front three channels now plays from the surrounds as it reaches a dramatic cadence. The abrupt groundswell of sound from every corner of the theater arguably functions as an expression of Judas's turmoil and suffering as he realizes the consequences of his betrayal. Additionally, it works to enrapture the audiences within the physical pains of Judas's spiritual awakening.

Marcellus, the roman tribune ordered to lead the crucifixion of Jesus, experiences similar epiphanies shortly after Jesus dies. While leaving the crucifixion, Marcellus cries out in the rain that the red robe that he took from Jesus has cursed him. And much like during Judas's realization, the rerecording mixers punctuate Marcellus's cries by sending the scene's tumultuous orchestral melodies and the crashing of thunder to the rear loudspeakers. A comparable acoustical design continues to occur in the following scene, as Marcellus sails from Jerusalem to Capri. While asleep inside the boat's cabin, he is haunted by visions of Jesus's dead body, which glows with blue light to indicate its divinity. During this vision, thunder and music blast from all four stereo channels. At the same time, the pounding of drums on the deck of the ship leads Marcellus to see and hear the hammering of nails into Jesus's hands. The blow of each hammer rattles through the rear loudspeakers of the theater, just as every blow shakes Marcellus's body as he awakens to the notion that Jesus was indeed the son of God.

The scene that most clearly depicts Jesus's ability to move his followers to spiritual epiphanies is the crucifixion itself, a sequence that contains the film's loudest surround sound effects. The crucifixion takes places during a torrential downpour, where thunder and howling wind fill the soundtrack. The scene also includes the yells of Roman soldiers who play a game of dice at the foot of Jesus's cross, and who shout over the storm in order to be heard. The drama of the crucifixion is further embellished by a dramatic orchestral score that rises and falls in volume to accent important onscreen action, such as the ante of Jesus's titular robe into the pot of the Roman dice game.

According to Murray Spivack, one of the film's re-recording technicians, this entire sequence was incredibly difficult to mix, largely due to the number of elements that were all ostensibly clamoring for priority in the soundtrack.[791] Each effect—whether it was the music, the storm, or the dialogue—had to continuously rise and fall in volume in order to make space for the next effect, and do so without undermining the drama of the scene. The moment during the crucifixion that proved to be the biggest obstacle for Spivack was when Jesus utters the line, "Father, forgive them, for they know not what they do." The line was delivered at a soft volume, and yet it needed to be heard over Newman's score and the tumultuous storm. As Spivack recalled, he couldn't simply raise the volume of the dialogue because "it wouldn't sound as though a man in tremendous pain with two big spikes in his two arms, hanging up there, ready to die, is going to be shouting."[792] Instead, Spivack adjusted the levels of the tracks so that the many competing sounds effectively disappeared from the mix. As the camera cranes up to look down at Marcellus from Jesus's point-of-view, the thunder and wind of the storm fade out, as does the symphonic score. All that is left is Jesus's voice, which plays through the center

channel, while the soft chord of an angelic choir plays from loudspeakers on the rear and side walls of the theater.

Spivack's stereo design—which recalls the performance of "Ave Maria" in *Fantasia*—creates space for Jesus to be heard. More, it helps strengthen the film's broader storytelling pattern. Every surround sound effect is thematically linked to scenes where Jesus wields the greatest influence on those around him. The crucifixion sequence is unique in that it contains the only lines that Jesus speaks in the entire film, and his words, "forgive them, for they know not what they do," have become one of the most famous quotes from the New Testament. As a result of their importance, the entire sequence contains the most noticeable and perhaps even the most memorable examples of surround sound effects.

The choice to mix *The Robe* differently than other early CinemaScope films was likely a product of the film's tent-pole status. Fox needed to prove to exhibitors, critics, and industry executive that the four-track stereo technology could further aid in the telling of a story. And the studio succeeded in this regard. By using the surround sound to accentuate the spiritual elements within the biblical narrative, Fox specifically created a dramatic contrast to *House of Wax*. The 3-D thriller aligned its rear-effect channel with moments of violence and terror. *The Robe* aligned the surrounds with moments of spiritual clarity and divine omnipotence. In other words, by linking the four-track stereo system to such religious and moral themes, Fox turned surround sound into a more thematically integrated cinematic technology.

The Twelve-Thousand-Cycle Tone

Nonetheless, Fox's surround sound technology was imperfect, and its mechanical flaws would discourage technicians from experimenting with similar rear-channel effects on other

CinemaScope releases. Unlike the left, center, and right tracks, the effects track was rather narrow, only .027 inches wide. Sponable, Bragg, and Grignon argued that a magnetic track needed to be at least .050 inches in order to produce a signal-to-noise ratio that was comparable to standard single-channel optical tracks.[793] The narrow width of track four—which was nearly half the size of this recommended width—meant that the track produced sounds that were inferior in quality to those produced from standard Academy Mono prints. Thus, Fox's uses of the surround channel may have been more respectable than Warners' uses, but the channel itself was far noisier.

This acoustical issue was not always evident. Sound effects and music that played from the surround speakers would often mask any unwanted noise that played from the rear loudspeakers. But during long periods when there were no rear effects to be played—especially during films like *How to Marry a Millionaire* and *Black Widow*—the rear loudspeakers risked creating hiss in the auditorium. Fox's solution to this noise problem was to add an electrical tone—specifically, a sine wave at twelve-thousand cycles—to every effects track.[794] This tone was automatically generated whenever mixers sent any effects or music to the surrounds. Its presence would activate a circuit that would allow the rear loudspeakers to emit sounds. And most importantly, its absence from the effects track would turn off the rear loudspeakers and prevent them from adding noise to the auditorium during scenes where the surrounds were meant to be silent.

Because the twelve-thousand-cycle control tone was well above the standard playback range of motion picture soundtracks, it was not intended to be heard by filmgoers in most cinemas.[795] That said, the control tone was stored at a gain of ten decibels, a relatively high volume in comparison to the levels of most surround sounds.[796] The high gain was necessary

because the sine wave needed enough power activate the sound system's rear loudspeaker circuit. The tone itself was thus likely to become audible if projectionists played the effects track at too loud of a volume, or if the decibel levels of their loudspeakers exceeded the acoustical range dictated by the industry's playback regulations. Indeed, contemporary sound systems reveal that the twelve-thousand-cycle tone is quite audible in a number of early CinemaScope titles. In Otto Preminger's *Carmen Jones* (1954), for instance, one can hear the control tone in the surround channel alongside cheers from the crowd who watch Joe and Husky's boxing match. In *The Robe*, one can similarly hear this tone as Marcellus has visions of Jesus while sailing to Capri. The administering of a twelve-thousand-cycle control tone was then also a way for Hollywood producers to make sure that theaters were abiding by the Academy Mono standard, and were not boosting the levels of the rear loudspeakers to create unwanted decibel effects. Given the rear channel's noise levels, the surround sound on CinemaScope releases were instead largely intended to add a subtle layer of detail to select sequences. And the twelve-thousand-cycle tone helped to ensure that such details could be added without diluting the sound design with unwanted noises.

Case Study: House of Bamboo

Nevertheless, the control tone was far from perfect. The process required a small amount of time for the sine wave to activate the system's circuit and for that circuit to then turn on the rear loudspeakers.[797] As a result, Spivack, Carl Faulkner, and other rerecording mixers at Fox were discouraged from filling the surround channel with quick sound effects—such as those that poked audiences from behind during *House of Wax*'s road shows. Though thrill-inducing, these fleeting effects might finish before the loudspeakers were even fully powered-up. Instead, any

sounds sent to the effects track would need to last several seconds in order to guarantee that they had time to play from the rear loudspeakers. This delay may then explain why the thunder that punctuates Judas's name in *The Robe* is not merely a jolting crack of sound—much like in *House of Wax*—but is instead a series of roars that erupt throughout Judas's slow exit.

In place of such one-off thrills, mixers of early CinemaScope releases largely constructed surround sound designs in which background atmospheres and musical embellishments underscored entire scenes. Notable examples include the repeated chirping of birds that populate several outdoor sequences in Richard Fleischer's *The Girl in the Red Velvet Swing* (1955), as well as the crashing of waves that accentuate the titular waterway in Otto Preminger's *River of No Return* (1954). One benefit of filling surround channels with atmospheric effects was that they could help reinforce the details of a given setting. Louder atmospheres, for instance, might function like an establishing shot, and indicate to audiences that the onscreen setting is enormous and even foreboding. Another benefit is that atmospheric effects were temporally long enough for audiences to hear them play from the rear loudspeakers. That said, this move from quick sound effects that punctuated onscreen actions, to background atmospheres that punctuated entire sequences, did not prevent sound mixers and other filmmakers from using the surround channel as a storytelling tool. Rather, its new function merely changed how this tool was to be implemented.

Throughout *House of Bamboo*, the surround channel was constructed to strengthen pre-existing acoustical designs and to help prioritize narratively important information in the soundtrack. The Tokyo-set film noir is structured around sound. As is true of most films, it features non-diegetic music as well as various sound effects that accentuate onscreen actions and that provide information about off-screen space. However, in *House of Bamboo* both the

orchestral score and the background atmospheres play a larger narrative role. Specifically, they work together to organize the film's scenes into broader categories pertaining to Eddie Spanier's safety as he investigates the murder of his friend Webber. The non-diegetic music is often present when Eddie is with people he can trust, namely Mariko, Webber's widow. In contrast, this music is often absent from scenes where Eddie is with those who are responsible for Webber's murder, namely Sandy Dawson and his gang of thieves. In place of music, these scenes contain car engines, boat horns, and even the racket of nearby gambling machines. This sound design gives *House of Bamboo* a semi-documentary feel, wherein the film juxtaposes melodramatic character development with scenes of criminal activity rendered with greater stylistic realism. As Lisa Dombrowksi notes, the film was essentially a remake of *The Street With No Name* (1948), itself a semi-documentary noir released by Fox during the studio's heyday of semi-documentary releases.[798] *House of Bamboo*'s use of music and atmospheric sounds to indicate melodrama and realism respectively throughout Fuller's film can thus be understood to be an extension of this broader stylistic practice, even if the story itself is less typical of Fox's earlier film cycle.

The surround channel works to accent these creative decisions. Specifically, the acoustical elements that modify the genre for each scene are what emanate from the rear loudspeakers throughout the movie. For instance, when Eddie first visits Mariko and reveals that he is an old friend of Webber's, and later when Eddie asks Mariko to move in with him, Leigh Harline's melodramatic score reverberates from every loudspeaker, including the rears. Likewise, during Eddie's violent robbery of a shipping dock and during the climactic shootout on top of a department store roof, the surrounds are filled with the more realistic soundscapes of downtown Tokyo, namely gunshots, engines, horns, and the clatter and walla of nearby crowds.

More interesting are the ways that the effects track extends the codes of semi-documentary storytelling beyond their literal, generic functions. When Sandy has Eddie arrested and interrogated by the local police, the atmospheric noises of a police station—including the typing of secretaries and the ringing of telephones—play from the rear speakers. In contrast, when American detectives meet with Eddie at a local temple, it is Harline's music that plays from the rears. Unlike at the police station, this stereo design at the temple aligns both Captain Hansen and Inspector Kita with Mariko. In turn, it reinforces what the narrative has recently conveyed, that Eddie is not being pursued by these two detectives but is instead working with them as an undercover agent. Even more significant is a scene in which both diegetic pop music and atmospheric effects are both sent to the surround channel at the same time. This occurs just after one of Sandy's men grows antagonistic toward Eddie and Mariko and harasses both of them during a party at Sandy's home. At this point both Sandy's party music and the atmospheric sounds of insects play from the rear loudspeakers. This unique moment—which is the only sequence in the film to include both music and atmospheres at the same time—provides extra stylistic emphasis to the scene as a whole, and to the fact that at this point in the film, Eddie's work is not only putting his own life in jeopardy, but also the life of Mariko, who is aiding in his investigations.

House of Bamboo featured far more surround-sound effects than *House of Wax* did, and yet *House of Bamboo* was never ridiculed for its four-track design the way that *Wax* was. Its lack of controversy was arguably a testament to Fox's conservative mixing techniques. The studio's restraint toward stereo grew out of a need to provide the industry with yet another reason to reject triple-track technology and to accept CinemaScope as the more practical alternative to seven-track Cinerama. The studio's surround-sound designs specifically demonstrated that stereo

need not be loud or distracting to be effective. It could be subtle and still remain a valuable narrative tool. As such, it was unlikely to become a financial liability for exhibitors who wished to attract more audiences into their theaters, but who did not want to offer refunds to those who disliked the stereo effects, or worse, became physically ill from their decibel levels. By design, stereophonic sound could be widely advertised on the CinemaScope posters that were hung in a theater's lobby, and it could remain largely unobtrusive to audiences once they entered the auditorium.

Conclusion

Although Twentieth Century-Fox announced its CinemaScope technology before triple-track was unveiled, the studio remained unable to begin producing and releasing its films in the anamorphic format for several months. Such a delayed roll-out gave triple-track stereo as advantage within the theatrical marketplace. Despite this setback, Fox saw the delay as an opportunity to improve its own format's design so that CinemaScope's Fall premiere would be as impressive and as flawless as possible. These improvements included a new print design that combined the picture and stereo tracks onto a single strip of 35mm film. They also included the construction of a set of conservative mixing techniques, which were designed to prevent many of the acoustical problems that plagued triple-track screenings. Fox's improvements were successful in enabling CinemaScope to overcome its initial market disadvantages. Studios and theaters universally preferred four-track CinemaScope over triple-track stereo, leading those who once promoted the three-channel technology to all but abandon it by 1954.

CinemaScope's popularity nonetheless came at a price. Fox's conservative approach to four-track mixing produced subtle stereophonic effects they largely concealed the technology

from audiences. As many industry leaders would soon ask: if stereo was not noticeable, was it even necessary? Similar questions would only grow in volume over the next several years. In the following chapter, I look at how such skepticism toward CinemaScope led to the emergence of competing stereophonic technologies. These new formats not only undermined Fox's dominance within the theatrical market, they also called into question the prevailing belief among its technicians that a conservative approach to surround sound was in fact the most profitable.

Citations

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Chapter 8: Perspecta and Other Challenges to CinemaScope, 1954-1958

Walter Reade Jr. did not want to pay for four-channel stereo installations. The president of Theater Owners of America, and the manager of several prominent movie theaters in New York and Boston, saw the format as a waste of money, if not a swindle.[799] Accordingly, Fox's installations were tantamount to ransom. The studio was holding *The Robe* hostage and was requiring exhibitors to pay ten- to twenty-thousand dollars for technical upgrades in order to play this title at their theaters.[800] Although a number of prominent exhibitors were willing to install the surround-sound systems, Reade had other plans. As luck would have it, there existed an underground market for projection equipment at the time CinemaScope was being rolled into theaters. And within that market was a device known simply as a "mixer." When wired into a standard 35mm projector, the small device could read all four magnetic sound tracks on a CinemaScope print, and mix them down into a single playback channel.[801] Thus, in lieu of paying the ten to twenty-thousand dollars for a four-channel sound system, exhibitors need only pay a few hundred for a small mixer and—*voila!*—they could play CinemaScope titles without paying CinemaScope prices.

Reade did not install these mixers in secret. Rather, the theatrical showman made sure that everyone in the industry knew about his plan to thwart Fox's contractual demands. In January 1954, before his scheduled screenings of *The Robe*, he publicized that he installed a mixer in his theater in Morristown, New Jersey, and that he was planning to install two more across the state, including one in his Majestic Theatre in Perth Amboy and another in his Broadway Theatre in Kingston.[802] And to further inflame the studio heads at Fox, Reade

continued to promote the "stereophonic sound" moniker at each of his venues, despite offering monaural down-mixes.

Needless to say, when Fox executives caught wind of what Reade was doing, they were none too pleased. The studio obtained an injunction against Reade, which threatened to withhold all CinemaScope content from the exhibitor if he did not remove the mixers from his projection booths at once.[803] Fox asserted that mixers would cause signal cancellation and might inadvertently remove dialog and other important sounds from the film.[804] Fox's Earl Sponable was especially bothered by the prospect of what a mixer might do. In lieu of brazenly objecting to playing prints in their proper four-track magnetic format, Sponable argued that at the very least projectionists could just play track two, which contained only the center channel, and which—given the way technicians designed each four-channel release—contained all the dialogue and most of the sound effects and music.[805] Though playing track two by itself would sound inferior to playing the entire four-track mix, doing so would at least avoid the signal distortion that would result from mixing multiple tracks haphazardly in theaters. Of greater concern, Fox accused Reade of being in breach of contract. The studio required that every exhibitor play its Cinemascope prints through a stereophonic sound system, and the studio accused Reade of false advertising by promoting *The Robe* in stereophonic sound when, in fact, its showings were in mono.[806]

Fox however did not have a particularly strong legal case against Reade. At the time, their contracts with theaters had only required the use of only "special" sound equipment. By not clarifying that this meant stereo specifically, Reade's mixer technically qualified as being of special status.[807] Further, Reade's advertisements that read "Stereophonic Sound" were not inaccurate, but merely misleading. Because much of *The Robe* was recorded in three-track

stereo, audiences were technically hearing a stereophonic sound recording even if they weren't privy to stereophonic playback. Nevertheless, the mere threat of withholding Fox's films from Reade's theaters led the two companies to come to a truce.[808] Fox agreed to let Reade continue showing *The Robe* with a mixer, as Fox still received a share of the gross from screenings at Reade's theaters. The concession was that Reade's future screenings had to play Fox's films in actual stereophonic sound.[809]

Though the two parties settled the dispute without incurring any long-term financial damage, the public dustup between Fox and Reade was anything but minor. It illustrated a growing resistance to Fox's mandate that every CinemaScope title play in four-track sound. The high cost of installations, in combination with Fox's choice to remain stylistically conservative when mixing four-channel sound designs, made it hard for many exhibitors to see the format as valuable or necessary. And Fox, having invested considerable capital in developing a four-track system, refused to back away from its theatrical demands.

This chapter looks at how the industry as a whole responded to the festering conflicts between Fox's studio heads and exhibitors like Reade. I argue that such battles spurred the creation of several alternative stereophonic systems designed to prevent similar infighting. Chief among these systems was Perspecta, a single-track audio technology invented by Robert Fine and financially backed by Loew's and MGM. Despite its single-track design, Perspecta was capable of delivering three-speaker sound with the help of sub-audible control tones and special projection equipment. Consequently, the system's popularity within the industry threatened to oust Fox's four-channel sound system as the premiere stereo technology in Hollywood.

In order to establish how exactly Perspecta became such a formidable adversary to four-track CinemaScope, I detail the many three-dimensional sound systems that emerged during the

1950s, as well as the philosophies that shaped the design and marketing of these systems. I then chronicle Perspecta's adoption by Hollywood and Fox's retaliatory campaign to undermine its legitimacy as a "true" stereophonic sound system. Following this discussion, I provide an analysis of two Perspecta releases—*Forbidden Planet* (1956) and *Silk Stockings* (1957)—in order to uncover what it was that made the technology's unique sound designs worthy of the label "pseudo stereo." I conclude that the many multi-speaker effects that comprised Perspecta sound designs collectively upstaged Fox's subtle surround-sound aesthetics. Despite Fox's attempts to undermine Perspecta's single-track design, it was Perspecta that instead undermined the economic and aesthetic value of four-track CinemaScope.

Stereo on the Cheap

As a means to mitigate the theatrical resistance to installing stereophonic sound systems, there were several attempts to develop less-expensive alternatives for smaller theaters. Similarly, there were attempts to develop higher quality sound systems that might appeal to exhibitors like Walter Reade who felt that four-track magnetic stereo was not worth the installation hassles. Few of these systems were adopted by studios, but their designs provide necessary context for the obstacles that Perspecta was able to overcome when it mounted its own formidable challenge to CinemaScope's dominance within the theatrical marketplace.

PhotoStereo

Among the more interesting four-channel alternatives was a two-track system developed and promoted by Westrex, the exports division of Western Electric. When the company became the Hollywood arm of Western Electric in 1949, replacing ERPI in the process, it acquired a

number of audio technologies developed at ERPI, including Joseph Maxfield's two-track Stereophonic Film sound system.[810] The system, which was invented in 1933 and first unveiled to the industry in 1937, was notable for being the first motion picture reproduction technology officially dubbed "stereophonic" by its inventor.[811] However, Maxfield's system was never licensed or adopted by studios. The invention was instead overshadowed by more lavish multi-channel formats, namely Harvey Fletcher's Stereophonic Sound-Film System and Disney's Fantasound.[812] In turn, Maxfield's two-track technology was discarded, if not completely forgotten, by Hollywood's acoustical engineers.

The technology, however, would not stay forgotten forever. During the 1950s, a period when exhibitors and studio heads were growing skeptical of four-track's long-term viability and were increasingly irritated by the format's high installation costs, Maxfield's innovation would be quickly repackaged. It became a means for Westrex's engineers to quickly cash in on the industry's newfound interest in multi-channel audio. The company merely needed to convince studios that their two-track system was indeed a viable alternative to Fox's four-channel stereo.

And to convince studios of the technology's strengths, Westrex opted to conceal the fact that it was a recycled technology from the 1930s. Whereas Maxfield dubbed his technology Stereophonic Sound, Westrex rebranded it PhotoStereo.[813] Aside from this new moniker, however, the technology itself was largely indistinguishable from ERPI's initial designs. Like Maxfield's system, the tracks were stored side by side on 35mm film, in the narrow column of space to the left of the image. Because it was typical for this space to contain the two push-pull noise cancellation tracks, repurposing this space for two separate stereo channels was simply a matter of changing the types of sounds stored onto each track. Instead of the tracks housing inversions of the same signal, the two tracks now held the left and right playback channels. This

repurposing of push-pull tracks therefore kept the stereo system backwards compatible. Projectors that did not have special PhotoStereo sound heads could still read and play all the sounds stored on the left and right tracks. These older projectors would merely send the signals from both tracks to one loudspeaker channel. As Maxfield initially intended, the system would not incur any loss of information when played through single-channel sound heads.[814]

There were nonetheless a few small changes made to Maxfield's designs that proved consequential to its viability. First, it was compatible with both variable-density and variable-area audio formats. Second, it was optimized for use on two-speaker as well as three-speaker sound systems. For wider screens that required three speakers, the two tracks were to be combined and sent to the center loudspeaker. This process of deriving a center channel from only two stereo tracks, however, was a surprisingly controversial issue, for there was a growing belief that a derived center would lead to a significant decrease in three-dimensional playback quality. Such ideas were largely informed by the auditory studies of Helmet Haas. In 1949, the German psychology student published a groundbreaking paper that outlined how a person's experience when listening to multi-speaker sound is governed by perceptual biases.[815] Accordingly, when the same sound plays from two loudspeakers at the very same time, a person will hear the sound as only coming from one loudspeaker, namely, the one closest to the listener. Thus, if the same sound is playing from the left loudspeaker and the center loudspeaker, a filmgoer situated closer to the center loudspeaker would only hear that sound as emanating from the center loudspeaker; the sound's directional properties would be lost. In other words, a derived center channel might actually remove stereophonic effects from the film's sound design.

Haas's findings, later known as the "Haas effect", were seen as a serious obstacle by many acoustical engineers. Bruce Bogert of Bell Laboratories, for instance, spent much of the

early 1950s developing a two-track stereo system that derived a center channel by delaying the playback of the channel by as few as 35 milliseconds.[816] According to Bogert, the small delay was enough to counter an audience's perceptual biases, and was therefore able to accentuate the directional effects found in two-track recordings. Westrex, in contrast, was not as worried about the Haas effect. Instead of adding a built-in delay to the center channel, Westrex's engineers merely lowered the volume of this channel by six decibels.[817] The weakening of the signal was arguably a means to quickly address Haas's findings without adding new costs to PhotoStereo's electrical processes. Additionally, Westrex saw their system as adding value to any feature, not just widescreen titles, and directional effects were of little importance to standard Academy-sized releases. What largely mattered to Westrex were proportional effects and the growing respectability associated with hearing a film in stereophonic sound. A derived center without localization properties could still boost a motion picture's acoustical resonance, as well as its prestige.

To bolster PhotoStereo's technological importance even further, Westrex chose John Frayne to serve as the sound system's official spokesman. As president of Westrex, and as a former engineer at Bell Labs, Frayne was a trusted name in cinema acoustics since the 1920s. He was one of several engineers to oversee the development of Warner's Vitaphone sound-on-disk reproduction system, and he aided Bell Labs in the multi-track musical recordings that Fletcher played at Carnegie Hall during his famed Stereophonic Sound-Film Concerts.[818] While at Westrex, Frayne also oversaw the development of magnetic recording technology, particularly the multi-track equipment implemented by Fox and other studios during the production and post-production of triple-track and CinemaScope features.[819] It was his experience and esteem as an expert in sound technology that led him to become president of the SMPTE, making him even

more suitable to sell PhotoStereo to the industry's technicians.[820] At the same time, it was perhaps his close business relationships with studio engineers that made his role as spokesman a liability.

Frayne was careful to frame PhotoStereo not as a replacement for four-track magnetic, but as a sound system for exhibitors who were specifically hesitant to abide by all of Fox's technical demands. As he stated in a column for *International Projectionist*, "It is not inconceivable that with its compatibility and economy features, PhotoStereo sound may become a useful adjunct to the more elaborate stereophonic systems in use in the motion picture industry."[821] In effect, by referring to the system as merely an adjunct, he was pushing the technology onto the smaller, neighborhood, and second-run venues, those that were themselves seen as adjuncts to the major chains and more profitable downtown palaces.

Frayne articulated this promotional frame in greater detail in October 1954, when he demonstrated PhotoStereo at the Fall convention of the SMPTE.[822] He began the presentation with a brief outline of the format's inner workings, its design benefits, and its general ease of use and adoption by sound departments and exhibitors. He then ended his presentation by screening two demonstration films. One was of an orchestra performing the overture from Rossini's *The Barber of Seville*. The other film was a dialogue sequence originally from *The Best Years of Our Lives* (1946), but re-enacted with different actors and re-shot on a different set. Initially known for its deep staging, the film was ostensibly now a vehicle to promote a similar three-dimensional depth of sound. As Westrex intended, Frayne designed his demonstration to align his format with more than the spectacular uses of multi-channel audio found in Cinerama's widescreen pageantry. To help sell the format to smaller theaters, he linked PhotoStereo with the tradition of quality associated with Wyler's Oscar-winning melodrama.

Despite Frayne's attempts to frame the two-track system as a mere adjunct to four-channel stereo, his presentation to the SMPTE received mixed reviews. According to the exchange that took place during the subsequent question and answer session, which was published in full by the Society's journal in 1955, PhotoStereo was greeted almost immediately by criticisms from fellow engineers, especially Fox's Lorin Grignon. The co-inventor of CinemaScope waited patiently for the session to come to an end, at which point he effectively dismantled the value of Westrex's two-track technology in front of potential customers. The decision to wage an attack on PhotoStereo was two-fold. For one, the two-track format had the potential to bite into Fox's share of the theatrical market. Though it was aimed at only smaller screens, Westrex's system might still attract the business of larger palaces that were looking for cheaper alternatives to four-track stereo. For another, Westrex was already working with Fox to develop CinemaScope's audio technologies, particularly its multi-track recording equipment.[823] Westrex's investment in a new format would have potentially meant that the company would no longer develop or service Fox's stereophonic equipment, or that it might inflate costs of its audio services in order to help push Fox's four-track system out of the marketplace. In the eyes of the studio, Westrex's choice to back two different multi-speaker formats constituted a conflict of interest. Grignon therefore felt compelled to shoot this system down with sniper-like precision.

The engineer nonetheless acted strategically. He stayed quiet and gave other defenders of magnetic recording the opportunity to grill Frayne before going in for the kill. Jack Mullin, the former Magnetophon promoter and now an engineer at Bing Crosby Enterprises, appeared particularly alarmed by noise levels in both demonstration films. He questioned why the system would require such narrow optical tracks for playback, especially when both films were initially recorded on magnetic tape.[824] Frayne did his best to avoid a scene with the famed promoter of

magnetic recording. He admitted that Mullins had a point, and that the low noise levels of magnetic tape became "inconsequential" once the recordings were transferred to the PhotoStereo prints.

Smelling blood, other magnetic recording engineers soon took aim at Frayne. Ralph Heacock of RCA hammered Frayne for claiming that low-quality optical tracks might save studios money: "We might get more for our money by developing and perfecting magnetic recording rather than continuing with the optical recording."[825] Frayne nonetheless defended his decision: "From the economic point of view, as long as we have photographic emulsion it seems advisable to try and make good use of it for sound also."[826] In other words, because film images were optically encoded, Frayne believed that it was more cost-effective for its sound tracks to be optically encoded as well. Nonetheless, Frayne's responses seemed less than adequate at mitigating his audience's skepticism toward PhotoStereo's technical design.

It was at this point, after the room had already weakened Frayne's resolve, that Grignon launched his first missile: "Are you disapproving of magnetic CinemaScope releases?"[827] The question likely took the Westrex president by surprise. "Not at all," Frayne declared, but Grignon did not stop there. He took aim at PhotoStereo's two-track print design, targeting its Achilles heel: the derived center channel. Grignon pressed Frayne to admit that this derived channel failed to work as well as Frayne promised. However, Grignon was not interested in its lack of a built-in time delay, as Haas's followers would be quick to point out. Instead, he was objecting to its proclivity for distortion. "We know very well from experience," Grignon asserted, "that you cannot combine two or three stereophonic tracks by mixing them indiscriminately, or by reproduction in parallel, without suffering curious and unpredictable losses in sound quality to a series extent."[828] For Grignon, PhotoStereo was no better than Reade's mixer. When dialogue,

music, and effects are recorded with two microphones onto two separate tracks, the sounds on the two tracks are not identical, but slightly out of phase with one another. If these tracks are then combined to create a single playback channel, the sound waves would then clash. The derived center signal was therefore prone to phase interference and audible distortion. For Fox, Westrex's system was no substitute for the discrete channels of four-track stereo.

Frayne did not voice any disagreements with Grignon's criticisms. Rather than risk his relationships with those at Fox, he appeared to give up trying to defend his company's system entirely. He acknowledged that Grignon's comments were accurate, and that PhotoStereo was far from perfect. And to avoid any further hostility from his friends at Fox, he then clarified that the purpose of his presentation was merely to explore the feasibility of two-track optical stereo, not its inevitability.

> I might add in closing, that the proposed system is not to be considered in any way competitive with 4-track magnetic CinemaScope but merely points out the possibilities of a 2-track photo-stereo system that could be reproduced in standard optical soundheads with a minimum of modification and additional of special equipment.[829]

In other words, Frayne appeared to have a realization during his presentation to the SMPTE. Given the pushback against the format, his PhotoStereo system was arguably not worth the price of selling it. Without the support from a major studio—and faced with animosity from Fox specifically—Western Electric's two-track sound system was once again discarded.

Panaphonic Sound and Five-Track Stereo

Whereas Frayne may not have fully understood the importance of studio support when he unveiled his system to the SMPTE, a relatively unknown engineer by the name of Lloyd Dorsett did recognize the value of studio backing. The Oklahoma native had considerable experience

inventing technologies that were sold and used to a variety of industries. These included wartime machines for the Department of Defense, as well as automated graders of multiple choice exams—a precursor to the widely used Scantron systems—for use in public schools.[830] In the 1950s, Dorsett directed his focus toward improving Hollywood's sound systems. Like Lansing and Ballantyne before him, Dorsett Labs became an independent manufacturer that provided technical service to those in the industry who were largely ignored by the major studios. The company, for instance, helped to develop a three-channel car stereo to be used by drive-ins hoping to play triple-track and CinemaScope releases with directional audio.[831] And in 1953, shortly after Fox's announcement of a four-track magnetic sound system, Dorsett Labs developed a multi-speaker system—dubbed Panaphonic Sound—that could similarly attract the business of independent theaters hoping to play stereophonic sound designs at a fraction of the cost of CinemaScope.[832]

Dorsett's sound system was warmly received by Hollywood studios, especially Paramount. During the early 1950s, the distributor grew interested in finding a means of providing stereophonic content to audiences without having to license Fox's cumbersome technology. Paramount was among the first studios to release a number of titles for triple-track stereo—including *Shane*, *The Caddy*, and *Those Redheads from Seattle*—but it was hesitant when it came to adopting the picture and audio demands of the CinemaScope process. Indeed, beginning in 1953, Paramount executives pursued a handful of cheaper ways to offer widescreen and stereophonic content without simultaneously asking exhibitors to completely overhaul their projection equipment. Projects included the development of a proprietary widescreen system—dubbed Paravision—that merely asked theaters to physically matte open-frame prints to produce an expansive 1.66 to 1 aspect ratio without the need of a special anamorphic lens.[833] Similarly,

Paramount pursued analogous stereo systems that were just as affordable and simple to install, and yet just as respectable as the Paramount brand.

Panaphonic Sound promised to be the type of system that Paramount was hoping to adopt. Like PhotoStereo, it was an optical format, and was thus materially cheaper than four-track magnetic. At the same time, Dorsett's system required only one track of sound, which made it backwards compatible in theaters with optical monaural sound heads.[834] Additionally, its prints featured small marks that cued the optical soundtrack to each loudspeaker independently of one another. Dorsett stored these marks in between the perforations on the left and right sides of the print.[835] The space between the two columns of perforations would either be clear or covered by a thick black line. This allowed for a set of binary cues—such as left-black/right-clear and left-clear/right-black—that created a total of four possible combinations. These combinations then corresponded to four different loudspeaker settings: left-only, center-only, right-only, and all loudspeakers including surrounds. Panaphonic Sound could therefore simulate a three-dimensional sound environment, where sounds emanate from specific locations behind the screen, without the requirement of narrower and noisier soundtracks. And as Dorsett noted, the black line between the perforations could be printed onto the filmstrips during development, or they could be manually added by using a thick black marker.[836] In theory, this system would then allow any film, even older films, to be re-purposed as Panaphonic stereo releases without too much difficulty.

And to win the attention of Hollywood, Dorsett did just that. Several weeks before the September 1953 premiere of *The Robe* in CinemaScope, Dorsett began installing Panaphonic sound heads in roughly twenty screens located in Oklahoma and Texas.[837] On August 12th, he began showcasing a number of Universal titles, a re-release of *Salome, Where She Danced*

(1945) and in later months *Wings of the Hawk* (1953), each retrofit for his multi-speaker system.[838] Costs of the installations were reportedly between $1,000 and $1,750 per screen, a stark contrast to five-figure price tag associated with CinemaScope.[839] Further, the directional effects deployed in these films were reportedly far more audible than those typically associated with stereophonic sound. According to Dorsett, "most moviegoers do not notice the difference between Panaphonic and other stereophonic systems, except that, since the new system uses auditorium speakers more freely, emotional impact is greater."[840] Because Fox designed its stereo effects to be subtle, Dorsett's systems stood out as being more dynamic and perhaps even more pleasurable to filmgoers looking to experience auditory thrills.

The sound designs of these experiments attracted the interest of Paramount's head engineer, Loren Ryder. In September 1953, Ryder hosted a demonstration of Dorsett's system in Paramount's Los Angeles screening room for an audience of studio executives, engineers, and members of the studio-run Motion Picture Research Council.[841] The demonstration was notable not only for its discussion of Dorsett's designs, but also for its use of Paramount's own *War of the Worlds* (1953) as an illustration of just how effective Panaphonic Sound could be when applied to the studio's own titles.[842] Additional demonstrations were subsequently held in October for Hollywood's East Coast executives, including representatives from Altec, Loew's, Warners, and the trade press.[843] Paramount even re-hosted one more demonstration of Panaphonic Sound in December for the Los Angeles meeting of the SMPTE. The presentation before the Society once again included a screening of *War of the Worlds*, as well as a brief overview of the technology by Paramount's assistant sound director, Louis Mesenkop.[844] As Grignon would later tell industry reporters, "This is the first step in recent months toward simplifying, rather than complicating, the presentation of motion picture entertainment. […]

Fortunately along with this simplification there is economy for the producer, distributor, and the theatre."[845] In sum, Paramount became a de facto public relations office of Dorsett Labs in asserting the value of its system to Hollywood executives.

Nonetheless, Loren Ryder and Paramount discontinued their working relationship with Dorsett Labs in early 1954. Though there were likely several reasons for Paramount to lose interest in Panaphonic Sound, one explanation may be a matter of acoustical standards. Paramount in 1950s was still a motion picture brand associated with prestige and high-quality products. If it were to adopt Panaphonic as its own sound system—and subsequently rename it "Paraphonic" with an r, not unlike Paravision and WarnerPhonic—the system would somehow need to enhance the value of the Paramount brand. And yet the system was an optical format that merely directed Academy mixes to multiple loudspeakers. Its simulation of stereophonic sound would have potentially diminished Paramount's reputation for motion picture excellence. More significantly, Paramount was also working on a comprehensive widescreen and stereo package of its own. Rather than invest in a competing engineer's invention, Paramount dedicated its resources toward its own proprietary motion picture technology, one that promised not to be cheaper than Scope, but of higher cinematic fidelity.

This system was VistaVision. Like CinemaScope, it was a format that expanded the size of the screen vertically while widening the aspect ratio to as much as 1.85 to 1.[846] VistaVision, however, did not squeeze its image. Rather, the image was recorded on 35mm prints that were rotated horizontally. This sideways orientation allowed for wider images to be recorded at much higher resolutions, and thus at higher qualities when projected onto a venue's wider and taller screens. Alongside this new picture system, Paramount also innovated a unique five-track sound technology that would further enhance the fidelity of their sound designs.[847] Like four-channel

CinemaScope, the system consisted of three channels for the front of the theater. Its distinction was that instead of one channel for the rear of the theater, it had two: a left surround and a right surround, what would be known as "split surrounds" or "stereo surrounds" by later generations of acoustical engineers.[848] The system was therefore much like Cinerama, as it was capable of directing sound effects to specific locations behind the audience, not unlike the jets that seemed to fly over audiences at the end of *Cinerama Holiday*. However, Paramount's five-track system was capable of creating these effects with only one strip of film.

According to the original blueprints, the studio spread five discrete tracks across the space of the entire strip of film.[849] The left, center, and right tracks were housed in the column directly to the left of the picture, while the left and right surround tracks were stored on the very outer edges of the filmstrip. This design meant that the left, center, and right tracks were slightly narrower than their CinemaScope counterparts, but the five-track prints nonetheless carried several advantages over CinemaScope releases.[850] First, the left, center, and right channels were protected from any damage to the sides of the filmstrips. Important narrative information stored in the front channels, thus, would not be lost due to routine print wear. Second, the narrow soundtracks meant that the five-track system did not require smaller sprocket teeth. Paramount instead devised their prints to use standard perforations and to fit into any 35mm projector.

Despite these acoustical advantages, when VistaVision premiered with the release of *White Christmas* (1954), its prints contained only Academy Mono tracks. It seems likely that Paramount's decision not to implement five-track technology was related to the high production and installation costs demanded by a fifth playback channel. At the same time, there was the belief among studio heads that the VistaVision format was a good enough addition to the company's brand even without an accompanying stereo system.[851] Despite having interests and

resources to build an alternative to CinemaScope's four-track system, Paramount concluded that its widescreen format with a single optical track was still capable of battling Fox for a greater share of the theatrical market. In sum, any studio that wanted to introduce viable alternatives to CinemaScope's stereo system needed both a cheaper technology as well as a system that could offer a higher quality acoustical experience for filmgoers. And neither PhotoStereo, Panaphonic Sound, or Paramount's five-track magnetic technology were able to improve upon both the price and quality of four-track magnetic stereo.

The Philosophy of Perspecta

There was nonetheless one stereo format that did successfully challenge four-track stereo's dominance within the industry: Perspecta. Between 1954 through 1958, the format became a popular alternative to Fox's stereo system among several prominent Hollywood studios and theater chains, thereby addressing the market demands for a less-expensive alternative to CinemaScope. Such success was not only due to its lower costs but its demonstration of a new stereophonic philosophy, one that questioned the efficacy of the leading theories of three-dimensional sound at the time. And by adhering to this new philosophy, Perspecta undermined Fox's ability to claim that its four-channel format was the best and only option for theaters wishing to provide audiences with high-quality stereophonic content.

The biggest selling point of Perspecta was that, unlike CinemaScope, it was easy to integrate into theaters. As a single-track stereo system, its prints did not require new sound heads, nor did they require smaller sprocket teeth. Instead, the physical design of Perspecta prints was indistinguishable from a standard Academy Mono print.[852] Curiously, Perspecta relied upon three inaudible control tones that engineers added to each films' final mix during re-recording.[853]

Perspecta's three control tones took the form of electrically generated signals at thirty, thirty-five, and forty cycles, which corresponded respectively to the left, center, and right loudspeaker channels.[854] When the amplitude of these signals increased and decreased, so too did the volume of their corresponding loudspeakers.

If a filmmaker wished for a sound to emanate from the left side of the screen, the thirty-cycle tone was mixed at its highest amplitude, while the other tones were either completely silent or were mixed at low amplitudes—typically a difference of only eight to ten decibels—to simulate the decay of a three-track stereo mix.[855] In a sense, its design was a blend between two multi-speaker sound systems of the 1930s: the proportional effects of Warner's Vitasound and the directional effects of André Debrie's Perspective Sonore. Like Vitasound, Perspecta's control tones raised and lowered the loudspeaker volumes, and like Perspective Sonore, the tones steered the monaural soundtrack to multiple loudspeakers.

As a control tone system, rather than a multi-track system, Perspecta was compatible with both optical and magnetic formats. However, it was largely conceived as an add-on to Academy Mono optical prints. This way, the new stereophonic sound process would remain backwards compatible with standard projection equipment. If theaters wished to play Perspecta prints through multi-speaker sound systems, they would need to install a special apparatus known as an "integrator" that decoded the three control tones and that then sent the sound track to the proper loudspeakers for the duration of the film.[856] Theaters without a Perspecta integrator would simply play the Perspecta soundtrack through a single loudspeaker, and the low-frequency roll-off of Academy-optimized amplifiers would prevent these three tones from being heard. Thus—unlike four-track magnetic stereo—any theater could play a Perspecta-encoded print. The backwards compatibility of Perspecta's design precluded the need for studios to hold dual

inventories of the same film, requirements that might otherwise raise production costs and storage overhead.

Fine and Efficiency

Perspecta was the brainchild of C. Robert Fine, a veteran audio engineer whose many contributions to stereo technology have already been addressed—albeit indirectly—throughout the pages of this dissertation.[857] Fine began his career working for James Miller, whose photomechanical sound recording device known as Millerfilm was passed over by the SMPE in the 1930s.[858] It was Fine who then refined Miller's photomechanical process following the industry's transition to magnetic recording. He specifically designed a device that inscribed an optical sound track next to an identical magnetic sound track in order to allow engineers to immediately visualize the sound record.[859] Additionally, Fine worked at Reeves Sound Studio in New York where, as head of disc-recording operations, he supervised the recording and mixing for several prominent orchestral sessions, including the recording of Virgil Thomson's score to Robert Flaherty's *The Louisiana Story* in 1948.[860]

Fine's more notable accomplishments, however, were less to do with cinema and more to do with developing recording techniques for classical music. Before Reeves embarked on the seven-track stereophonic sound design for *This Is Cinerama* in 1952, Fine left the studio to begin his career as an engineer for Mercury Records.[861] An increasingly common recording technique for symphonic music at the time involved using an expensive array of microphones spread across the recording stage. Engineers would then mix down these signals into a monaural track for vinyl records. Fine, however, had found this technique unsatisfactory and unnecessary, as illustrated by his innovations at Reeves Sound Studio. During his recording of *The Louisiana Story*, Fine

placed a single Altec 639 cardioid microphone just above conductor Eugene Ormandy's head in order to create what he believed was the most aesthetically pleasurable symphonic sound.[862] For Fine, one microphone sounded better than many.

At Mercury, Fine and his wife, audio engineer Wilma Cozart Fine, were given the freedom to explore and develop this single-microphone technique even further. After concluding that a condenser microphone would be more sensitive to the details of a symphonic performance than would a cardioid microphone, Fine opted to stage a Neumann/Telefunken U47 model microphone exactly twenty-five feet above the conductor podium.[863] This position, he argued, would best capture the full symphonic signal as well as the atmospheric effects created by the performance hall. And it did so without his having to mix together multiple microphone signals, a process that would introduce unwanted phase distortion into the final mix. Fine's first execution of this recording technique was in April 1951 with Rafael Kubelik's performance of Modest Moussorgsky's *Pictures at an Exhibition*.[864] Upon release, *New York Times* music critic Howard Taubman hailed Fine's work, opining: "Thanks to one of the finest technical jobs of recording made on this side of the Atlantic, the orchestra's tone is so lifelike that one feels one is listening to the living presence."[865] In response to this review, Mercury Records branded its Fine recordings as the "Living Presence" series.[866]

Fine's success as a recording engineer at Mercury Records was therefore tied to his broader interest in material efficiency. While Harvey Fletcher argued that stereo recordings needed as many as three microphones and three loudspeakers to reproduce the sense of space, illusion of presence, and auditory perspective of a live orchestra, Fine ostensibly argued that such demands were unnecessary. The same sensory experience could be reproduced with a single microphone, all one needed to know was which microphone to use and where exactly to place it

in the room. And Fine's ongoing investigations of material efficiency helps to explain the technological design of his Perspecta process. In lieu of using multiple tracks of sound on a single filmstrip, Fine demonstrated that studios could reproduce similar three-dimensional auditory sensations by using only a single track of sound, one that can expand to multiple loudspeakers to create proportional and directional effects.[867] By and large, Fine saw himself as a problem-solver in the field of audio engineering, someone who could reduce costs without reducing quality, and in 1953 he and his company, Fine Sound, Inc., specifically saw the problems inherent to the adoption of motion picture stereo to be a simple matter of material costs. Perspecta was their solution.

New Stereo Ideals

These principles that shaped the system's design were a reflection of the broader changes in attitude toward three-dimensional sound technologies and listening practices that took place within the field of audio engineering at the time of Perspecta's conception. Fletcher's principles of auditory perspective from the 1930s were about transmitting live performances from one concert hall to another room of equally large size, as demonstrated by his multi-speaker concerts in Constitution Hall and Carnegie Hall. Though by the 1950s, particularly with the rise of smaller loudspeakers and home listening cultures, the type of wavefront stereo that epitomized early stereophonic theory was not always practical. The emergence of post-war high-fidelity discourse introduced a new acoustical ideal, one that valued signal compression as much as signal replication. As the pages of *High Fidelity* magazine regularly suggested, the art of fidelity was often about maintaining the illusion of a live concert in one's living room without relying upon the material and electrical needs of a large auditorium's sound reinforcement system.[868] If

stereophonic discourse of the 1930s was about replicating the sonic signature of the performance hall, then comparable discourse of the 1950s was about eliminating the redundancies in the stereophonic signal and about letting the space of the playback room shape the experience of listening to a concert hall performance's reproduction.

This historical change was most clearly articulated in a 1955 paper about Perspecta that was presented to the SMPTE by Norman Crowhurst, a colleague of Fine's at Fine Sound and a frequent contributor to high-fidelity literature at the time. According to Crowhust, much of the acoustical information that CinemaScope and other Fletcher-inspired stereo designs use to produce three-dimensional sound images are redundant and unnecessary. Details like reverberation and signal decay could be removed from the storage and transmission process without anyone noticing, but they are nonetheless included in the recording and transmission process as a result of the way audio engineers idealize the sounds created by performance hall themselves.[869] In other words, these audio engineers believed in the notion that three-dimensional sound is about reproducing the room as much as it is about reproducing the performance.

For Crowhurst, however, the reverberation and decay that comprise the original performance hall's sonic signature was not significant to the three-dimensional auditory illusion. Further, it could never be adequately reproduced in a new listening space. He contended:

> The listener is conscious not only of the characteristics of the sound but also of the room in which he is listening to the sound. This means that to recreate accurately a sound field around any individual listener the pattern of standing waves, their rate of building and decay, etc., must all be accurately recreated according to the size and shape of the original room. It is quite obvious that this objective is impossible, even for one seat in a large theater auditorium, let alone for every seat throughout the auditorium.[870]

As Crowhurst argued, reproducing the acoustical characteristics of the performance hall would be undermined by architectural differences between the performance hall and the playback room. Because the playback room would also have its own unique sonic signature, any attempts to simulate the concert hall's reverberation would cause the sound of this acoustical signature to clash with the playback room's own architectural design. Though in theory the importance of reproducing the room was necessary, Crowhurst believed that in actual practice it was a nuisance. By proxy, formats like four-channel CinemaScope were similarly susceptible to poor acoustical reproductions.

To improve the process of reproducing three-dimensional soundscapes, Crowhurst posited a series of revisions that were needed to improve the way engineers conceive of stereophony, revisions that informed the technical design of Perspecta. In place of prioritizing the reproduction of decay and reverberation, Crowhurst argued that stereophonic engineers should focus solely on the attributes that are key to the reproduction of a three-dimensional sound. "The important thing is to recreate some essential features in the sound field by which the ear is able to identify the sense of direction and the various qualities by which it identifies the other characteristics of interest."[871] He suggested that the most important of these features are "transients," the very first waves that travel from the loudspeakers to the filmgoer's ears. Transients not only cue filmgoers to the sources of the sounds—such as a violin or a voice—but, given the slight difference in time it takes for that first sound wave to travel to our two ears, they also inform filmgoers as to the direction of the sounds. And by prioritizing a sound signal's small transient details, and by deprioritizing redundant information like reverb and decay, engineers can reduce the size of their stereophonic signal before transmitting the three-dimensional sounds from the performance hall to the playback room.

By focusing on transients, Crowhurst also argued that engineers could lower noise levels in select loudspeakers. As was typical of stereophonic sound design at the time, if an actress were speaking in frame left, her voice would play through the left loudspeaker, while a softer and more distant rendering of her voice would play through the other loudspeakers. However, if these decayed signals were too low in volume, the presence of audible hiss would "mar the realism of stereophonic sound."[872] As previously discussed, Fox's solution to this problem was to use a twelve-thousand cycle control tone to turn on and off the loudspeakers situated on the rear and side walls of the auditorium. Crowhurst, however, found this unacceptable, and likened this solution to a public-address system, where the pressing of a microphone button creates a loud hiss and alerts people that an important announcement is forthcoming. Instead of turning on and off the loudspeakers, Crowhurst suggested that this problem could be solved simply by removing low-level reverberation and decay from the playback signal. Not only were these details often marred by hiss and hum when transmitted through loudspeakers, the removal of these details from the mix allowed movie theaters with expansive architectural designs to create their own reverberation effects, those that would not clash with the soundtrack. Crowhurst, in turn, was suggesting that the removal of these redundancies would increase the aesthetic quality of the final three-dimensional soundscape.

Crowhurst would continue promoting these ideas in the years that followed. He famously penned dozens of articles for *High Fidelity* and *Audio* about the virtues of increasing the efficiency of stereo technologies, specifically for use in the home.[873] He also suggested that such theories of auditory compression were not actually new, but merely overlooked in history. As he would later argue in his 1959 monograph *Hi-Fi Made Easy*, the idea of eliminating redundancy from a stereophonic signal was traceable to the sum and difference channels developed by Alan

Blumlein in 1931.[874] And indeed, such sum and difference compression models would go on to inform the designs of later home stereo technologies, namely the quadraphonic stereo systems of the 1970s.[875] But in the early 1950s, the aesthetic value of signal compression still required detailed articulation in order to be accepted by industry engineers, particularly those who anointed the concepts of Fletcher and Bell Labs as the ideals to which any stereo system should adhere.[876] In order for Perspecta's design to succeed, Fine and Crowhurst could not merely state that they were offering Fletcher stereo or four-channel CinemaScope at a lower price. Such statements might insinuate—much as Frayne's statements insinuated—that their system was subsequently of lower aesthetic value. Fine and Crowhurst instead argued that their system comprised a new conception of three-dimensional sound reproduction. It was more than just a less expensive alternative; it represented an entirely new ideology, one that removed the flaws from Fletcher's theories and thereby created higher quality acoustical designs.

Perspecta in Hollywood

The many benefits of Perspecta—including its low material costs, its backwards compatibility, and its promise of higher quality reproductions—were enough to convince Arthur Loew to adopt the format as the studio's proprietary stereophonic technology. In March 1954, Loew's and MGM announced their purchase of a 51% stake in Fine Sound (for a mere $40,000) as well as their dual intentions to begin encoding select CinemaScope titles, including *Knights of the Round Table*, in Perspecta, and to begin licensing the process to other studios through the newly formed holding company, Perspecta Sound, Inc.[877] Thus, unlike PhotoStereo or Panaphonic Sound, Perspecta would become the first alternative to four-track stereo to see its application on a major Hollywood release.

MGM's initial announcement was designed to address any anxiety—particularly among the studios heads at Fox—that Perspecta would in any way cut into four-track stereo's dominance over the theatrical market. MGM and Loew's were one of the first studios to license CinemaScope technology. They were also one of the few studios to not develop their own widescreen formats, such as VistaVision, or WarnerSuperScope.[878] In short, MGM made sure that its purchase of an alternative stereo system adopted a posture of neutrality that allayed Fox's concerns amidst the industry's highly competitive market for new cinema technologies.

MGM therefore clarified that Perspecta would not directly compete with the four-track technology on domestic soil. *Knights of the Round Table*, *Rose Marie*, and their other CinemaScope titles would see single-track Perspecta releases only in foreign markets.[879] MGM's decision was a practical solution to the studio's distribution obstacles. European exhibitors had been particularly slow to install four-track sound systems, thereby creating a bottleneck that made it difficult for MGM's CinemaScope releases to play in stereo abroad.[880] By releasing films in both Perspecta and four-track magnetic, MGM would avoid such a bottleneck and enable its titles to reach a larger number of theaters with stereophonic sound, much as the studio intended. Moreover, MGM indicated that it would use Perspecta in the States only on its non-anamorphic titles—such as *Betrayed* (1954) and *Blackboard Jungle* (1955).[881] Doing so would add more flash to the studio's less spectacular releases, while it would simultaneously increase returns on its investment in Fine Sound by encouraging more screens to install Perspecta integrators.

Initial Success

MGM's unveiling of Perspecta was met with considerably enthusiasm within the foreign and domestic film industries. Major engineering firms purchased licenses to manufacturer and sell Perspecta's integrators to theater chains, beginning with Fairchild Industries and continuing with RCA, National Theatre Supply, Westrex, Altec Lansing, and Ampex.[882] The competition among manufacturers kept installation and equipment costs as low as $850 per screen.[883] The newly formed Perspecta Sound, Inc. similarly began licensing the process to foreign studios—including Italy's Incom and Thetis Films as well as England's Associated British Pictures Corp—licenses further designed to increase the demand for installations of Perspecta integrators.[884]

Other Hollywood studios soon began installing the equipment for use with their non-CinemaScope releases. Shortly after giving up on adopting Panaphonic and its own five-track stereo system, Paramount decided to use Fine's technology for its VistaVision titles, including *To Catch a Thief* (1955), *We're No Angels* (1955), and *Strategic Air Command* (1955).[885] United Artists also licensed the technology for use on their non-anamorphic widescreen releases, including *The Barefoot Contessa* (1954), which was encoded at Fine's New York office.[886] Such demand for Perspecta sound designs was covered extensively by the trades. In the Fall of 1954, *Motion Picture Daily* published a special issue dedicated entirely to Perspecta technology, wherein its editors wrote that that the format "has been so authoritatively accepted by Hollywood," and that it "is making its own significant contribution to the new excitement and interest which surrounds surround motion pictures and in so doing is helping to reclaim the screen's own audience."[887] By and large, the positive trade coverage was validation of Loew's and MGM's investment.

Subsequently, MGM responded to Perspecta's success by breaking its initial promises to Fox. Less than one year following its initial investment in Fine Sound, MGM began licensing the process to Warners and Columbia for specific use on CinemaScope releases including George Cukor's *A Star Is Born* (1954) and John Ford's *The Long Gray Line* (1955).[888] Consequently, MGM began distributing its own CinemaScope films—including *Brigadoon* (1954), *Bad Day at Black Rock* (1955), and *The Prodigal* (1955)—for domestic release in both Perspecta and four-track magnetic.[889] Such decisions now placed MGM's sound system in direct competition with Fox's stereo technology. Moreover, these business decisions proved economically beneficial for the studio. In October 1954, it was reported that close to 700 screens had been wired for Perspecta sound systems—including Radio City Music Hall and Loew's State Theater on Broadway.[890] By the end of 1955, this number would increase four-hundred percent, to more than 2800 screens worldwide, with even more theaters waiting for their integrators to arrive.[891] Indeed, Perspecta's popularity among exhibitors on either side of the Atlantic can be attributed not only to its viability as a low-cost stereo alternative, but also to its acoustical enhancement of standard monaural sound.

Perspecta encoding would even become a site of aesthetic innovation in and of itself. Because the system did not limit its application to optical soundtracks, some producers applied the Perspecta process to magnetic stereo films in order to enhance the types of effects afforded by four-track prints. For the 35mm four-track release of *Around the World in 80s Days* in 1957, engineers encoded three control tones onto the rear-effects track, which increased the number of playback channels from four to six, and which allowed the film's surround sounds to play through either the left-, center-, or right-surround speakers.[892] The film's 35mm release could therefore simulate the acoustical presence of its 70mm six-track road show, despite playing in

theaters with smaller screens. MGM repeated this stereo experiment for *Raintree Country* (1957), a Civil War melodrama initially produced and slated for release in the studio's proprietary 70mm six-track format, MGM Camera 65.[893] Much as the new camera technology replicated Cinerama's expansive screen, MGM's encoding of three rear channels harnessed Cinerama's split-surround aesthetic in order to further punctuate the melodrama's onscreen action.

Perspecta's success in Hollywood was thus not simply due to its backward compatibility and material efficiency. Rather, its encoding process made possible a multi-channel storage system that afforded industry practitioners the opportunity to explore creative uses of stereo that—given the narrow width of 35mm filmstrips—might otherwise be deemed too impractical. Much as Fine established a reputation for innovation in the recording industry, he built a motion picture sound system that was not just economical or ideologically distinct, it was above all a new storytelling tool for motion pictures.

Fine's Decline

Despite these aesthetic benefits, Hollywood stopped mixing films for Perspecta by the end of the decade. Its decline in popularity was the result of legal battles between Fine and Hollywood, as well as an effective campaign on the part of several audio engineers to delegitimize Perspecta's design and its subsequent use in motion pictures. Perspecta's decline revealed a hard truth to Fine; he was an independent engineer in an industry unwilling to relinquish creative and financial control over its products. And when independent engineers sell their technologies and companies to major Hollywood studios, they also hand over their ability to make decisions free from studio oversight. Though the 1953 contract between Fine Sound and

Loew's was initially well-received by the New York inventor, he grew increasingly unhappy with the ways that Loew's was promoting Perspecta throughout the industry. Yet he lacked the ability to stop the business decisions of the company.[894] Nonetheless, rather than passively accepting the consequences of his initial arrangement with the studio, Fine fought back.

In 1956, shortly after Fine's departure from Fine Sound, he waged a civil suit for ninety million dollars against Loew's, MGM, its subsidiaries Fine Sound and Perspecta Sound, as well as Paramount and Warners.[895] Fine alleged that Loew's was in breach of their initial 1953 contract, wherein the studio agreed to market the Perspecta process to Hollywood and split the profits from the venture between Fine and MGM. Beginning in August 1954, however, Loew's began offering free licenses to use Perspecta to Paramount, Warners, and other studios, a decision which increased the status and long-term viability of Perspecta within the industry, but which prevented Fine from receiving royalties from his invention's use.[896] MGM and Loew's responded to the allegations by issuing a countersuit against Fine, accusing him of having violated a non-compete clause in the initial contract when he opened Fine Recording Company and when he began using this company to solicit clients like Mercury Records away from the MGM-controlled Fine Sound.[897] The long legal battle lasted for several years and ended in 1961, when the New York Supreme Court not only cleared the Hollywood studios of any wrongdoing, but found Fine's establishment of Fine Recording in clear violation of his contract with MGM.[898]

The long period of litigation exacerbated any animosity that Fine and the industry had for each other. His invention of Perspecta was initially a means for Fine to join the ranks of other prominent sound engineers in Hollywood, much as Cinerama helped to launch Hazard Reeves's status several years prior. Yet instead of being met with esteem, he was beset with criticism. According to detailed accounts shared between Fox technicians, the industry's top engineers

voiced strong disdain for the Perspecta process. After the first prominent demonstration of the system to studios in April 1954, Lorin Grignon reported to Earl Sponable that he overheard one anonymous attendee ask, "Isn't someone going to say that this is a disgrace to the industry?" while a second one remarked, "It seems like a costly and complicated scheme to degrade sound."[899] As Grignon concluded, whereas there was general praise for the system's cost efficiency, the overall tenor among technicians in the room was that Perspecta was not a step forward but a step backward for motion picture sound reproduction.

Douglas Shearer of MGM appeared especially resentful of his studio's decision to adopt Fine's invention. Loew's investment in Perspecta occurred while Shearer was developing his own 35mm optical stereo system, one that featured three variable-area tracks squeezed into a 150-mil column of space next to the picture track.[900] The technology was based off a three-channel Omni-Dimensional Sound system invented by Robert Stephens, an independent manufacturer and former sound technician at MGM.[901] During the 1930s, Stephens was one of several engineers who helped build the studio's famed Shearer Two-Way Horn.[902] And in 1953, Stephens was hoping to sell his former employer on his latest invention: affordable stereo. Loews passed on the three-track system, but this rejection did not deter Shearer from continuing to promote the technology to his colleagues in Hollywood. Following Fine's January 1954 demonstration of Perspecta in MGM's screening room, Shearer offered an impromptu presentation of his own three-track system.[903] Though short, the presentation appeared to fuel additional ill-will toward Fine, with Sponable later confiding to Grignon that despite MGM's decision to adopt Perspecta, Shearer's stereo system sounded "a lot better."[904] This resentment toward Perspecta undercut Fine's ability to ever become part of Hollywood's elite club of sound

engineers. As a result, Fine chose to stay in New York, where he remained far away from the day-to-day decisions surrounding Perspecta stereo.

Fine's stay in New York meant that he was not actively promoting Perspecta at industry conventions, nor was he making sure that producers were understanding the potential aesthetic value of the system. By the time that the New York Supreme Court issued its ruling on the Fine-MGM feud, Perspecta had thus lost most, if not all, of its appeal among studios and theaters. The number of installations was decreasing each year. As larger palaces were renovating their screens for 70mm prints and six-track stereo formats—such as Todd-AO, Super Panavision, and MGM Camera 65—there were fewer incentives for smaller theaters to install Perspecta integrators in an attempt to offer the highest quality sound systems in their respective regions. Despite its benefits, single-track Perspecta arguably paled in comparison to six-track magnetic stereo.

Where Perspecta continued to thrive was in foreign markets, particularly in Japan, where there were fewer 70mm screens. The country had shown considerable enthusiasm for the technology during its initial rollout in the mid 1950s, and during the early 1960s Japanese studios were still releasing titles with Perspecta sound, including *Kwaidan* (1964) and Akira Kurosawa's *High and Low* (1963) and *Red Beard* (1965).[905] Yet despite such international popularity, Fine had already turned his attention back to the recording of concert music, while MGM focused its attention to releasing films in six-track sound for 70mm venues. As a consequence, the push within the industry to produce films in affordable optical stereo formats slowly waned.

"Pseudo Stereo"

The ill-will between Fine and MGM illustrates how Perspecta was facing death by a thousand cuts, for there was a concerted effort on the part of several industry engineers to

undermine the system's added value to motion pictures. To those like Shearer and Grignon, Perspecta was not actual stereo, but merely an illegitimate substitute. Fletcher's three-speaker sound system was stereo. Likewise, Cinerama's seven-track technology was stereo. Perspecta, accordingly, could only simulate such true stereophonic sound reproductions. As a result, it was treated like a virus within Hollywood, one that was blamed for as eating into true stereo's market potential. By the end of 1956 roughly 75% of theaters (17,591 screens) had installed CinemaScope lenses, whereas only 4609 screens of these screens installed four-track stereo.[906] The remaining theaters, many of which were smaller venues, were saving money by only offering audiences single-channel sound. Perspecta was blamed for such lens-only CinemaScope installations. Fox engineers therefore felt they needed to eradicate Perspecta from Hollywood if multitrack magnetic stereo were to remain a viable theatrical format for motion picture audio.

To do so, engineers began calling Perspecta fake, ersatz, or pseudo stereo. As Grignon argued to Sponable in May of 1954:

> Perspecta sound has frequently been referred to as a stereophonic sound system. No single-track system, optical, magnetic, or disc, can be a stereophonic system; at best it can be a pseudo-stereophonic or directional system. Stereophonic recording and reproducing demands, by the very nature of the method, at least three separate and distinct records.[907]

Grignon's use of "pseudo-stereophonic" was likely a reference to a paper that was delivered to the Pacific Coast Section of the SMPTE the previous year, titled "Stereophonic and Pseudo-Sterophonic Sound in Motion-Picture Production."[908] Its author, veteran Bell engineer William Snow, set out to define the differences between true stereo—as based upon Fletcher's principles of auditory perspective—and stereo simulations—those that used changes in intensity and phase delays to create multi-speaker sound designs without the use of multiple soundtracks. Snow's paper was an attempt to provide clarity to ongoing discussions about multi-channel audio in

Hollywood. As Grignon's statement to Sponable indicates, however, Snow's concept of pseudo stereo also helped to articulate a line of attack that would be launched against Perspecta to delegitimize its design throughout Hollywood.

Following the extensive coverage of Fine's system in the trade press, coverage that had been generally positive due to its reliance on MGM press releases, Grignon and Sponable wrote to reporters to refute their coverage, and to ostensibly educate the journalists about stereophonic terminology in a manner that would encourage more a negative framing of Fine's invention.[909] They took issue with claims that Perspecta's optical soundtracks were of commensurate quality to magnetic soundtracks. They also took issues with the notion that Perspecta was cheaper than four-track, being that both systems required the installation of at least three costly loudspeakers. Of specific concern to Grignon and Sponable were claims that Perspecta met the definition of true stereophonic sound. For Fox engineers, these statements were inaccurate and needed to be corrected in future articles.

Whether or not they took Fox's criticisms seriously, the trade press nonetheless echoed Fox's criticisms of Fine's invention in their weekly coverage of motion picture technology. Some reporters began lodging subtle attacks against Perspecta. *Motion Picture Daily*'s George Schutz, for instance, wrote that Hollywood "has but recently entered upon its use, experimenting, sometimes resorting to new and tentative tricks of pseudo-stereophonic. […] The simple commercial fact of stereophonic sound is that it is better than one-channel sound."[910] Other trades were less cautious about describing Perspecta as a pseudo-stereophonic system, though they nonetheless found other ways of describing Perspecta of lower value. *The Hollywood Reporter*, for instance, characterized Perspecta as "the first serious threat to 20th-Fox's four-

track magnetic tape stereophonic sound system," but argued that Perspecta was not stereophonic sound but merely "watered down" stereo.[911]

More commonly, trades began using the term "directional" in place of stereophonic. When MGM, Warners, and Paramount were fighting with Fox for control over European theaters, reporters for *Variety* remarked that the "competitive battle between Perspecta optical directional sound and magnetic stereophonic sound is raging abroad."[912] Similarly, they noted that how studios were not distributing stereophonic prints in Europe, "with Metro, Warner Bros. etc. sticking to Perspecta-Sound which achieves a directional sound effect via an optical track."[913] And during the prolonged legal battle between Fine and MGM, *Variety* even used parentheses to distinguish Fine as the "inventor of the Perspecta (directional) sound system" and not the inventor of the Perspecta stereophonic, or (stereophonic), sound system.[914]

The qualification that Perspecta was merely a directional technology, and not a stereophonic technology, was repeated even in *International Projectionist*, the official trade paper for Hollywood's projectionists' unions. The monthly magazine was a routine opponent of new theatrical media that would require massive technological changes to theaters and projection booths, often at the expense of projectionist labor. It therefore was telling that a paper with such animosity toward stereophonic sound would nonetheless adopt the status quo and appear defensive of four-track stereo when confronted with a low-cost alternative like Fine's single-track system. In an article titled "Perspecta Sound Operation Data," writer Mark Stephens noted that CinemaScope's four-track magnetic stereo "is capable of true stereosound because it makes use of three (sometimes four) independent sound recordings."[915] In contrast, Stephens all but condemned Fine's system and its sound track aesthetics. Perspecta's "so-called 'stereophonic' sound heard in theaters is a purely synthetic product. It is 'faked' during the re-recording

procedure to produce only the *effect* of natural stereophonic. The reproduced sound is directional, but it is not truly stereophonic."[916] Further, "Perspecta sound is recorded in the usual single-channel manner, and it does not require a directional quality until the single soundtrack is 'doctored' during re-recording."[917]

Stephens's criticisms toward Perspecta's three-dimensional soundscapes recall similar debates about the value of depth to other facets of filmmaking, namely deep-focus cinematography. As David Bordwell documents, Gregg Toland achieved great renown for reproducing impressive depth-of-fields on motion pictures like *Citizen Kane* (1941), but his work has since undergone careful scrutiny, for many of *Kane*'s deep-focus spectacles were created not in-camera but through composite photography and other optical effects.[918] Fine's means of cheating or "doctoring" what the industry defined as true stereophony is thus a similar example of how the reproduction of depth was something that was highly regarded for much of the studio era; any attempts to cut corners invited criticism, if not also admonishment. Indeed, the idea that Perspecta's stereophonic reproductions are faked and doctored suggests a moral position toward the Perspecta process, whereby Perspecta lies to its audiences by counterfeiting the indexical nature of motion pictures.[919] Through the widespread application of terms like pseudo stereo, directional sound, and even faked or doctored stereo, the illegitimacy of Perspecta was codified as an accepted truth throughout the industry.

In concert with the rest of the industry, studios that licensed the technology from Loew's also avoided the term stereophonic when promoting the sound system's aesthetic capabilities. Paramount, for instance, simply dubbed their Perspecta releases as featuring "dimensional sound."[920] The moniker enabled the studio to make reference to the sound system's three-dimensional acoustics, without directly comparing such soundscapes to those created by four-

track releases. Historian Jean-Pierre Verscheure specifically notes that the format's potential for dimensional acoustics were prominent throughout Paramount's promotional material for *The Man Who Knew Too Much* (1956), a VistaVision thriller which used the audio technology to punctuate the film's iconic cymbal crashes.[921] Indeed, in the wake of Hollywood's first major foray into three-dimensional images, Paramount's ability to call their soundtracks dimensional enabled the studio to further suggest that their films, not unlike CinemaScope releases, offered the sensation of three-dimensional effects without special glasses. It also avoided public debates with Grignon and Sponable about whether or not VistaVision titles were featuring true or pseudo stereo designs.

The biggest blow to Perspecta's reputation, however, was from Fine's former employer, Hazard Reeves. In a 1954 interview with *Variety*, the highly esteemed Cinerama mogul argued that single-track optical sound could never be stereo. Whereas magnetic recording offers an expansive acoustical range from stereophonic reproduction, "optical reproduction is mediocre at best. […] You can't expect to put three speakers behind the screen and automatically come up with stereophonic sound."[922] For Reeves, stereophonic sound was contingent upon a form of three-dimensional audio that could only occur with multiple tracks and wide-range acoustics. And Perspecta, being an optical technology, was unable to reach the same wide-range frequency characteristics of four-channel CinemaScope and other magnetic technologies.

Reeves's charges against Perspecta were damning, and his stating them in public indicated to onlookers that Fine's system was of such poor quality that even his friends were unwilling to support it. As a result of these public attacks, Fine mounted a response in *Variety* that following May.[923] In it, he stood firm by his earlier statements to the industry that his system was acoustically indistinguishable from four-track sound. He nonetheless continued to contradict

this very defense when addressing Reeves's claims about optical and magnetic frequency characteristics. Fine acknowledged that optical sound is perhaps of lesser quality, but that this was not the fault of his stereophonic process. Rather, it was the fault of studios for continuing to adhere to Academy mono as the standard for motion picture soundtracks. "Optical Sound," Fine argued, "is not currently being reproduced to the range it has."[924] He surmised that the best solution to solve Perspecta's limitations should not be to reject the technology, but to adopt a new playback standard for optical mono across the industry. The studios did not take Fine's suggestions seriously. Instead, they ostensibly left Fine out in the cold, where he was forced to admit to the entire industry that his system was indeed of inferior acoustical quality, thereby lowering its financial value to exhibitors.

In the end, there was little Fine could do to defend himself against these attacks. The discursive battles surrounding Perspecta left many industry leaders convinced that there existed a stable and coherent definition of stereophonic sound, one in which four-track magnetic was true stereo while Perspecta was pseudo or fake stereo. Of course, there was no institutional law mandating that stereo required multiple tracks sent to an equal number of loudspeakers, nor was there any law of physics suggesting that three-dimensional sound required multiple channels. Technically speaking, sound—being mere waves of air—is always three-dimensional, even when transmitted through the small horn of a wax record. Nonetheless, the industry accepted the idea that there was true stereo as well as pseudo-stereo imitators by proxy. Despite Fine's and Crowhurst's attempts to sell their system as a technological improvement over four-channel CinemaScope, Perspecta could never be higher quality because it failed to meet the arbitrary specifications for proper three-dimensional sound as promoted by Grignon and his colleagues. Though initially praised throughout Hollywood, there were enough studios heads and engineers

with financial stakes in magnetic stereo systems to make sure that Perspecta would never become a viable format.

Single-Track Stereo Aesthetics

There was an irony to the way that Grignon, Shearer, Reeves, and their colleagues worked to undermine Perspecta's value to the industry. As I detail in the preceding chapter, Fox rarely included perceptually salient stereophonic effects in its early CinemaScope releases. Instead, the studio recommended that mixers hide the stereophonic technology from audiences. Such tactics were implemented in response to triple-track's many acoustical problems, and the way these mishaps distracted audiences from paying full attention to films like *House of Wax*. Though four-channel CinemaScope mixes were capable of including all sorts of three-dimensional audio effects that Perspecta was not able to achieve, most four-channel titles during the mid-1950s deployed subtle stereo effects, such as the quiet atmospheres in *House of Bamboo*, those which kept audiences attuned to the film's story.

Perspecta, in contrast, was anything but subtle or inaudible. Because it was a single-track system, it required more aggressive mixing techniques in order to create its stereophonic effects. And these techniques called a great deal of attention to the multi-speaker technology and the many ways it can enhance a film's narration. The irony was thus as follows: though Fox attempted to lower the value of Perspecta technology, Perspecta's more noticeable stereo effects questioned the value of Fox's conservative approach to multi-channel mixing.

The differences between Perspecta releases and Fox's four-channel releases were related to the types of effects heard in the theaters, as well as the types of scenes that received these effects. In general, four-channel releases used proportional effects as a means to further

punctuate musical numbers, action sequences, and other scenes of cinematic spectacle. Perspecta releases were different. Indeed, by analyzing the control tone for two surviving Perspecta soundtracks—*Forbidden Planet* and *Silk Stockings*—I draw two conclusions about the format's aesthetic. First, Fine's single-track technology encouraged technicians to create directional effects as much as proportional effects. Second, it encouraged technicians to deploy such effects not only during the film's more visually spectacular sequences, but during conversations and other sequences that were often less ostentatious.

Case Study: Forbidden Planet

Forbidden Planet's sound design serves as a useful example of such directional aesthetics and their narrative functions. MGM's space melodrama tells the story of an astronaut crew from Earth, who land on planet Altair IV to rescue members from an earlier scientific expedition, and who find themselves hunted by an unknown and invisible creature that inhabits the planet. The film was part of the larger science-fiction cycle in the 1950s that began with releases like *Destination Moon* (1950) and *The Day the Earth Stood Still* (1951), and that continued with *War of the Worlds* (1953), *It Came from Outer Space* (1953), and *Invasion of the Body Snatchers* (1956). *Forbidden Planet*'s distinction within this cycle was its reliance on popular psychoanalytic concepts, such as the subconscious and the id, as well as for its strong similarities to Shakespeare's *The Tempest*. It was also distinct for its experimental sound design. The science fiction melodrama was among the first films to feature a completely synthesized score in place of traditional orchestral music. As a result, the film's experimental soundtrack—composed and performed by avant-garde musicians Louis and Bebe Barron—blurs the ontological line between what is non-diegetic musical accompaniment and what is a mere diegetic sound effect. In so

doing, it creates an auditory puzzle for attentive filmgoers to solve when watching the motion picture.

The film's Perspecta design further enhanced the strangeness of its soundtrack. As critic Rick Mitchell wrote in response to hearing the film play through Fine's technology:

> On the whole the presentation resembled the results of putting a mono track through a good stereo synthesizer, however in dialog scenes where attempts were made to position the dialog on the screen with the actor speaking it, rather incongruously the entire track, including production effects and ambience would also jump from speaker to speaker![925]

Indeed, because Perspecta integrators could not separate dialogue from effects once each element was mixed together, the individual sounds were forced to play and move together when panned to individual speaks. As a result, when lines of dialogue panned between the left and right sides of the theater, so too did the film's other soundtrack elements.

A sequence that would have no doubt caught Mitchell's attention occurs toward the end of the film, when Commander Adams (Leslie Nielsen) explains to Dr. Morbius (Walter Pidgeon) that his educational machine is transforming his subconscious desires into a villainous creature. At various points throughout the conversation, the characters speak from opposite sides of the frame, leading Perspecta's control tones to direct their voices to the left, center, and right loudspeaker channels in correspondence to their on-screen location. At the scene's mid-point, however, Robby the Robot walks into the frame's background. He remains relatively motionless and quiet as he listens to the two men talk, but the spinning motor on his forehead is audible on the soundtrack. Thus, when the dialogue pans back and forth between the left and right loudspeakers, Robby's motor also pans back and forth. In turn, the scene calls greater attention to the robotic noises as well as to the stereophonic technology.

Such acoustical effects continue to occur later on in the sequence, as Adams, Morbius, and Alta (Anne Francis) all hide from Morbius's "id monster" beyond the locked doors of the engine room. During this scene, the characters confront each other over whether it is actually possible for Morbius's id to be made manifest into a living and breathing monster. To accent the dramatic qualities of the dialogue, the Barrons underscore the conversation with pulsating electronic frequencies, not unlike the quivering sine waves that comprise the film's opening titles. And as the Perspecta integrator directs the characters voices to different loudspeakers, it also pans these musical gestures to different speakers. Indeed, the scene's Perspecta design enhanced the avant-garde nature of the score for those audiences who heard the film play through Fine's sound system. In addition to the strange timbres, the music routinely bounced between the left and right side of the theater in defiance of traditional Hollywood norms.

In his comprehensive study of the score, historian James Wierzbicki notes that—intentionally or not—the music largely works to conceal the many artifacts of the film's B-movie origins. He cites the story's frequent continuity errors, the many technical gaffes involving lighting and camera work, and he goes on to cite Steve Rubin's critique that the final edit at times feels more like the rough cut than a finished product. According to Wierzbicki, "If audience members overlook the film's many rough edges, it is likely because they are smoothed over by the score."[926] Yet the Barrons' score adds more than simple aesthetic repairs to the film's production. It also adds a mysterious texture to the titular planet, one that perhaps invites filmgoers to ask questions about Altair IV's atmosphere beyond those posed by the visuals.

When the spaceship first lands on Altair's surface, the soundtrack includes glissandos, high-frequency hiss, and electronic howls. The scene evinces Wierzbicki's claim that, "throughout *Forbidden Planet* the audience member is made to wonder, especially at the onset of

a cue, about the source of what is being heard."[927] Indeed, it is unclear if those electronic howls are merely part of the underscore, or if they are stemming from an off-screen animal who is hunting the characters from afar. Such ambiguity, in turn, works as an extension of the broader enigmatic motifs woven into the film's narration. Just as there is a puzzling ambiguity about the ontological state of the monster (a real creature or a figment of Dr. Mobius's subconscious), so too is there ambiguity about the sound effects (non-diegetic commentary or noises that are audible to the characters).

The Perspecta design of the film builds upon these deliberate ambiguities through the application of directional effects. For example, after the invisible monster breaks through the electronic perimeter that surrounds the planet's base camp, we witness its footsteps in the dirt as it steps toward the spaceship. Later, as the monster ascends the ship's steps, we see the metal stairs bend, as if suppressed by the weight of the large and mysterious creature. The music that accompanies its footsteps are a similar set of electronic pulses that underscore the conversation in the engine room. More consequently, the Barrons punctuate each footstep with a low-frequency "whoomp" that plays in synchrony with each step. As is the general rule throughout the film, it is unclear if these whoomps are examples of the Barrons creating musical cues intended merely to accent the onscreen actions, or if these whoomps are indeed the noises made by the footsteps. In either case, the score is alerting filmgoers to the dangers that lurk outside of the spaceship.

Nonetheless, there is ambiguity as to whether or not the sounds are also audible to the onscreen characters, thereby alerting them to the monster's presence. Interestingly, the whoomps play from different loudspeakers throughout the scene, first from the left loudspeakers, in accordance to the footsteps' presence in frame-left, and then to the center and right loudspeakers

as the footsteps travel to the other parts of the frame. Because the whoomps are inseparable from the musical pulses that also underscore the scene, both types of sounds move together throughout the scene to different locations within the theater. The stereo effects therefore create a diegetic unity through their directional alignment. That is, as both sets of sounds move together as one unit within the theater, then by convention they are coming from same source within the film's story. Accordingly, the monster is not only creating loud footsteps as it walks, but emitting musical noises as well.

Typical readings of *Forbidden Planet* suggest that the musical sound effects in the film are designed to express the plot's gradual descent into a mysterious paranormal world, one run by "id monsters" and governed by logic foreign to Earth's sciences. Wierzbicki specifically argues "Just as the absence of music suggests normalcy at the start of four of the six acts, the presence of music at the end of all six acts suggests a day-to-day progression toward the abnormal."[928] Perspecta enhances this reading. As the film progresses from normalcy to the abnormal, the stereo technology also increases the number of directional effects, which in turn provides filmgoers with more and more hints as to the location and source of the mysterious sound effects. The film's Perspecta design therefore becomes part of the broader techno-sonic logic of the film.

That said, such readings of the film's use of playback technology would have only occurred in Perspecta theaters, not in the more commonly attended monaural theaters. In sum, filmgoers may have left screenings of *Forbidden Planet* with completely different interpretations of the soundtrack's greater narrative function based upon the stereo technology being used in each movie theater. Perspecta's directional effects were constructed in a manner that invited

audiences to pay greater attention to the many auditory puzzles present throughout the film and, by proxy, to the theater's multi-speaker sound systems.

Case Study: Silk Stockings

In addition to Perspecta's integration of audible directional effects, MGM's use of the sound technology also deviated from the traditional conventions concerning which scenes received the stylistic emphasis. Whereas it was typical for sequences linked to visual spectacle to receive the greatest amount of stylistic experimentation—usually camera movement, color, and staging—with Perspecta tracks, the technology's constraints encouraged technicians to add stylistic emphasis to sequences that were generally less visually ostentatious.

MGM's *Silk Stockings* is one of the clearest illustrations of this pattern. The musical was based upon Cole Porter's 1955 Broadway show, itself an adaptation of MGM's Ernst Lubitsch romantic comedy *Ninotchka* (1939). And like the stage musical, the film depicts the humorous courtship between American film producer Steve Canfield (Fred Astaire), who hires a Russian composer to score his latest picture, and Russian government operative Nina Yoschenko (Cyd Charisse), who attempts to bring the composer back to Russia after he decides to defect. The musical satirizes both capitalism and communism during the early years of the Cold War, and given Canfield's role in Hollywood, this film's playful commentary largely takes aim at the market value of 1950s cinema technologies, as well as at the Hollywood moguls who promote such technologies, namely Fox chief Darryl Zanuck.

Such capitalist ideologies are explicitly articulated in the film's iconic "Stereophonic Sound" number.

> Today to get the public to attend a picture show,
> It's not enough to advertise a famous star they know.

> If you want to get the crowds to come around,
> You've gotta have glorious Technicolor, breathtaking CinemaScope,
> And stereophonic sound.
>
> If Zanuck's latest picture were the good old-fashioned kind,
> There'd be no one in front to look at Marilyn's behind.
> If you want to hear applauding hands resound,
> You've gotta have glorious Technicolor, breathtaking CinemaScope,
> And stereophonic sound.

The number is sung by Canfield and Hollywood starlet Peggy Dayton (Janet Paige), and performed for a crowd of film critics wanting to hear more about Canfield's latest picture. During the sequence, the film's audiovisual design adds further embellishment to the number's commentary on new cinematic technologies. As Canfield and Dayton sing and dance, they at times perform together in a long shot from opposite sides of the screen, highlighting the immense distance between sides of the CinemaScope picture. And when Canfield and Dayton sing about stereophonic sound, their voices are sweetened with added reverberation. The acoustical effect highlights the three-dimensional nature of multi-channel audio, and it playfully pokes fun at the way in which surround sound is most often used to create echo during musical performances. The song is thus a moment of salient reflexivity wherein we are asked to pay attention to the many stylistic devices that will be used throughout the film—both to add excitement to the narration and, cynically, to increase the movie's box office returns.

With respect to the film's use of stereophonic sound, however, *Silk Stockings* was distributed to theaters in a variety of audio formats. MGM released a standard monaural optical mix for prints sent to smaller, neighborhood theaters. The studio also released to larger venues two different stereophonic mixes: one for four-track magnetic stereo, and one for single-track Perspecta stereo. In turn, the song's titular stereophonic effects differed from theater to theater. And much like in *Forbidden Planet*, the Perspecta design encouraged a unique reading of the

film's narration as a result. Whereas the four-track mix arguably contradicted and clashed with the message within the film's opening number, the Perspecta mix provided an alternative sound experience.

The film's four-track magnetic mix was similar to the types of CinemaScope designs being produced at Fox. This resemblance was largely due to the film's narration, which followed the typical plot structure of a Hollywood musical. Songs were interspersed throughout the film at semi-regular intervals, often providing visual and auditory contrast to the less fantastic dialogue sequences. The four-track mix merely reinforced this structure. Every scene played from the screen speakers; music and effects played through the left, center, and right, whereas dialogue generally playing through only the center speaker. Like all other stereophonic pictures recorded at MGM at the time, dialogue was recorded on one track as opposed to three.[929] Moreover, the screen channels were stylistically consistent throughout the film, regardless of whether or not the sequence was a musical number or a conversation scene.

The sound design provided the film's stereophonic emphasis through the absence and presence of rear effects. During musical numbers, the rear channels were activated to add such acoustical details as orchestral accompaniment and—as promised in the "Stereophonic Sound"—extra reverberation. The rear loudspeaker therefore punctuated moments when the musical moves from the diegetic setting to what Rick Altman calls the "supra-diegetic" space, a fantasy world where onscreen characters hear and interact with the musical score.[930] As is typical of the genre, such supra-diegetic spaces are conveyed to audiences through various acoustical cues, including an increase in volume and a temporary widening of frequency characteristics. With four-channel stereo, the presence of the rear channel offers one more cue to audiences that the film has moved from the diegetic to the supra-diegetic.

One vivid example occurs when Dayton performs "Satin and Silk" while trying on expensive evening wear in front of Russian composer Peter Illyich Boroff (Wim Sonneveld). Throughout the number, Dayton succeeds at convincing the former communist of the merits of a consumer-driven lingerie market that privileges seductive excess over modest, utilitarian fabrics. As she undresses and caresses the shy composer, for instance, she sings:

> You cannot expect a burlesque queen to cherish further hope,
> If her bra is made of buckram and her G-string is made of rope.
> But she knows 'cause she has traveled miles
> She can always lay 'em in the aisles,
> If she's wearing silk and satin, she can flatten any Latin.
> If she's wearing silk and satin, satin and silk.

Audiences watching the humorous number in monaural theaters would have heard the song's raunchy lyrics as well as the symphonic score that accompanies Dayton's performance. They may have also noticed the slight increase in the volume of Dayton's voice when she begins to sing—an artifact of the scene's dialogue being recorded on the set and the song being dubbed on a different production stage. However, they would have heard all of this information from a single playback channel located behind the screen. In venues playing the film's four-channel magnetic stereo mix, audiences would have heard the entrance of the song differently. Not only would the acoustical characteristics of Paige's voice change, the orchestra would begin to play from loudspeakers on the rear and side walls of the theater. In so doing, the surrounds simulate the types of reverberation effects that audiences might hear in an expansive concert auditorium.

Though such rear-channel effects in *Silk Stockings* were limited to the film's music, their aesthetic was largely in keeping with the kind of effects heard in CinermaScope releases like *House of Bamboo*. In both films, the rear channel is activated during changes between scenes, often to emphasize genre characteristics. Whereas in *House of Bamboo* the rear effects punctuated the move from melodramatic sequences to scenes designed with a documentary

aesthetic, in *Silk Stockings*, the rear effects accentuated the move from diegetic settings to supra-diegetic spaces. In effect, the musical's use of four-track stereo functioned as a form of stylistic redundancy. Being that many filmgoers would only hear the film in monaural theaters, and would therefore be unable to hear any sounds emanating from the rear channels, the information stored in the rear channel needed to be inconsequential to following the plot. In turn, it merely replicated the other stylistic decisions within the film—including choreography and soundtrack volume—that guide the audience to pay attention to dramatic details. In this case, the four-channel stereo technology worked to guide filmgoers to the musical numbers, and it did so with the very reverberation effects that are ridiculed throughout the movie's most iconic songs.

The Perspecta release of the film was similar to its four-track mix, at least to a certain extent. Though Perspecta prints could not offer surround sounds, they nonetheless created proportional effects during musical numbers by opening up the mix from one or two screen channels to all three channels, and by increasing the amplitude of the control tones in order for all three channels to play at louder volumes. Such effects were thus similar to those heard during Warners' Vitasound releases, where the soundtrack would suddenly play from three loudspeaker channels during more spectacular sequences, such as the aerial battles in *Dive Bomber* or the symphonic performance in *Four Wives*. In this respect, Fine's claim that his sound system was not very different from other stereo formats was a fair characterization. The soundtrack increased in proportion during select sequences, not unlike stereo release of the 1940s, and not unlike four-track stereo releases during the 1950s. Without the addition of rear channels, however, Perspecta's volume boosts were limited to the screen channels only. Its punctuations of *Silk Stockings*'s musical numbers were therefore subtler than were those offered during four-track presentations of the musical.

In lieu of emphasizing musical numbers, Perspecta prints largely punctuated the film's less spectacular sequences, such as the flirtatious conversations between Canfield and Yoschenko after the two first meet each other in Yoschenko's hotel room. Both characters speak to each other at times from opposite sides of the frame, and as a result their voices pan back and forth between the left and right sides of the theater. The scene's Perspecta design, however, does not pan the dialogue merely between the left and right loudspeakers. Both Canfield and Yoschenko move throughout the frame, causing their voices play through the center channel as much as from the sides. The scene's sound design therefore is about the movement of sounds in general. And because the preceding conversation between Yoschenko and her three envoys is mostly kept in the center loudspeaker, the sudden change in stereo design once Canfield enters the room creates an audible contrast that punctuates the flirtatious conversation that ensues.

Similar instances of this type of punctuation occur throughout the film. For instance, after Canfield and Yoschenko dance together following a performance of "All of You" they both lounge by the fireplace, with Canfield in frame-center and Yoschenko in frame-right. Much as before, their voices travel back and forth between center and right loudspeaker, a notable contrast to the previous dance number in which the music plays from all three loudspeakers concurrently. As a result, the Perspecta sound system became a way for MGM to turn a visually banal conversation into a moment of auditory excitement just before the characters shared their first onscreen kiss.

The film's Perspecta design was therefore quite different from its four-channel mix. Instead of focusing solely on musical numbers, Perspecta's directional effects were deployed to a wider number of sequences, those of romantic courtship and flirtatious banter. And in a romantic comedy like *Silk Stockings*, such scenes between the two leads are perhaps just as important, if

not more so, to the development of the plot. Further, this unique stereo design potentially changed the meaning of the film. By focusing on reverberation effects, the four-channel mix punctuates the very stereophonic sound aesthetics being satirized in the film. Although *Silk Stockings* is meant to critique Fox's stereophonic aesthetics, its four-channel design's adherence to such aesthetics undermines this critique, and thereby turns the film into just another punchline woven into the satirical storyline. In contrast, the Perspecta design accentuates dialogue over spectacle, or talk over technology. It showcases a different kind of stereophonic emphasis, one which is not ridiculed by the film's lyrics. This stereo design encourages audiences to read *Silk Stockings* less as the butt of a reflexive joke, and more as a tasteful aesthetic alternative to the inferior soundscapes being produced at Zanuck's studio.

As *Forbidden Planet* and *Silk Stockings* demonstrate, Perspecta designs offered new ways for audiences to engage with cinematic narration. The format's single-track construction specifically required sound mixers to deploy a greater number of directional effects, and apply greater stylistic accentuation to dialogue sequences, in order to showcase its stereophonic capabilities. Because these effects were less likely to be deployed by conventional four-channel CinemaScope mixes at the time, they were more likely to be noticed by audiences. Put another way, a so-called "pseudo" stereo format offered greater acoustical salience and narrative payoff to its soundtracks than did a "true" stereo format. Such aesthetics may then explain why exhibitors like Walter Reade rejected Fox's sound system, and why many other theaters opted for Perspecta as an alternative to four-channel stereo. Fine's system provided theaters with simply more bang for their buck.

Conclusion

Shortly after Fox unveiled CinemaScope to theaters, a number of cheaper systems appeared in the theatrical market in the hopes of replacing four-track stereo as Hollywood's premiere multi-speaker sound technology. Among the more successful of these alternative formats was Perspecta—a single-track technology that privileged acoustical compression and material efficiency over the more conventional ideals that shaped three-dimensional reproductions at the time. Subsequently, Perspecta's adoption by MGM, Paramount, and other studios was met by opposition from many sound engineers within the industry. In order to undermine Perspecta's aesthetic value to motion pictures, these engineers called the format pseudo, ersatz, and fake stereo. As a result, the single-strip stereo technology it fell out of use by the end of the decade.

Whether or not it was fake stereo or simply a different type of stereo, the multi-speaker effects produced through Perspecta sound systems were far more noticeable than four-track's effects were. They were more likely to be integrated into each scene, and—as *Forbidden Planet* and *Silk Stockings* demonstrate—these effects at times changed the meaning of the narrative. In other words, Perspecta's aesthetics called into question Fox's choice to downplay the storytelling potential of its four-channel technology. Such was a serious problem for Fox. If the studio was going to prevent competing audio formats from challenging the necessity of its own stereo format, then it would need to reconsider the ways its system was being deployed in the cinema. In the following chapter, I explain how exactly the studio addressed these competing aesthetic ideals. Despite attempts to undermine the legitimacy of Perspecta, I argue that Fox specifically chose to adopt many of flashy stereo techniques it once shunned as pseudo or fake in order to preserve the market value of its own four-track format.

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Chapter 9: Stereo-Telling, or the Persistence of Mono, 1956-1959

"Faster! … Hit him! … HIT HIM!!!" Artie and Judd slam the pedal of their convertible and speed toward a drunken pedestrian crossing a suburban street. The two boys are ecstatic as they chase the man down. But at the last second, the would-be murderers steer away from the pedestrian, knocking him over as they screech by.

This sadistic joyride serves as the opening hook to Fox's *Compulsion* (1958), a four-track CinemaScope thriller adapted from the popular 1956 novel by Meyer Levin. The story is loosely based on Nathan Leopold and Richard Loeb, two Chicago friends who murdered an innocent boy solely to see if they could thwart capture by police. Like Leopold and Loeb, Artie and Judd (Bradford Dillman and Dean Stockwell) will indeed commit murder during the film, and their playful chase of the pedestrian serves to foreshadow their heinous crime. However, the joyride does not explain why two boys would commit such an atrocious act. Their sadistic games and violent actions remain enigmatic to their friends as well as to the police throughout *Compulsion*. Indeed, why would these two boys take pleasure in killing a child?

The film's first reel presents audiences with one explanation: the boys are sexually aroused by their own acts of violence. As they plow their convertible down the suburban street, for instance, they display eroticism in their faces. Judd, who is behind the wheel, seems turned-on when taking orders from Artie, especially as Artie shouts "Hit him!" from the passenger seat. And after they pull over, Judd leans in and quietly confides, "I'll do anything you say," as if to cement his sexual subservience to Artie.

Interestingly, the rear loudspeakers amplify such physical arousal. After the opening credits, Artie and Judd discuss the thrill of committing a crime and not getting caught. As they

speak, the chirping, buzzing, and mating calls of insects fill the background atmosphere. Unlike conventional sound designs, the pulses of the insects play from the surrounds at a relatively loud volume, preventing the mating calls from being confined to merely background noise. There is also a slight time delay between the front and rear loudspeakers. Each pulse is articulated twice, first from behind the screen, and then from within the theater, as if simulating the dual beats of a heart as it pumps blood through a body. When the rear loudspeakers are turned on, Artie and Judd's physical excitement are expressed through similar sounds pumping through the theater.

This link between surround sound and arousal is further established during the very first seconds of the film, as the two boys crawl out of a fraternity house window carrying a stolen typewriter. The repetition of the insect pulses in the surrounds align their dramatic significance with the illegalities of the two boys. Indeed, the rear loudspeakers not only amplify the film's themes, they invite an additional reading of the film: the boys are like insects, and as such their illicit deeds are driven by subconscious urges and compulsions. As Artie bluntly explains to Judd, he wanted to murder "because I damn well feel like it. That's why." Such surround sound effects are not subtle either. Throughout the film's opening reel, the stereo channels blast a number of noises, including the buzzing of insects, the screeching of the car wheels, and the musical stingers of Lionel Newman's jazz score. Fox's sound technicians wanted audiences to pay attention to the studio's four-track technology, and these many stereo effects that play throughout the opening are striking for being more than just loud noises; they are woven into the film's narration.

Compulsion's aesthetic was arguably very different from the studio's earlier stereophonic mixing techniques. Whereas these earlier titles like *How to Marry a Millionaire* or *House of Bamboo* kept the stereo effects hidden from audiences, *Compulsion* made sure that these effects

were perceptually salient. Sounds that played from behind the audience were now designed to be at the forefront of the audience's attention. In a sense, it was reminiscent of surround sounds heard in Cinerama's road shows, such as the creaking of the roller coaster during *This is Cinerama*, or the roaring of the jets at the end of *Cinerama Holiday*. But such seven-track effects were largely about punctuating onscreen attractions. In *Compulsion*, the stereo effects punctuate moments of narrative importance. This was, by any measure, a new type of multi-channel aesthetic.

Such an aesthetic did not appear overnight, however. Rather, it slowly crystallized over the course of several years. I argue that it was formed in response to the growing skepticism to four-track stereo among studios and exhibitors, a skepticism that was fueled by the high cost of stereo and the success of cheaper alternatives. Though magnetic stereo was of higher fidelity than optical sound, acoustical quality alone was not enough to market the format to exhibitors and filmgoers. Fox needed to make its sound system artistically, emotionally, and financially valuable to its potential customers. And the new stereo aesthetic was Fox's final attempt to boost the market value of its controversial four-track format.

This final chapter of my dissertation traces the many generative mechanisms that pushed Fox to abandon its previous ideals for proper surround sound mixing, and to instead develop a new set of techniques for stereophonic storytelling, what I playfully call "stereo-telling." Its development begins with the creation of mag-optical prints and the many technical problems that beset the studio following the slow decline of four-track motion pictures. It then chronicles Fox's various attempts to change its stereo techniques, including its adoption of a stereo synthesizer and the implementation of a new post-production workflow, one that allowed rerecording mixers to have a greater say in the pre-planning of a motion picture. I conclude this chapter with an

analysis of *Compulsion* and *Journey to the Center of the Earth* (1959), two very different films that illustrate how stereo-telling practices were integrated within the studio's high-profile releases. Through this chapter, I demonstrate that it was not the design of four-track technology that forced Fox to change its surround sound practices. Rather, it was the persistence of mono in Hollywood that forced Fox to produce films in which the four-track technology was so invaluable to the story that filmmakers, exhibitors, and audiences would deem stereo an indispensable component of the cinema.

Magnetic Stereo vs. Optical Mono

The growing resistance to four-track stereo initially led Fox to reconsider the design of its CinemaScope prints. As discussed in chapter seven, four-track magnetic stereo began its tenure in the 1950s with unprecedented success. Unlike earlier multi-speaker systems, the format was quickly adopted by a number of studios—including MGM, Columbia, Disney, and Warners—and was soon used to enhance the sound designs of over a hundred titles. Indeed, the format improved upon triple-track's many shortcomings, and was therefore able to surpass triple-track's popularity among exhibitors. For one, Fox encouraged engineers to design their four-track mixes with subtle stereo effects. The resultant aesthetic reduced the possibility of acoustical mishaps, like those that nearly deafened *House of Wax*'s audiences. Additionally, CinemaScope's picture and stereo tracks were housed on a single filmstrip. This design greatly lowered the costs of material and projection labor, and thereby rendered CinemaScope a more practical investment than its many stereophonic predecessors.

CinemaScope Mono

However, optical mono did not disappear with the advent of magnetic stereo. Many studios continued to release their CinemaScope titles in optical throughout the decade, thereby ignoring Fox's policy of offering films on only four-track prints. There were several prominent reasons that studios preferred optical over magnetic. The process of magnetic striping made four-track prints expensive to manufacture. Similarly, because four-track film degraded faster than optical film, it required a greater number of replacement prints to be made throughout a title's theatrical run. According to Al Lichtman, Fox's Director of Distribution, the costs of supplying four-track prints to theaters was substantially higher than it was for optical prints by as much as $250,000 per film.[931] Though magnetic stereo was of considerably higher acoustical quality, optical mono was cheaper and was thus of greater value to many within the industry.

To address the financial burden of stereo, many studios began supplementing their four-track prints of CinemaScope titles with standard optical monaural prints. Warners became among the first studios to offer multiple formats. For the release of its first CinemaScope production, *The Command* (1954), Warners distributed two different sets of prints.[932] The first set was the standard CinemaScope design, with four narrow stripes of magnetic oxide and with the full 2.55-to-1 anamorphic picture. The second set of prints did not house four magnetic stripes, but instead boasted a standard Academy optical track to the left of the anamorphic image, a design that cropped the picture to a 2.33-to-1 projection ratio.[933] Though the cropping of the picture meant that the film's title sequences and compositions were a bit off-center, Warners nonetheless found the dual-format distribution strategy beneficial enough to reuse it later that year for the Judy Garland musical *A Star is Born* (1954) and the biblical epic *The Silver Chalice* (1954).[934]

Other studios soon followed Warners' lead. By the following season, a handful of titles were being distributed to theaters in either four-track magnetic or Academy optical.[935] They included MGM's *Brigadoon* (1954) and *Bad Day at Black Rock* (1955) as well as Disney's *20,000 Leagues Under the Sea* (1954) and *Lady and the Tramp* (1955). Columbia similarly offered four-track and optical prints for the Glenn Ford western *The Violent Men* (1955) and the Betty Grable musical *Three For the Show* (1955). However, the studio did not distribute optical prints for the initial release of John Ford's *The Long Gray Line* (1955). Instead, and perhaps at the request of the sound-conscious director, Columbia provided theaters with single-track magnetic prints.[936] Such prints replicated the frequency characteristics of magnetic stereo, and at only a fraction of the material cost.

Universal also created dual inventories for their CinemaScope content, but their strategy was even more accommodating than those of Warners, MGM, Disney, and Columbia. In addition to distributing multiple soundtrack formats, the studio offered theaters multiple picture formats. Films such as *To Hell and Back* (1954) and Douglas Sirk's *Sign of the Pagan* (1954) were released with four magnetic tracks on anamorphic prints and with one optical track on special spherical prints.[937] This strategy thereby enabled non-CinemaScope theaters to play Universal's widescreen content without anamorphic lenses

For all of these studios, dual-format distribution soon became the norm. By the 1955 and 1956 film season, Fox's competitors released more than fifty CinemaScope titles on optical prints, as well as a handful that were only offered with Academy mono soundtracks.[938] These optical-only titles included Columbia's *Hot Blood* (1956) and *Storm Over the Nile* (1956), RKO's *The Conqueror* (1956), Warners' *Helen of Troy* (1956), and United Artists's *Trapeze*

(1956). Indeed, for many studios the cost savings of not producing four-track magnetic prints outweighed any benefits of playing these films in surround sound.

At the same time, the replacement of four magnetic tracks with one optical track greatly increased the number of theaters that could play anamorphic releases. By the mid 1950s, there were a host of theater chains that boasted the CinemaScope picture without stereophonic sound. Indeed, with installation costs reportedly between ten- and twenty-thousand dollars per auditorium, it was more than just Walter Reade, Jr. who concluded that four-track magnetic stereo was simply not a worthwhile investment. Theater Owners of America (TOA), one of the largest trade organizations for independent exhibitors at the time, expressed its adamant opposition to Fox's mandate that all CinemaScope lens and screen installations require the addition of a four-channel surround sound system.[939] In addition to its cost, four-track sound was impractical in the industry's smaller venues, as these theaters were in need of neither a volume boost nor a surround speaker placed within inches of a filmgoer's ears. For these screens, standard Academy Mono was simply a better acoustical fit. Though Reade himself owned a number of theaters that could accommodate a massive loudspeaker upgrade, as President of TOA his stance against Fox's policies and his flaunting of a black-market mixer was likely orchestrated to protect the many small exhibitors who would be financially harmed by the upgrades, but who were not powerful enough to mount such a strong challenge against the studio without facing repercussions—namely, being blocked from screening any of Fox's titles.

Like TOA, the National Allied Drive-In Theaters Association similarly found Fox's demands "hostile, monopolistic and unlawful and violative of the spirit and letter of the decrees in the Paramount Case."[940] Like smaller screens, drive-ins had no practical way of installing a surround sound system. The venues, by definition, lacked walls and a roof. For many exhibitors,

the mounting of new speakers around their outdoor arenas was simply a non-starter.[941] At the same time, there was not a practical means of providing cars with portable four-channel sound systems. At best, drive-ins could offer only various forms of three-speaker devices, such as those that were affixed to windshields via suction cups.[942] It is hard to determine just how frequently such portable technologies were ever used, for high fidelity sound was arguably not too important to outdoor exhibitors during the 1950s. Teenagers who frequented the venues during their romantic nights away from home presumably were not parking their cars to experience films in glorious technicolor, breathtaking cinemascope, and stereophonic sound. They were there to neck. Those who instead wished to be enveloped by a soundtrack knew to patronize their local Rivoli, Orpheum, or Loew's.

In view of these concerns, it is not surprising that a number of independently operated theaters scoffed at the opportunity to wire their screens with Fox's pricey four-channel stereo systems. By the end of 1955, more than sixteen-thousand venues had installed CinemaScope screens and lenses (roughly 75% of all theaters). By comparison, however, only about 4,400 of these theaters (roughly 20%) were capable of playing four-track sound.[943] The remaining CinemaScope screens relied upon black-market mixers to play four-track prints, or they relied upon the optical alternatives that were cheaper to produce and easier to project. Despite the many benefits of Fox's single-strip four-track magnetic stereo technology, the majority of the industry saw only the format's costs and failed to recognize its broader potential to motion pictures. To these exhibitors, optical mono was simply good enough.

Mag-Optical Prints

Such attitudes were a serious problem for Fox's executives. They wanted every theater to install four-track and every studio to license four-track. In order to avoid the wrath of their shareholders, Fox needed its hefty investment in sound technology to pay off. Such was especially the case for Fox president, Spyros Skouras. As John Belton argues, Skouras's investment in CinemaScope was a major gamble, one intended to fight off a hostile takeover of the studio by a group of stockholders led by New York appliance wholesaler, Charles Green.[944] In the wake of the Paramount decision and the post-war slump in studio profits, Green was fomenting dissent among fellow investors about the direction of the studio and the strength of its executive board. Accordingly, Skouras's decision to invest in the new CinemaScope format was a strategic decision to ward off efforts to replace him and show his investors that he was capable of pulling the studio out of its financial predicament.

Skouras's gamble paid off in the short-run, for Green's *coup d'état* was ultimately defeated. However, the potential for Skouras to face similar backlash from stockholders remained up in the air. If only 20% of theaters installed four-track sound, and if Fox's four-track prints were not playable in the majority of screens, then Fox was needlessly undermining its own box office profits. The optics of the situation were quite poor, as evidenced by the release of *The Robe*. The Biblical epic had become one of the biggest money-makers ever produced by the studio. And yet following its popular road shows, Fox was unable to milk the title for more money by extending its run into neighborhood screens. The majority of these screens simply could not play CinemaScope prints.[945] Fox was stuck between the proverbial rock and a hard place. Whereas other studios were able to release their CinemaScope titles with optical sound, Fox was incapable of jettisoning their four-track format without revealing to stockholders that it

was a poor investment. At the same time, Fox also could not keep releasing films in four-track and subsequently lose out on potential ticket sales.

Fox's solution to this predicament was curious. In lieu of making a clear decision as to the type of prints they would distribute, the studio opted to address a less-obvious but nonetheless consequential problem: their poor brand identity. The industry's resistance to four-track sound was indeed driven by an anti-stereo ideology, or at the very least, an anti-stereo-pricing ideology. However, as illustrated by the anger among independent theater owners, there was also animosity toward Fox itself. The growing sentiment was that Fox cared more about its own profits than the needs of smaller exhibitors, and as a result many exhibitors were disinclined to buy the studio's sound system. In order to ameliorate such resistance, Fox believed that it needed to improve its reputation as a reliable and trustworthy corporate citizen. The more confidence that exhibitors had in Fox's brand, the more they might trust the studio's rhetoric that four-track sound was a necessary upgrade that improved motion pictures and enhanced their commercial appeal.

The studio commenced this new rhetorical campaign in April 1954 with a public forum that investigated the merits of both monaural sound and four-track stereo.[946] The studio screened reels from several films—including *The Egyptian* (1954), *A Woman's World* (1954), *Broken Lance* (1954), and *There's No Business Like Show Business* (1954)—all before an audience of more than 500 exhibitors.[947] Each excerpt was played twice, once in four-track magnetic stereo and once in standard Academy Mono. The screenings were followed by a discussion of the soundtracks, at which point those in attendance were asked to cast their votes on secret ballots as to whether or not there was a significant difference in acoustical quality between the optical and magnetic formats. The public hearing helped Fox gauge the honest opinions of exhibitors, those

which had been overshadowed by the public protests by the likes of Walter Reade. Arguably, however, it was a promotional campaign designed to convey to the industry that Fox was indeed interested in listening to what customers had to say.

Fox's campaign to win back the support of the industry was nonetheless welcome news for independent exhibitors. Following the forum, the studio announced that by the end of the summer it would begin releasing all of their CinemaScope titles onto three different types of prints: four-track magnetic stereo, single-track magnetic, and single-track optical.[948] Moreover, the optical prints were to be housed on filmstrips with standard KS perforations. The wider perforations and the wider sound track narrowed the width of the picture track from .912 inches to .839 inches, causing the final aspect ratio of the Cinemascope image to shrink slightly from 2.55 to 1 to a new ratio of 2.35 to 1.[949] The KS perforations thus made the picture smaller, but they also ensured that theaters without Scope-optimized sprocket teeth could still play Fox releases; they merely needed anamorphic projection lenses and, in some cases, slightly wider screens.

In contrast, the special single-track magnetic prints would continue to be printed on film with the CS "fox hole" perforations, which allowed them to maintain the preferred 2.55:1 ratio. Though not as popular as optical, the magnetic mono format was a compromise between four-track magnetic and Academy mono. It was designed to encourage smaller theaters to offer the wider frequency characteristics of magnetic sound without extra loudspeakers. These smaller theaters needed only to install new soundheads for their projectors, the cost of which was more affordable than new loudspeakers. Fox's new distribution policies therefore increased the number of theaters that were able to play Fox's CinemaScope titles. More significantly, the announcement worked to portray Fox as a studio that was willing to change its policies in order

to meet exhibitor needs. And if Fox was seen as more trustworthy, then its four-track promotional campaign would perhaps be taken more seriously.

Such at least was the belief of studio heads. In the weeks that followed, Fox reintroduced its four-track stereo system to exhibitors, and reframed the technology as a benefit to everyone, not just Fox's shareholders. Specifically, Fox began inviting exhibitors and journalists to special screenings of a seventy-five-minute instructional film about the virtues of the full Cinemascope package, titled *The Advancing Techniques of Cinemascope* (1954).[950] Narrated by Darryl F. Zanuck, the film discussed the history of cinema technology, with the development of Fox's anamorphic widescreen and stereophonic sound as the pinnacle of such innovations. This history included an in-depth demonstration of the four-track magnetic stereo system, as well as an acoustical comparison between this system and the two single-track alternatives. For example, at one point an actor stood on a large stage and walked across its width as he spoke, allowing the source of that sound to follow him across the three front-loudspeakers. He then compared two different sound designs for a train passing across the Cinemascope frame. One sound design was monaural, the other was stereophonic. Finally, the actor played the sound of a lightning bolt in single-track optical, single-track magnetic, and finally in four-track magnetic. Through such comparisons of the different formats, the film ostensibly told audiences what to pay attention to when listening to a stereophonic motion picture.

The demonstrations were key to the success of stereophonic sound. If audiences and exhibitors could not hear the major and minor differences between four-track magnetic and single-track optical, then Fox's claims about stereo would continue to be read as nothing more than empty rhetoric. Indeed, Fox effectively clarified that there were unmistakable acoustical differences between four-track and single-track, namely that stereo was more pleasurable and

more sensational than Academy mono. The seventy-minute commercial thus argued that four-track magnetic was designed to benefit the entire industry through better storytelling and higher ticket sales.

The studio's new four-track campaign was short-lived. Despite Fox's promotional theatrics, it was unable to deliver on its promise to distribute single-track prints of its CinemaScope content. The studio had announced that it would begin distributing the single-track prints by July of 1954, but reporters noted shortly thereafter that it was slow in making optical prints available.[951] Fox's excuse at the time was that each film's negative was needed to make the four-track stereo prints, those which were being sent to first run houses. In turn, single-track optical prints could only be created once there were enough magnetic prints to cover a film's initial four-track run. By June 1955, Fox agreed to resolve this single-track bottleneck by making duplicate negatives.[952] This way, optical prints could be developed alongside magnetic prints. That following November, however, the trades again reported that Fox was only using the duplicate negatives to make optical prints for the foreign market.[953] Domestic screens that could only play CinemaScope titles in Academy Mono still needed to wait several months for single-track prints.

Though it is likely that Fox initially intended to deliver single-track prints to smaller venues, the costs of managing multiple inventories and distributing multiple prints to different theaters and exchanges became an expensive enterprise. It was specifically reported that Fox was spending more than three million dollars a year just to distribute its films on three different types of prints.[954] It is doubtful that these costs were in any way celebrated by the studio's shareholders. In response, Fox cut back on its optical print production, thus sowing the seeds of

dissatisfaction among the vast majority of independent exhibitors. In effect, the studio's attempt to improve its reputation did not work; ironically, it made matters worse.

Fox nonetheless remained determined to find a means of getting their films into as many theaters as possible. Rather than adopt the expensive practice of manufacturing multiple types of prints, the studio opted for something far simpler. It began distributing its CinemaScope titles on special 35mm prints that housed five different tracks of sound: four magnetic and one optical. Such "mag-optical" prints could therefore hold four-track stereo and Academy mono mixes side by side without the need for dual inventories.

The design of these five-track filmstrips had been finalized and approved by the Motion Picture Research Council in 1955, though the design had several technical caveats.[955] Like four-track magnetic stereo prints, the mag-optical film featured four tracks of magnetic oxide placed on either side of the two rows of CS perforations. But the optical track was different. Much of the space initially reserved for optical sound was now covered by magnetic oxide. As a result, the optical track was reduced to only .038 inches, less than half its original width. This design allowed the aspect ratio of the picture to remain as large as 2.35-to-1, but it added a substantial amount of noise to the Academy mono mix. The inferior quality of the optical track was rarely acknowledged within industry discourse.[956]

Following the Research Council's approval of the mag-optical design, several studios revealed that they would begin using the prints on a number of select CinemaScope titles. Universal was one of the first to announce the adoption of new prints, though for reasons that are unclear, it ultimately never used the new format on any of its releases.[957] Instead, it chose to only release westerns like *Pillars of the Sky* (1956) and *Walk the Proud Land* (1956) as well as melodramas like Douglas Sirk's *Interlude* (1957) and *The Tarnished Angels* (1957) in optical

mono. MGM, in contrast, began using mag-optical prints on CinemaScope titles almost immediately, beginning with the December release of *Kismet* (1955).[958] Already tied to using Perspecta, the studio could now offer both stereophonic sound formats on a single filmstrip without needing to manage which multi-speaker theaters received which multi-channel prints. Fox soon followed MGM's lead. In June 1956, the studio announced that *Bus Stop* (1956) would be its first title distributed on mag-optical prints.[959] Due to equipment delays, however, their first film would actually become *The True Story of Jesse James* (1957), released the following February.[960] For the remainder of that year, and during the many months that followed, Fox distributed all of its films on mag-optical prints.[961]

At first glance, Fox's decision to adopt an all-mag-optical policy appeared to give theaters the license to play its stereophonic mixes in optical mono. When given the option between expensive and inexpensive audio formats, a great number of theaters would no doubt choose the inexpensive format. However, the mag-optical policy was arguably beneficial to Skouras's studio. Fox's four-track CinemaScope prints were now able to play in single-channel theaters. The studio was thus able to expand the number of theaters capable of playing its titles without having to abandon its stereophonic technology, pay for multiple inventories, or admit to shareholders that there were reasons to question its investment in four-track equipment.

Of greater significance, mag-optical prints lowered the playback quality of optical tracks. The tracks were noisier; the upper and lower registers were marred by hiss and hum, while musical numbers and action sequences were rendered acoustically unimpressive. By allowing the optical mixes to sound even worse compared to the four-track magnetic mixes, Fox effectively made it unpleasant for smaller theaters to continue playing CinemaScope titles through only one loudspeaker. Fox's decision was therefore a means to manipulate the stereophonic marketplace.

To theaters, it looked as if Fox was compromising its ideals, when in reality the studio was helping to codify optical mono's poor acoustical quality while simultaneously boosting the value of four-track magnetic sound throughout the industry.

Nonetheless, Fox's scheme, like every prior scheme, failed. When given the option to play CinemaScope content in single-track optical, independent exhibitors indeed played these titles in optical. There was no sudden uptick in the number of surround sound installations.[962] The owners of smaller theaters were not audiophiles, and they did not hold strong opinions about the quality of their acoustical reproductions. Mag-optical prints may have lowered the quality of optical soundtracks, but in the eyes of the industry's stereo hold-outs, the new prints merely allowed smaller theaters to finally screen Fox's latest Marilyn Monroe flick without the need for extra loudspeakers or a black-market mixer. Further, the mag-optical prints made it possible for larger surround sound theaters to play CinemaScope titles without needing to power their multi-speaker sound systems and without needing to pay to have these systems serviced. In effect, the adoption of mag-optical prints encouraged theaters to cut back on the operating costs of their four-channel equipment.

With no guarantee that theaters would play a mag-optical print's four-track mix, producers began cutting back on their stereo output as well. The SMPTE reported that in 1957 several studios specifically returned to producing most of their content solely in mono.[963] MGM, for instance, released only five of their Cinemascope titles in stereophonic sound. Warners released only two films and a total of eight mag-optical films; the remainder were optical only. Columbia, Universal, and RKO released zero films in four-track magnetic sound, while the only film Disney was playing in four-track magnetic was its re-release of *Fantasia*, which premiered in 1956 and which continued its road shows throughout 1957. The adoption of mag-optical prints

was indeed a disaster for Fox. Instead of encouraging more stereophonic mixes and installations, it merely revealed that exhibitors and filmgoers did not care about acoustical fidelity as much as Fox had hoped. The quality differences between magnetic stereo and optical mono were not, by themselves, enough of a marketing factor to prevent four-track to succumb to the same fate that beset all previous stereo formats.

The Decreasing Value of Stereo

Mag-optical's adverse consequences forced Fox to make additional changes to its CinemaScope practices. Because the industry was not impressed with magnetic stereo's acoustical enhancements in and of themselves, the studio needed to drive home the aesthetic value that four-track surround sound added to the filmgoing experience. To do so, the studio focused on the design of its stereo effects. Whereas Fox initially favored mixing techniques that minimized the salience of these effects, such aesthetic ideals would change. The studio's rerecording engineers would now develop sound designs that incorporated noticeable effects and that subsequently attracted more attention to its four-track technology. The logic behind this move was as follows: the greater the presence of stereo in Fox's CinemaScope releases, the more positively audiences would respond to stereo releases, the more commercially valuable stereo releases would become, and the more likely that other studios—not just Fox—would then supply theaters with stereophonic content.

These shifts to more dynamic four-track aesthetics occurred in 1956, with a handful of titles receiving a substantial amount of proportional and directional emphasis. Nunnally Johnson's existential melodrama *The Man in the Gray Flannel Suit* (1956, Fox), for instance, boasts a number of directional sound effects for the many cars and trains that pass by the camera.

The train that takes businessman Tom Rath from Manhattan to Connecticut roars by the camera twice within the first three minutes of the film, each time traveling from the left loudspeaker to the right, and each time growing increasingly louder in volume. Such acoustical accentuation of moving vehicles was a departure from Fox's earlier mixing practices. The many automobiles that populate the screen of *My Sister Eileen* (1955, Fox), for instance, are never directly referenced in the soundtrack, but are instead underscored with generic, asynchronous sounds like car horns and truck engines that are collectively meant to denote busy city streets. The same can be said for the onscreen trucks and trains in the mystery *Ring of Fear* (1954, Fox), most of which are very quiet, kept in the center channel, and often drowned-out by the orchestral score. By and large, Fox's new focus on loud stereophonic effects meant that the roar of passing engines were brought from the soundtrack's background into its foreground.

It also meant that onscreen jokes were rendered with stereophonic emphasis, as is heard during the opening sequence to Frank Tashlin's satirical comedy *Will Success Spoil Rock Hunter?* (1957). The sequence consists of individuals, one-by-one, selling different preposterous products—such as a comb that pulls out women's hair, or a washing machine that refuses to let go of various pieces of clothing. Each cut to a new product repositions the salespeople on the opposite side of the frame. As they speak, their voice then travels the corresponding left and right loudspeakers, creating a noticeable, distracting "ping pong" stereo effect that rerecording mixers often avoided. In turn, the ridiculous nature of this tacky stereo design serves to punctuate each salesperson's attempt to sell an equally ridiculous household item. The effects are humorous because they are perhaps too noticeable. It is as if the characters are breaking the fourth wall to wink at the audience and alert them to stereo's aesthetic potential.

Though the stereophonic effects deployed in these films were more audible than they were in earlier Fox releases, they mostly occurred during the films' opening reels. Once the plots unraveled, the four-track technology was relegated again to the background. As a result, the bulk of these titles sounded more like *House of Bamboo* than *House of Wax*. One explanation for the persistence of such conservative aesthetics had to do with the continued difficulty in recording onscreen performances in three-track stereo. For many engineers, multi-channel techniques were increasingly burdensome. By the mid-to-late 1950s, Fox has slowly begun recording more and more dialogue with only one microphone track. Mixers subsequently let this signal play from only the center channel, with only select dialogue panned to the side speakers.

Such changes to recording techniques were generally credited to the routine difficulty in staging three microphones above the actors. Carl Faulkner, Fox's sound director throughout much of the 1950s, once commented:

> Our sound engineers on production are constantly fighting a battle of microphone placement for the best sound quality. This is caused by set lighting, high front light, dolly and camera crane shots not permitting the free movement of the microphone boom without shadows, thus forcing them into a compromise microphone position.[964]

Other sound technicians echoed Faulkner's complaints. According to sound mixers James Corcoran and Douglas Williams, Fox's decision to slowly decrease its implementation of stereophonic production recording

> was principally brought about by the introduction of handheld cameras, zoom lenses, and extended flexibility in the use of camera dolly shots. It is difficult enough to achieve adequate monaural quality under these conditions let alone the recording of stereophonic sound involving the use of multiple microphones.[965]

Indeed, as the costs of production budgets declined, so too did the amount of time and resources that sound departments were able and willing to dedicate to solving the problems associated with multi-channel recording.

Such concerns even led some CinemaScope titles, like Tashlin's earlier comedy *The Girl Can't Help it* (1956), to lack any stereophonic entirely. According to historian Matthew Malsky, Tashlin's comedy even failed to include stereophonic music.[966] The musically oriented feature was in many ways the perfect vehicle to promote the studio's technical accomplishments. The film's soundtrack was filled with rock and roll performances by the likes of Little Richard and Fats Domino, many of whom also appeared onscreen in cameo performances, and its story was about the commercialization of music technologies, recording studios, and jukeboxes. But as Malsky's research reveals, the comedy was produced only in monaural sound, a consequence of several institutional constraints including the technical limitations of recording studios.[967] Fox's choice to eschew multi-channel recording for simpler techniques was a matter of practicality. As the CinemaScope camera became more mobile, and as budgets became more constrained, the microphone apparatus needed to become less cumbersome, and for some filmmakers this meant removing all multi-channel effects from the motion picture.

The Stereo-Synthesizer

The implementation of more dynamic stereophonic mixes was therefore a matter of making multi-channel recordings easier to produce, or at the very least easier to simulate. Faulkner, being especially concerned about the growing problems in stereophonic production recording, had begun investigating possible solutions to the matter not long after the first wave of anamorphic productions passed through Fox's sound stages. His fix became known as the "stereo synthesizer."[968] Patented in April of 1955, the synthesizer was designed to manipulate a single-track signal so that it could be panned among three screen channels.[969] The synthesizer, however, was far more advanced than the standard pan-pot. If the signal were directed to the very right

loudspeaker channel, the center channel would play the signal at a lower volume, and the left channel would play the signal at an even lower volume, approximately nine decibels below the right channel's level.[970] At the same time, Faulkner designed his synthesizer to include built-in time delays between the three channels in accordance with the Haas effect. Specifically, each channel would be delayed by fractions of a second. If a signal were directed to the left loudspeaker, it would play first from that loudspeaker, then from the center, and then from the right, with the difference between the left and right channels being as small as only fourteen milliseconds.[971] The different volume levels and the added time-delays helped the stereo synthesizer simulate the naturally occurring stereo differences between the left, center, and right microphone signals, and it thus helped Fox's single-track recordings sound somewhat similar to its three-track recordings.

Although it was initially developed in 1955, Fox did not publicize its use of Faulkner's stereo synthesizer until 1959.[972] The announcement came only after Perspecta had fallen out of use in Hollywood, and after the discourse surrounding true and fake stereo had all but run its course in the trades. The choice to delay the announcement until after such discursive disputes was no doubt motivated by the synthesizer itself, which arguably manifested a pseudo-stereo design. An earlier announcement might have revealed to the industry that, despite its criticisms of Perspecta, Fox too was codifying the use of fake stereophonic techniques on its own productions. Nonetheless, Fox found the equipment valuable enough for its sound engineers to risk being criticized as hypocrites for using it.

For one thing, the synthesizer helped minimize the audible mishaps that occur when looping individual lines of dialogue. Rather than attempting to match the acoustical characteristics of three-track production recordings with the characteristics of post-production

recordings, rerecording mixers could run the production and post-production dialogue through the same synthesizer settings, thereby blending the acoustical differences and concealing the film's post-production process from most audiences. For another, the synthesizer enabled Fox to implement more dynamic camera movements without simultaneously having to worry about the mobility of three microphones throughout each shot. As the cinematography throughout Blake Edwards' *High Time* (1960), George Cukor's *Let's Make Love* (1960), and Irwin Allen's *Voyage to the Bottom of the Sea* (1961) collectively demonstrate, single-mic stereo reproductions gave filmmakers greater creative control over the choreography of the widescreen camera, and it did so without sacrificing the aesthetic ideals of a three-dimensional acoustics.

At the same time, the stereo synthesizer offered Fox greater control over the sound design of its CinemaScope releases. Because the acoustical technology gave mixers the ability to exaggerate or understate directional effects, some sequences could be rendered with more pronounced stereo designs. Filmmakers therefore had the opportunity to harness these new forms of acoustical contrasts to shape the way audiences pay attention to a film's narration.

Compulsion offers a clear example of how such storytelling devices were deployed. During the long interrogation of Judd by District Attorney Harold Horn (E. G. Marshall), the film's rerecording mixers use the stereo synthesizer to expand and contract the dialogue's presence in theaters. For instance, as Horn interrogates Judd about the discovery of Judd's eyeglasses at the scene of the murder, Horn holds the glasses up for Judd to see the evidence, then places them onto a small desk and says, "Now how would you like to tell us about Wednesday afternoon." The shot of Horn placing the glasses onto the desk is a close-up, with the glasses in the bottom of frame-center, a lamp in frame-right, and a window in the background

which looks out onto nearby rooftops. The time of day is afternoon, and sunlight shines through the window and its curtains.

As the camera holds on the glasses, the film's representation of time changes. The light from the sun dims in a matter of seconds, and the neon signs on nearby buildings turn on, indicating that it is now evening. At this point the torso of Horn enters frame-left and turns on the lamp, and a reflection of Judd appears in the right lens of the glasses. Horn exits the frame and reappears as a similar reflection in the left lens of the glasses. The two converse again. "I must say, you've given us a very detailed account of your activities, Judd," Horn tells the suspect. "Ten times," Judd replies. "Oh, we're very thorough," says Horn. The shot ends, and we cut to a new angle of the interrogation.

This virtuosic moment of temporal compression occurs within a motion picture that is otherwise stylistically prosaic. Its role in the film is therefore to accentuate the dramatic significance of the interrogation and to the glasses that sit in the center of the frame. The stereo design throughout the scene works to further punctuate the significance of the glasses. As Horn stands outside frame-left and asks Judd about Wednesday afternoon, the mixers deviate from standard stereo designs and send his voice to the center channel, where it could play through the loudspeakers directly behind the glasses. Instead of sending Horn's voice to frame-left, Fox used the synthesizer to manipulate the location of the dialogue track and call subtle attention to the evidence. Such prominent stereo effects occur at the end of the shot as well. Despite the reflections of the two characters on the pair of glasses in frame-center, their dialogue is sent to the left and right channels, thereby opening up their voices to the far ends of the frame.

This sudden and unexpected use of the wide loudspeakers contrasts with the onscreen location of the actors, as well as with the location of Horn's voice at the beginning of the shot.

Such contrasts accent the tense exchange of words between Judd and Horn, and renders the scene a pivotal moment within the murder investigation. The synthesizer thus offered filmmakers a means of using production recordings to highlight important narrative information for audiences. Like Perspecta, it allowed mixers to render a film's stereo design beyond the three-dimensional reproduction of onscreen performance. It turned stereo into a subtle storytelling tool that could be harnessed during post-production to punctuate select storytelling information.

Cue Sheets and New Workflows

Another reason that Fox engineers refrained from incorporating stereophonic effects throughout each feature was that there was the belief that many theaters wired for four-channel sound systems would leave their loudspeakers turned off for the duration of a film. As Norman Crowhurst argued in his 1955 presentation to the SMPTE, the control-tone system that Fox used to turn on and off the surround was flawed.[973] Rather than creating a seamless transition between silence and sound, there would be a brief moment when the loudspeakers began to play noise, much like a public-address system's brief hiss before broadcasting its intended message. Exhibitors who chose to leave the speakers off for the duration of the film were likely wanting at avoid these sorts of acoustical distractions. Additionally, being that Fox was one of the few studios to regularly release titles in magnetic stereo, it was likely deemed inefficient for theaters to regularly pay to power and service their sound systems. In sum, if exhibitors were unwilling to play Fox's multi-channel effects, there would have been little incentive for Fox technicians to spend energy and resources in order to create them.

Fox's executives therefore worked to address this problem head on. The studio sent letters to the major theater owners, alerting them to all the times their forthcoming films would

use surround sound effects, and—more importantly—reassuring them that their installations were still worthwhile expenditures and not a complete waste of money. Engineer Fred Leslie even personally wrote major theater managers, like Harry Rubin of Manhattan's Paramount Theatre, with lists of every surround sound effect in the studio's forthcoming releases, as well as the exact moments during each reel (measured in feet) when the effects occur.

In Leslie's letters, the list of surround sound effects included music, background sounds, and at times even short sound effects like gunshots. As illustrated by the list of effects for reel four of Henry King's western *The Bravados* (1958), many of these surround sounds lasted no more than a few feet.[974]

```
Reel 4:     Start at 12 feet - Start of reel
            Stop at 129 feet - Horsemen ride out

            Start at 201 feet - Man, on horse
            Stop at 203 feet - Man on horse

            Start at 301 feet - DISSOLVE to Long Shot - mountains
            Stop at 549 feet - Man, in grass

            Start at 759 feet - CLOSEUP - Peck
            Stop at 761 feet - Same

            Start at 890 feet - Three people, on horses
            Stop at 1031 feet - Same

            Start at 1145 feet - LONG SHOT - man on horse
            Stop at 1390 feet - LONG SHOT - cabin

            Start at 1424 feet - Man shoots rifle
            Stop at 1426 feet - Same

            Start at 1474 feet - Horsemen, in woods
            Stop at 1523 feet - End of reel.
```

In contrast, the list of effects for reels four and five of Jean Negulesco's romantic drama *A Certain Smile* (1958) referred mostly to orchestral music, diegetic background effects, and the reverb of voice-over narration, which often lasted for several minutes at a time.[975]

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Reel 4:     Start at 287 feet - Girl at flowers after boy leaves.
            Stop at 473 feet - First shot of train at station.
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            Start at 783 feet - Car starts and pulls out
            Stop at 1007 feet - First shot of train at station

            Start at 1056 feet - Girl, on verandah
            Stop at 1263 feet - Interior hotel room

            Start at 1586 feet - Girl and Luc down steps to man selling toys
            Stop at 1669 feet - End of reel.

Reel 5:     Start at 12 feet - Start of reel
            Stop at 162 feet - Girl, at beach

            Start at 227 feet - Luc hugs two children
            Stop at 322 feet - Int. Hotel room – girl in dressing robe

            Start at 418 feet - Luc picks up phone
            Stop at 569 feet - Car down street, to station

            Start at 759 feet - Int. train compartment
            Stop at 1287 feet - Phone rings

            Start at 1268 feet - Int. Be-Bop joint
            Stop at 1287 feet - Boy sits down at table.
```

Ostensibly, Leslie's letters to theater managers were cue sheets. They alerted projectionists to when in the film surround sound effects were to occur, and they made sure that projectionists did not assume that Fox's releases, unlike those of other studios, were being released without four-channel sound designs.

A Certain Smile was a particularly important stereo release in the eyes of the studio, for Earl Sponable personally requested that the narrator's voice be recorded in multiple microphone channels with different spatial characteristics in order to give it an "intimate" quality that might separate its texture from the onscreen dialogue.[976] If theaters were to have ignored Fox's requests to play the film in four-channel sound, then the desired effect of the narrator's performance would be lost to audiences. As Sponable argued, "In past pictures we have had instances where the off-stage voices did not come out well in the theatres, to the point of hurting the entertainment value of the picture."[977] In other words, Sponable conceived of the film's stereo

effects as a means to solve the problem of non-diegetic speech, and to add clarity to the narrative details included in the soundtrack.

In addition to providing theaters with effects cues, Fox's letters acted as reminders that the studio was still treating their four-track investment as a necessary component of their CinemaScope aesthetics, and that they too should treat their sound systems as necessary components of motion picture exhibition. If theaters began using their rear loudspeakers more frequently, then it was likely that filmmakers would have greater incentive to incorporate such stereo effects in their anamorphic releases.

Fox, however, wanted more than just audible effects. In order to convince theaters of stereo's aesthetic value, the studio's top executives believed that any such effects needed to be integrated within the film's narration. Individual sounds were to be sent to the rear speakers in such a way that if filmgoers heard the films in mono, they would feel as if they were missing out on aesthetic details that were paramount to experiencing the full motion picture. In sum, surround sounds needed to be properly integrated within the film's broader storytelling apparatus. As Sponable articulated to Skouras in February 1958, "The point at issue is not whether our existing product is better than others, […] but whether we can make still more effective use of our sound system capabilities in the theatre. We believe we can."[978] Unlike the studio's earlier reliance upon magnetic stereo's intrinsic fidelity or the mere sprinkling of stereo effects throughout each reel, Fox's engineers and technicians felt that narratively integrated effects had greater potential to solidify the value of four-track magnetic sound and adequately defeat the skepticism and resistance toward stereo that allowed optical mono to remain the dominant format for widescreen content.

Skouras took on an active role in overseeing the sound design of each film. Rather than standing back and letting filmmakers and rerecording mixers slowly add more effects to each title, he made sure that the studio's new directives were being followed to a tee. In 1957, he began examining working edits of forthcoming films in his private New York screening room, and he began sending each producer a set of instructions for how each picture could (and should) incorporate more surround sound effects within the story. For instance, after reviewing *The Enemy Below* (1957) and *Peyton Place* (1957), Skouras sent producer Buddy Adler a list of suggestions on ways to incorporate more stereophonic effects into both films.[979] For *The Enemy Below*, Skouras suggested that more atmospheric sounds from the naval ship—such as machinery, and background chatter—should be sent to the surrounds during the first two reels. Similarly, the explosions that occur in the final reel need to not only have been sent to the surrounds, but they need to be replaced with low-frequency booms as opposed to high-frequency firecracker sound effects. The effects would have given filmgoers the impression that they too were immersed in an undersea battle as British submarines are besieged by German U-boats.

For quieter melodramas like *Peyton Place*, Skouras continued to suggest to Adler that the sound department add more atmospheric effects like church bells and trains. During the scene that takes place at the mill, the Fox executive demanded that the background sound of looms and the mill's other industrial activity play from the rear horns. Further, during the scene that takes place at the secret overlook, Skouras argued that the sound department should be free to add sound effects that complement the beauty of the environment, and that punctuate the scene's distinction from the rest of the setting.

> The realism of the first view of the scene might be enhanced by such things as birds in the nearby woods, the distant lowing of cattle, the sound of a steamboat on the river, the distant drone of a plane passing in the sky, the remote sound of factory whistles, or many other similar sounds which might be used to create an

> even sharper contrast between the immensity of the view and the secluded intimacy of the spot in which the dramatic sequence occurs.[980]

Whereas Skouras suggested surround sound effects during war films should be deployed so that audiences could experience what it feels like to be under attack, during melodramas like *Peyton Place* they were to be deployed so that filmgoers could be absorbed within the intimacy of the small-town environment. This way audiences would be able to feel—and not simply hear—the emotional changes in the music and diegetic environment that correspond to the film's dramatic plot twists.

Finally, Skouras took issue with the use of Alfred Newman's iconic orchestral music that played under the studio's trademark logo before each film. On prints for *The Enemy Below*, Skouras felt that the music sounded like an nth generation mono recording, and was therefore a poor way to showcase the four-track magnetic sound. He in turn praised the recording used under the trademark logo of *Peyton Place*, particularly its use of the surround horns. Although Skouras cautioned Adler that too much presence of Newman's music in the surround might encourage projectionists to lower the volume of the rear loudspeakers for the remainder of the feature, he commended the use of a higher quality recording, asserting that "this title hit the screen in a way which would lend satisfactorily into the following main picture material."[981] In other words, Fox's logo should not be sullied by a poor rendition of Newman's fanfare. The studio's brand identity should instead be associated with high quality magnetic stereo, and future pictures should thus make sure to use these four-track recordings.

Adler sent Skouras's notes to Carl Faulkner, who responded with a letter that was defensive and peppered with excuses as to why the surrounds remained unused.[982] He suggests that these extra surround sounds were difficult to implement, for they would clash with the orchestral music, or these sounds would overpower the important dialogue. He indicated, for

instance, that in *The Enemy Below* the many submarine noises made the dialogue difficult to understand and were therefore kept to a minimum. He argued that the real reason that surrounds were being used sparingly were because directors simply opposed their inclusion. Without naming names, Faulkner noted that there were a few films, "which have gone through very recently in which surround horns seemed useless, either because they specifically did not contribute anything or those footages which could be included were so slight that we felt it best to eliminate them completely."[983] Faulkner was interested in making stereo reproduction more efficient. His synthesizer was one such example, and his removal of scant surround sound effects was another. But Skouras's demands asked Faulkner to stop cutting corners in the name of efficiency. He asked for more work on the part of the sound department, which meant budgeting more time to add stereo details to motion pictures.

Both Sponable and Adler sided with Skouras and pushed back against Faulkner's series of excuses.[984] Sponable nonetheless argued that there did exist a serious obstacle in the way of making Skouras's recommended changes: There simply was not enough time in the standard post-production schedule for sound crews to effectively design a fully immersive stereophonic surround sound mix. His solution to this problem, however, was consequential. He wanted sound teams to be involved in the picture's design much earlier in its development. As he outlined to Skouras, "it seems essential that sound recording personnel should take part in the early planning of a picture, as well as checking the final script."[985] Such recommendations were not new ideas. Sponable had specifically complained about the stereo design to *Peyton Place* shortly after the film's release, namely that it lacked the type of imagination needed in order to sell the four-track sound system theaters.

> We have an excellent example of the situation that arises when the uses of the surround effects are not planned from the beginning; but when at the last moment

> the realization dawns that no use has been made of the fourth track, a little music is added or other incidental and relatively insignificant sound effects are thrown in.[986]

Sponable continued to suggest that in future productions, the sound department at the very least needed to be invited to view working cuts of each release. This way, Fox's veteran sound technicians—including Alfred Bruzlin, James Corcoran, Warren Delaplain, Bernard Freericks, Eugene Grossman, and Clayton Ward—could play a larger role in the aesthetic design of the picture and begin planning and rerecording the film's stereo effects, particularly the surround channel, earlier in the process. Sponable's solution was ostensibly a compromise that appealed both to Skouras's demands for more immersive effects, as well as to Faulkner's interests in protecting his fellow sound editors and mixers from working longer hours without a codified change in post-production practices.

More consequently, Sponable also argued that his sound team should even be involved in the earliest stages of a film's conception. He contended:

> One must start when the picture is planned to think out not only how the camera can best use the full value of CinemaScope in photography, but the sound engineer, under supervision of someone who understands stereo work, must be given a chance to completely plan his end of the job and be allowed to execute it properly.[987]

Sponable was calling for an overhaul of how all aspects of a motion picture are decided upon, as well as who gets to have a voice in making these decisions. He treated Skouras's suggestions as an opportunity to ask that his sound department have a much larger say in the film's story. And as head sound engineer at Fox, he had the power to make sure that such changes were quickly enacted.

Sponable outlined his ideas to Faulkner that September. He addressed Faulkner's disagreements with Skouras's suggestions, specifically that these suggestions would mean that

Fox's sound team would effectively be asked to work longer hours. Nonetheless, Sponable's argument to his colleague was that these changes would also generate greater respect for sound technicians and their contribution to each release.

> What Mr. Skouras is pointing out is that the writers and directors do not have a full appreciation of what they could do with proper use of stereophonic sound, and particularly with proper use of the fourth track. In other words, he is saying that, if the story is written and produced with this in mind, sound and fourth track could become a real and integral part of the action, or drama, or what have you, in the picture, instead of just a superficial added atmosphere.[988]

In effect, Sponable wanted his employees to be valued not as technicians, but as filmmakers. With Fox's sound personnel actively involved in such pre-production processes as art direction and script development, there would therefore be more opportunities to design set pieces and sequences around their sonic characteristics of the onscreen elements. There would also be more opportunities for sound mixers to effectively showcase the value of their collective labor.

Sponable's push to overhaul the studio's sound design procedures were thus driven in large part by economics, not just the working conditions of sound engineers but the dwindling market demand for stereo content. He specifically asserted to Skouras that such changes to stereophonic workflows were vital to addressing the resistance to four-track CinemaScope among theaters owners. The lack of stereophonic product had meant that sound systems were no longer being serviced, and that the quality of four-track playback was decreasing due to poor sound heads and an absence of proper loudspeaker tune-ups. With these changes to stereophonic aesthetics, Sponable was hoping to win the business of exhibitors.

> If they could be assured that every picture we made would be capable of fine presentation I believe most theatres would try to improve their conditions. […] Now that we were forced to compromise CinemaScope and make MagOptical and optical prints, it is going to be hard to get more theatres converted to magnetic sound. […] For Twentieth Century-Fox, possibly the best general plan to follow is to try to improve our regular CinemaScope product.[989]

In sum, an increase in the number of ostentatious stereophonic mixes would increase the number of theaters willing to replace their single-channel optical sound systems with four-track magnetic stereo systems. And to create such mixes, Fox's sound department became more invested in the development and production of each picture. There is no record of Skouras's response, but given the mogul's interest in stereophonic effects he presumably agreed to Sponable's ideas without voicing any objection.

Stereo-Telling Aesthetics

What emerged from Fox's new post-production workflows were a series of CinemaScope releases in which the surround channel was not only more audible, but fully woven into the film's narration. This series of films included *Compulsion*, *Journey to the Center of the Earth*, *Seven Thieves* (1960), *The Lost World* (1960), *Can-Can* (1960), *Voyage to the Bottom of the Sea*, and *State Fair* (1962). Like Fox's earlier releases, the stereo effects articulated changes in setting and punctuated moments of visual drama. More significantly, however, the surround channel now conveyed information that contrasted the visuals. In earlier releases, a one-off orchestral passage or sound effect was often sent to the rear channel to punctuate an onscreen action—such as the quick gunshots during the climax of *House of Bamboo*. But under Fox's new workflows, stereophonic effects rendered off-screen plot elements with such dramatic importance that the effects were essentially telling audiences something new about the story. I call such multi-speaker aesthetics stereophonic storytelling, or stereo-telling.

One aspect of this new stereo-telling aesthetic was the way it could direct audiences to find new interpretations of a scene or sequence. *Compulsion* presents a useful example of how exactly surround sound designs would encourage this activity. As detailed in this chapter's

introduction, when Artie and Judd first discuss their plans to commit murder, we hear the off-screen buzzing of various insects. These background sounds reinforce that the scene is taking place in a tranquil suburban setting at night. Yet at the same time, they are expressive of the interior states of the two men. The rhythmic pulses of insects work to underscore the physical urges and drives of the characters, both by simulating the growing intensity of their heartbeats and by drawing a comparison between the lawless, primordial behaviors of nature and the antisocial passions of the murderers.

In some ways, this surround sound aesthetic was an intensification of the stereo experiments created earlier in the decade, particularly those in which the multi-speaker technology underscored such actions as a character's religious epiphanies in *The Robe*. In these earlier films, however, the stereo effects call attention to themes and ideas already prominent within the story. *Compulsion* marked a unique turning point from this earlier trend. The four-track technology was now louder and used to express the interior states of characters, information that was subdued within the film's narration. Indeed, throughout the conversation between Artie and Judd, the atmospheres help filmgoers make sense of why two upstanding gentlemen would commit such heinous crimes: like insects they are driven by primal urges. The stereophonic atmospheres therefore present an explanation for the violent events. Audiences hearing the film without surround sound speakers would likely pay little to no attention to the background noises, and thereby miss the analogy drawn between the Artie, Judd, and the suburban pests.

Beyond these small expressive functions, sequences that embodied stereo-telling were also characterized by a deliberate absence of visual information, and this absence motivated the use of stereo sound to convey the missing information. In this regard, stereo-telling recalled the

early stereophonic demonstration film of Joseph Maxfield, in which audiences heard but could not see a man bump into various objects as he failed to navigate his way around a darkened room. However, Fox's use of stereo-telling was less gimmicky than Maxfield's one-reel comedy. Some plot details would still be told through the mise-en-scène, while other details were told through dialogue or editing, and some of the narrative information—perhaps some of the most emotional information—would be articulated solely through the surround sound design. Stereo-telling was therefore the antithesis of the "see a chair, hear a chair" aesthetic of *House of Wax* and other films where surround sounds merely reinforced onscreen information. Moreover, stereo-telling revealed the efficacy of allowing Fox's sound technicians to participate in the pre-planning of motion pictures.

Case Study: Journey to the Center of the Earth

Henry Levin's *Journey to the Center of the Earth* is one of the clearest examples of how Fox incorporated this aspect of stereo-telling throughout each of their CinemaScope releases. And as a work of science-fiction, it was perhaps a better vehicle for multi-speaker experimentation than was a semi-documentary crime thriller like *Compulsion*. The film follows Professor Oliver Lidenbrock (James Mason), a geologist at the University of Edinburgh who leads an expedition through the opening of an Icelandic volcano in search of a pathway to the Earth's core. His scientific expedition intends to complete a similar journey which was commenced by explorer Arne Saknussemm several centuries earlier, and which was mysteriously cut short. Oliver and his team also face several adversaries once they begin their journey. These include Professor Göteberg of Sweden (Ivan Triesault), who wishes to be the first man to discover the Earth's core, and who subsequently kidnaps Oliver. They also include the

murderous Count Saknussemm (Thayer David), who intends to stop anyone from following in his ancestor's footsteps.

The film's diegesis is therefore organized into more quotidian terrestrial locations, such as Oliver's laboratory and his family's residence, as well as more fantastic subterranean settings, such as the various caves and underground pathways scaled by the scientists. The surround channel works to accentuate these two types of locations through the use of reverberation and atmospheric effects. As a general rule, actions that take place above ground lack any surround sound effects. Instead, all plot information is articulated through the image, and the corresponding sounds emanate only through the front three loudspeakers.

For example, when geology student Alec (Pat Boone) visits Oliver's niece Jenny (Diane Baker) at her house toward the beginning of the film, he plays the piano and croons to her a song about the romantic associations of June flora, titled "My Love is Like a Red Red Rose." Typical stereophonic mixing techniques at the time would have sweetened this musical performance by sending details like studio reverb and low-volume piano accompaniment to the rear loudspeakers. However, Alec's song is striking in that it plays only from behind the movie screen. Similarly, when Carla Göteberg (Arlene Dahl) visits an Edinburgh inn to investigate the disappearance of her husband, the clanking of dishes and other atmospheric noises that originate from inside the building play softly in the soundtrack's background. That said, rather than emanating from the rear channel, they only play through the front speakers. In both of these instances, music, atmospheres, and other sounds that might typically be sent to the surrounds are deliberately kept in the front of the theater. By deviating from conventional stereophonic articulations, the film defines the above-ground settings through the absence of surround sound, and thereby renders these settings acoustically unremarkable.

In contrast, actions that take place underground are articulated through a number of stereo-telling effects that play from the surround channels. For example, when Oliver and his team scale the walls of the Icelandic volcano and trek through the winding caves below it, the rumbling of what Oliver calls "a slight tremor coming from undefined regions" overtakes both the front and rear loudspeakers at an impressively loud volume. However, the source of these sounds is never seen in the image. The four-channel sound design expands the space of the diegesis beyond the onscreen mise-en-scène. As a result, the tremors not only radiate from an undefined location in the volcano, they also rumble inside the cinema auditorium.

Comparable stereo-telling effects occur once the characters reach the end of the journey. During that sequence, the characters discover a tempestuous chimney that connects the Earth's core to its surface. They are all taken aback by sheer volume and power of what Oliver refers to as the chimney's "violent updraft." The piercing whistles of this updraft emanate from the front loudspeakers and, more significantly, they continue to swirl around the theater through the rear loudspeakers. Like the volcanic tremors, the updraft is referenced in the dialogue, but because it is merely air, it is not depicted in the image. Indeed, the deliberately invisible qualities of this set piece create an opportunity for the updraft to be articulated solely through stereophonic effects.

Arguably, the film's most compelling example of stereo-telling occurs during the narrative's midpoint, just after Alec inadvertently falls into an underground cavern and stumbles into the evil Count Saknussemm. For the duration of the sequence, Bernard Herrmann's orchestral ostinatos play through the surrounds, but the music stops once the Count pulls out his gun and shoots Alec in the back. The act of violence is punctuated by the loud crack of the gun that reverberates from all four walls of the theater. Of even greater significance is the manner in which the film continues to utilize the extra loudspeakers to accentuate the dramatic salience of

the attack. The crack of the gun travels throughout the underground caverns, echoing and bouncing along the subterranean walls, until it reaches the other scientists. It is the sound that tells Oliver that Alec has been shot.

To underscore the importance of this moment, the filmmakers convey the dramatic information through surround sounds. Once the Count pulls the trigger, the film presents different close-ups of the various oddly shaped walls of the cavern. For each of these images, the crack of the gun plays repeatedly from the rear loudspeakers, with each iteration of the effect playing at a slightly lower volume and with slightly more acoustical decay. Much like with the volcanic tremors and the tempestuous chimney, the film's sound technicians harness the film's four-track technology to tell audiences that the crack of the gun is reverberating through the caverns. Thus, it is not just the soundtrack that signals to us that Oliver has been alerted of Alec's injury, it is specifically the rear effects channel that tells us this information.

The surround sound designs for *Compulsion* and *Journey to the Center of the Earth* both indicate that by 1959, Fox had all but abandoned its adherence to Harvey Fletcher's concepts of auditory perspective and authenticity, as well as his claim that true stereophonic reproduction preserved the integrity of the three-dimensional illusion. The concepts had notably informed the studio's stereo innovations beginning with the 50mm experiments in the early 1940s, and continuing with the initial four-track designs of the CinemaScope sound system. Fletcher's ideas were not acoustically flawed. Indeed, Fox continued to administer his multi-channel techniques in the recording and mixing of orchestral music. Nonetheless, his ideas were economically flawed. Auditory perspective simply did not matter to the vast majority of exhibitors and filmgoers. As a result, Fox's sound technicians stopped implementing the concept in their dialogue and effects designs.

In its place, Fox began administering more dynamic uses of stereo and surround sound effects. These effects were louder, they were woven into the narration, and they often sacrificed three-dimensional authenticity in order to add meaning and emotion to the cinema. In other words, Fox chose to adopt the same directional stereo techniques it once denigrated as fake several years prior. Indeed, the industry's resistance to four-track sound systems prompted the studio to reconsider its conception of proper stereophony and effective narration. For Fox, an ideal sound design had changed. It was now one that treated rear loudspeakers as integral to cinema's storytelling toolkit. Just as Perspecta systems panned musical effects to the left and right sides of the theater, so too did Fox bounce dramatically significant sound effects off the rear loudspeakers in order to call greater attention to the sound system's presence. The stereo-telling aesthetic worked to elevate the value of four-track CinemaScope among patrons and exhibitors who merely wanted to see and hear a good story. As a result, it remained the dominant style of surround sound mixing for many decades to come.

Conclusion

Despite the acoustical benefits of four-track magnetic stereo, Hollywood studios continued to release their CinemaScope prints in optical mono, and major theater chains continued to play motion pictures solely out of one loudspeaker. This ongoing resistance to multi-channel sound reproduction forced Fox to make several alterations to its stereo practices in order to more effectively promote its four-track technology throughout the industry. It first administered technical changes to its CinemaScope hardware, including the distribution of single-track prints and the adoption of mag-optical prints. However, Fox's more successful strategy involved altering its four-channel mixing techniques. The studio installed stereo

synthesizers and codified new post-production workflows in order to render its films more dynamic. The result was a new surround sound aesthetic that integrated stereo effects within the plot, and which called upon audiences to pay greater attention to Fox's multi-speaker sound system and to the immense aesthetic value that four-track stereo afforded motion pictures.

Magnetic stereo, however, never superseded optical mono as the industry's dominant sound format. In the years that followed, stereo was largely relegated to select films and select theaters, namely those that catered to road shows and expensive productions. That being said, Fox's stereo-telling aesthetic never disappeared. In the conclusion to this dissertation, I trace the continuation of this aesthetic through the stereo renaissance of the 1970s to today. Further, I account for why this aesthetic has become such an indispensable component of cinematic sound design, and why the advent of new stereo technologies has not greatly changed the ways that Hollywood's stories are acoustically designed.

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Conclusion: An Obscure History of Stereo

The two-year theatrical run of Fox's science-fiction blockbuster *Star Wars* (1977) is often treated as turning point in the history of stereo. As I detail in this dissertation's introduction, scholars have credited the film for revolutionizing Hollywood use of sound, if not also ushering in a completely new era of surround sound design.[990] As debatable as this historical claim is, it neatly illustrates a feeling that persists within the minds of many film sound enthusiasts, that the stereo design of *Star Wars* was historically unique and a significant step forward for surround sound aesthetics. In light of this dissertation's findings, this belief is worth revisiting.

The stereo technology used for the theatrical release of *Star Wars* was neither new, nor did it provide for new kinds of stereophonic effects. Similar to most road show releases in the 1950s and 1960s, Fox distributed *Star Wars* onto two sets of stereo prints. 35mm venues received four-channel prints, as had been typical of the studio's CinemaScope titles, while 70mm screens received six-channel prints, as remained standard of its Todd-AO and Panavision titles. Both formats were nonetheless altered, albeit slightly.[991] 70mm prints no longer boasted five full-range channels for the front of the theater. Instead, two of these channels were repurposed as dedicated low-frequency channels, thereby reducing the kinds of directional effects that could be achieved.

Likewise, 35mm prints no longer boasted four discrete soundtracks. Instead, the four channels were compressed into two narrow optical tracks, specifically the twin PhotoStereo tracks that Westrex unveiled in 1954.[992] This mode of compression, known as matrixing, was significant in that it combined individual stereo channels, and it did so in a manner that prevented these channels from ever being fully separated during playback.[993] For instance, the

front-left channel did not just play out of the front-left speaker. Because it was matrixed together with the center and surround, information that was intended to play out of only the left speaker inadvertently played out of the center speaker and the rear speakers; in other words, it played out of every speaker in the auditorium except for the right speaker. Thus, as a result of matrixing, two-track optical prints actually discouraged the creation of directional effects.

This consequence is best illustrated by the film's opening scene, when an Imperial battleship chases a rebel spacecraft. In 70mm screens, where there was perfect separation between the individual channels, the roar of the battleship panned from the rear speakers to the front speakers—not unlike the sounds of the jets at the end of *Cinerama Holiday*.[994] However, due to directional constraints inherent to matrix compression, the film's two-tracks prints were unable to achieve this localization effect. Any information stored in the surround channel also played out of the front channels, specifically the left and right speakers. Thus, in 35mm venues the roar of the Imperial battleship did not pan from the rears to the front speakers; it played from every side of filmgoer at the same time.

Despite such stereophonic limitations, the film's acoustical design was nonetheless different from earlier stereo releases. For instance, both 35mm and 70mm prints were treated with a compression-based noise reduction process, which widened the decibel range of each stereo channel. The film's quieter information was boosted (or compressed) when the soundtrack was being encoded, and it was then lowered back to its original levels (or expanded) during playback. As a result of this compression and expansion, any unwanted noise that was inadvertently added during the encoding process was also lowered in volume. The scientific principle behind this noise reduction process, known as "companding," was developed and innovated by Bell Labs over the course of the 1930s for both telecommunication and

stereophonic film systems—as I detail in chapter two.[995] During the 1960s, however, engineers at Dolby Labs further refined this process by opting to apply a different compression setting to different frequency ranges.[996] Because electrical hiss is often more pronounced in certain frequency ranges, the variable compression settings prevented the noise reduction procedure from distorting the less-noisy parts of a soundtrack, mainly its mid-frequencies.

Dolby's process was initially tested on the recording and rerecording stages of several British-made releases—including *Oliver!* (1968), *Ryan's Daughter* (1970), and *A Clockwork Orange* (1971)—and it was soon used on the release prints for a number of Hollywood-made releases—such as the four-track release of *Nashville* (1975), the six-track release of *Logan's Run* (1976), and the two-track releases of *A Star is Born* (1976).[997] Like previous uses of a compandor, these soundtracks were able to achieve wider volume ranges during quieter sections. In *Star Wars*, for instance, the short silences that separate symphonic stingers just before the Death Star explodes becomes more noticeable as a result of Dolby's refinement of Bell's noise reduction process. To help highlight and market these acoustical effects even further, the film's two-track and six-track formats were subsequently branded Dolby Stereo.

Of even greater consequence, *Star Wars* benefited from the timing of its production, for it was one of the first films to be released without the constraints of the Academy's 1938 playback characteristics. Following the Motion Picture Research Council's dissolution in 1960, as well as years of testing theaters and dubbing rooms around the world, the International Organization of Standardization (ISO) unveiled in 1977 a revised frequency response, which Hollywood quickly adopted.[998] Indexed as ISO 2969 and nicknamed the "X Curve," the new playback standard expanded the flat characteristics and lessened the steepness of a soundtrack's high-frequency roll-off. Hollywood releases like *Star Wars* were therefore able to boast impressively wide

frequency ranges, ones that was unavailable to audiences outside of 70mm road shows, and ones that perhaps even resembled the acoustical showmanship that once defined prestigious musicals like *Naughty Marietta* (1935) and *The Great Ziegfeld* (1935).

Like these earlier titles, the X-Curve no doubt helped Ben Burtt's intricate sound design and John Williams's symphonic score sound much more spectacular in theaters. I suspect excitement over the film's stereophonic sound design—and the use of Dolby-branded stereo technology, in particular—would not have been as pronounced were it not for this revised playback standard and its ability to render individual mixing effects with greater clarity. The X-Curve lent freshness, if not also a newness, to the way *Star Wars* sounded. And given the prominence of the Dolby Stereo logo on cinema-marquees throughout the country, it was perhaps difficult not to attribute such newness to the film's use of stereo—as Sergi does.

However, these multi-channel effects used throughout the film were far from new. They were instead manifestations of the many stereo techniques that had been established by Hollywood technicians several decades prior. The reproduction of the musical score abides by Harvey Fletcher's principles auditory perspective, whereby the recording and playback process creates the impression that the London Symphony Orchestra is performing live in the theater. Additionally, both the 70mm and 35mm releases recreate the many surround sound atmospheres and thrills that once defined science fiction releases like *House of Wax*, *Forbidden Planet*, and *Journey to the Center of the Earth*. As Jay Beck argues, *Star Wars* embodied a type of new classicism, where "the techniques and practices used on the film followed several standard film sound aesthetic choices and attempted to make them fit the Dolby Stereo technologies."[999] Just as director George Lucas repackaged elements from *The Searchers* (1956) and *Hidden Fortress* (1958) to create visuals imbued with nostalgia, his soundtrack was also historically minded.

Mixed by a number of seasoned technicians—including Bob Minkler and Richard Portman, son of veteran rerecording mixer Clem Portman—the film's sound design renewed many of the stereo practices established during the studio era.[1000]

This renewal of older practices, however, was not solely due to Clem Portman and other mixers passing down technical advice to their sons. There were also consequential changes in the ways that stereophonic films were distributed. As I discuss in chapters seven and nine, Fox had spent much of the 1950s investing its resources into the refinement of four-channel stereo, largely in an attempt to bolster its value with other studios. However, the growing availability of optical tracks on CinemaScope prints undermined Fox's investments and led to a sharp decline in four-track stereo releases among other studios. As a result of this decline, the SMPTE declared in 1959 that, "stereophonic sound, except for roadshow-type releases, seemed dead."[1001] This announcement, of course, was an exaggeration. In the years that followed, mainstream and independent studios alike released a number of titles in four-track magnetic stereo, including *Master of the World* (1961), *The Music Man* (1962), *Mary Poppins* (1964), *The Trip* (1967), *Wild in the Streets* (1968), *They Shoot Horses, Don't They?* (1969), *Phantom of the Paradise* (1973), *Earthquake* (1974), *Silent Movie* (1976), *The Amityville Horror* (1979), *The Blues Brothers* (1980), and *Scarface* (1982), to name a few.[1002] What the SMPTE presumably meant was that four-track never became the new motion picture standard that Fox hoped it would become.

With little means of reviving excitement for the format, Fox turned to six-track Todd-AO, the premiere technology for road shows. In December of 1958, Fox signed an exclusive contract with the 70mm company, where for $600,000 Fox would purchase a share of the company in exchange for the license to release several motion pictures in the prestigious format

over the course of the next decade.[1003] Shortly thereafter, Fox began distributing a number of titles in 70mm Todd-AO—including *Can-Can* (1960), *Cleopatra* (1963), *The Sound of Music* (1965), *The Agony and the Ecstacy* (1965), *The Bible: In the Beginning…* (1966), *Doctor Dolittle* (1967), *Hello, Dolly!* (1969), and *Patton* (1970). All of these titles were released in six-track surround sound, and they all embodied the kind of stereo-telling Fox initially developed for the 35mm market.[1004] Music and atmospheric effects routinely radiated from all directions of the theater, and during screenings of *The Bible* God himself even rattled the surrounds as he speaks to Abraham. Fox's move to 70mm carried the studio's multi-channel aesthetics into road show venues, and thereby cemented their place among road show audiences.

And such aesthetics continued to inform the mixing decisions of 1970s sound technicians, especially those of Minkler and Portman. When the spirit of Obi-Wan Kenobi tells Luke Skywalker to "Use the force" at the end of *Star Wars*, the disembodied voice emanates from every speaker in the theater, much like God's omnipresence was conveyed to audiences a decade earlier. Despite being routinely credited as ushering in a new era of sound, *Star Wars* is more accurately seen (and heard) as a continuation of long-established dedication to stereophonic storytelling at Fox, and in Hollywood more broadly.[1005] In other words, blockbusters like *Star Wars* heralded a stereo renaissance, not a revolution.

As my dissertation demonstrates, the aesthetics that have come to define contemporary stereo releases were in fact a byproduct of the studio-era economy. The 1930s, 1940s, and 1950s saw the development of a number of multi-channel systems, and to create the need for these systems the industry's studio heads, engineers, manufacturers, re-recording technicians, and critics collectively established a set of aesthetic principles that rendered these sound systems valuable. I presented this history over the course of nine chapters, each of which detailed a

different phase in Hollywood's long process of stereophonic adoption. The first three chapters traced stereo's origins to the early years of synchronous sound recording. I chronicled the many multi-speaker sound systems that emerged in the late 1920s in response to both the amplification problems of talking pictures, and the desire for filmmakers and engineers to flaunt their technical prowess. I next argued that one type of multi-speaker system—stereophonic sound—was valued above all others for the way it corrected the narrow playback ranges of standard Academy Mono prints. Following this establishment of stereo's value, I looked at the many ways that Disney, Fox, and other studios developed and promoted their own stereophonic formats. The collective problem with these systems, I explained, was that they relied upon optical sound encoding, and that they were too mechanically and financially inefficient to be viewed as a viable alternative to Academy Mono.

The next six chapters analyzed how the advent of magnetic tape revived earlier attempts to wire stereophonic systems into cinemas. I argued that although studios were initially reluctant to see magnetic recording as anything other than a cost-saving technology, filmmakers working outside of Hollywood—namely in New York and London—developed their own magnetic stereo systems in order to undermine Hollywood's status as the purveyors of the highest quality film technology. The popularity of New York-based Cinerama specifically forced studios to innovate their own magnetic stereo formats that could be sold to the industry's largest theaters. These included triple-track stereo—which was largely promoted by Universal, Columbia, and Warners—as well as Fox's four-track CinemaScope system. These also included single-track stereo systems like Perspecta, which both MGM and Paramount adopted as a less-expensive alternative to the new magnetic formats. The competition among these many types of systems during the 1950s engendered debate among studio technicians as to the proper way to design

stereophonic soundtracks so that they were pleasurable to audiences, cost-efficient for exhibitors, and non-disruptive to storytelling norms. Further, given the continued use of Academy Mono prints, stereophonic films needed to remain intelligible in theaters wired for only monaural sound.

What emerged from this period of competition were stereophonic technologies, mixing norms, and distribution procedures that allowed multi-channel sound designs to fit the many different needs of filmmakers and theaters, to lend a degree of prestige to those willing to pay for the acoustical upgrades, and—by design—to address these matters without requiring the entire industry to convert to stereo. And this technical economy for stereophonic production never disappeared. When *Star Wars* was released in 1977, Hollywood had already amassed an infrastructure to ensure that stereophonic and surround sound releases could play to as many audiences as possible. Multi-channel recording and rerecording practices were firmly in place, as were the procedures for storing stereo tracks onto 35mm and 70mm prints, for distributing stereo sound formats to different venues, and even for properly powering stereophonic theater systems.

Moreover, the concept of multi-channel playback was now pre-sold to audiences. Filmgoers were taught the distinctions between stereo and mono. As a result, the experience of hearing a movie in surround sound had an established value within the broader cinephile and audiophile communities.[1006] By the 1970s, the industry had codified a set of norms and guidelines for the production and distribution of stereophonic cinema. Films like *Star Wars* did not "break the rules" when it integrated multi-channel effects into its soundtrack. Rather, the popularity of its stereophonic release was a product of its effortless way of following these rules. What stereo history ultimately reveals is the extent to which Hollywood continues to abide by the aesthetic ideals of the past, in spite of social, economic, and technological changes—such as

new noise reduction procedures or new acoustical standards for playback range. Put another way, Hollywood is defined by considerable inertia that prevents any one film, filmmaker, or film technology from revolutionizing the way its stories and soundtracks are designed.

Additional Findings

This dissertation set out to detail exactly what the norms of stereophonic cinema were, how they were formed, what shaped their development, and why stereo become a valuable addition to motion pictures. In so doing, I saw several recurring themes that can help to explain the logic that shapes the technical economy of Hollywood. First, despite the widespread circulation of promotional material that touts its aesthetic benefits, the development of new filmmaking technology is not always driven by a desire to improve or enhance audiovisual aesthetics. Instead, a technology's value to the storytelling process—and, likewise, the experience of watching a film—is often secondary to financial concerns, and is typically generated in an effort for inventors, patent owners, and studio executives to sell their new technology to the rest of the industry.

The adoption of talking pictures is one such example of this phenomenon. As historians like Douglas Gomery and Janet Wasko argue, synchronous sound recording was valued as a means for smaller companies, like Warners and the Film Booking Office, boost their status as major studios, and for larger companies to create a barrier for entry for producers who wished to distribute their releases to the more profitable theaters.[1007] At the same time, sound was valued for the way it encouraged leading financial institutions and venture capitalists to increase their investments in motion pictures, thereby strengthening ties between Hollywood and Wall Street, and endowing studio heads with the ability to expand the size of their institutions.[1008] The arrival

of sound, of course, did lead to significant aesthetic changes—such as the ways that actors performed and the ways that writers conveyed information to audiences. In terms of the economic needs of film executives and investors, however, these aesthetic benefits were not the primary reason for why studios adopted talking picture technologies.

Stereo is an even clearer example of this investment logic, for the period of technological adoption lasted several decades, not several years. It therefore provides a detailed picture of the many small-scale changes—both technological and ideological—that were made to multi-speaker designs in order to better situate stereo within the industry economy. This longer time period similarly offers a clearer understanding of the arguments that were created in order for studios to continually reject stereophonic systems throughout the studio era. As I discuss in chapter two, during the 1930s Joseph Maxfield's two-track system was ridiculed for being too noisy, yet technicians could have easily added a better noise reduction processes. Likewise, Harvey Fletcher's four-track system was criticized for being too loud, yet technicians could have easily lowered its volume.

In each case, the reasons for rejecting the stereo system were aesthetic in nature, but there were bigger reasons for their rejection. For one, the studios were no doubt hesitant to sign addition licensing arrangements with ERPI and the Bell System, following what had been a series of legal setbacks that rendered the manufacturers less financially stable in the eyes of studio heads. Additionally, the costs of each system arguably outweighed their ability to generate higher box office numbers. As I detail in chapter three, the stereo systems that studios innovated in response to both Maxfield's and Fletcher's product were aesthetically quite similar, though as Warners' Vitasound illustrates they were often produced in-house and at much lower costs.

These reasons for why stereo systems were once rejected helps to explain why the more conservative technologies—those which are the least disruptive to the economic and aesthetic practices within a given studio—are often those that see their widest use within the motion picture industry. As I argue in chapter seven, Fox understood this principle when constructing its four-track CinemaScope format. To win over its fellow studios and theaters, CinemaScope could not disrupt production and exhibition practices, nor could it create acoustical mishaps like those associated with triple-track stereo. Fox made sure to accentuate the ways that CinemaScope avoided these earlier pitfalls, and it did so by sacrificing stereophonic aesthetics. The technology greatly reduced acoustical fidelity in order to fit multiple soundtracks onto a single 35mm print. Moreover, the techniques first associated with CinemaScope were often subtle, if not at times inaudible, in order to prevent anyone from noticing problems with the system. Of course, this also meant that many audiences may not have even noticed the four-track system, but such inaudibility was the price Fox was willing to pay in order to wire their proprietary technology into as many screens as possible.

We can similarly think of today's popular sound technologies like Dolby Stereo and digital 5.1 in terms of their conservation of earlier designs. The addition of both noise reduction and a new surround channel constituted only small-scale refinements to previous sound systems. These minimal changes thereby enabled studios and theaters to keep using older loudspeakers, rerecording machines, sound heads, and many other stereo components. In so doing, each system dramatically reduced installation costs of a typical stereo system, which was no small feat. Any new stereo format that can be wired into sound stages and theaters at a low price will no doubt have higher value to an industry that wants to be seen as offering state-of-the-art cinema technology, but that is simultaneously unwilling to invest its resources to achieve such a

reputation. Indeed, both Dolby Stereo and digital 5.1 provided Hollywood with more than just new acoustical experiences. They provided status.

By definition, such prestige requires that filmgoers believe that the newly installed technology is, in fact, new. Otherwise, audiences might doubt that they paid for a cutting-edge film-going experience. In order to head off any doubts, the marketing campaign for new film technologies—whether Fantasound, CinemaScope, Todd-AO, Dolby Stereo, or digital 5.1—generally overstate just how revolutionary the technology is. But such exaggerations can be quite debatable. After all, there are far more similarities than differences between six-track Todd-AO and six-track Dolby Stereo. The same can easily be said for the differences between the stereo design of CinemaScope and Todd-AO. Nonetheless, Hollywood routinely suggests otherwise, and when it does it erases the accomplishments of many technicians and engineers who are no longer alive to promote their own creative achievements. Indeed, what this study of stereo also reveals is the extent to which Hollywood hides its own history.

To a certain degree, it is easy to understand why it is in the interest of the industry to correct its past mistakes. Disney's decision to keep the racially insensitive *Song of the South* (1946) out of circulation is not too surprising, being that it has the potential to promote harmful stereotypes.[1009] Similarly, given the rise in mass shootings at schools, one can see why Steven Spielberg chose to digitally alter the home video release of *E.T.* (1982) so that the children's film features fewer onscreen guns.[1010] What is curious, however, is that these decisions can also work to conceal Hollywood's own accomplishments.

This is especially true of stereo. Studio-era surround sound mixes are routinely replaced by digital 5.1 mixes for home video release, perhaps so studios could sell their remastered titles at higher prices. This is not unlike Warners' need to routinely boost the saturation of their MGM

technicolor titles like *Wizard of Oz* (1939) in order to "correct" their color palettes for contemporary audiences.[1011] And when Warners releases a film like MGM's *Seven Brides for Seven Brothers* (1954) on DVD and Blu ray in 5.1, and when it does so without also offering the original 4.0 stereo mix, the studio hides the fact that the film actually boasted a surround sound design during its initial theatrical run. The implication here is that because a new 5.1 mix was specially created for the home video release, the film must not have had a stereo mix that could have been used. In reality, the film did have such a mix, but Warners opted to keep it in storage.

This does not appear to be a new problem either. Throughout history, studios have routinely failed to preserve many of the original stereophonic and surround sound mixes for a number of their most prestigious releases, including *Hell's Angels* (1930), *Fantasia* (1940), and even contemporary films like *Star Wars* and *Apocalypse Now* (1979).[1012] In a sense, no history of stereo and surround sound is completely without also noting that Hollywood makes it very difficult to hear this history. Perhaps this obstacle is due to a general lack of awareness that this acoustical history actually exists. Perhaps it is something else, such as a widespread desire among post-production technicians to willfully keep this history hidden.

Based on the broader production culture in Hollywood, one could easily argue that filmmakers and sound personnel wish to be known as the first to innovate the use of stereo technologies, even when they were far from the first. Indeed, it is curious to hear an incredibly talented sound designer like Walter Murch claim to be the first person to mix a film for two separate surround channels in 1979, being that Gordon McCallum mixed *Superman* (1978) with the same split-surround technology one year prior, or that IMAX technicians mixed their films for two surround channels since the early 1970s, or—as I detail in chapter five—that Richard Pietschmann, Dick Voriseck, and others mixed Cinerama's films for two (and sometimes three)

separate surround channels throughout the 1950s.[1013] I doubt Murch would have made this claim were it not for the fact that Hollywood obfuscates our ability to read about this early history of stereo, and that all sorts of statements can be made about surround sound without any real consequence.

Nevertheless, it seems much more likely that stereo history remains hidden because stereo's aesthetic potentials have to be continually reinvented and repackaged by industry practitioners. The story of stereophonic cinema is really about the struggle of engineers and technicians to convince the industry that stereo matters. Further, it is about the unwavering skepticism to any suggestion that three-dimensional sound is an integral aspect of motion picture artistry. This explains why mixers and engineers feel compelled to continually explain the value of stereo and surround sound on the pages of *Mix Magazine* and *SMPTE Motion Imaging Journal*, and why sound designers like Murch are valued for how they talk about stereo and how they call our attention to the way it can enhance a scene. And despite such discursive labor, there are still many who remain unconvinced that an inventive use of stereo technology is valuable to the telling of a motion picture story.

Final Thoughts

Many pages ago, I asked why the 2003 romantic comedy *How to Lose a Guy in 10 Days* was released to theaters in digital 5.1 surround sound. It was a fair question, considering that not once during the film does Matthew McConaughey jump out of an exploding helicopter, nor does Kate Hudson ever protect the people of Manhattan by shooting lasers into a giant alien spaceship. However, the answer to this question no longer a mystery. As I have shown, stereo serves many functions beyond its ability to enhance action sequences. It can secure a better

theatrical release, it can showcase the talents of sound technicians, and—as I detail in chapter nine specifically—it can signal to investors that the studio's choice to adopt stereo was not a mistake, and that the equipment is being used on every type of release, even romantic comedies. Indeed, the decision to release a film in stereo is not necessarily motived by the needs of the story or the wants of an audience.

Knowing this, it is then productive to end this dissertation with a different question: Can *How to Lose a Guy 10 Days* tell us about the history of stereo? The answer is yes. Its orchestral score plays from every channel, at full volume from the front speakers and—during several scenes—at a much lower volume in the rears. This concert-hall aesthetic recalls the principles of auditory perspective outlined by Harvey Fletcher, as well as their manifestation in films like *Fantasia*, *Miss Sadie Thompson* and the four-track mix for *Silk Stockings*. Diegetic atmospheres are similarly kept to the front three channels, with the exception of several sequences where background noises also play from the rears, a device that recalls the use of atmospheres to accentuate scene changes in *House of Bamboo* and other early CinemaScope releases

In contrast, sound effects throughout *How to Lose a Guy in 10 Days* are generally kept to the center channel, with the exception of select moments when louder effects are either doubled in the side channels or the rears, such as the basketball game buzzer that blasts through every channel. This surround sound design recalls Warners' use of directional effects to heighten select onscreen actions in four-track films like *Rebel Without a Cause*, if not also in their WarnerPhonic releases like *House of Wax*. Lastly, as McConaughey races his motorcycle through New York traffic in an attempt to catch up to Hudson's taxi, all the surrounds swell in volume, an aesthetic that recalls climactic moments from virtually every studio-era stereo release, from the "Ave Maria" sequence in *Fantasia*, to the storm in *Portrait of Jennie*, to

Marcellus's final epiphany in *The Robe*, and to the violent updraft that ends the scientists expedition in *Journey to the Center of the Earth*.

Though Hollywood routinely works to conceal its own history through stereo remixes and technician discourse, a film like *How to Lose a Guy in 10 Days* reveals that its history is never fully hidden. We can experience significant traces of studio-era surround sound designs when we watch contemporary movies. The many years of researching and writing this dissertation aside, the history of stereo is perhaps much more accessible than initially thought. We just have to know how to listen for it.

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