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Eric Dienstfrey

Film History: An International Journal, Volume 28, Number 1, 2016, pp. 167-193 (Article)

Published by Indiana University Press



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ERIC DIENSTFREY

The Myth of the Speakers: A Critical Reexamination of Dolby History

ABSTRACT: This article corrects misconceptions regarding the history of film stereo. I show that the technical and aesthetic innovations regularly credited to Dolby Stereo, to sound designers like Walter Murch, and to films like *Apocalypse Now* (1979) were not revolutions but extensions of surround-sound practices that Hollywood codified in prior decades. I call such historical misconceptions the “Dolby myth.” Further, I argue that practitioners circulated this myth to critics and scholars in order to elevate the value of postproduction sound labor following the industry’s transition from a studio-based economy to one dominated by independent productions.

KEYWORDS: Dolby, quadraphonic stereo, sound technology, *Apocalypse Now*, Walter Murch

In February 1979, United Artists (UA) sent movie theaters bid letters with unusual demands regarding its forthcoming road show of *Apocalypse Now* (1979).¹ In order to accommodate the unique sound design of the film’s 70mm prints—and at a cost of between five thousand and twenty thousand dollars—theaters were asked to install Dolby’s Surround Adapter 5 (SA-5), a new processor that allowed helicopters, gunfire, and other sound effects to emanate not just from behind the screen but from specific loudspeakers surrounding the audience.² The letters arrived three years after director Francis Ford Coppola started production on *Apocalypse Now*, during which time the movie became the subject of ongoing publicity in the Hollywood trade press.³ News of its difficult fourteen-month shoot in the Philippines and of the controversies around its violent imagery and political commentary created an expectation that Coppola would deliver a groundbreaking depiction of the Vietnam conflict.⁴ Within this context, the subsequent bid letters created similar expectations for the road show’s sound design, whereby the installation of state-of-the-art equipment would produce equally groundbreaking sensory experiences.

The SA-5 was one of several processors that established Dolby Laboratories as New Hollywood's foremost innovator of sound technology. According to historians Jay Beck and William Whittington, Dolby earned this reputation after developing equipment that removed audible hiss from *Nashville* (1975), *Days of Heaven* (1978), and other releases encoded with the company's popular A-type noise reduction.⁵ Dolby continued to bolster its value to the industry with the release of its Cinema Processor 100 (CP-100), a projection unit that allowed neighborhood theaters to play blockbusters like *Star Wars* (1977) and *Close Encounters of the Third Kind* (1977) in high-quality Dolby Stereo.⁶ Beyond these technical developments, Dolby soon gained renown for enabling a new generation of filmmakers to experiment with the aesthetic possibilities of its equipment. Sound engineering trades routinely suggested that the company's technologies encouraged creative sound mixers like *Nashville*'s Jim Webb and *Star Wars*'s Mike Minkler to recreate the multitrack soundscapes that permeated home stereos and rock recordings during the 1960s.⁷ As Whittington explains, New Hollywood practitioners "were not simply baby boomers but stereo babies, fascinated by sound technology and its utilization" and driven to introduce film audiences to the music industry's new mixing techniques.⁸ Dolby's noise reduction and stereophonic equipment were consequently defined by filmmakers as tools for recreating these new techniques in cinemas.

Such discourses of ingenuity around Dolby Labs reached an apex with *Apocalypse Now*. Following its release, sound editors and mixers hailed the film for its use of rear loudspeakers and for providing audiences with extraordinary experiences that "changed forever the way we think about film sound."⁹ Dolby engineers similarly treated the mix of *Apocalypse Now* as the aesthetic fulfillment of the company's technical innovations, while critics proclaimed that stereo effects like the "whump-whump of helicopters at the opening of *Apocalypse Now* heralded a new age of film sound."¹⁰ Such reverence was largely nurtured by the film's sound designer, Walter Murch.¹¹ In several oft-quoted interviews, Murch recalled that listening to experimental recordings on a home stereo system inspired his creation of authentic Vietnam-era soundscapes.¹² He attributed the panning effects between the front and rear loudspeakers to the way that music in quadrasonic stereo came "from all sections of the room," and he further likened the sensory illusion of hearing objects fly through the theater to a representation of the era's "psychedelic haze."¹³ These surround-sound effects were possible, he attested, only through Dolby Stereo: "I investigated, and working together with Dolby, came up with what is now called the 5.1 format—it had no name then, it was just 'what we were doing for *Apocalypse Now*'—that allowed me to move the helicopters in three dimensions, among other things."¹⁴ For Murch, the advent of Dolby cinema technology inaugurated a new paradigm

in cinematic storytelling: “You could divide film sound in half: There is BD, Before Dolby, and there is AD, After Dolby.”¹⁵

The prevalence of such anecdotes among practitioners and critics helped Hollywood craft its own history of film stereo. According to this history, Dolby technology enabled sound-conscious filmmakers to radically transform the way movies sounded, and *Apocalypse Now*'s sound design was a major force—if not *the* force—behind the transformation. This type of mythmaking is common in Hollywood. In a wide-ranging study of the media industry's social practices, John Caldwell asserts that the trade stories that craftspeople circulate serve “as rationalizations, solidarity-making devices, guarantors of career mobility, forms of social pedagogy, and self-serving legitimization.”¹⁶ In this vein, the industry's history of film stereo is a tool that Murch and other practitioners used, and still use, to negotiate the value of their labor to the broader production community. I call their construction of this history the “Dolby myth.”

The Dolby myth holds a unique, yet dubious, place in academia: while historians largely dismiss trade stories that exaggerate a casting agent's intuitions or a camera operator's physical hardships, tales of a Dolby mixer's unprecedented artistry often form the foundation of film sound scholarship. One notable example is Gianluca Sergi's *The Dolby Era: Film Sound in Contemporary Hollywood*, a history of motion picture sound technology published in 2004. Sergi argues that when studios agreed upon loudspeaker standards in the 1930s, they inadvertently restricted film sound to a narrow frequency range.¹⁷ It was not until Dolby Stereo's arrival in the mid-1970s, Sergi asserts, that the industry rectified this problem and filmmakers began exploring sound as a sensory and storytelling device.¹⁸ Drawing upon interviews with sound designers and Dolby executives including Ray Dolby himself, Sergi pronounces Hollywood's adoption of Dolby technology “nothing less than a comprehensive industry-wide transformation, from studio attitudes to sound, filtering through to filmmakers' creative use of sound and audience expectation.”¹⁹ Echoing Murch, Sergi ultimately divides the history of film into two eras: the pre-Dolby era, when filmmakers edited sound tracks to “match the image without attracting unwanted attention,” and the Dolby era, when filmmakers used Dolby technology to render each sound track “a site of interest and experiment in its own right.”²⁰

Sergi's observations are widely repeated in textbooks, indicating the extent to which Hollywood's own construction of its surround-sound history has become the dominant one.²¹ However, by treating practitioner trade stories as a reliable record of Hollywood's past, scholarship not only becomes a loudspeaker for the industry's values, it risks compromising itself when the stories unwind under closer scrutiny—as indeed the Dolby myth does. In the following pages, I address this problem by reevaluating the historical distinction of Dolby

technology and Dolby-era aesthetics. I reveal that 70mm Dolby Stereo was not a revolution but a continuation of stereo practices that Hollywood codified during earlier decades. I support these findings by investigating the original stereo design of *Apocalypse Now* and by analyzing other surround-sound releases including *Journey to the Center of the Earth* (1959), *The Sand Pebbles* (1966), and *Tron* (1982). I then argue that the Dolby myth was formed in reaction to a period of economic uncertainty for Hollywood's sound community, with editors and mixers compelled to promote themselves by crafting a flattering, yet untenable, history of their trade as a matter of professional necessity.

APOCALYPSE NOW'S ROAD SHOW AND DOLBY'S SPLIT-SURROUND PROCESS

Although critics and scholars eulogize *Apocalypse Now's* initial theatrical run as a milestone for film sound, most theaters did not play its highly regarded surround-sound design. UA released *Apocalypse Now* in 35mm with two-track optical stereo and in 70mm with six-track magnetic stereo, formats known as Dolby SVA and Dolby Six-Track, respectively.²² Both formats featured Dolby's A-type noise reduction and, subsequently, both were called Dolby Stereo in advertisements. This marketing strategy simplified Dolby technology around a single brand identity, but it also concealed the many acoustical differences between the two formats. Murch, for instance, removed all surround-sound effects from the film when mixing its 35mm release.²³ His decision was in response to Dolby SVA's storage process, which adopted Sansui Electric's method for compressing four loudspeaker channels into two tracks.²⁴ Known as matrixing, this method caused every sound intended for the rear loudspeakers to also leak into the front loudspeakers.²⁵ Matrixing, in turn, compromised the creation of auditory sensations like the illusion of hearing helicopters circle the theater. In order to avoid signal leakage, Murch designed the two-track prints to play exclusively from the front loudspeakers.

Audiences therefore heard *Apocalypse Now's* surround-sound design only during 70mm engagements, as these wider prints did not rely upon matrix compression to produce rear-channel effects. Each 70mm filmstrip contained four stripes of magnetic iron oxide that collectively housed six individual audio tracks.²⁶ Tracks one, three, and five corresponded to the left, center, and right loudspeakers at the front of the theater, while tracks two and four were sent to additional loudspeakers behind the screen and were intended to boost only those sounds with frequencies below 200 Hz (roughly half an octave below middle C).

As designed by Dolby's Max Bell and David Watts, the film's 70mm prints played two different surround-sound mixes depending on the auditorium's sound system.²⁷ Theaters equipped with only the CP-100 played 70mm prints

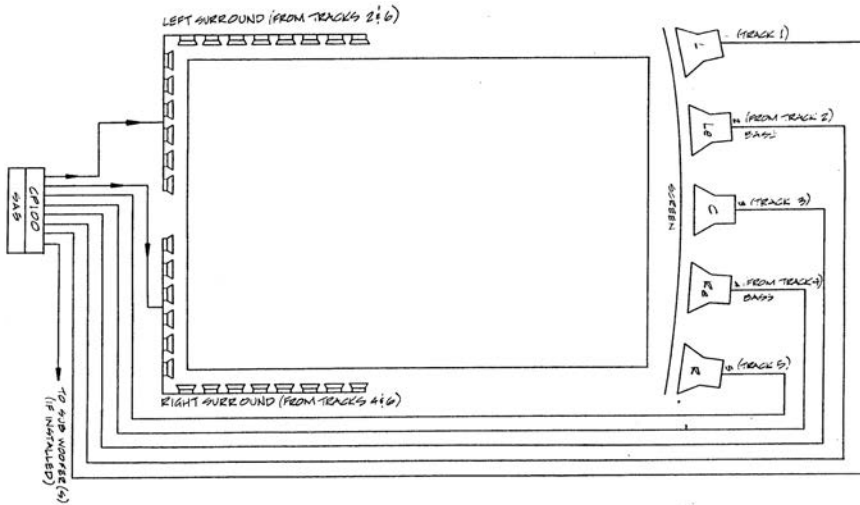


Fig. 1: Dolby's hand-drawn illustration of *Apocalypse Now's* split-surround configuration, which appeared inside the Dolby SA-5 Surround Adapter manual. (Courtesy Dolby Laboratories)

with a single channel of surround sound; loudspeakers on the rear and side walls of the auditorium reproduced the sound effects stored on track six.²⁸ In contrast, theaters that acceded to UA's demands and installed an additional SA-5 processor played 70mm prints with a modified surround-sound design. To achieve this modification, prints contained additional sound effects on tracks two and four in the unused frequency range above 500 Hz (roughly one octave above middle C).²⁹ The SA-5 read these high-frequency sounds and divided them among the rear loudspeakers; the high frequencies on track two combined with the full range of frequencies on track six to create a left-surround channel, and the high frequencies on track four similarly combined with track six to create a right-surround channel.³⁰ Dolby referred to this pair of rear channels as either "stereo surrounds" or "split-surrounds" (fig. 1). Despite the value that historians place on *Apocalypse Now's* split-surround design, fewer than twenty screens worldwide had installed Dolby's SA-5 by the time of the film's release.³¹ Only a small number of audiences actually heard these split-surrounds.

Further, the many spectacular surround-sound effects that scholars routinely attribute to *Apocalypse Now's* 1979 road show were not possible given the problems inherent to the split-surround process. For instance, mixing track six with tracks two and four would inadvertently mute sound effects intended for the rear loudspeakers. Dolby consultant John Iles recalls that this phenomenon, known as "signal cancellation," continued to be a major issue during the creation of split-surrounds for MGM's *Pink Floyd: The Wall* (1982), released

three years after *Apocalypse Now*. When re-recording engineers tried to pan a guitar between the left- and right-surround channels, all but the guitar's reverb disappeared when tracks two, four, and six played through the rear loudspeakers.³² As a result of signal cancellation, ironically, screens wired for split-surrounds would potentially play fewer sounds than would screens with only one channel of surround sound. Similarly, the use of tracks two and four for both low frequencies and surround sounds restricted the split-surround effects to frequencies above 500 Hz. This prevented engineers from panning mid- and low-frequency sounds across the rear loudspeakers. Engineers could only store these lower effects on track six, meaning that the sounds would emanate from loudspeakers on three sides of the theater rather than from a specific location behind the audience. This points to a key problem with Dolby's split-surrounds: the process might have allowed for two channels of surround sound, but its design significantly limited the quality and quantity of sounds that played through these two channels.

Such technical limitations indicate that *Apocalypse Now*'s digitally restored sound track is historically unreliable. The film's original six-track prints are reportedly unplayable due to the degradation of magnetic iron oxide, and more durable copies of the final mix were apparently never made.³³ In 1997 Murch transcoded the raw sound elements into Dolby's Audio Codec 3 format (AC3) in order to create a new mix that modified the split-surround design with frequency characteristics optimized for digital stereo but not afforded by Dolby Six-Track.³⁴ Histories of film that draw upon this digital restoration as evidence of Dolby's and Murch's extraordinary designs are therefore subject to error.

For instance, scholarship devotes considerable attention to the film's opening long take, during which an American helicopter flies in and out of the frame before dropping napalm on a Vietnamese jungle. In the digital reconstruction, the pulses from that helicopter ostensibly circle the audience; the sound begins in the right-surround channel behind the audience, then pans to the left-surround channel, and then pans across the left, center, and right channels in front of the audience (fig. 2).³⁵ In order for the original split-surround process to allow for this sound design, the range of pitches from that helicopter would all need to remain higher than 500 Hz when they pan between the two surround channels. However, an analysis of this sequence from the digital restoration reveals that the frequency range of the helicopter extends as low as 190 Hz in the right-surround and 390 Hz in the left-surround.³⁶ In other words, the restoration allows the helicopter to pan across the rear loudspeakers with all the sensory benefits provided by a full range of frequencies. The same panning effect, designed for the road show's restrictive frequency range, would have ultimately produced a different, limited illusory experience.

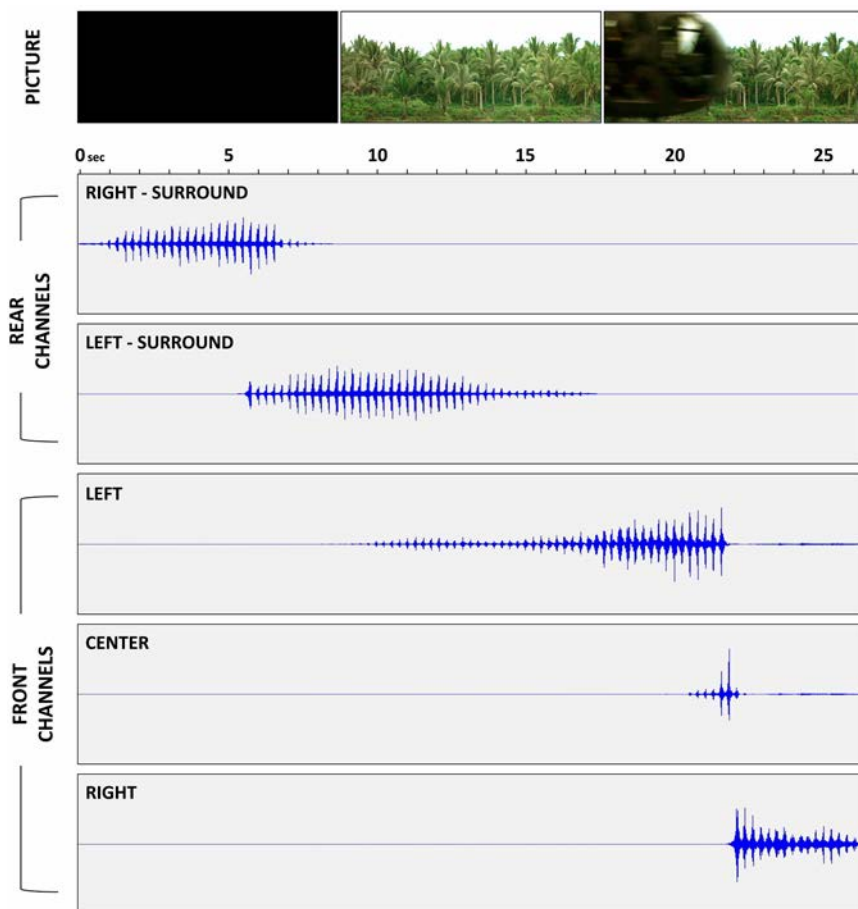


Fig. 2: The first twenty-six seconds of *Apocalypse Now*'s 1997 digital 5.1 restoration, which features a helicopter panning across the five loudspeaker channels as it flies over a Vietnamese jungle. The rear channels consist of two different audio signals that extend below 500 Hz at separate instances, stereo effects that were not possible during the film's 1979 road show.

Murch's modifications to *Apocalypse Now* therefore conceal the technical limitations of Dolby's split-surround process. As such, the digital restoration does not authentically reproduce the film's 1979 surround-sound mix. Instead, it reflects a design that Murch would have preferred to create, and those who use this restoration to write histories of surround sound are inadvertently mistaking an aesthetic ideal for actual practice. A more thorough understanding of Dolby's split-surround process reveals that *Apocalypse Now*'s original surround-sound design played to fewer audiences and was less sensational than what Murch and

the Dolby myth claim, what critics and audiences remember, and—as a result of the film’s digital restoration—what media scholars commonly assert.

SIX-TRACK AND SPLIT-SURROUNDS BEFORE *APOCALYPSE NOW*

We can further qualify *Apocalypse Now*’s place in history by examining the origins of its surround-sound technology. As Jay Beck notes, the 35mm Dolby SVA format for smaller theaters was promoted as an original technology but was actually cobbled together from the innovations of other companies, including Sansui’s matrix and Westrex’s two-track stereo format.³⁷ Less well-known is that Dolby’s celebrated 70mm six-track format for flagship theaters similarly repackaged preexisting stereo technologies and processes into both its physical media, or hardware, and its encoding processes, or software.

The design of Dolby’s 70mm prints, its hardware, was more than twenty years old by the time of *Apocalypse Now*’s release. During the early 1950s, Todd-AO’s Brian O’Brien led engineers at American Optical, Ampex, and Westrex in the construction of a six-track print design that producer Michael Todd could utilize for 70mm road shows.³⁸ Todd wanted to offer audiences cutting-edge exhibition technologies, and six-track stereo was intended to build upon the recent innovations in the field of sound reproduction following the success of *This Is Cinerama* (1952). As John Belton records, Cinerama’s widescreen image was a composite of three separate filmstrips projected simultaneously onto the left, center, and right sections of the expansive Cinerama screen.³⁹ A fourth strip of film that was fully coated with magnetic oxide played in synchrony with the pictures and contained seven audio tracks for the front and rear loudspeakers.⁴⁰

Cinerama’s requirement of multiple projectors was both expensive and cumbersome for theaters to install, but the popularity of its surround-sound design encouraged producers to develop cheaper and simpler methods of adding magnetic, stereophonic sound tracks to commercial releases. One method, known as 35mm Cinemascope, simplified Cinerama’s three-track image and seven-track stereo to a single filmstrip that housed one picture track between four narrow stripes of magnetic oxide.⁴¹ These stripes contained four tracks of sound corresponding to the left, center, right, and surround channels. Another means of reducing Cinerama to a single filmstrip was the Todd-AO format, what Todd reportedly called “Cinerama out of one hole.”⁴² Todd-AO’s 70mm prints similarly consisted of four stripes of iron oxide, but these wider stripes held six different audio tracks, five corresponding to loudspeakers behind the screen and the sixth providing the surround-sound effects.⁴³ The six-track stereo format premiered with Todd-AO’s *Oklahoma!* (1955) and *Around the World in 80 Days* (1956) and was soon adopted by other studios for such films as *West*



Fig. 3: A 70mm print of *Battle of the Bulge* (1965). The four solid stripes of iron oxide located on each side of the sprocket holes housed the six-track magnetic stereo channels.

Side Story (1961) and *Battle of the Bulge* (1965) (fig. 3). The 70mm prints used for *Apocalypse Now*'s road show also employed Todd-AO's six-track design.

As with its physical hardware, Dolby's various encoding processes, its software, originated several decades before the premiere of *Apocalypse Now*. Dolby's A-type noise reduction, which allowed for an increase in stereo channels without a notable increase in noise levels, was ostensibly the same noise-reduction process developed at Bell Telephone Laboratories in 1932 and routinely used by record companies throughout the following decades.⁴⁴ At that time, vinyl media were prone to high-frequency surface noise, and to help minimize

this hiss, engineers increased the volume of high frequencies when cutting a record's grooves.⁴⁵ During playback, listeners manually adjusted the sound system's equalizer to decrease high frequencies, an adjustment that also decreased the amount of noise emanating from the loudspeakers.⁴⁶ By the late 1940s, this "pre- and post-equalization" process also became a standard way for Hollywood studios to reduce noise and optimize a film's decibel levels.⁴⁷

Although Ray Dolby himself claimed that he solved the problem of noise "in a way that no one had done before," his A-type noise reduction was merely an automation of the Bell method.⁴⁸ His system divided the original audio signal into four separate frequency ranges, after which it increased the volume of the high frequencies during recording and decreased the volume of these frequencies during playback.⁴⁹ As with earlier forms of noise reduction, this decrease in high-frequency volume similarly decreased the amount of hiss on the recording. In other words, Dolby Labs did not encode their prints with a new noise-reduction method, but with a method that recording engineers had already invented.

Dolby's split-surround process had similar origins. Shortly after the premiere of *This Is Cinerama*, sound departments experimented with storing extra surround-sound channels on prints designed with only one track for surround sound. These modifications were intended to provide theaters with a variety of sound-track options without requiring distributors to house multiple inventories of a single film. One such split-surround format premiered with the 35mm release of *Around the World in 80 Days* in 1957.⁵⁰ In order for the film's four-track prints to sound as startling as its 70mm six-track prints, sound engineers implemented Robert Fine's Perspecta process, whereby the surround track contained inaudible, low-frequency control tones that corresponded to different loudspeakers located along the rear and side walls of the theater.⁵¹ A Perspecta integrator then decoded each control tone and sent the fourth track's audio to each of these locations, a process that—like Dolby's split-surrounds—allowed rear-channel effects to emanate independently from the left- and right-surround loudspeakers.⁵² A similar experiment premiered with the film adaptation of the rock opera *Tommy* (1975). Former Sansui consultant John Mosely applied the company's four-channel matrix to *Tommy*'s 35mm four-track prints in order to create five playback channels, which Mosely named "Quintaphonic Sound."⁵³ Specifically, Mosely stored the film's center channel on track one, while he matrixed the left, right, left-surround, and right-surround into tracks two and three.⁵⁴ Upon playback, the system directed the audio from tracks one, two, and three into five loudspeakers that surrounded the audience, including separate surround channels for the two rear corners of the theater.

Further, many split-surround designs before *Apocalypse Now* avoided these convoluted methods of multichannel compression. The road show of MGM's *How the West Was Won* (1962), for instance, featured a seven-track stereo format that allowed each loudspeaker channel to receive its own magnetic sound track.⁵⁵ The system sent five of the film's stereo tracks to the row of five loudspeakers behind the screen and sent the two remaining tracks to the left- and right-surrounds. Additionally, Imax releases beginning with *North of Superior* (1971) contained six tracks of audio stored on a separate filmstrip that played in synchrony with a 70mm picture.⁵⁶ The six tracks corresponded to three loudspeaker channels located behind the screen, two channels for the rear of the theater, and a height channel for the theater's ceiling. Thus, despite claims that Dolby and Murch were the first to introduce filmmakers to separate left- and right-surround channels, numerous split-surround formats existed in cinemas well before *Apocalypse Now*'s road show, and—unlike Dolby Six-Track—these formats did not suffer from technical constraints that limited the effects to only high frequencies.

In his study of Hollywood branding, Paul Grainge argues that “the Dolby name became a means through which exhibitors could help audiences meaningfully differentiate one theatre from another and appropriately distinguish the immersive potential of cinematic sound from the flatter audio effects of domestic television.”⁵⁷ However, the presence of the Dolby logo on marquees and advertisements also suggested that there was a meaningful difference between the company's six-track stereo technology and earlier six-track formats. The reality, as I have illustrated, is that 70mm Dolby Stereo was not a new and improved surround-sound technology; it was a new brand name for preexisting processes. The innovations regularly attributed to Dolby Labs and Walter Murch were developed by an older generation of sound engineers. As such, the design of *Apocalypse Now*'s 70mm prints pieced together hardware and software found in competing stereo systems. Although the Dolby brand helped to reinvigorate the theatrical market for multichannel sound systems during the late 1970s, the Dolby myth's disregard for previous innovations has subsequently perpetuated misconceptions about the historical distinction of Dolby Stereo technology.

SURROUND-SOUND AESTHETICS BEFORE DOLBY STEREO

Unlike Dolby's technical origins, there are considerable challenges when tracing the development of the company's stereo aesthetic, given that *Star Wars*, *Apocalypse Now*, and other prominent sound tracks from the Dolby era have since been remixed for digital stereo, rendering their original surround-sound designs inaccessible. Nonetheless, my examinations of unrestored four-track and six-track mixes from the 1950s through the 1980s reveal that the stereo designs of

the Dolby era were continuations of the stylistic conventions that Hollywood had established before the 1970s. I illustrate this finding through an extended analysis of *Tron*.⁵⁸ Similar to Murch's sound design for *Apocalypse Now*, practitioners and critics argue that Frank Serafine's sound effects, Wendy Carlos's electronic score, and Mike Minkler's six-track mix made *Tron* "one of the most adventurous" of Dolby releases.⁵⁹ Its use of surround sound also typifies how *The Wiz* (1978), *Alien* (1979), and other 70mm Dolby Stereo films routinely sent music and effects to the rear loudspeakers.⁶⁰ The originality that historians attribute to the sound design of these films, I contend, further feeds the Dolby myth.

The story of *Tron* follows Kevin Flynn, a computer engineer who is absorbed into the digital universe of a computer's mainframe when attempting to stop the evil Master Control program from taking over the world. Similar to those of other Dolby releases, *Tron's* surround channel remains active throughout the film. More than sixty of *Tron's* ninety-five minutes contain either diegetic or nondiegetic music cues, all of which emanate from every loudspeaker. For instance, when Lora and Alan visit Kevin at his video-game arcade (0:17:10), the arcade's source music—Journey's "Only Solutions"—plays from the surrounds. Similarly, when an illuminated disc slices Sark's skull (1:24:22), Carlos's score accents the dramatic blow in the front and rear channels.

The practice of sending music to the rear loudspeakers was common in Dolby Six-Track releases, yet this technique did not originate in the 1970s or 1980s but in the 1940s. The road show of *Fantasia* (1940) notably featured three channels of music that emanated from loudspeakers at the front and back of the theater.⁶¹ Further, re-recording engineers in the 1950s and 1960s routinely enhanced sound tracks by filling the surrounds with music, such as Lionel Newman's jazz score in *Compulsion* (1959), the lyrical whistling of street gangs in *West Side Story* (1961), and the many song-and-dance numbers in *Sweet Charity* (1969).⁶² Although *Tron's* use of electronic music was unique, even for the 1980s, the placement of this music in the rear loudspeakers adhered to the practices codified by Hollywood filmmakers during earlier decades.

Dolby Six-Track's dependence on earlier mixing techniques also extended to a film's atmospheric effects and reverberations, diegetic sounds that were sent to the rear loudspeakers to provide greater contrast between changes in setting. In *Tron*, the use of atmospheric effects accentuates the differences between Los Angeles and the computer world. For instance, when Kevin, Lora, and Alan converse in Kevin's small apartment, their voices and the noises of the city remain in the front loudspeakers (0:19:10). In contrast, when Kevin, Tron, and Ram discuss their plan to attack Master Control, the buzzes of the mainframe's neon lights emanate from every channel (0:48:15) (fig. 4). In order to emphasize the digital world's stadium-like size, Kevin's, Tron's, and Ram's



Fig. 4: Ram, Kevin, and Tron converse on the edge of an expansive room within the computer's mainframe in *Tron* (1982).

voices also resonate loudly from the front channels while echoing quietly in the rear. As *Tron* illustrates, the surround-sound designs for Dolby Six-Track films organize the story's universe so that spectacular settings receive rear-channel effects while ordinary settings do not.

Notably, similar designs also occur in surround-sound mixes throughout the 1950s and 1960s. In *Journey to the Center of the Earth*, geologist Oliver Lindbrook leads an expedition from the Earth's surface to its core, and much like in *Tron*, the four-track mix provides acoustical contrast between the aboveground and belowground environments.⁶³ For example, when Carla visits an Edinburgh inn to investigate the disappearance of her husband, the atmospheric noise from the restaurant emanates from only the front channels (0:36:34). In contrast, when Oliver, Alec, Carla, and Hans scale the walls of a subterranean cavern, the rumbling of what Oliver calls "a slight tremor coming from undefined regions" overtakes both the front and rear loudspeakers (0:53:16). Later, when the four characters discover a volcanic chimney, its violent updraft whistles from every wall of the theater as well (1:54:02).

The Sand Pebbles offers another example of how pre-Dolby mixers used surround-sound effects to highlight changes in location. The film follows Jake Holman, a naval engineer on the USS *San Pablo*, who is tasked with patrolling the coast of China. Similar to *Tron*, the military drama employs a patterned use of reverberation effects to contrast the cramped quarters of the *San Pablo* with the expansive settings of Chinese villages.⁶⁴ For instance, when Collins reprimands Jake in his office after the accidental death of a *San Pablo* crewmember, the dialogue plays through only the front loudspeakers (0:41:22). But when Jake and Frenchy stop debt collectors from undressing Maily in the lobby of a brothel,

the echo from Frenchy's yells and the laughter from the onlookers issue from the front loudspeakers and resonate quietly in the rear loudspeakers to simulate the echoes created by the stone brothel's high ceilings (1:44:40). The surround-sound effects in films like *Journey to the Center of the Earth* and *The Sand Pebbles* illustrate that the dramatic function of atmospheres and reverberation during the Dolby era was a practice that, like musical effects, originated before Hollywood's adoption of Dolby Stereo.

Finally, Dolby Six-Track films routinely sent sound effects to the rear channels for dramatic impact. Rick Altman writes that after the emergence of Dolby Stereo, "the surrounds began a new career (especially in fantasy or horror films) as purveyors of spectacular effects," where "every menace, every attack, every emotional scene seemed to begin or end behind the spectators."⁶⁵ In *Tron*, these sound effects emanate from objects that pose the greatest threat to Kevin's life. As tanks chase Kevin, Tron, and Ram, the roaring of engines and the firing of missiles play in both the front and rear loudspeakers (0:45:40). Similarly, after Kevin jumps inside the Master Control's core, its rhythmic pulses and subsequent eruptions issue from every wall of the theater (1:27:20).

Although scholars trace the origins of such surround-sound effects to the Dolby era, these effects were just as prominent in earlier decades. In *Journey to the Center of the Earth*, Count Saksussemm shoots Alec with a gun that fires from every loudspeaker (1:22:05). Likewise, the bullets and missiles launched by the Chinese fleet at the climax to *The Sand Pebbles* all explode behind the screen and ricochet in the surrounds (2:36:45). Films even panned sounds over the heads of filmgoers long before *Apocalypse Now's* vaunted helicopter effects. The opening of *Battle of the Bulge*, for instance, pans the humming of Kiley's airplane between the front and rear loudspeakers to simulate the Nazi colonel's perspective from the ground (0:06:50).⁶⁶ More so, the Pearl Harbor attack in *Tora! Tora! Tora!* (1970) features a complicated mix in which the engines of Japanese airplanes continually pan between the front and back channels, creating the sensation that planes were flying not only across Hawaiian skies but through the space of the theater (1:46:25).⁶⁷

These and the other examples explored above considerably predate the Dolby era yet employ equivalent stereo designs. Thus, contrary to the Dolby myth, the company's arrival in the 1970s did not lead filmmakers to establish a new set of surround-sound practices defined by atmospheres, echoes, and flying objects. Like six-track stereo and split-surrounds, the rear-channel aesthetics that historians attribute to Dolby were developed and refined by Hollywood's sound departments in earlier decades.

HOME STEREO AND ITS DISCOURSES OF SOPHISTICATION

Despite the wealth of evidence that contradicts the Dolby myth, its claims remain a fixture of industry discourse due to the way they dignify the field of postproduction sound. The myth originated in response to the economic conditions during the decades that followed the Supreme Court's *Paramount* decision of 1948. According to Whittington, the court's decrees that studios divest from theaters and cease their block-booking and price-fixing practices created adverse consequences for Hollywood's sound community.⁶⁸ The sizeable decrease in studio releases and the concurrent rise of independent productions as a result of the decrees prompted studios to downsize their labor force and dismantle their sound departments. Editors and mixers either became freelance contractors or formed independent postproduction studios.

By the 1960s and 1970s, Whittington reports, producers were often failing to reserve adequate funds for postproduction sound, a predicament that forced Hollywood's sound workers to compete for fewer, lower-paying jobs. Answering these conditions, sound personnel attempted to elevate the status of their profession and thereby increase the financial value of their creative services. Initially, practitioners—including Walter Murch and Alan Splet—began calling themselves “sound designers” instead of less glamorous titles like supervising sound editors or re-recording mixers. As Beck argues, practitioners used this loftier appellation not only to work across the different domains of postproduction without violating the rules of local sound unions but also, and more frequently, to promote themselves as artistically minded filmmakers and not simply expendable technicians.⁶⁹ The job title, however, soon acquired a stigma due to “a number of individuals, like Frank Serafine, who marketed themselves as ‘sound designers’ but who were little more than novice manufacturers of electronic sound.”⁷⁰ As a result, the term decreased in use by the 1990s, and most practitioners resumed traditional divisions of labor between editors and mixers.

Taken together, Whittington's and Beck's histories detail how the title of sound designer failed to redefine postproduction sound as an essential component of Hollywood filmmaking. I propose that, despite this failure, the industry's adverse economic conditions induced practitioners to cultivate other means of increasing their worth to producers. Specifically, Hollywood's sound community began to circulate a history of their profession that positioned themselves as indispensable, radical innovators. They claimed that their use of Dolby technology drew inspiration from the music industry's mixing experiments of the 1960s and 1970s, and that this in turn distinguished their work from studio-era sound tracks. In other words, practitioners sought to define themselves as following in the tradition of *Sgt. Pepper* (1967) rather than *Sergeant York* (1941).

The stories that would later form the Dolby myth began as tools for editors and mixers to solidify this reputable historical lineage. Serafine, for instance, recounts that he was drawn to the field of sound after listening to the feedback from Jimi Hendrix's guitar, and—like psychedelic recordings by the Beatles—that his effects for *Tron* and *Star Trek: The Motion Picture* (1979) drew upon the teachings of musician-spiritualist Ravi Shankar.⁷¹ These inspirations were then channeled through new audio technologies, whereby Serafine contends they radically changed the filmgoing experience; rather than simply telling stories, movies now delivered “a jump in our level of consciousness.”⁷² Following Serafine's lead, practitioners including Ben Burtt and Gary Rydstrom offered critics similar accounts of the Dolby era's origins.⁷³ Murch's explanation for how music technology influenced *Apocalypse Now*, however, remains the most-cited example of this storytelling tradition.⁷⁴ According to Murch, Coppola wanted his war epic to “partake of the psychedelic haze” of Vietnam and “create a far out juxtaposition of imagery and sound.”⁷⁵ In order to conceive of this haze, Coppola and Murch listened to experimental recordings for a quadraphonic stereo system, an experience that reportedly inspired Murch to create the film's split-surrounds and prompted Coppola to require theaters to install Dolby's cutting-edge surround-sound equipment.⁷⁶ As a result of *Apocalypse Now*'s ingenuity, Murch asserts, its stereo format became the technological standard for all motion pictures.⁷⁷

Murch's reference to quadraphonic stereo (or quad) is significant in that it draws upon the format's reputation for sophistication. During quad's short-lived tenure in the early 1970s, magazines like *Rolling Stone*, *High Fidelity*, and *Stereo Review* dedicated columns to the system's technical complexities, while recording engineers similarly argued that proper quadraphonic listening required consumers to develop sensitivities to the small, yet important, details of a four-channel mix.⁷⁸ Such discourses of sophistication were common to home stereo consumer cultures. Music historian Keir Keightley argues that owning high-quality stereo systems connoted “a sense of elevated class, cultural capital and prestige” and signified the owner's ability to enjoy listening to sound for its own sake.⁷⁹ Tim Anderson similarly observes that this refined appreciation of home stereo even encouraged music aficionados to exchange esoteric knowledge through games of “stereomanship,” whereby they achieved elevated social status by eloquently indulging in the format's esteemed technical jargon.⁸⁰ This growing prestige of home-stereo listening came at a time when Hollywood sound practitioners hoped to define themselves as a nonexpendable workforce. By aligning themselves with home stereo's sophistication, practitioners distinguished their own sound tracks as essential to the creation of quality cinema.

Despite their rhetoric, however, practitioners were unlikely to have treated home-stereo recordings as the aesthetic model for Dolby-era surround sound, for these recordings rarely featured the extraordinary panning effects that filmmakers valued. Such was the case with quadraphonic stereo. Quad's use of additional loudspeakers resembled psychedelic performance art of the 1960s, specifically works that flaunted light projectors, multichannel stereos, and other small-scale technologies in order to replace the authenticity of a live concert with a kaleidoscope of denaturalized sound.⁸¹ Audiophiles further associated the technical complexities of the format with innovation, experimentation, and heightened sensory experiences.⁸² These associations emboldened Murch and other filmmakers to portray quad as the inspiration for their own ingenuity, but this reputation for psychedelic experimentation misrepresented the format's actual surround-sound designs.

Quadraphonic recordings instead epitomized the tradition of fidelity that, as Keightley notes, privileged "the approximation of aural 'reality' and an illusion of presence ideally indistinguishable from the 'live' real thing."⁸³ Quad's four loudspeakers were arranged in a rectangle that surrounded the listener, a staging designed to enable engineers to more faithfully approximate concert-hall acoustics within the living room. Because stereo enthusiasts at the time argued that most concertgoers value the sounds that bounce off the rear and side walls of an auditorium, many quad recordings reproduced these echoes by facing microphones toward the rear of the auditorium during a live performance and by sending this reverb to the two rear channels during playback.⁸⁴ Additionally, four-channel mixes often recreated the location of musicians within recording studios. Some producers even arranged entire symphony orchestras in a circle around the conductor and then preserved the conductor's audio perspective when mixing these recordings for a listener's living room.⁸⁵ The hope of such re-creations, and indeed the mission of quadraphonic stereo, was to document what Keightley calls the "aural 'reality'" of a live performance for smaller-scale reproduction.

One rare exception to this fidelity aesthetic was the original four-channel mix for Pink Floyd's album *The Dark Side of the Moon* (1973).⁸⁶ During instances of lyrical binaries in the song "Us and Them"—such as "us and them" and "up and down"—recording engineer Alan Parsons repeatedly panned the repetitions of each word clockwise around the four loudspeakers, a spiraling effect that encircles the listener and augments the song's themes of disorientation.⁸⁷ Similarly, as the words "the lunatic is in my head" emanate from the front two channels during the song "Brain Damage," Parsons sent staccato laughter to random loudspeakers, simulating the way that this lunatic might bounce around inside someone's cranium.

Although such experiments with surround sound had the potential to create a “psychedelic haze,” they were almost impossible to hear. In order to avoid dual inventories, stereo engineers developed methods of compressing two- and four-channel mixes onto the same two-track records, and these methods inadvertently remixed a quad recording’s intended surround-sound designs.⁸⁸ For instance, the popular matrixing method compressed a quadrasonic recording by altering the volume (amplitude) and timing (phase) of all four channels.⁸⁹ During playback, the decompression caused sounds that were initially intended to play through only one loudspeaker to play through three loudspeakers at the same time.⁹⁰

Matrixing was perhaps advantageous for musicians who wished to increase each instrument’s “illusion of presence,” but it was not advantageous for recordings in which the location of a sound was integral to the psychedelic experience. For example, once Parsons encoded *The Dark Side of the Moon* with CBS’s Stereo-Quadrasonic (SQ) matrix, the clockwise movement of the repeated “us” in “Us and Them” no longer panned from speaker to speaker. Instead, each word issued from three loudspeakers concurrently, a remix that replaced the sensation of feeling encircled by voices with a conventional wall of sound wherein voices inundate the listener from no discernible direction.⁹¹ The experience of hearing “Us and Them” in its initial quadrasonic release was ostensibly the same as hearing it play through a single-channel sound system at a loud volume. In other words, not only were psychedelic or experimental stereo mixes rare, but home-stereo encoding technologies erased the psychedelic traits from the few recordings that featured salient surround-sound effects. The use of additional loudspeakers merely reinforced conventional stereo aesthetics. It was therefore difficult for Dolby-era editors and mixers to continue home stereo’s tradition of surround-sound experimentation because, in most circumstances, such directional effects did not actually exist.

Further, even if experimental home-stereo effects were to have existed in large quantities, filmmakers would have been dissuaded from replicating them due to the differences in how audiences pay attention to music and film. As Anderson and Keightley observe, people listen to records in a variety of ways: some might close their eyes and listen intently, some might read along to the lyrics, and some might pay only light attention to the music while socializing with friends. Although columns in audiophile magazines recommended that consumers sit in the middle of the room so that loudspeaker channels would be adequately balanced, the pleasure of listening to music was not diminished if consumers moved around for the duration of the recording; in fact, a good beat all but demanded it.⁹² Recording engineers consequently had the flexibility to experiment with stereo effects without worrying about listeners turning to face

the loudspeakers in response, for moving one's head did not interfere with the auditory experience.

In contrast, the prominence of the movie screen prevented motion picture mixers from exercising the same degree of freedom in their surround-sound designs. Filmgoers might chat or daydream in movie theaters, but they do so while resting on seats that face the screen. If audiences look away from the image, not only might they miss important story information, they risk removing themselves from film's immersive storytelling apparatus. Sound engineers fretted that surround sounds could have this undesirable effect. Tomlinson Holman, for one, warned that "drawing attention to the surrounds breaks the suspension of disbelief and brings the listener 'down to earth'—their environs, rather than the space made by the entertainment."⁹³ Recognizing this, motion picture sound engineers discouraged any surround-sound effects that could prompt audiences to turn around in search of the sound's source—a phenomenon that became known among mixers as the "exit sign effect" due to the typical proximity between a theater's rear loudspeakers and the emergency exits.⁹⁴

Mark Kerins argues that because filmmakers feared that audiences "will misinterpret attention-drawing sound effects in the surround channels as originating from occurrences in the theater," they routinely designed "conservative screen-centric surround mixes regardless of whether aggressive surround mixing might be more appropriate for the scene at hand."⁹⁵ This tendency occurs even in the Dolby Six-Track releases commonly credited with surround-sound innovation. Although films like *Star Wars*, *Apocalypse Now*, and *Tron* featured sequences that reportedly mixed together as many as two hundred different sound effects at once, fears of the exit sign effect caused practitioners to channel these effects predominantly through loudspeakers in front of the audience rather than through those in the rear of the theater.⁹⁶ The belief that audiences should face the screen at all times in turn made Dolby-era practitioners reluctant to offer audiences the types of sensational surround-sound effects that were associated with home stereo.

Despite such obstacles, motion picture sound practitioners nonetheless claimed that their surround-sound mixes drew upon home stereo's experimental effects. In so doing, filmmakers engaged in a form of promotional rhetoric that has been common to the sound-recording industries since the 1970s. According to cultural historian Timothy Taylor, alt-rock musicians, big-beat DJs, and other recording artists often downplay the degree to which their work borrows from popular traditions. In order to appear more sophisticated, these artists constructed alternate histories in which they become heirs to a European avant-garde defined by "the romantic notion of the un(der)appreciated solitary genius" and exemplified by avant-garde composers such as Pierre Henry and

Pierre Schaeffer.⁹⁷ The reluctance of Dolby-era practitioners to acknowledge the indebtedness of their surround-sound designs to Hollywood's popular practices, and their eagerness to situate themselves alongside home stereo's more esoteric traditions, inspired the construction of a comparable alternate history in which these practitioners revolutionized Hollywood aesthetics by elevating the craft of sound mixing from a technical skill to an art.⁹⁸ Though untenable, this alternate history was easy to perpetuate in an industry that benefited financially from claims that productions like *Apocalypse Now* were of great aesthetic importance.

The construction of the Dolby myth, however, was not ill intentioned; it was a way for craftspeople to convince film producers that postproduction sound was critical to the filmmaking process and that editors and mixers deserved a larger share of the film's budget. Freelance sound practitioners like Walter Murch and Frank Serafine could then recite versions of this trade story in order to increase the value of their creative work. The Dolby myth is therefore a record of the film sound community's insecurities during a moment in history when these professionals felt undervalued and threatened by Hollywood's transition from a studio-based economy to one dominated by independent productions. By treating the hyperbolic claims embedded within the myth as reliable accounts of the past, historians inadvertently conceal the discursive strategies that sound practitioners were pressured to employ during periods of economic uncertainty.

CONCLUSION

This article invites scholars to apply greater skepticism to the trade stories that industry professionals routinely volunteer. Contrary to popular anecdotes, Dolby did not dramatically transform Hollywood surround sound. Rather, the company inherited technologies and popularized mixing styles that were established by an earlier generation of motion picture sound engineers. What made Dolby distinct was the extent to which filmmakers exploited its brand for personal gain. Craftspeople who were hard-hit by the dismantling of Hollywood's studio system promoted themselves to producers and critics by characterizing their uses of the latest Dolby technology as aesthetic innovations that launched an industry-wide revolution. These characterizations then engendered a myth that exaggerated Dolby's effect on surround-sound history and mitigated the financial toll that Hollywood's economic changes had exerted upon its below-the-line communities. Indeed, the continued reliance on such characterizations in both Hollywood and academia suggests that the perpetuation of the Dolby myth was a more consequential phenomenon in film history than was the adoption of Dolby Stereo.

Notes

I thank William Knoblauch, Alex Kupfer, Jonathan Lippman, and Brandi Rogers for their invaluable feedback on earlier drafts of this paper; Jay Beck for sending me the transcript to his interview with Walter Murch; Katherine Quanz for offering me her rhetorical analyses of Toronto sound practitioners; and Jeff Smith for encouraging me to publish this article. I also thank Bob Heiber and Jordan Pery of Chace Audio for facilitating my access to their production files for a number of four- and six-channel magnetic sound tracks.

1. "Bid Letters Out on *Apocalypse*," *Variety*, February 28, 1979, 5.
2. *Variety* later reported that installations were not required and that they would cost closer to \$5,500. "Exhibs Asked to Buy Dolby Unit for 70m *Apocalypse*," *Variety*, September 5, 1979, 6, 43.
3. "An Archival Detailing of UA's *Apocalypse Now* Since 1967 Start," *Variety*, May 23, 1979, 5, 46.
4. For coverage of its production difficulties, see "Typhoon Olga Wrecks Coppola Production; Forces 6-Wk Hiatus," *Variety*, June 2, 1976, 1, 69; "Temple Roof Falls at *Apocalypse* Location, but Injuries Avoided," *Variety*, March 23, 1977, 6; and "Coppola Hocks His Personal Fortune," *Variety*, June 8, 1977, 5. For coverage of its controversial content, see "Milius Re-Heats His *Apocalypse*," *Variety*, September 3, 1975, 5, 27; and "Word Leaks of Pentagon's Sour View of Coppola's *Apocalypse Now*; Deemed 'Anti-U.S.' in Script," *Variety*, June 23, 1976, 5, 35.
5. Jay Beck, "A Quiet Revolution: Changes in American Film Sound Practices, 1967–1979" (PhD diss., University of Iowa, 2003), 37–55.
6. William Whittington, *Sound Design & Science Fiction* (Austin: University of Texas Press, 2007), 117–18.
7. For instance, see Jim Webb and Don Ketteler, "Using the Multitrack Format for Production Film Recording," *Recording Engineer/Producer*, April 1980, 110, 112, 114–17; Tom Kenny, "Mike Minkler: Storytelling through Sound," *Mix*, September 2002, 50, 52, 54, 56.
8. William Whittington, "Sound Design in New Hollywood Cinema," in *Sound and Music in Film and Visual Media*, ed. Graeme Harper (New York: Bloomsbury Academic, 2009), 559.
9. Randy Thom, "Designing a Movie for Sound," *Iris* 27 (1999): 11. See also Skip Lievsay's discussion of *Apocalypse Now* in Vincent LoBrutto, *SoundOn-Film: Interviews with Creators of Film Sound* (Westport, CT: Praeger, 1994), 268; Rob James, "Gary Rydstrom Interview," *Studio Sound*, September 2000, 51, 56; and Larry Blake, "*Apocalypse Now* REDUX: New Scenes, New Sounds for Francis Coppola's 1979 Masterpiece," *Mix*, August 2001, 55.
10. Kevin Jackson, "Murch's Sound, Coppola's Fury," *Independent* (London), November 24, 2001, 10. Dolby engineers discuss the film's stereo technology in "The New Technology: The Role of Noise Reduction, Evolution of Film Sound," *Dolby Background Information on Film Sound* (San Francisco: Dolby, 1980), 6; see also, Bruce Emery, "Beyond the Matrix: Dolby Digital Surround Sound," in *Cinesonic: Experiencing the Soundtrack*, ed. Philip Brophy (Sidney: Southwood, 2001), 41–45.
11. Examples include Frank Paine, "Sound Mixing and *Apocalypse Now*: An Interview with Walter Murch," in *Film Sound: Theory and Practice*, ed. Elisabeth Weiss and John Belton (New York: Columbia University Press, 1985), 356–60; LoBrutto, *SoundOn-Film*, 83–99; Mark Cousins, "Walter Murch: Designing Sounds for *Apocalypse Now*," in *Projections 6: Filmmakers on Filmmaking*, ed. John Boorman and Walter Donohue (London: Faber, 1996), 149–62; Tom Kenny, "Walter Murch: The Search for Order in Sound & Picture," *Mix*, April 1998, 12–24; and Michael Jarrett, "Sound Doctrine: An Interview with Walter Murch," *Film Quarterly* 53, no. 3 (2000): 2–11.

12. LoBrutto, *SoundOn-Film*, 84; Michael Ondaatje, *The Conversations: Walter Murch and the Art of Editing Film* (New York: Knopf, 2002), 6–10.
13. Cousins, “Walter Murch,” 159–60.
14. Jackson, “Murch’s Sound, Coppola’s Fury,” 10.
15. Matt Schudel, “Ray Dolby, 80: Audio Pioneer Changed Sound of Music,” *Washington Post*, September 18, 2013, C8.
16. John Thornton Caldwell, *Production Culture: Industrial Reflexivity and Critical Practice in Film and Television* (Durham, NC: Duke University Press, 2008), 68.
17. Gianluca Sergi, *The Dolby Era: Film Sound in Contemporary Hollywood* (Manchester: Manchester University Press, 2004), 12–15.
18. See also Gianluca Sergi, “Tales of the Silent Blast: *Star Wars* and Sound,” *Journal of Popular Film and Television* 26, no. 1 (1998): 12–22.
19. Sergi, *Dolby Era*, 11.
20. Gianluca Sergi, “A Cry in the Dark: The Role of Post-Classical Film Sound,” in *Contemporary Hollywood Cinema*, ed. Steve Neale and Murray Smith (New York: Routledge, 1998), 158, 162.
21. For instance, see James Wierzbicki, *Film Music: A History* (New York: Routledge, 2009); John Richardson, Claudia Gorbman, and Carol Vernallis, eds., *The Oxford Handbook of New Audiovisual Aesthetics* (New York: Oxford University Press, 2013); and Kathryn Kalinak, ed., *Sound: Dialogue, Music, and Effects* (New Brunswick, NJ: Rutgers University Press, 2015).
22. SVA was an acronym for stereo variable area, a name for the pair of optical tracks that housed each print’s multichannel mix.
23. Beck, “A Quiet Revolution,” 52; Blake, “*Apocalypse Now* REDUX,” 57.
24. “Dolby Labs Reports Appreciable Increases of Sound System Installations in Theatres,” *BoxOffice*, December 13, 1976, 30.
25. The matrix involved storing the left, center, right, and surround channels onto two tracks: left-total (Lt) and right-total (Rt). The Lt track contained the left, center, and surround channels, and Dolby sent this entire track to the front-left loudspeaker. Similarly, the Rt track contained the right, center, and surround channels, and Dolby sent this track to the front-right loudspeaker. As a result, surround-sound effects emanated not only from rear loudspeakers but from two loudspeakers at the front of the theater. Larry Blake, “Mixing Dolby Stereo Film Sound,” *Recording Engineer/Producer*, April 1981, 68–79; Larry Blake, “Mixing Techniques for Dolby Stereo Film and Video Releases,” *Recording Engineer/Producer*, June 1985, 94–107; and Benjamin B. Bauer, “Directional Ambiguity of Quadraphonic Matrices [sic],” *Journal of the Audio Engineering Society* 19, no. 4 (1971): 315–16.
26. Larry Blake, “The Evolution and Utilization of 70mm SixTrack Film Sound,” *Recording Engineer/Producer*, April 1983, 64–78.
27. “Seeking Excellence in Cinema Audio: SMPTE Honour Max Bell,” *Cinema Technology*, December 2011, 38. Bell and Watts first tested their split-surround design on select prints of *Superman* (1978).
28. David P. Robinson, “CP100 Cinema Processor—A New Audio Control Center for the Motion Picture Theatre,” preprint no. 1112, Audio Engineering Society Convention 54, May 4–7, 1976, n.p.; “Now Meet See-Peewuno-o,” *BoxOffice*, December 17, 1977, 17.
29. John F. Allen, “A 70mm Review,” *BoxOffice*, January 1984, 29–30. The 500 Hz cutoff was designed for Dolby’s preferred Altec A-4 speaker systems, which divided the network of frequencies for the

- playback signal at 500 Hz. John Mayer and Terry Tomaselli, "Generating Low Frequency Audio Energy for *Apocalypse Now*," *Recording Engineer/Producer*, October 1979, 118.
30. *Dolby SA5 Surround Adapter* (San Francisco: Dolby, 1979), 1–3; "Dolby Develops SA5 Stereo Surround Unit for Francis Ford Coppola's *Apocalypse*," *BoxOffice*, September 17, 1979, 28.
 31. "Dolby Develops SA5 Stereo Surround Unit." In 1980 Dolby announced the release of their CP-200, a single processor that combined the functions of the CP-100 and the SA5 with greater economy, but the CP-200 was not available until after *Apocalypse Now*'s release. See David Robinson, "The CP200—A Comprehensive Cinema Theater Audio Processor," *SMPTE Journal* 90, no. 9 (1981): 778–85; "Dolby's CP200," *BoxOffice*, February 4, 1980, M26, M29.
 32. John Iles, "Dolby Stereo Surround on 70mm," *in70mm*, November 2, 2012; and July 2, 2014, http://www.in70mm.com/news/2012/format_43/index.htm.
 33. Blake, "*Apocalypse Now* REDUX," 58.
 34. *Ibid.*
 35. *Apocalypse Now*, directed by Francis Ford Coppola (1979; Hollywood, CA: Paramount, 1999), DVD. Coppola has released two separate versions of the film for home video: the 1979 theatrical version with a digitally enhanced sound track, and a similarly enhanced director's cut *Apocalypse Now Redux* from 2001. Both versions use the same 5.1 surround-sound design for this opening sequence.
 36. For this analysis, I used the sound editing software Audacity, which allows for the muting of sound effects above 500 Hz and for the separation of the 5.1 mix's two rear channels into individual waveforms.
 37. Beck, "A Quiet Revolution," 57–59.
 38. Lloyd Thompson, "Progress Committee Report," *Journal of the SMPTE* 65, no. 5 (1956): 248–49. See also Arthur Rowan, "Todd-AO—Newest Wide-Screen System," *American Cinematographer*, October 1954, 494–96, 526; "Westrex Wins 'Oscar' For Todd-AO Recording Job," *International Projectionist*, May 1958, 21.
 39. See John Belton, *Widescreen Cinema* (Cambridge, MA: Harvard University Press, 1992), 85–112.
 40. Hazard E. Reeves, "The Development of Stereo Magnetic Recording for Film (Part II)," *SMPTE Journal* 91, no.11 (1982): 1087–90; Ernest W. Franck and Edward Schmidt, "New Products and New Applications in the Magnetic-Tape and Film Fields," *Journal of the Audio Engineering Society* 4, no. 3 (1956): 90–100.
 41. E. I. Sponable, H. E. Bragg, and L. D. Grignon, "Design Considerations of CinemaScope Film," *Journal of the Society of Motion Picture and Television Engineers* 63, no. 1 (1954): 1–4. See also John Belton, "1950s Magnetic Sound: The Frozen Revolution," in *Sound Theory, Sound Practice*, ed. Rick Altman (New York: Routledge, 1992), 154–67; and Matthew Malsky, "The Grandeur(s) of CinemaScope: Early Experiments in Cinematic Stereophony," in *Living Stereo: Histories and Cultures of Multichannel Sound*, ed. Paul Théberge, Kyle Devine, and Tom Everett (New York: Bloomsbury, 2015), 207–25.
 42. Michael Todd Jr. and Susan McCarthy Todd, *A Valuable Property: The Life Story of Michael Todd* (New York: Arbor, 1983), 245.
 43. James Morris, "The Todd-AO System: A Projector for Both 70- and 35-mm Film," *International Projectionist*, October 1955, 7–10, 34.
 44. H. A. Frederick and H. C. Harrison, "Vertically Cut Sound Records: Recent Fundamental Advances in Recording and Reproducing Sound Using Vertical Undulations on a Disk," *Transactions of the American Institute of Electrical Engineers* 51, no. 4 (1932): 987–92.
 45. C. G. McProud, "Audiana—Recording Characteristics 2," *Audio Engineering*, January 1950, 20–21, 45.

46. "Dialing Your Discs," *High Fidelity*, February 1955, 70.
47. Wesley C. Miller, "Magnetic Recording for Motion Picture Studios," *Journal of the Society of Motion Picture Engineers* 48, no. 1 (1947): 61.
48. Emery, "Beyond the Matrix," 42.
49. The four separate frequency bands were (1) below 80 Hz, (2) between 80 Hz and 3 kHz, (3) between 3 kHz and 9 kHz, and (4) above 9 kHz. Ray M. Dolby, "An Audio Noise Reduction System," *Journal of the Audio Engineering Society* 15, no. 4 (1967): 383–88.
50. Carl E. Warner, "'Around the World' in 35-mm," *International Projectionist*, July 1957, 7–8.
51. Robert Fine, "Perspecta—The All-Purpose Recording and Reproducing Sound System," *International Projectionist*, July 1954, 32–33, 41–42.
52. According to Mark Davis, the Perspecta process specifically created three different loudspeaker channels for the rear of the theater: left-surround, right-surround, and center-surround. Davis, "History of Spatial Coding," *Journal of the Audio Engineering Society* 51, no. 6 (2003): 560.
53. "In Memorium: John Mosely," *Journal of the Audio Engineering Society* 44, no. ½ (1996): 93.
54. John Mosely, "Quintaphonic Sound," *SMPTA Journal* 86, no. 1 (1977): 20–29.
55. The original seven-track magnetic release was transcoded into a digital 5.1 mix during April 2002 by Chace Audio. Descriptions of this process and of the original seven-track mix are documented at Chace Audio in "Transfer and Synchronize: *How the West Was Won* (1962)," 26 April 2002, folder 020415-03/751702-02, Chace Audio, Burbank, CA.
56. Graeme Ferguson, "'North of Superior': The World's Largest Motion Picture," *American Cinematographer*, September 1971, 899–901, 912, 943–49; and "The Imax/Omnimax Giant Theaters," *BoxOffice*, March 19, 1979, MT4–MT5.
57. Paul Grainge, *Brand Hollywood: Selling Entertainment in a Global Media Age* (New York: Routledge, 2008), 94.
58. For this analysis I consulted the original surround-sound channel available as the 4.0 audio option on *Tron*, directed by Steven Lisberger (1982; Burbank, CA: Buena Vista, 2000), DVD. Subsequent DVD and Blu-ray releases only offer the 5.1 remix.
59. Blake, "The Evolution and Utilization," 77; for in-depth discussions of the mix's construction, including Michael Fremer's role as sound-track supervisor, see Robert Moog, "Wendy Carlos & Michael Fremer Reveal the Secrets Behind the Soundtrack of *Tron*," *Keyboard Magazine*, November 1982, 53–57; Ralph Hodges, "The Wonderful Sound World of Walt Disney," *db: The Sound Engineering Magazine*, December 1982, 38–41; and Marc Mancini, "The Sound Designer," in *Film Sound: Theory and Practice*, ed. Elisabeth Weiss and John Belton (New York: Columbia University Press, 1985), 362–63.
60. *The Wiz*, directed by Sidney Lumet (1978; Burbank, CA: Universal, 2004), DVD. The original surround-sound channel from *Alien* is available as the 4.1 audio option on *Alien*, directed by Ridley Scott (1979; Beverly Hills, CA: Twentieth-Century Fox, 2011), Blu-ray.
61. W. M. E. Garity and J. N. A. Hawkins, "Fantasound," *Journal of the Society of Motion Picture Engineers* 37, no. 8 (1941): 127–46.
62. *Compulsion*, directed by Richard Fleischer (1959; Beverly Hills, CA: Twentieth-Century Fox, 2006), DVD; *Sweet Charity*, directed by Bob Fosse (1969; Burbank, CA: Universal, 2003), DVD. The original surround-sound channel from *West Side Story* is available as the 4.0 audio option on *West Side Story*, directed by Robert Wise and Jerome Robbins (1961; Beverly Hills, CA: Twentieth-Century Fox, 2011), Blu-ray.

63. *Journey to the Center of the Earth*, directed by Henry Levin (1959; Glendale, CA: Twilight Time, 2012), Blu-ray.
64. *The Sand Pebbles*, directed by Robert Wise (1966; Beverly Hills, CA: Twentieth-Century Fox, 2007), DVD.
65. Rick Altman, "The Sound of Sound," *Cineaste*, January 1995, 70.
66. "Battle of the Bulge: Original LCRS Surrounds," 27 July 1999, folder 990917D, "Create 5.1 CDS: Battle of the Bulge, The (1966)," Chace Audio, Burbank, CA.
67. The original surround-sound channel is available as the 4.0 audio option on *Tora! Tora! Tora!*, directed by Richard Fleischer (1970; Beverly Hills, CA: Twentieth-Century Fox, 2011), Blu-ray. For more discussion of Murray Spivack's mix for the film, see *An Oral History with Murray Spivack*, interview by Charles Degelman, 1995, 139–40, 191–93, Academy Oral History Program, Margaret Herrick Library, AMPAS.
68. Whittington, *Sound Design*, 27–31.
69. Beck, "A Quiet Revolution," 293; Caldwell makes a similar point in his discussion of why "art directors" renamed themselves "production designers," namely that a new moniker aligns the "production designer" with above-the-line creatives and forces the industry to recognize the importance of the profession. Caldwell, *Production Culture*, 47.
70. Beck, "A Quiet Revolution," 298–99.
71. LoBrutto, *SoundOn-Film*, 220; Frank Serafine, "The New Motion Picture Sound," *American Cinematographer*, August 1980, 796; see also Peter Lavezzoli, *The Dawn of Indian Music in the West* (London: Bloomsbury Academic, 2006), 147–99.
72. Serafine, "New Motion Picture Sound," 846.
73. For instance, Burt characterizes himself as an expert historian of Hollywood sound effects, but he distances his own work from this history when describing his first Dolby Stereo project: "We weren't going to follow the science fiction style in sound prior to *Star Wars*—like *Forbidden Planet*, *War of the Worlds*, and countless science fiction movies up to that point." See LoBrutto, *SoundOn-Film*, 143. Rydstrom similarly channels Murch by situating his designs for Dolby Six-Track releases including *Cocoon* (1985) and *Spaceballs* (1987) within rock music's more experimental lineage, specifically John Cage and "Revolution 9" by the Beatles, "because of that early, almost Musique Concrète use of multitrack to use real-life sounds and to turn them into rhythms." See LoBrutto, *SoundOn-Film*, 241–42.
74. For instance, see Whittington, *Sound Design*, 22–23; Beck, "A Quiet Revolution," 471–90; and Mark Kerins, *Beyond Dolby (Stereo): Cinema in the Digital Sound Age* (Bloomington: Indiana University Press, 2010), 33–35.
75. Cousins, "Walter Murch," 159–60.
76. Walter Murch, telephone interview with Jay Beck, January 23, 2001; see also Beck, "A Quiet Revolution," 485.
77. Walter Murch, "Touch of Silence," in *Soundscape: The School of Sound Lectures, 1998–2001*, ed. Larry Sider, Diane Freeman, and Jerry Sider (London: Wallflower, 2003), 95.
78. See Mitchell Newman's monthly Acoustics column in *Rolling Stone*, Robert Long's 4-channel Discs/Tapes column for *High Fidelity*, and Julian D. Hirsch's Technical Talk column in *Stereo Review*; John M. Eargle, "Multichannel Stereo Matrix Systems: An Overview," *Journal of the Audio Engineering Society* 19, no. 7 (1971): 558.

79. Kier Keightley, "'Turn It Down!' She Shrieked: Gender, Domestic Space, and High Fidelity, 1948–59," *Popular Music* 15, no. 2 (1996): 150.
80. Tim Anderson, *Making Easy Listening: Material Culture and Postwar American Recording* (Minneapolis: University of Minnesota Press, 2006), 155.
81. For instance, see discussions of "The US Company" (USCO) art collective in Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006), 48–58.
82. John Covach and Andrew Flory, *What's That Sound? An Introduction to Rock and Its History*, 3rd ed. (New York: Norton, 2012), 254–95; Jean Baudrillard, "Stereo-Porno," in *Seduction*, trans. Brian Singer (New York: St. Martin's, 1990), 30–31.
83. Keightley, "'Turn It Down!'" 152.
84. Mitchell Newman, "Stereo Stereo, part one," *Rolling Stone*, November 26, 1970, 40. Examples of concert hall simulation occur on most classical recordings from Leonard Bernstein's EMI release of Berlioz's *Symphonie fantastique* (1977) to a Beverly Sills recital, which *High Fidelity* claimed had enough reverb to "resemble a bowling alley." Robert Long, "Four-Channel Discs and Tapes," *High Fidelity*, April 1972, 71. A more typical instance of this concert-hall simulation occurs throughout the quadrasonic re-release of Johnny Cash's *Live at San Quentin* (1974). The front channels contain Cash and his band, while the rear channels contain reverb and the prisoners' claps, stomps, and cheers.
85. Edward Greenfield, "London," *High Fidelity*, July 1972, 13, 16; Peter G. Davis, "Quad—Love It or Leave It," *New York Times*, May 20, 1973, 158; Paul Myers and Bob Auger, "Schonberg's Gurrelieder," *Studio Sound*, June 1975, 38–41.
86. For this analysis I used the 4.0 Quad Mix available on Pink Floyd, *The Dark Side of the Moon: Immersion Box Set*, produced by Alan Parsons, recorded 1973, EMI, 2011, compact disc.
87. Alan Parsons, "Four Sides of the Moon," *Studio Sound*, June 1975, 50–52.
88. "High Fidelity Compares Columbia's and RCA's Four-Channel Disc Systems: Matrix vs. Discrete—A Preliminary Report," *High Fidelity*, January 1974, 35–44.
89. For the CBS Stereo Quadrasonic (SQ) matrix, for instance, the left track (L_l) contained three channels: " $L_l + (0.707 R_l) - j (0.707 L_r)$ " where "0.707" denotes an amplitude level and "j" denotes a ninety-degree phase shift. In order to derive a new loudspeaker channel, such as left-back (L_b), an SQ decoder performed one of four operations, such as " $(0.707 L_l) - j (0.707 R_l)$." Benjamin B. Bauer, Daniel W. Gravereaux, and Arthur J. Gust, "A Compatible Stereo-Quadrasonic (SQ) Record System," *Journal of the Audio Engineering Society* 19, no. 8 (1971): 638–46.
90. John M. Eargle, "4-2-4 Matrix Systems: Standards, Practice and Interchangeability," *Journal of the Audio Engineering Society* 20, no. 10 (1972): 809–15. In addition to the matrix, there was a less popular "discrete" method that stored four-channel information across very high frequencies. Its use of an extended frequency range, however, made it incompatible with the bandwidth limitations of commercial radio. Toshiya Inoue, Nobuaki Takahashi, and Isao Owaki, "A Discrete Four-Channel Disc and Its Reproducing System (CD-4 System)," *Journal of the Audio Engineering Society* 19, no. 7 (1971): 576–83; Ralph Hodges, "The 4-Channel Plunge," *High Fidelity*, June 1975, 64.
91. The 4.0 Quad Mix on the 2011 disc does not contain any of the technical compromises inherent in the four-channel release. I used Audacity software to recreate a matrixed version adhering to the CBS SQ process.
92. For instance, see Norman H. Crowhurst, "Where to Put Your Stereo Speakers," *High Fidelity*, October 1958, 54–56; Norman Eisenberg, "Loudspeakers: Their Choice and Installation," *High Fidelity*, June 1966, 51–58.

93. Tomlinson Holman, *5.1 Surround Sound: Up and Running* (Burlington, MA: Focal, 2000), 126.
94. *Ibid.*, 53–55.
95. Mark Kerins, “Multichannel Gaming and the Aesthetics of Interactive Surround Sound,” in *The Oxford Handbook of New Audiovisual Aesthetics*, ed. John Richardson, Claudia Gorbman, and Carol Vernallis (New York: Oxford University Press, 2013), 591–92.
96. Sergi, “Silent Blast,” 14–18; Jordan Fox, “Making Beaches out of Grains of Sand,” *Cinefex*, December 1980, 52–56; Frank Serafine, “Sound Effects Design and Synthesis for *Tron*,” *American Cinematographer*, August 1982, 807, 830–34.
97. Timothy D. Taylor, *Strange Sounds: Music, Technology and Culture* (New York: Routledge, 2001), 67.
98. For analyses of similar instances of practitioner rhetoric, see Katherine Quanz, “Pro-Tools, Playback, and the Value of Postproduction Sound Labor in Canada,” *Velvet Light Trap* 76 (Fall 2015): 37–48.

Eric Dienstfrey is a doctoral candidate in film studies at the University of Wisconsin–Madison. His dissertation examines how early theories of acoustical fidelity shaped the designs and uses of stereophonic technology from 1930 to 1959.