EVOLUTION OF DOLBY FILM SOUND

The Evolution of Dolby Film Sound

Going to the movies today is more exciting and involving than ever before, thanks in large part to a continuing effort to improve film sound undertaken by Dolby Laboratories in the early 1970s. Indeed, the history of cinema sound over the past two decades closely mirrors the history of Dolby film sound technologies.

Optical soundtracks

The photographic, or "optical," soundtrack was the first method of putting sound on film. Today it remains the standard, in both analog and digital forms.

The classic analog optical soundtrack consists of an opaque area adjacent to the picture containing narrow, clear tracks that vary in width according to variations in the sound (Figure 1). As the film is played, a beam of light from an exciter lamp or LED in the projector's soundhead shines through the moving tracks. Variations in the width of the clear tracks cause a varying amount of light to fall on a solar cell, which converts the light to a similarly varying electrical signal. That signal is amplified and ultimately converted to sound by loudspeakers in the auditorium.

Economy, simplicity, and durability are among the advantages that have contributed to optical sound's universal acceptance. The soundtrack is printed photographically on the film at the same time as the picture and can last just as long, which—with care—can be a long time indeed. And the optical soundhead within the projector is itself economical and easily maintained.

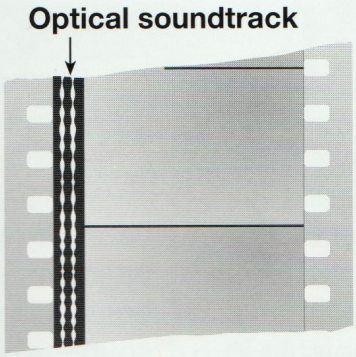

Figure 1: 35 mm optical print

Success gets in the way of progress

Motion pictures with sound were first shown to significant numbers of moviegoers in the late 1920s. Within a few years, many thousands of theatres were equipped to show "talking pictures" with optical soundtracks.

This phenomenally rapid acceptance of a new, sophisticated technology was not without drawbacks, however. Equipment was installed in cinemas so rapidly that there was no time to take advantage of the improvements that occurred almost daily.

A good example is loudspeaker design. The first cinema loudspeakers had very poor high-frequency response. Speakers with superior response became available within just a few years, but there was no time to retrofit the original systems with new units. Engineers were too busy equipping other cinemas with their first sound installations.

This caused a dilemma for soundtrack recordists. Should the tracks be recorded to take advantage of the improved speakers, or should they be prepared to sound best on the many older installations already in place? Given that it was impractical to release two versions of a given title, the only alternative was to tailor soundtracks to the older speakers. The result was to ignore the improved high-frequency response of the newer, better units.

To forestall compatibility problems, in the late 1930s a de facto standardization set in, the cinema playback response that today is called the "Academy" characteristic. Cinema owners knew what to expect from the films, and therefore what equipment to install. Directors and sound recordists knew what to expect from cinema sound systems, and thus what kind of soundtracks to prepare. The result was a system of sound recording and playback that made it possible for just about any film to sound acceptable in any cinema in the world. The problem was that the system lacked the flexibility to incorporate improvements beyond the limitations that existed in the 1930s.

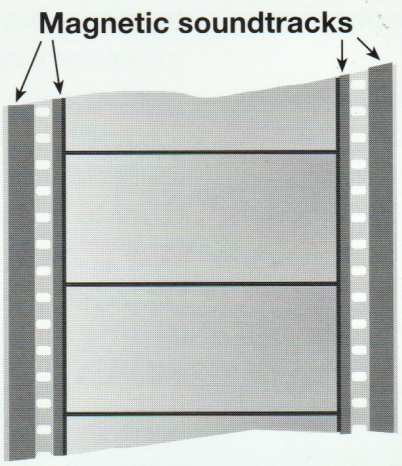

Figure 2: 70 mm magnetic print

Magnetic striping and multichannel sound

In the early 1950s, as the film industry sought to woo viewers away from their fascinating new television sets, a new method of putting sound on film was introduced. After the picture was printed, narrow stripes of iron oxide material (similar to the coating on magnetic recording tape) were applied to the release print (Figure 2). The sound was then recorded on the magnetic stripes in real time. In the cinema, magnetic prints would be played back on projectors equipped with magnetic heads similar to those on a tape recorder, mounted in a special soundhead assembly called a "penthouse."

Magnetic sound was a significant step forward, and at its best provided much-improved fidelity over the conventional optical soundtrack. It also enabled the first multichannel sound reproduction, dubbed "stereophonic sound," ever heard by the public. The voice of an actor appearing to the left, center, or right of the picture could be heard coming from speakers located at the left, center, or right of the new wide screens also being introduced at this time. Music took on a new dimension of realism, and special sound effects could emanate from the rear or sides of the cinema. The two main magnetic systems adopted were the four-track 35 mm CinemaScope system, introduced with *The Robe,* and the six-track 70 mm Todd-AO, first used for *Oklahoma!*

Magnetic falls into disuse

Magnetic sound was widely adopted in the 1950s. By the 1970s, however, when the film industry experienced an overall decline, the expense of magnetic release prints, their comparatively short life compared to optical prints, and the high cost of maintaining the playback equipment led to a massive reduction in the number of magnetic releases and cinemas capable of playing them. Magnetic sound came to be reserved for only a handful of first-run engagements of "big" releases each year.

By the mid-1970s, then, movie-goers were again hearing low-fidelity, mono optical releases most of the time, with only an occasional multitrack stereo magnetic release. Ironically, just as the industry was reverting to mono optical, more and more moviegoers were enjoying better sound at home over superior hi-fi stereo systems.

Dolby gets involved

By the late 1980s, the situation that prevailed in the mid-1970s had completely changed. Thanks to new technology and a turnaround in the financial decline of the industry, almost all major titles by that time were being released with wide-range multichannel stereo

soundtracks, as is the case today.

The breakthrough was the development by Dolby Laboratories of a highly practical 35 mm stereo optical release print format originally identified as Dolby Stereo. In the space allotted to the conventional mono optical soundtrack are two soundtracks that not only carry left and right information as in home stereo sound, but are also encoded with a third center-screen channel and—most notably—a fourth surround channel for ambient sound and special effects (Figure 3).

This format not only enabled stereo sound from optical soundtracks, but higher-quality sound as well. Various techniques were applied to the soundtrack during both recording and playback to improve fidelity. Foremost among these was Dolby A-type noise reduction to lower the hissing and popping associated with optical soundtracks, and loudspeaker equalization to adjust the cinema sound system to a standard response curve.

As a result, stereo optical prints could be reproduced in cinemas installing Dolby cinema processors with far wider frequency response and much lower distortion than conventional soundtracks. In fact, the Dolby optical format led to a new worldwide playback standard (ISO 2969) for wide-range stereo prints.

An important advantage of the Dolby optical format was that the soundtracks were printed simultaneously with the picture, just like mono prints. Thus four-channel stereo optical release prints cost no more to make than mono prints, and far less than magnetic prints. In addition, conversion to stereo optical proved relatively simple, and once the equipment was installed, very little maintenance was required. The result was multichannel capability equaling that of four-track magnetic 35 mm (which soon became obsolete), with consistently higher fidelity, greater reliability, and far lower cost.

The next step: Dolby SR

In 1986, Dolby Laboratories introduced a new professional recording process called Dolby SR (spectral recording). Like Dolby noise reduction, it was a mirror-image, encode-decode system used both when a soundtrack is recorded and when it is played back. It provided more than twice the noise reduction of Dolby A-type, and, moreover, permitted loud sounds with wider frequency response and lower distortion.

The 35 mm optical soundtracks treated with

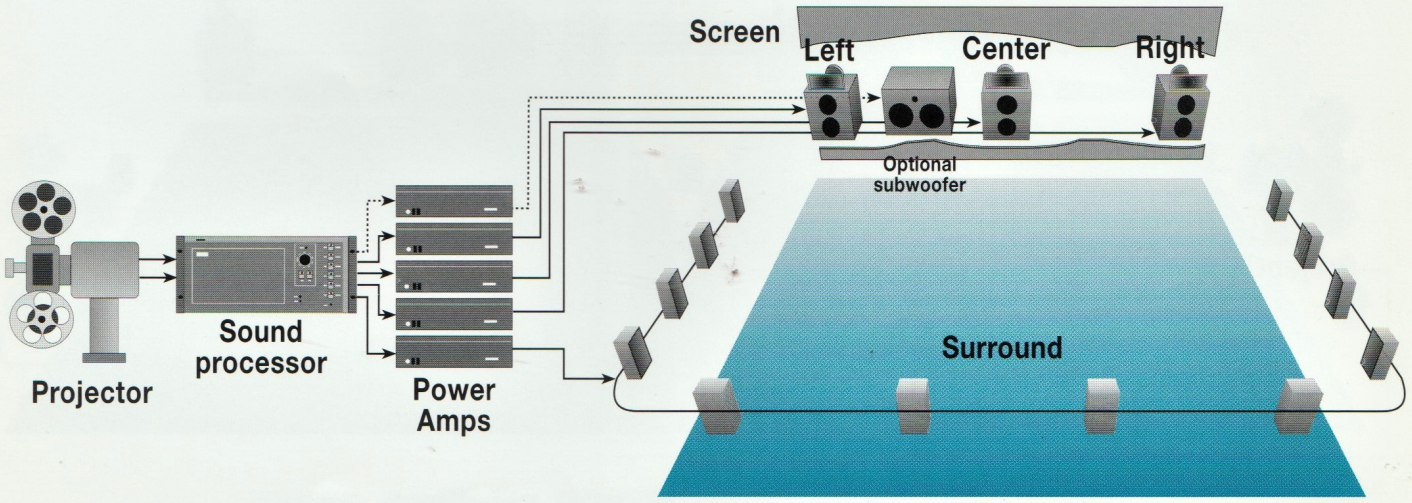

Figure 3: Dolby analog 35 mm playback

Dolby SR instead of Dolby A-type not only sounded superb in cinemas equipped with new SR processors, but also played back satisfactorily in all cinemas. This led to the situation today, whereby the analog soundtracks on virtually all prints are Dolby SR tracks.

The digital age begins

The next film sound development from Dolby Laboratories was Dolby Digital, introduced in 1992. Dolby Digital puts a six-channel digital optical soundtrack in addition to a four-channel SR analog track on 35 mm prints (Figure 4). This format is yet another significant step forward in film sound, providing independent left, center, right, left surround, and right surround channels, plus a sixth channel for bass effects (Figure 5).

In addition to its six-channel capability, Dolby Digital provides extraordinary dynamic capability, wide frequency range, low distortion, and relative immunity to wear. Its combination of high quality, reliability, and practicality has been proved in cinemas around the world, and today it is the most popular digital format, with the most releases, and the most cinemas worldwide equipped to play them.

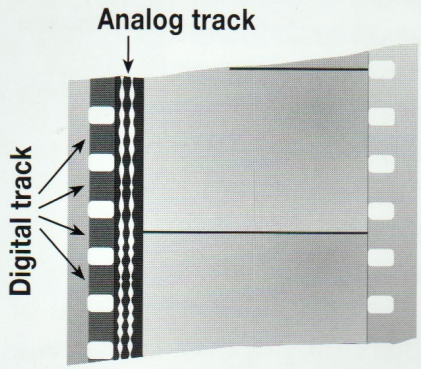

Figure 4: Dolby Digital 35 mm print

As with previous Dolby developments, Dolby Digital did not make existing cinema installations obsolete. Prints can play conventionally in any cinema, while the digital track can be reproduced in cinemas with Dolby Digital soundtrack readers and decoders.

Dolby Digital Surround EX

The newest Dolby format, Dolby Digital Surround EX, was introduced in 1999, and adds a third surround channel to the Dolby Digital format. Enabling improved realism, more precise sound placement, and exciting special effects, the third channel is reproduced by rear-wall surround speakers, while the left and right surround channels are

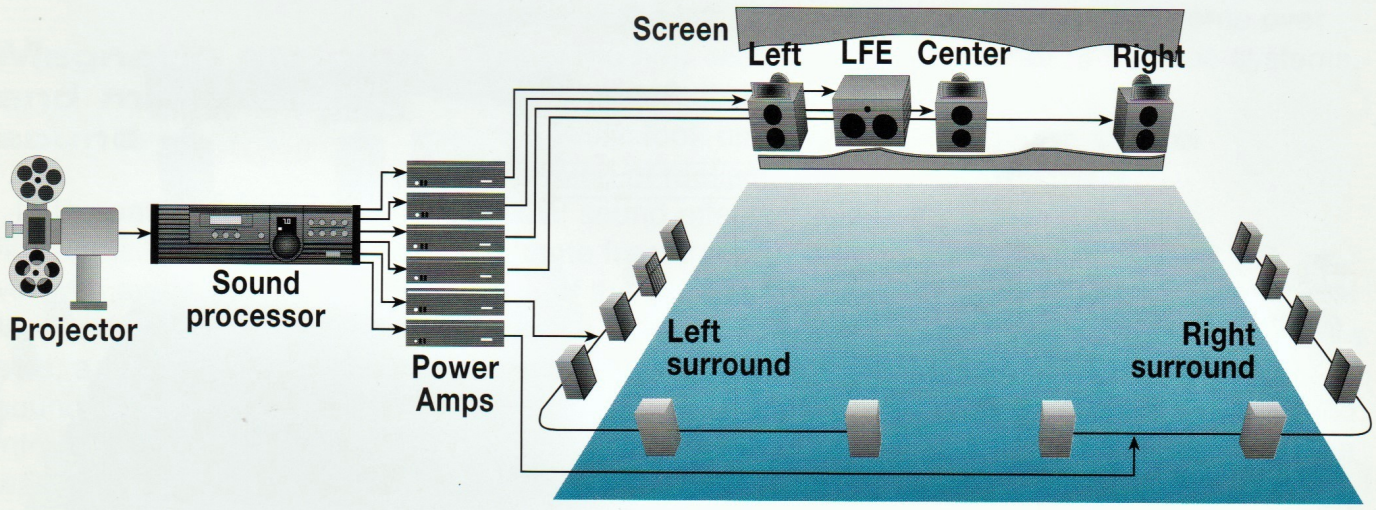

Figure 5: Dolby Digital playback

reproduced by speakers on the side walls (Figure 6).

As with all other Dolby soundtrack improvements, Dolby Digital Surround EX is backwards-compatible, with prints playable in all Dolby Digital cinemas, whether or not equipped to decode the additional surround track. To find films that use the new format and cinemas in your area equipped to play it, visit *www.dolby.com/movies.*

Making films sound better

Film soundtracks encoded with Dolby technologies, and the equipment for playing them, are only links in a chain that extends from the original location, through the dubbing theatre, to the processing laboratory, and finally into the cinema. Developments like Dolby SR and Dolby Digital ensure that the soundtrack itself remains one of the strongest links. But the extreme fidelity of the latest Dolby formats can reveal the quality of each step in the recording, mixing, and dubbing processes, and this has necessitated new approaches to soundtrack production. Admittedly, the results can vary—the final reproduced soundtrack can be no better than the elements it comprises—but Dolby film sound at its best means not only better sound quality, but sound in the theatre that consistently realizes the director's original intentions.

While Dolby Laboratories' involvement with film sound first achieved wide recognition with the spectacular audio effects of such films as *Star Wars,* it has long since come to mean more than just special or dramatic effects. The objective is high-quality sound reproduction overall—from the dialogue and the score to the sound design and effects. Dolby technology is a means, not an end. It can be likened to an artist's palette that provides the director with a full range of colors, where before there were but a few. Above all, Dolby formats have been developed to enhance that very special experience of going to the movies.

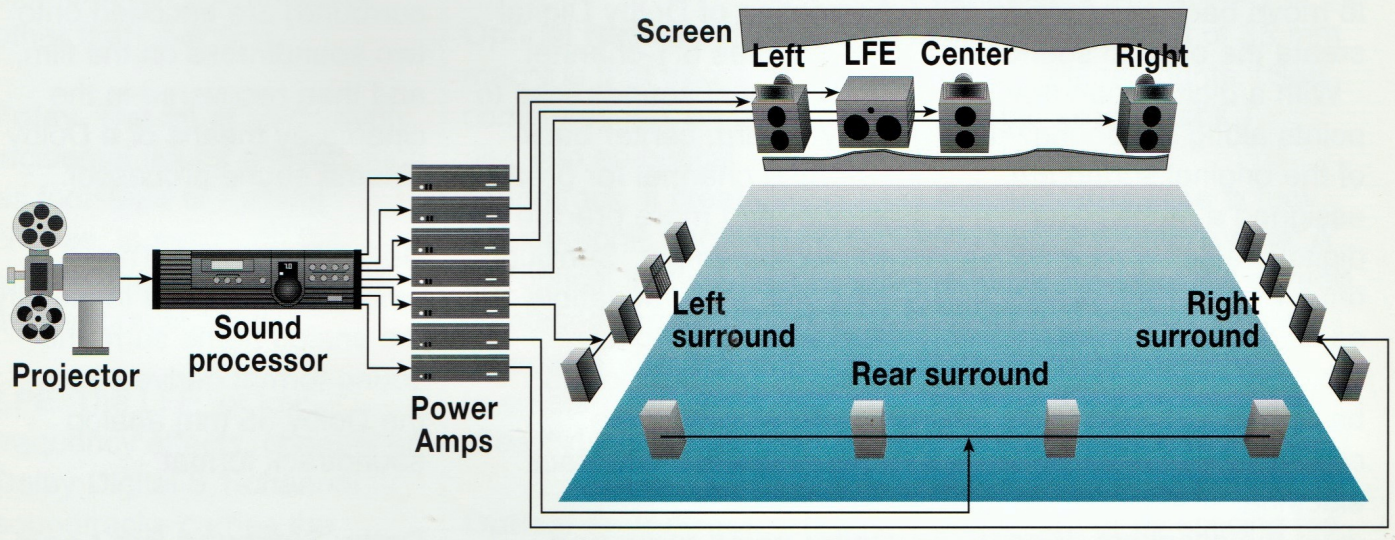

Figure 6: Dolby Digital Surround EX playback

Film Sound Glossary

Acoustics. The characteristics, such as how sound is reflected and absorbed, that give a space such as a living room, concert hall, or cinema an identifiable sonic "signature."

Ambience. Low-level sounds (including sound reflections) that set a mood or suggest the character of a particular place.

Analog vs. digital soundtrack. The width of an analog soundtrack varies in a way that is directly analogous to the varying soundwaves of the original sound. When played back, the varying width of the track is translated to a varying electrical voltage which ultimately causes the theatre's loudspeaker cones to move back and forth to re-create the original sound.

With a digital soundtrack, points along the soundwaves of the original sound are assigned a numeric (or digital) value, consisting of ones and zeros represented as tiny dots on the track. When a digital track is played back, the numeric values are converted to the varying electrical voltage needed to drive the speakers. (See **Optical soundtrack.**)

Atmospheres. Low-level background sounds, such as wind or traffic noise, on a film's soundtrack, which add to the reality of a scene. These sounds are sometimes recorded separately at a shooting location, creating what is called a wild track for mixing into the soundtrack later.

Dolby Digital. The most widely used multichannel digital sound format in the world, used for everything from 35 mm films in the cinema to HDTV broadcasts and DVD discs in the home. Dolby Digital provides up to 5.1 channels (left, center, right, left surround, right surround, and low-frequency effects).

Dolby Digital Surround EX. A variation of Dolby Digital that enables 5.1-channel Dolby Digital soundtracks to carry a third, center back-surround channel for greater realism and more precise sound placement. Surround EX prints are compatible with all Dolby Digital cinemas, whether or not equipped to play the additional surround track.

Dolby noise reduction. Complementary (record-play) signal processing system that reduces the noise inherent in analog recording media without affecting the sound being recorded.

Dolby SR. The most powerful analog Dolby system, Dolby SR (spectral recording) is used today for the analog soundtracks on virtually all releases, including those with digital tracks. Dolby SR soundtracks provide a dynamic range rivaling that of digital, are compatible with any 35 mm theatre, and provide backup in case of playback problems with digital tracks.

Dolby Stereo. The original name for Dolby Laboratories' multichannel analog soundtrack technology, whereby four channels of sound (left, center, right, surround) are encoded onto two soundtracks on the film, and then recovered in the cinema by means of a Dolby cinema sound processor.

Dolby Surround. The umbrella term used to identify the analog home surround-sound format derived from the Dolby 35 mm analog soundtrack format.

Dolby Surround Pro Logic. The advanced form of Dolby Surround decoding found in

virtually all home theater systems, providing at home, from video sources, the same four-channel surround sound heard in cinemas from Dolby analog theatrical films.

Dubbing theatre. A theatre equipped for and dedicated to mixing film soundtracks. The sound systems in dubbing theatres where Dolby soundtracks are mixed and those in cinemas equipped for Dolby playback are calibrated to the same standards. This helps makes it possible for audiences to hear the sound the director heard—and intended—when the soundtrack was mixed.

Dynamic range. The range between the loudest and softest sounds a soundtrack and/or sound system can reproduce properly.

Effects. Sound effects, i.e., the non-musical elements on a soundtrack other than dialogue.

Foley. The art of re-creating incidental sound effects, such as footsteps or rustling clothes, in sync with the picture. Named after one of its first practitioners.

LFE. The LFE, or low-frequency effects, channel on Dolby Digital 5.1-channel soundtracks carries the powerful low bass frequencies (explosions, rumbles, etc.) that are felt more than heard.

Magnetic soundtrack. Narrow stripes of oxide material (similar to the coating on recording tape) added to a developed release print, then recorded in real time with the film's sound. Introduced in the 1950s to provide the first stereo sound in the cinema, magnetic soundtracks have been superceded today by advanced analog and digital optical soundtracks, which are more practical and durable.

Mix. The blend of dialogue, music, and effects which comprises a film's soundtrack. Also, when used as a verb, the process of assembling and balancing these elements electronically, thereby creating the final soundtrack.

Optical recorder. The machine that transforms a completed mix on tape or disc into an optical soundtrack. It creates a photographic negative of the optical track, which is combined ("married") with a negative of the picture to create a release print. (See **Printer.**)

Optical soundtrack. Photographic strips on movie prints that vary in some way with the variations in sound (see Figure 1). Analog optical soundtracks vary in width, while digital optical soundtracks have patterns of dots. (See **Analog vs. digital** and **Variable area.**)

As the film is pulled through the projector's soundhead, a narrow light beam passes through the moving soundtrack, which causes the intensity of the beam to vary. The varying light falls on a sensor, creating electrical signals, which the theatre's loudspeakers convert back to sound.

Printer. A machine that exposes raw film stock to negatives of the movie's soundtrack and picture, at speeds up to 20 times faster than film is projected, to create a release print. The rapid, simultaneous printing of sound and picture contributes significantly to the relatively low cost of 35 mm optical release prints. (See **Optical soundtrack.**)

Release print. The actual film played in the cinema. A release print consists of reels approximately 20 minutes long which are played consecutively without interruption either by alternating between two projectors, or by splicing the individual reels together into

one large reel called a platter. Prints are recorded at 16 frames per foot and played at 24 frames per second.

Stereo. Sound recording and reproduction by more than one (mono) channel. In home music reproduction, "stereo" came to mean two channels (left and right), while in the film industry, "stereo" is understood to include surround and center channels in addition to left and right. To avoid confusion, multichannel stereo is often referred to as "surround sound."

Subwoofer. A loudspeaker dedicated to reproducing very low bass. Dolby Digital soundtracks provide a separate low-frequency effects (LFE) channel specifically for playback over subwoofers.

Surround sound. The reproduction of ambience, atmospheres, and occasional special effects that are recorded on one or more dedicated channels, and played through speakers placed along the sides and rear of the auditorium to surround the audience.

THX. A trademark identifying compliance with the playback performance parameters of Lucasfilm THX for commercial and home theater sound systems. THX develops standards for the playback environment, regardless of film format. THX-certified theatres use professional Dolby cinema processors for playing Dolby soundtracks (which is why both logos can appear on the same cinema marquee), and THX-licensed home theater systems are based on Dolby Surround Pro Logic and Dolby Digital decoding.

Variable area. The technical term for the analog optical soundtrack whose width varies with the sound. A Dolby analog optical soundtrack sometimes is referred to as an SVA track, for "stereo variable area." An earlier type of optical track, variable density, varied the track's photographic shading (rather than its width) with the sound.

Dolby

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