The Evolution of Dolby Film Sound

Thanks to such developments as multichannel digital sound, the motion picture viewing experience today is more exciting and involving than ever before. And what the audience hears today, is very much the result of a continuing effort to improve film sound originally undertaken by Dolby Laboratories more than twenty years ago. Indeed, the evolution of motion picture sound over the past two decades is, in great part, that of Dolby film sound technologies.

Optical sound

The photographic or "optical" soundtrack was the first method of putting sound on film, and today it remains the most popular.

An opaque area adjacent to the picture contains narrow, clear tracks that vary in width with variations in the sound *(Figure 1)*. As the film is played, a narrow beam of light from an exciter lamp 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.

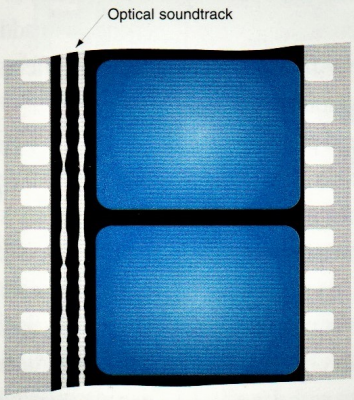


Figure 1: 35 mm optical print

Several advantages of optical sound have contributed to its universal acceptance, the foremost being economy. For one thing, the soundtrack is printed photographically on the film at the same time as the picture. For another, the soundtrack can last as long as the picture, which—with care—can be a long time indeed. A further benefit is that the optical soundhead within the projector is itself economical and easily maintained.

Motion pictures with sound were first shown to significant numbers of movie-goers in the late 1920s. By the mid-1930s, the "talkies" were no longer a novelty, but a necessity, and many thousands of cinemas were equipped in that short time to show films with optical soundtracks. This phenomenally rapid acceptance of a sophisticated new technology was not without drawbacks, however. Equipment was installed in cinemas so rapidly that there was no time to take advantage of improvements which were occurring on an almost daily basis.

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, because 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. On the other hand, however, it lacked the flexibility to incorporate improvements beyond the limitations that existed in the 1930s.

Even with these limitations, for years optical film sound provided higher quality sound than home phonographs and radios. But by the late 1960s and early 1970s, superior hi-fi stereo systems had been installed in so many homes that a significant and influential proportion of the movie-going public was used to better sound at home than could be heard in the cinema.

Magnetic sound

In the 1950s, a new method of putting sound on film was introduced as an alternative to the optical track. After the picture is printed, narrow stripes of iron oxide material similar to the coating on magnetic recording tape are applied to the film *(Figure 2)*. The sound is then recorded on the magnetic stripes in real time. The film is played back on projectors equipped with magnetic heads, similar to those on a tape recorder,

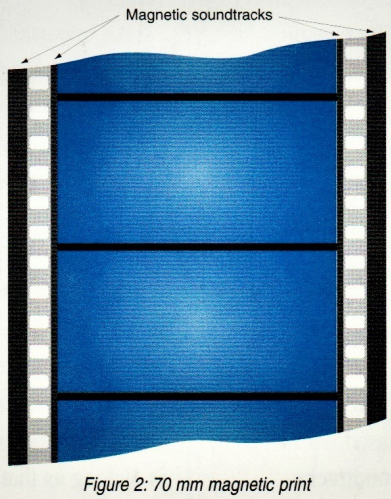


Figure 2: 70 mm magnetic print

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. Magnetic sound also permitted the multiple tracks required by stereophonic sound. The voice of an actor appearing to the left, centre, or right of the picture could be heard coming from speakers located at the left, centre, 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 Twentieth Century Fox's four-track 35 mm CinemaScope system introduced for *The Robe*, and the six-track Todd-AO system first used for such 70 mm films as *Oklahoma!* and *Around The World in 80 Days*.

Many cinemas were equipped for magnetic sound in the 1950s, even though the playback equipment was expensive. Many films were issued with magnetic soundtracks, although magnetic prints were, and remain, much more expensive than optical sound prints (35 mm magnetic prints cost at least double their optical equivalents, and today's 70 mm magnetic prints cost up to fourteen times as much).

By the 1970s, however, the film industry declined overall, with fewer films and fewer cinemas. The expense of magnetic release prints, their comparatively short life compared to optical prints, and the high cost of maintaining magnetic cinema 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, movie-goers were again usually hearing low fidelity, mono optical releases, with only an occasional multitrack stereo magnetic release.

Dolby gets involved

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

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 carry not only left and right information as in home stereo sound, but also information for a third centre-screen channel and—most notably—a fourth channel for ambient sound and special effects, surround.

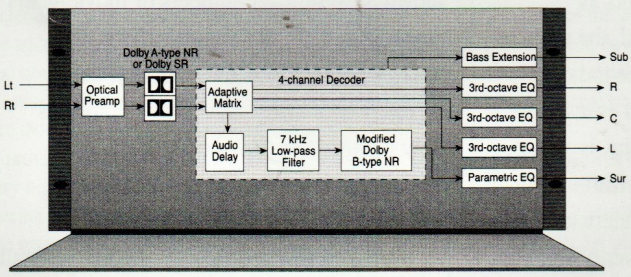


Figure 3: Dolby stereo optical playback processor

This format not only enabled stereo sound from optical soundtracks, but higher quality sound as well. Various techniques are applied both when the soundtrack is recorded and when it is played back to improve fidelity. Foremost among these is Dolby 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 *(Figure 3)*.

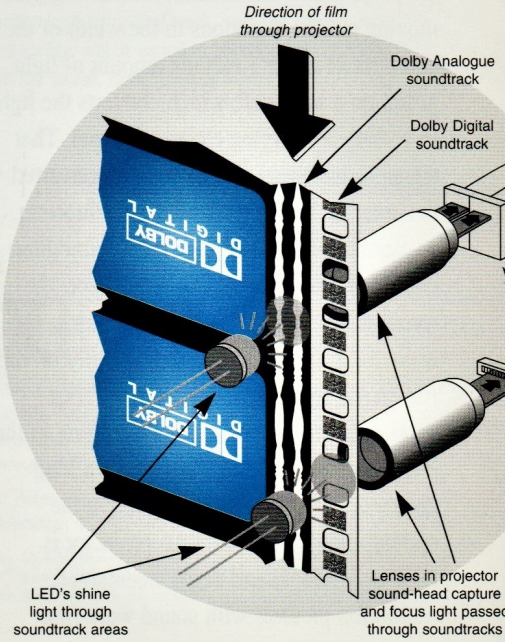
All this means that these prints can be reproduced in cinemas with Dolby-manufactured cinema processors with far wider frequency response and much lower distortion than conventional soundtracks. In fact, the Dolby optical format has led to a new worldwide playback standard (ISO 2969) for wide-range stereo prints, just as the "Academy" characteristic applies for mono prints.

An important advantage of the Dolby optical format is that the soundtracks are printed simultaneously with the picture, just like mono prints. Thus a four-channel stereo release print costs no more to make than a mono print (although it is more expensive to record and mix in stereo than in mono). Conversion to Dolby optical is relatively simple and, once the equipment has been installed, very little maintenance is required, particularly when compared to magnetic stereo playback systems. Moreover, print life is as long as that of conventional mono optical prints, unlike magnetic prints. The result is multichannel capability equalling that of four-track magnetic 35 mm (made all but obsolete by the stereo optical format), consistently higher fidelity, and few of the drawbacks of magnetic formats.

Much of the new technology, including noise reduction and equalization, also is applied to 70 mm magnetic releases (also originally designated as Dolby Stereo). Although these release prints continue to be very expensive, Dolby improvements brought a resurgence of interest in this "big" format for road shows where the ultimate in picture and sound presentation is particularly likely to be reflected in box office figures. There are six magnetic tracks on 70 mm film, two of which carry low bass effects. Some 70 mm films also use a technique developed by Dolby Laboratories to provide two separate surround channels in addition to the left, centre, right, and bass effects screen channels.

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 is a mirror-image, encode-decode system used both when a soundtrack is recorded and when it is played back. It provides more than twice the noise



reduction of Dolby A-type, and, moreover, wider frequency response and lower distortion, especially with loud sounds.

35 mm optical soundtracks treated with Dolby SR instead of Dolby A-type not only sound superb in the many cinemas equipped with special SR processors, they also play back satisfactorily in any cinema. As a result, most SR titles are released single inventory. In fact, in cinemas equipped with regular A-type processors, the moderate compression that results helps prevent the louder peaks on SR soundtracks from overloading the cinema's sound system. This feature further obviates the need for separate mixes and releases.

And now... Dolby Digital

The newest film sound development from Dolby Laboratories puts a six-channel digital optical soundtrack in addition to a four-channel SR analogue track on the same 35 mm prints *(Figure 4)*. This Dolby Digital format is yet another significant step forward in film sound, providing independent left, centre, right, left surround, and right surround channels, plus a sixth channel for low frequency bass effects, usually called subwoofer *(Figure 5)*.

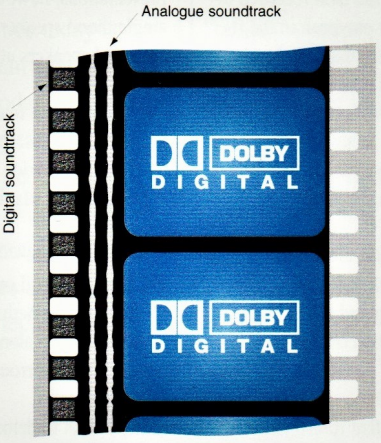


Figure 4: Dolby Digital 35 mm print

As well as multiple channels, 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 already been proved in thousands of cinemas around the world. And because the digital track is right on the film, the format has none of the drawbacks of separate disc systems.

As with previous Dolby developments, Dolby Digital does not obsolete existing cinema installations. Prints can play conventionally in any cinema, while the digital track can be reproduced by adding digital readers to the projectors and a digital decoder which interfaces with the cinema's existing Dolby processor, or through a digital Dolby cinema sound processor.

Making films sound better

Dolby format release prints and the equipment which reproduces them are only links in a chain that extends from the original location, through the dubbing theatre, to the 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 just like high-quality CDs played on the best home stereo equipment, Dolby formats are capable of carrying a higher fidelity "message" than previously—and so can reveal the quality of each step in the recording, mixing, and dubbing processes. Taking advantage of the new formats has thus required 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 quality sound, but sound in the cinema that consistently realises the director's original intentions.

While Dolby's 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—dialogue and music, as well as 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 colours, 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.

DOLBY DIGITAL

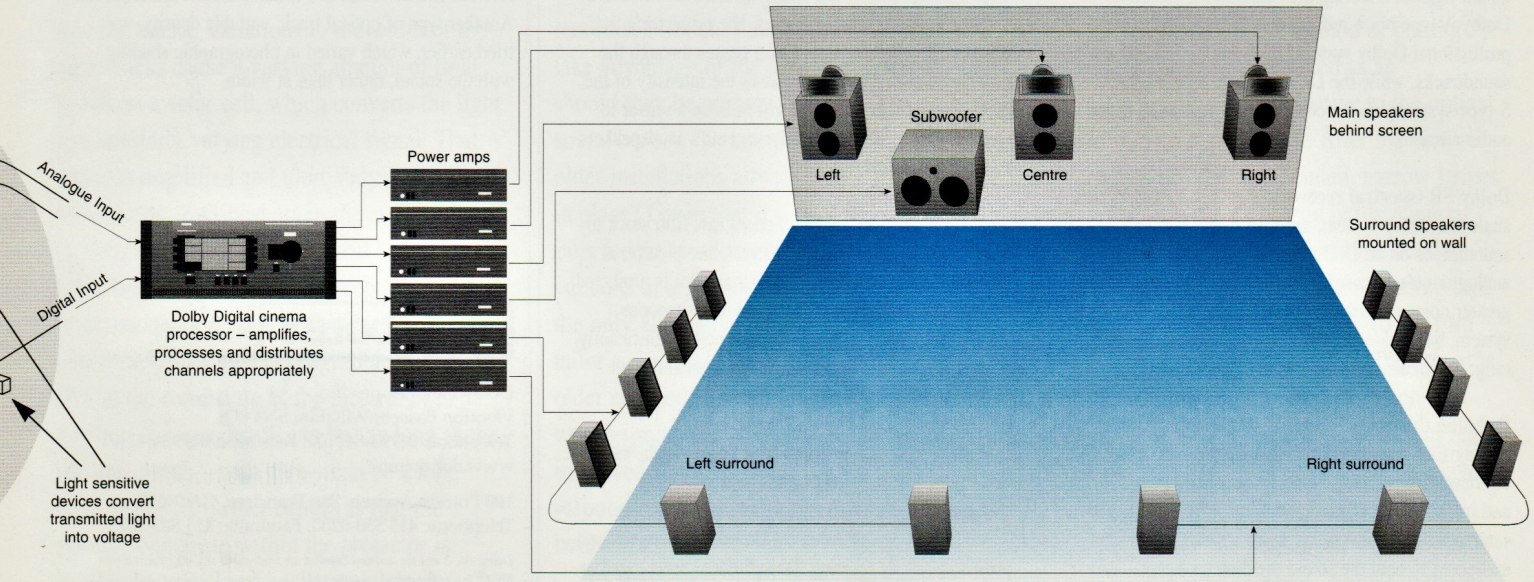


Figure 5: Dolby Digital playback

A Film Sound Glossary

Analogue vs. digital — The difference between analogue and digital sound is explained best in terms of the analogue and digital soundtracks on the Dolby Digital print shown in Figure 4.

The width of the analogue soundtrack varies in a way that is directly *analogous* to the varying soundwaves of the original sound. All analogue formats have an equivalent varying parameter, such as the strength of the magnetic field on recording tape, or the side-to-side swings of the groove on a phonograph record. When played back, the varying width of the track is translated to a varying electrical voltage which ultimately causes the cinema's loudspeakers cones to move back and forth to recreate the original sound.

With a digital optical soundtrack, points along the soundwaves of the original sound are assigned a numeric (or *digital*) value, which are represented as tiny dots on the track. These values can also be recorded as magnetic pulses on tape, or as microscopic pits on CDs. When a digital track is played back, the numeric values are converted to the varying electrical voltage needed to drive the speakers.

Digital sound can be of very high quality, and resistant to wear and tear. Without sophisticated techniques such as the Dolby AC-3 process used on Dolby Digital prints, however, it takes much more space to record or transmit digital sound than analogue.

Atmospheres — Low level background sounds, such as wind or traffic noise, 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 AC-3 — The multichannel coding technology used on Dolby Digital film soundtracks and the new Dolby Digital laser discs, by the upcoming US High Definition TV system, and in numerous cable and satellite applications.

Dolby noise reduction — Complementary (record-play) signal processing systems developed by Dolby Laboratories to reduce the noise inherent in recording media without affecting the sound being recorded. Dolby A-type noise reduction is the original professional Dolby system and is used on Dolby movie soundtracks, while the Dolby B-type, C-type, and S-type systems are for consumer formats such as the audio cassette.

Dolby SR (spectral recording) — The most powerful analogue Dolby system, used for the analogue soundtracks on all Dolby Digital prints and on many analogue-only releases as well. It not only provides greater noise reduction than the original Dolby A-type system, but also permits recording a wider frequency range, particularly at high signal levels.

Dubbing theatre — A special theatre equipped for mixing film soundtracks. The sound systems in dubbing theatres where Dolby soundtracks are mixed and in Dolby-equipped cinemas are calibrated to the same standards. This helps make 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 sound format or system can reproduce properly.

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

Foley — A special soundstage used exclusively for recording sound effects (footsteps, doors closing, etc.).

Magnetic soundtrack — Narrow stripes of oxide material (similar to the coating on recording tape) that are added to a developed release print, then recorded in real time with the film's sound. For playback in the cinema, projectors are equipped with magnetic heads like those on a tape recorder. Introduced in the 1950s to provide stereo sound in the cinema, magnetic offers very high sound quality. The prints themselves and cinema maintenance are costly, however, so today only one magnetic format remains, six-track 70 mm.

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 magnetic tape 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 — A photographic strip adjacent to the picture on a 35 mm movie print, varying in some way with the variations in sound (see Figure 1). Analogue optical soundtracks vary in width, while digital optical soundtracks have patterns of dots (see **Analogue vs. digital** and **Variable area**). Because optical soundtracks are printed at high speed at the same time as the picture, the release prints are economical, as opposed to magnetic prints whose soundtracks are recorded in real time as a separate step. Therefore, they are widely available.

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 to create electrical signals for the cinema's loudspeakers to 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 twenty 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.

Stereo — Sound recording and reproduction by more than one (mono) channel. In home music reproduction, "stereo" means two channels (left and right). In the film industry, however, "stereo" is understood to include a surround channel (see **Surround sound**). Proper movie stereo also has a centre channel to keep on-screen dialogue centered for viewers seated off to the sides.

Dolby-format stereo film presentations comprise at least four channels, with left, centre, and right speakers behind the screen, and surround speakers at the rear and sides of the auditorium. Other so-called "stereo" presentations, however, may consist of no more than a single mono speaker behind the screen with some surround speakers at the back.

Subwoofer — A loudspeaker dedicated to reproducing the very low bass. Dolby Digital and 70 mm magnetic soundtracks provide separate bass effects channels specifically for playback over subwoofers

Surround sound — The reproduction of ambience, atmospherics, and occasional special effects 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 licensed to movie cinemas and manufacturers of home cinema products, identifying compliance with the performance parameters of Lucasfilm Ltd. for commercial and home cinema sound systems. Unlike Dolby's focus on soundtrack formats and processes, THX develops standards for the playback environment, regardless of film format. THX-certified cinemas use professional Dolby cinema processors for playing Dolby soundtracks (which is why both logos can appear on the same cinema marquees), and all THX-licensed home cinema systems are based on Dolby Pro Logic Surround decoding.

Variable area — The technical term for an analogue optical soundtrack whose width varies with the sound. A Dolby analogue optical soundtrack sometimes is referred to as an SVA track, for "stereo variable area." Another type of optical track, variable density, was tried earlier, which varied in photographic shading with the sound, rather than in width.

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