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**DIGITAL STEREO:
A MAJOR BREAKTHROUGH BRINGS CLOSER
THE PROMISE TO TRANSFORM THEATRE SOUND**

**BY
JOHN F. ALLEN**

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FIRST IN DIGITAL STEREO

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NEWTON, MA 02459 USA • TEL: 1-617-244-1757

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On September 18th, 1989, Optical Radiation Corporation President Richard D. Wood made the long awaited announcement that composite motion picture release prints with a full digital stereo soundtrack were now possible. Working closely with the Eastman Kodak Company, the two organizations have developed the technology required for encoding, photographing, printing, reading and decoding digital sound on conventional movie film. The system will be trade named Cinema Digital Sound.

This is truly a major breakthrough! To fully appreciate this accomplishment, try to imagine cramming ten times more information than ever before into the same space currently available in the soundtrack area.

Digital vs. Analog

Digital recording is fundamentally different from analog systems. We are all familiar with the wiggles of an optical soundtrack. If the sound is loud, the wiggles are wide. If the sound has a high pitch, the wiggles are short and fast. The wiggles represent an analog of the sound; an analogous form of the pressure waves in the air which we hear as sound. The analog recording systems we are most familiar with are: magnetic tape, phonograph records and optical movie soundtracks. Each of these storage mediums has its own limitations of noise and distortion. All require some form of passive or active noise reduction for best results.

Tape can certainly do a fine job of recording the highest frequencies we can hear, but it can be noisy. A phenomenon called "print through" can also be a problem. This occurs when the tape is stored on a reel. One layer of tape faintly "prints" its magnetic recording on an adjacent layer. In other words, we may get to hear something two or three times when we play it back.

Though phonograph records lack a wide dynamic range, they can still sound quite good. But surface noise, scratches and pops are a constant annoyance. Optical motion picture soundtracks do not have either the dynamic range or frequency range to be truly called

High Fidelity. In addition, a matrix must be employed to achieve more than a two channel presentation. Without sophisticated noise reduction methods, optical variable area soundtracks are virtually unacceptable by today's standards.

In digital recording systems, the audio signal itself is never recorded on anything. The sound is first converted into binary digits: ones and zeros. It is these numbers that are recorded. We never hear the background noise, clicks and pops of the recording's storage medium because we are never listening to it. The numbers are "simply" retrieved from the recording and converted back into the audio signal. (See **BOXOFFICE** January, 1986: "Digital Stereo, How It Works").

The noise of a digital recording is so low we can hear the noise of the microphone preamplifiers and mixer. With digital recordings, wow and flutter are absent. This is due to the precise timing with which the digits are converted back into an analog signal.

Digital's History in Film

Digital sound in motion picture studios actually began about ten years ago. Walt Disney Studios began recording the sound for films produced for their theme parks with digital recorders. In 1982, **FANTASIA** was rerecorded using these early and often temperamental machines. This marked the first time a feature film was digitally recorded, mixed and dubbed. Film historians will recall that in 1940, **FANTASIA** was also the first film ever recorded and presented in stereo.

In 1984, as part of the introduction of my **HPS-4000™** installation at the Plitt Century Plaza Theatre in Los Angeles, I enlisted the assistance of Glen Glenn Sound along with Giorgio Moroder's Oasis Recording Studios, and presented the world premiere of digital stereo in a commercial motion picture theatre. The presentation was so successful, it was all but mandatory that we follow it with a full length digital stereo feature presentation. As if it were fulfilling its own destiny, **FANTASIA** opened in digital stereo and **HPS-4000™** sound at the Century Plaza Theatre on February 8, 1985. This was the first public digital stereo film presentation ever. The response was enormous. **FANTASIA** went on to two more digital presentations in Washington D. C. and New York City. (See **BOXOFFICE** July, 1985: "Presenting Digital Stereo").

For the next year or so, digital was one of the most talked about topics in the industry. Interest seemed to fade, however, as people realized how difficult it would be to marry a digital soundtrack to a composite release print.

Showscan and Disney began using digital discs synchronized to their films. Until now,

these double system presentations remain the only ones regularly done in digital stereo. The three digital FANTASIA engagements were also done with a double system. Instead of compact discs, we used VHS video cassettes with the digital sound recorded in the Sony PCM-F1 video format.

The reason digital presentations in normal movie theatres stopped after 1985, was mainly due to the lack of an inexpensive way to put the sound on the film. Wide acceptance of digital stereo for films required a single system approach. It should also be mentioned that studios have resisted investing the millions of dollars required to convert and replace their sprocketed analog recorders.

Towards A Solution

Two “single” digital sound on film systems were seriously explored. The first was an ingenious approach called Fluorescent Sound, developed by Mr. Peter Custer of Pennsylvania. This system used a print with a normal analog optical soundtrack. The digital information was printed over the picture area. Detection in the projector was done by focusing an ultra violet light on the film and reading the “dots” on the film, which represented the ones and zeros, as they fluoresced. This system featured eight full frequency, fully redundant channels. In other words, the sound was placed on the film twice. If the pickup missed it in one place, it would get it in the other.

The drawback to the Fluorescent Sound system was the increased print cost. Distributors resisted any digital approach that increased either printing complexity or costs. They wanted a system that would put the digital soundtrack on the film at normal printing speeds using conventional printers.

Some within the industry felt this would prove impossible, believing the dot’s representing the digits would have to be too small to be resolved at a film velocity of only 18 inches per second. Others questioned whether conventional printers would be up to the task of reliably printing such tiny images while running at speeds of hundreds of feet per minute.

Actually, no one was even trying to find out if such an approach would really work until Showscan asked Kodak to look into the question. Showscan wanted to know if a digital soundtrack could be photographically placed on their 70 MM 60 frame per second films.

Headed by Ronald Uhlig, a team at Kodak computed the dot size required for digital sound on such a film and discovered that it could indeed be printed and read from a Showscan print. The question remained whether smaller dots could be printed on a 35

MM film running at 24 frames per second. It looked very promising. It still, however, remained very unclear if the number of dots which would fit in the optical soundtrack area could be enough for a discrete multi-track digital recording and what quality such a soundtrack could be. Could it match compact discs? From a marketing standpoint, the public might seem indifferent to a digital sound in a theatre, with less quality than they had at home.

The 3.2 Million Dollar Gamble

Optical Radiation's President Wood quietly took it upon himself to decide that his company would make the investment required to complete the research required and bring digital stereo to motion pictures. Without any fanfare, he budgeted some 3.2 million dollars of the company's money and directed Howard Flemming to form a team of engineers and computer experts. Working closely with Uhlig and his colleagues at Kodak, Flemming and his group developed a six channel digital format that would fit into the existing soundtrack areas of 70 MM and perhaps even 35 MM film. Error correction became a most difficult problem, taking months to resolve.

During this time the Society of Motion Picture and Television Engineers (SMPTE) formed a digital sound study group. With the significant help of BOXOFFICE readers and others, this group found a general acceptance of a six channel stereo format. The format called for three full range screen channels, two full range surround channels and one 20-80 Hertz bass channel. ORC and Kodak found that such a "5.1" channel digital recording could be made to fit and developed a new camera to photograph it. The ".1" channel refers to the bass channel. With a range of only 20 to 80 Hz, the amount of data required equals a fraction of that needed for one of the main full bandwidth channels.

All the digital sound negatives were transferred onto positive prints at normal printing speeds, on normal printers. Only when ORC was convinced the "digits" were sufficient to be reliably read in a projector with sound actually reproduced, did they go public and proudly announce their stunning breakthrough.

A "Measured" Introduction

Current plans call for a 70 MM digital demonstration film to be introduced early in 1990. With the large soundtrack area available with 70 MM prints, it is believed this new system will work quite well. It is conceivable that limited 70 MM digital feature presentations could follow later in the year. 35 MM digital presentations are perhaps as much as two years away. This will allow researchers time to further evaluate, perfect and refine the smaller and slower 35 MM process before offering it to the worldwide 35 MM market.

Digital and The Public

Obviously the public loves digital sound. In only ten years, the quality and convenience of compact digital discs has made vinyl records nearly extinct in some stores. Digital sound may be the single most important development for consumer electronics since the introduction of solid state components. Can digital sound prove as potent a tool for the motion picture industry? In my opinion, it can. Will it? Only if audiences can truly hear the difference.

To assure that they will hear the difference, theatre owners should seek a far greater understanding of speaker systems and amplifiers than they ever have.

Most of the loudspeakers found in theatres today and many of those currently offered for use in theatres, were never intended for the performance level required for full reproduction of digital films. Many of today's theatre sound systems should therefore not be considered completely "digital ready". To hear a digital stereo presentation which sounds significantly better than current stereo films, I recommend that inadequate speakers and amplifiers be upgraded along with the installation of the digital processor.

Recognizing the possibility that in some cases the additional dynamic range afforded by digital recordings could overload some theatre loudspeakers, ORC plans to include circuits which will sense amplifier clipping and limit the processor's output to protect the system from damage. This will allow a theatre owner to install digital stereo without fear that his existing sound system will be over-stressed.

To prevent the need for limiting and thus deliver the full benefit of digital stereo to audiences, I have advised my clients not to consider stage speakers for digital systems unless they have a sensitivity of at least 106 dB Sound Pressure Level (1 Watt, 1 meter). Theatres over 75 feet long will likely need speakers with a sensitivity of 109 dB SPL.

Surround speakers with a sensitivity of less than 98 dB SPL, should not, in my opinion, be considered sufficient for digital sound reproduction in theatres.

Some manufacturers have offered speaker systems with the sensitivities suggested and power outputs required. Some of these speakers, however, represent very old and often compromised designs. Recognizing their inadequacies, manufacturers have generally withdrawn such older designs from the theatre market in the past few years.

The power amplifiers found in many many theatres are nowhere near powerful enough

for current stereo presentations let alone digital stereo. Many factors must be considered when selecting amplifiers for theatre use: reliability, rugged construction, continuous power output, speaker protection, distortion, frequency response, etc. It's no wonder so many people seem to disagree about which one to use. I have my favorites as well.

The point I should make here, is to use amplifiers with at least four times the power needed to play the program material at proper levels. This will ensure that the amplifiers will never run out of power and "clip", causing speaker damage and reducing the life of the amplifier itself.

An Exciting Future Awaits

We are now standing at the beginning of what could well prove to be the rest of our lives in motion picture sound. Digital stereo holds the promise for vastly improved film presentations and audience pleasure. With a comprehensive digital sound system design approach, exhibitors stand the best chance of delivering the full impact of this new technology to their patrons.

If serious full blown digital stereo systems with the proper acoustics, speakers and amplifiers are widely installed, the public will come to associate digital stereo with a superior sound experience which, in its own way, will rival that of a fine concert hall. When you consider the small percentage of the population regularly exposed to the beauty and pleasure of live sound, I believe that digital motion pictures, properly recorded and presented, will represent a tremendous cultural enhancement, enriching all our lives. Wait 'til you hear it!

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John F. Allen is the founder and president of High Performance Stereo in Newton, Mass. He is also the inventor of the HPS-4000® cinema sound system and in 1984 was the first to bring digital sound to the cinema. John Allen can be reached by E-mail at JohnFallen@aol.com.