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THE EIGHT CHANNEL ADVANTAGE

BY

JOHN F. ALLEN

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THE EIGHT CHANNEL ADVANTAGE

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Sony Dynamic Digital Sound is the only digital eight-channel motion picture sound release format currently being offered to exhibition, bringing back and expanding a widely heralded stereo format with five full-range speakers behind the screen. BOXOFFICE contributing writer John F. Allen provides some insights into eight-channel stereo and the considerable history behind it.

October, 1984. It was a moment I had long awaited: my first opportunity to hear a 70mm six-track motion picture, recorded and played with five full-range channels behind the screen. When all was finally ready, I signaled the projectionist to bring down the lights and roll the film. For years I had heard how wonderful this format had been, how much better than the others using only three screen channels. But really, I had thought, how good could it be? Weren't the three-channel systems I was so used to as satisfying as they could be? Now was the moment of truth. I was finally going to be able to decide for myself.

The film began. Frankly, I couldn't believe my ears. As a music and sound lover, I was truly wowed. Never had I heard anything like it in a theatre before. As I sat there in amazement, I began to question how I had been able to tolerate listening to sound systems with only three screen channels for so long. The experience I had so anticipated suddenly became a moment of both discovery and intense self-doubt.

For almost the last 20 years, stereo motion picture soundtracks have employed just three main loudspeakers behind the screen. Yet, clearly, five channels adds a quality and dimension unattainable by these smaller systems. And yet today, Sony's eight-channel SDDS system is the only digital release format offering this advantage. Where did this superior format come from? Where is it now? Why is it better? Why has this presentation and marketing advantage been left dormant for so long?

BASICS

The answers to these questions go back more than 60 years. In 1933, engineers from Bell Laboratories, under the auspices of the National Academy of Sciences, performed what is believed to be the first large-scale demonstration of stereophonic sound reproduction. The

goal was to perform a live concert of the Philadelphia Orchestra in their home, the Philadelphia Academy of Music, and reproduce it live, over loudspeakers, in Washington, D. C.'s Constitution Hall, 141.6 miles away. Many of the most basic principals and practices employed by audio engineers today can be traced back to this fundamental and pioneering work.

In this early attempt at stereophonic sound, it was realized that mere recreation of the sound of the Philadelphia Orchestra was not enough. The orchestra had to be reproduced in *full auditory perspective* as well. Instruments should not only be heard in Constitution Hall as they sounded in the Academy of Music, but they should appear to be located in the same positions within the orchestra: left to right *and* front to back.

The most basic hurdle to overcome was determining the number of independent channels required. The first thought that comes to mind is what audio pioneer W. B. Snow referred to as a “curtain” of small microphones placed in front of the orchestra in Philadelphia, and a corresponding “curtain” of loudspeakers placed on the stage in Washington, D. C. The idea, of course, is that if one is to capture the curtain, or wall, of sound produced by an orchestra, one “simply” needs as many channels as possible.

After much (now legendary) experimentation, it was discovered that a satisfactory illusion of auditory perspective could be created using only three discrete channels of microphones and speaker systems. Three channels also provided the most economical means to demonstrate the fundamentals of stereo. Thus, full-scale stereophonic sound reproduction was born as a three-channel medium. Since the 1930's, much has occurred to modify this approach, some good and some not so good. For the purists, perhaps one of the least welcome evolutions was the development of the two-channel phonographic long playing record (LP). Although the stereophonic LP did indeed bring stereo to the “masses,” it also seemed to fix everyone's mind on stereo as a two-channel (left and right) medium.

If one examines the papers that came out of the 1933 Bell Labs experiments, one sees that, while a good left to right perspective was attained with the three-channel system, nearly half of the virtual depth of the stage was lost. (See Figure 1.) In other words, the front to back perspective was only about one half of what it should have been. Another phenomenon one observes is the tendency of the sound sources to be grouped around the three speakers. Rather than a “curtain” of sound, the three-channel system had a tendency to become three spot sources that the sound came from. Although the test conditions may have exaggerated this effect, listening to three-channel systems today confirms its existence.

Another 20 years would pass before the next major advance in stereophonic sound.

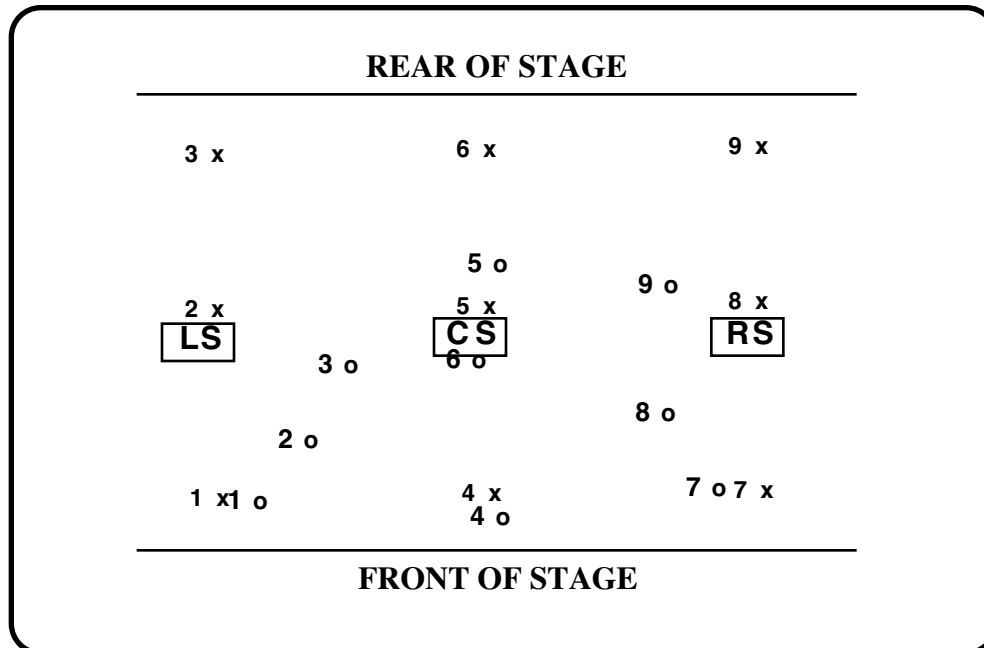


Figure 1

Reality vs. perception: 1x through 9x show nine actual locations on the stage. 1o through 9o show the corresponding perceived locations. LS, CS and RS are the left, center and right loudspeakers, respectively.

MOTION PICTURES LEAD THE WAY

The earliest predecessor of the Sony eight-channel format first appeared in U.S. theatres over 40 years ago. In the early 1950s, television began to affect attendance at movie theatres; many theatres were closed. The motion picture industry responded with several new widescreen film formats. The two largest of these formats were Cinerama, a three-projector process, and Todd-AO, a 70mm single projector system. Both of these film formats included discrete multichannel stereophonic sound and were easily capable of projecting very large pictures indeed. Screens of 60 feet or more in width were not uncommon.

In developing these formats, engineers quickly realized that, even with the largest loudspeakers, three channels of sound behind the screen were not enough. The “holes” in the spaces between the speakers were not only noticeable, but they were worse. This was due to the fact that the speakers would be even farther apart than had been the case in the

Bell Labs work two decades years earlier. Something had to be done.

It was also recognized that motion picture sound is in motion, literally moving around from scene to scene, often within a scene - something sound from a symphony orchestra never does. If a sound was required to be panned across a screen with only three channels, it appeared to virtually jump from speaker to speaker, rather than moving smoothly from one point to another. Clearly, something had to be done.

Of course, adding more than the minimum three channels to the Bell Labs system would have been a difficult decision due to the costly 141.6 mile transmission link. But this problem does not present itself in movie theatres. As such, a sound format for motion pictures can easily provide the opportunity to employ enough channels for the finest possible sound.

**Five channels behind the screen adds a quality and dimension
unattainable by smaller systems.**

For the sound engineers of the 1950s, the solution became obvious. To maintain the continuous wall of sound that stereo is supposed to be, to increase the virtual depth of the stage, or scene, and to eliminate the “holes’ between the speakers, more than three channels were needed. After considerable research, it was found that, with two additional channels increasing both the number of directional cues as well as the total radiating area of the loudspeakers by 66 percent, five full-range-channels behind the screen added a significant and seamless dimension to stereophonic sound.

With the addition of the surround channel, 70mm Todd-AO was introduced with a discrete six-track format on October 10, 1955. The soundtrack was recorded on the now familiar magnetic stripping placed on either side of the film’s perforations. This became the release print format of choice for major motion pictures for the next 40 years. Todd-AO was not alone. The engineers at Cinerama, and others overseas as well, had themselves reached the same conclusion and also used five channels behind the screen. However, in 1977 there was a major change in the way the screen channels were allocated. The left-center and right-center channels were eliminated in favor of a separate subwoofer channel. For the first time since its introduction, the 70mm sound format was, in the opinion of some, downgraded. Though the subwoofer channel was a welcome

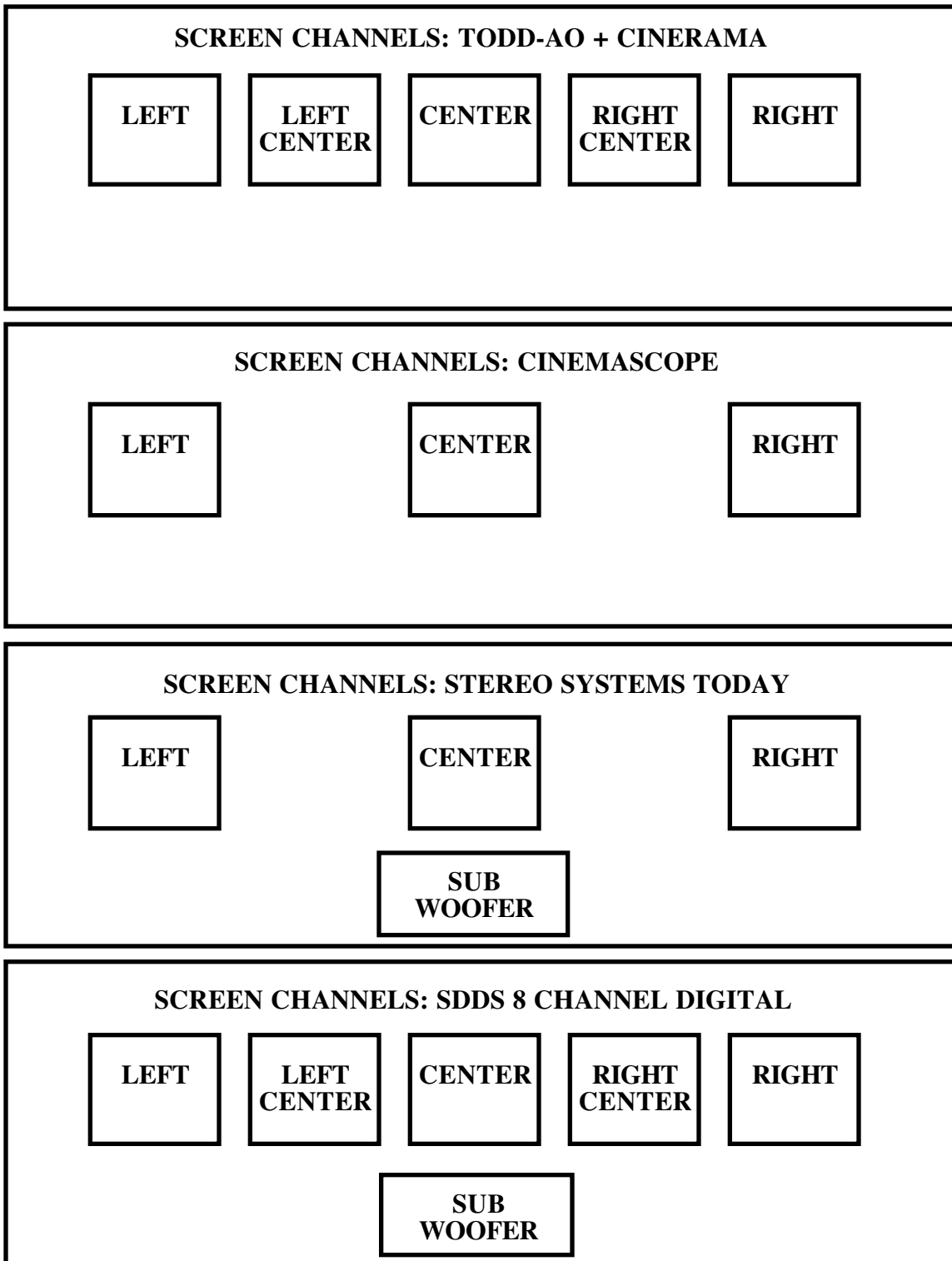


Figure 2
Screen channel configurations.

**STEREO
QUALITY
IN PERCENT**

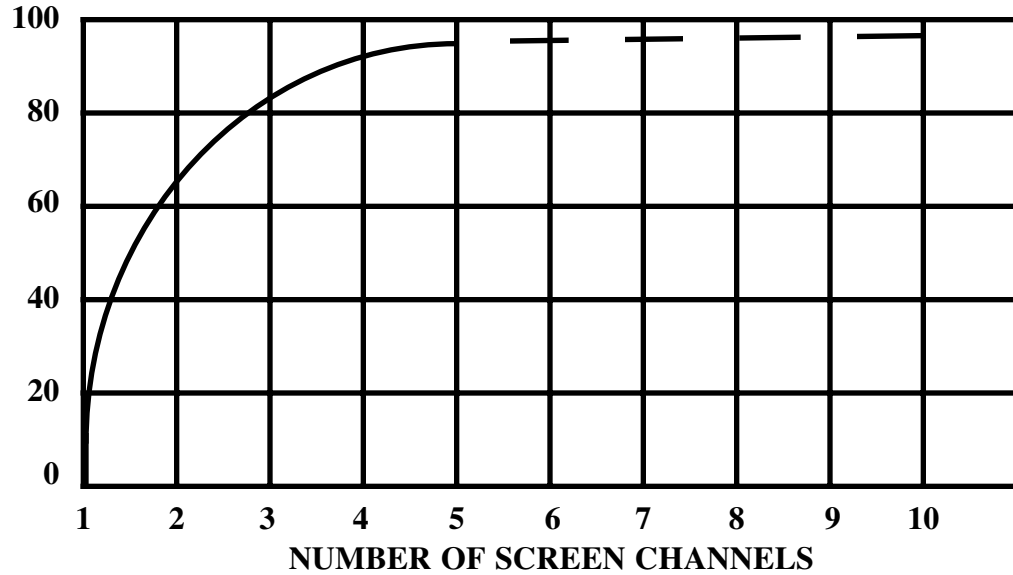


Figure 3

**Stereo quality vs. the number of screen channels.
Previously published.**

**STEREO
QUALITY
IN PERCENT**

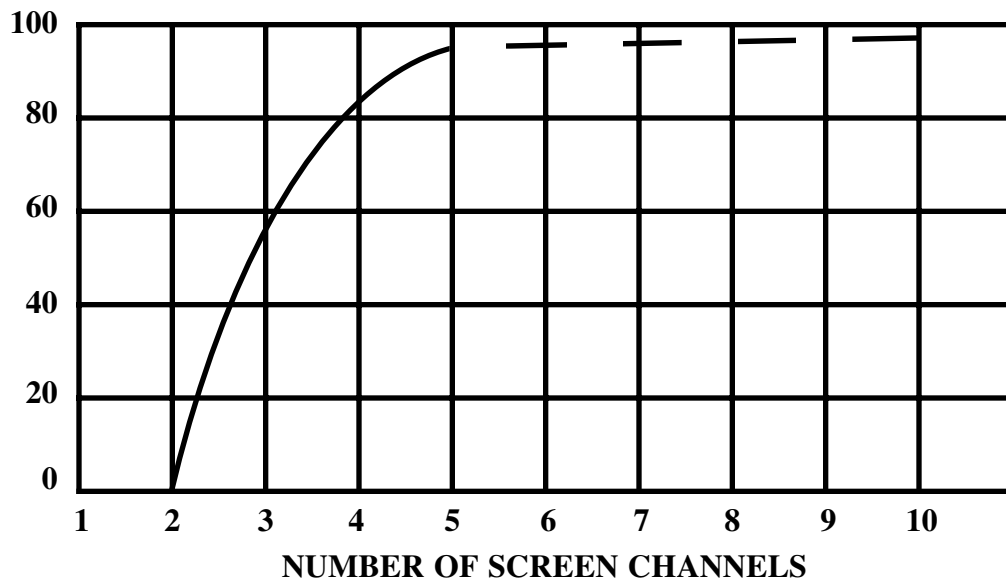


Figure 4

**Stereo quality vs. the number of screen channels, off center.
From author's experience.**

addition, the 70mm format now offered only three channels behind the screen, the same as 35 mm stereo films. For the next 17 years, motion picture sound remained a three (screen) channel format. (See Figure 2.)

STEREO QUALITY VS. THE NUMBER OF SCREEN CHANNELS

Sound and cinema engineers in Russia were also studying stereophonic film sound. In his book “Wide-Screen Cinema and Stereophonic Sound,” Michael Wysotsky published a most interesting graph comparing the quality of stereophonic reproduction to the number of screen channels employed. (See Figure 3.) This graph assumes a stereo quality rating of 100 percent to be perfect and natural sound, indistinguishable from the original. Note that with one channel there is no stereo. Therefore the stereo quality is zero. With three channels, the stereo quality is around 85 percent. With five channels, the stereo quality increases to about 95 percent - roughly a 10 percent improvement over three screen channels.

In my own experience, Wysotsky’s chart seems conservative, perhaps significantly underestimating the advantage of five screen channels. This would seem especially true if one considers those seated off to one side of a theatre. Figure 4 shows my own experience and factors in those sitting off center, which is most of the audience.

Consider that we have all had the experience of hearing only the speaker we are closest to, when we sit off center with a two-channel home stereo. As we move off center, the sound becomes mono - actually less than mono, because all the information isn’t there. This explains my zero percent stereo quality rating for a two-channel system, *when sitting off center*. When one is sitting off to one side (say the left) in a cinema with three channels behind the screen, the stereo image collapses to the left and center speakers, not strictly to the left. Three channels, after all, are better than two. But when five screen channels are used, virtually filling the entire width of the screen with sound, the stereo image is better maintained throughout the theatre. This makes sense intuitively, as there is no such “image collapse” in a concert hall.

SONY DYNAMIC DIGITAL SOUND

From its earliest inception, the engineers at Sony felt that, if they were going to offer a deluxe digital motion picture soundtrack, it had to be all inclusive. It had to be a sound on film format. It had to provide all digital processing right up to the outputs to the power amplifiers. It had to meet a long list of Sony digital specifications. But most of all, it had to return the advantage of five full-range screen channels to the motion picture industry. With the subwoofer and stereo surround channels included, the SDDS system

was introduced in 1993 as the industry's first discrete eight-channel general release digital sound format.

Today's SDDS eight-channel motion picture mixes often make full use of this advantage by typically recording their orchestras with five main microphones, one for each of the five screen speakers. The result is the closest possible replication of an orchestra as well as a huge increase in stereo quality and audience involvement with the film.

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Rerecording mixer Chris Carpenter (INDEPENDENCE DAY, IMMORTAL BELOVED) notes that mixing in eight channels provides a greater clarity and openness than is possible with the conventional six channels. The bigger the mix, the greater the advantage. Although music derives the most benefits, Carpenter points out that effects are also improved and that panning opportunities are enhanced.

With five channels behind the screen, there is less "competition" among tracks. In other words, in an intense scene the left center and right center might carry some loud effects while the center remains clear for dialogue. The added discreteness helps the audience keep everything separated and hear the dialogue more easily and clearly.

EIGHT CHANNEL INSTALLATIONS

Some may be surprised to learn the actual number of eight-channel theatres. As of this writing, Sony reports that there are well over 500 eight-channel installations worldwide. Ninety percent of these are in North America. This may be a surprisingly large number when one considers that it exceeds the number of 70mm Todd-AO installations by some 200. In addition, nearly 50 films have been mixed in this powerful format.

In addition to technical advantages, these eight-channel theatres can boast a genuine marketing advantage as well. Laserdiscs already provide discrete six (5.1) digital soundtracks for home viewing. These can sometimes be superior to the soundtracks played in theatres. As the new digital video disc (DVD) gains acceptance, six-channel stereo will become increasingly relegated to little more than a fairly common home format. Movie theatres equipped to present films in eight full channels can build and maintain a greater marketing edge over home theatres.

Of course, the SDDS processors are equipped to fold-down eight-channel soundtracks for

playback in conventional six (5.1) channel and even four channel theatres. This ensures that all the sound is reproduced even with the smaller systems. However, eight channels should not be considered just for the larger screens.

SCREEN SIZE DOESN'T MATTER

I used to subscribe to the general notion that, for screen widths up to 40 feet, there was little or no advantage in using five backstage speakers over three.

As it turns out, this is not so.

Nothing could drive this point home more than an experience I recently had in a Sony screening room with a mere 12-foot wide screen. The film I was listening to included a fairly equal amount of both original music recorded for five screen channels, and licensed popular music played through only the three left, center and right speakers.

The difference in stereo quality between the original and licensed music was startling. The original music had more depth, more fullness and a far more natural quality. With such a sound as a comparison, listening to the three-channel licensed music became an annoying and distracting disappointment, even with a 12 foot screen. Obviously my earlier notion had been mistaken. The SDDS eight-channel advantage will work in any theatre.

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(My thanks to rerecording mixer Chris Carpenter, sound historian Ted Uzzle and representatives of Sony Cinema Products Corporation for their valuable assistance in preparing this article.)

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.