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## THE MIGHTY SOUND OF THE CENTURY PLAZA THEATRE

BY

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H/GH PERFORMANCE STEREO™



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Every now and then a sound system designer enjoys a very special opportunity: To design and install a system in one of his favorite places. The installation of the Los Angeles area's first HPS-4000<sup>™</sup> sound system at the Century Plaza Theatre was certainly one such opportunity for this writer. (HPS<sup>™</sup> stands for High Performance Stereo<sup>™</sup>).

This beautiful theatre is located in Century City, the ultra modern office and shopping center built on what used to be the back lot of 20th Century-Fox. Known for its exceptional comfort, presentation quality and 1400 plus seating capacity, the Century Plaza Theatre has become a favorite for world premieres and other special screenings.

Several things distinguish the sound system from other current installations. Perhaps the most interesting is the use of four-way fully horn loaded loudspeakers behind the screen. Virtually all theatre sound systems still use two-way speakers. Also unusual is that because of the size of the Century Plaza Theatre, this is a 10 channel sound system. Finally, the entire system is matched to the individual theatre by a proprietary computer program, assuring even coverage and adequate power.

At 160 feet long and 92 feet wide, the theatre is huge. The seating area is divided by a transverse aisle about 100 feet from the screen. The rear "grandstand" section has a 16 foot slope.

An obvious design goal for any theatre sound system is even coverage. This holds true for both the screen speakers as well as the surrounds. Another factor should also be considered, tonal balance throughout the listening area. A modern theatre playback system must be capable of reproducing, without distortion, the full bandwidth and dynamic range of today's analog soundtracks and tomorrow's digital recordings as well. First arrival peaks of 103 to 105 dB SPL per channel must be delivered to the middle of the theatre.

To achieve these goals, four-way fully horn loaded speaker systems were selected for the main screen channels. Their high (109 DB) sensitivity afforded many benefits. The seven

foot long folded horn woofer yields an eight-fold increase in low frequency radiating area over a direct radiator type system. In my opinion, the importance of this cannot be emphasized enough. Concurrent with an increase in sensitivity and therefore total power output, is a reduction in distortion - both harmonic and, more importantly, modulation distortion products. One should also note that the 10 1/2 square foot radiating area of just one woofer horn exceeds, by 30 per cent, the low frequency radiating area of an entire 70 MM sound system using five direct radiator woofers. Also avoided are the breathing sounds associated with ported boxes as the horns employ a sealed rear air chamber.

The crossover points are 350 Hz, 1 kHz and 6.5 kHz. While single-horn type high frequency systems are often used in theatres, dividing this spectrum can audibly lower modulation distortion by reducing the low frequency material carried by such a single horn. One final and important benefit of high efficiency loudspeakers is the elimination of the traditional needs for multiple amplifiers, bi-amping etc.

The passive crossover used has an insertion loss of about 1/2 dB, a 1000 Watt capacity and is designed specifically for the loudspeaker. The four sections of the speaker system are within 1 dB of each other in sensitivity, versus 11 dB for systems using direct radiator woofers and horn tweeters. Since the high frequency horns are a exponential, and not a constant directivity type, no high frequency boost is required to overcome the natural roll off of the compression drivers. Most importantly, multiple amplifiers provide no audible improvement when listening to these systems. Consequently, we only required seven amplifiers for the seven stage speakers instead of the 22 we would have otherwise needed. The system is then simpler, more stable, less vulnerable to failure and less costly.

Normally 70 MM installations use five screen speakers placed behind the screen. These can be full range systems. However, most 70 MM films are currently released in what is called the "baby boom" format, where the left center and right center channels are used only for bass extension. This is in recognition of the severe bass deficiency found in the majority of theatre speakers.

Since the Century Plaza Theatre is used for so many special events where films of all types and formats may be shown, we installed a full 70 MM six-track system with full range speakers for all five main channels. With such a large room, it was felt wise to add two extra woofer horns fed from the subwoofer output of the processor. This ensures proper bass balance with six-track films and reduces the load on the left center and right center woofers during "baby boom" operation. Needless to say, with over 70 square feet of low frequency radiating area behind the screen all sitting on top and within a 12 x 50 foot baffle, the bass quality is phenomenal and can even be felt through the concrete out in the

#### **EVEN COVERAGE**

The dual requirements of consistent horizontal coverage angles and uniform tone throughout the listening area, argues against the current practice by some of using constant directivity horns. There are two reasons for this. The screen acts as a beam spreader as frequency increases. To obtain relatively consistent horizontal beamwidth through a movie screen, the speaker's horizontal radiation pattern must be correspondingly reduced. The vertical radiation pattern needs to be reduced as well, but by and even greater amount so that more high frequencies can be aimed at the rear of the theatre to overcome the air's greater attenuation in this range. By tailoring coverage patterns in this way, consistent tone and level are better maintained throughout the room. All this from a single speaker system placed behind a movie screen.

### SURROUND SPEAKERS

Throughout the motion picture theatre industry, a most unfortunate situation exists. The installation of surround speakers has been, and mostly still is, a very haphazard process. Usually no attention whatsoever is paid to the radiating patterns. One writer recently offered formulas for locating surround speakers that totally ignored beamwidth when determining the proper height. Often the speakers used are very inefficient systems with absolutely no possibility of matching the sound of the screen speakers. Beyond that, it simply isn't possible to put enough power into these "quiet-speakers" without burning them up or driving them into gross distortion before they reach the levels required, especially in larger theatres.

Though compromised almost as a matter of course, the surround channel is actually a very important element in modern theatrical presentations. With quiet ambience, such as a gentle wind sound, to full blown effects including spaceships flying through the theatre, the surround channel must be considered equal to a main screen channel.

The surround sound is provided by the familiar distributed system - typically, 10 to 12 speakers placed on the side and rear walls of the theatre. In reality, many installers entirely ignore the rear wall which means that no one is surrounded at all. Surround coverage in many theatres can vary as much as  $\pm 5$  dB throughout the surrounded area. Proper coverage from the surrounds, however, must be exceptionally even, and without the ability of any listener to localize to a single speaker. In addition, the timbre of the sound and the dynamic range must be equal to a screen channel.

To accomplish all this, I developed special proprietary formulas that do equate the

radiating patterns of the surround speakers to the dimensions of the room. These formulas have been incorporated into a first of its kind, 750 step computer program that has been used to design all the HPS-4000<sup>TM</sup> systems. Once the type of system (35 or 70 MM) and room dimensions are entered, the program yields the total number of surround speakers required, their needed power for the particular room, their height, location along the wall and tilt down angles. The screen speakers and their power requirements are also determined by the program.

Surround arrays constructed according to these formulas, have been noted for their unusually even coverage, typically  $\pm 1/2$  dB within the surrounded area. There is no localization to any speaker even when sitting underneath one. Formulas have also been developed for round rooms and theatres where the ceiling is lower than the ideal height for the speakers. Called the ALLEN SURROUND ARRAY<sup>TM</sup>, these arrays have been installed in over 100 theatres worldwide.

In the case of the 160 foot long Century Plaza Theatre, two separate surround arrays were required. The main floor was covered by only eight speakers, four per side at about 22 feet high. As though they were in a corner, the rear most of these were aimed at the center of the front row, while the other six were fired across the seating area. The grandstand was covered by a second group of 16 surround speakers. Since the ceiling is only eight feet high at the back row, the number of speakers had to be increased to avoid localization. The larger number of speakers required and their precise locations were also provided by the computer program.

Normally surround sound is delayed to arrive slightly after the screen sound. 70 MM discrete six-track prints have a built in delay of 1 1/2 frames or about 60 milliseconds for the surround track. 35 MM stereo optical prints encode the surround information in real time onto the left and right soundtracks. In this format, the delay is done electronically and is adjusted according to the length of the theatre. The delay must be set carefully. Too much results in an echo effect. Too little results in a pre-echo effect and a noticeable dialog leakage from the surrounds as well.

In a 160 foot long room, no single delay will be correct for every area. Accordingly, the front and rear surround groups were put on separate delays of about 80 and 120 milliseconds respectively. These settings were empirically arrived at by listening to several films at the rear of the two areas. If the additional delay for the rear seating area is kept to less than 45 milliseconds, experience has shown that there will be no audible double arrival effects in the common areas covered by both surround groups.

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A few 70 MM releases have been recorded with split or stereo surrounds. To play these films, additional circuitry is needed. The modules required were installed in the processor. This results in four separate surround channels; left front, right front, left rear and right rear.

The surround speakers selected are 3-way types employing a 12 inch direct radiator woofer in a sealed box with a horn loaded midrange and tweeter.

Sonic matching between the stage and surround systems is accomplished by using the same high frequency drivers in both speakers. Full dynamic range from the surrounds is assured by the 98 dB sensitivity of the speakers and, of course, adequate amplifier power.

### POWER FOR THEATRE SOUND SYSTEMS

Any one channel of a 70 MM print, played at "normal" levels, can be expected to reach peaks of 101 to 103 dB SPL in the center of a theatre. Since movie soundtracks are so carefully modulated and limited (we hope), we need not build in the usual amount of headroom which one would prefer for a live performance system. In motion picture sound systems, I generally recommend a safety margin of about 6 to 8 dB and specify enough power to deliver around 109 dB SPL per channel in the center of a theatre. At the Century Plaza, this would nominally require 635 watts per screen speaker and 2645 watts for the surrounds. Sometimes this works out conveniently with today's amplifiers, sometimes not. A 400 watt amplifier was installed for each stage main channel and six 400 watt amplifiers for the surrounds. With 400 watts playing into one of the four-way stage systems, we can expect about 107 dB 80 feet away in the center of the surround amplifiers powered the forward assembly of eight speakers, and the remaining two powered the rear 16.

#### FOR THE RECORD

Since its installation in late 1984, it's fair to say that this sound system has become known by critics and producers alike as the finest in the area. The Los Angeles Daily News called it "the best in area, if not the country". Directors such as Sir David Lean, Sir Richard Attenborough, Sidney Pollak and others have hailed the sound quality as the best they've heard. One particularly gratifying comment often offered by producers is that they can hear fine nuances in their recordings which were not known to be there, or that certain films playing over this system sounded better than they were made. I attribute these findings to the higher efficiency and lower overall distortion exhibited by the loudspeakers, as well as the quality of the power amplifiers and the careful tuning of the entire system. On December 6, 1984, in cooperation with Glen Glenn Sound and Oasis Recording Studios, we presented the world premiere of digital sound in a commercial movie theatre to an invited industry audience. This presentation was quite successful and lead directly to the first ever digital presentations of a full length feature film. On February 8, 1985 Walt Disney's classic masterpiece FANTASIA opened a stunning seven week digital engagement at the Century Plaza Theatre. This was followed in May and November by additional digital presentations of the same film in Washington D.C. and New York City.

Playing digital movies at the moment is rather tricky as there is not yet a proven method for storing and retrieving a digital recording using 35 or 70 MM release prints. It is hoped that such methods will become available sometime in 1986. The digital FANTASIA presentations were made possible by the use of a synchronizer developed by Walt Disney Pictures' sound department for the EPCOT center.

To avoid the complexity of changeovers, the entire film was spliced together and placed on a platter. New prints were used because we needed every single frame in order to stay synchronized with the sound. The 1982 re-mastered digital stereo soundtrack was copied onto the video track of a 1/2 inch VHS cassette recorder along with SMPTE time code placed on the audio track. As part of the Disney synchronizing system, the projector's motor was replaced with a stepping motor which was driven by the synchronizer. As long as the film was laced up in the projector, on the "Start Picture" frame, the time code from the VHS cassette would tell the synchronizer where the projector should be. In this way we could use an otherwise normal stereo release print and switch to it should that be needed. The system, however, never failed in over 270 performances. Reliable as it was, we await composite digital release prints for any wide scale use of digital stereo in movie theatres, a marketing tool they disparately need.

In the past six years, HPS-4000<sup>™</sup> sound systems have been installed in many leading theatres around the world. The Century Plaza Theatre has to rank as one of the finest and most comfortable theatres anywhere and I would urge anyone who is interested in a real cinematic treat to visit this theatre when in the Los Angeles area.

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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<sup>®</sup> 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.