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# **THE ULTIMATE SYSTEM ?**

**BY**

**JOHN F. ALLEN**

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*FIRST IN DIGITAL STEREO*

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# THE ULTIMATE SYSTEM ?

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I suppose I'm too careful to claim such a distinction but the sound system recently installed at the Plitt Century Plaza Theatres in Los Angeles has been called "ultimate" by more than one. Three things do distinguish it from other highly touted 70 MM sound systems: At 160 by 90 feet, the room is huge. The installation utilizes every feature of the Dolby CP-200, including one never used before, and even employs gold plated speaker wire connectors. Most important for Plitt's investment, the sound system is digital ready. That is the theatre now has a sound system with the dynamic range necessary to meet the demands of digital sound. To put it another way, the Century Plaza has one of the most acoustically powerful theatre sound systems in the world with a total output in the neighborhood of 600 acoustic watts.

The best way to describe the features of this sound system is to describe the Dolby CP-200 itself. When playing 35 MM stereo films, the CP-200 is much like Dolby's smaller CP-50. The two discrete channels of sound recorded on the film are optically detected. Ultimately these so-called left-total and right-total channels are each fed to their respective speakers behind the screen and become the left and right channels that we hear. The center channel is derived using a 50 year old technique that combines the left and right channels together. When this summing occurs, any sound which is 180 degrees out of phase (reversed polarity) from one track to the other is canceled. Dialog is recorded in equal levels and phase on both channels. This is then monophonic information and should come from the center speaker. To help ensure that it does, the 35 MM Dolby systems detect when there is only monophonic information, assume it is dialog and turn down the left and right channels about 14 dB. This improves intelligibility over what we would have with all three screen speakers delivering dialog at the same level.

The fourth or surround channel is recorded on both channels in equal levels but 180 degrees out of phase from one channel to the other. Decoding the surround is much like deriving the center except that before the two main channels are summed, the polarity of one of them is effectively reversed. This provides the surround information as well as a canceling of the mono dialog so it won't be heard through the surround speakers.

In addition to surrounds, six-track 70 MM systems have traditionally used five speakers behind the screen. The original wide screens where 70 MM was installed used the

additional speakers to avoid “holes” in the wall of sound which stereo is supposed to be. These “holes” appear when stereo speakers are too far apart.

Today, for the most part, these two extra channels are called Left-Extra and Eight-Extra and are generally used only for bass extension. This has been done in recognition of the bass deficiency found in most theatre loudspeakers. For this reason the left-extra and right-extra speakers need only be woofers, that is most of the time. One might well ask what of the future?

If a 70 MM theatre retains its five conventional stage speakers, the CP-200 also provides a special low frequency output. For 70 MM films, the signal provided here is the sum of the left-extra and right-extra channels below 200 Hertz. For 35 MM films the signal provided is the sum of the left-total and right-total channels below 100 Hertz.

Incidentally, 35 MM theatres equipped with CP-50's and conventional theatre speakers can install Dolby's CAT 160 bass extension card and the necessary woofers to achieve the optical bass extension feature of the CP-200.

70 MM operation of the CP-200 differs substantially from the 35 MM. Instead of two channels made into four, 70 MM provides six discrete channels of recorded sound; left, left-extra, center, right-extra, right and surround. The Century Plaza is the first theatre anywhere to use all the needed accessories of the CP-200 to deliver up to ten channels of sound.

Large theatres need bigger speakers, more woofers, more amplifier power, more surround speakers and in this case, additional surround delay.

Ten channels? This installation includes the circuitry required for stereo surrounds. This gives us left and right surround channels. Additionally, because of the size of the theatre, the surrounds speakers are divided into forward and rear groups. The forward group covers the main floor. The rear group covers the grandstand area. It is these rear surround speakers that required the additional delay. The ten channels thus become: left, left-extra, center, right-extra,, right and low frequency. These six channels are behind the screen. The four surround groups make up the rest and are designated left surround, left rear, right rear and right.

Delaying the surround sound is required because the audience is closest to the surround speakers. Without a delay, the surround sound would arrive at our ears before the screen sound. Recalling how the surround channel in 35 MM stereo is decoded from the main

two channels, dialog should be canceled. However, some dialog is still present in the surrounds though at a very low level. To fool us into not noticing it, the surround sound is precisely delayed so that the dialog leakage arrives just slightly after we hear it from the center speaker. A precedence effect makes us think that we only hear the dialog from the screen where it belongs.

In 35 MM optical stereo, the surround channel delay is done electronically. The length of time can be adjusted. The setting must be just right. Too short, and we hear the dialog leakage. Too long, and the surround becomes a distracting echo. In discrete 70 MM films, the surround channel is recorded with a built in delay of 1 1/2 frames or about 60 milliseconds. There is no dialog leakage to worry about, but in a 160 foot long theatre such as this one, 60 milliseconds will not be enough for the rear surrounds. People in the grandstand will hear the surrounds as a pre-echo. The original design of the CP-200 took this into account and called for additional optional delay circuits. These modules (CAT-214) are used here for the first time.

We have had previous experience with large 35 MM systems which required additional outboard delay units. Findings indicate that the additional delay should not exceed 45 to 50 milliseconds or the two surround groups will become audibly separated.

I've saved the speakers and amplifiers for last. Though they are the most important element in sound playback, in theatres they are usually the most inadequate. There may not be any such thing as a good speaker. Somehow the original real sound is always more satisfying. A major problem is distortion. Speakers produce lots of distortion, lots of frequencies on their own which are not part of the original sound or recording. I have always enjoyed the big clean rich natural sound of well designed horn type speaker systems. Indeed I have never heard a non-horn or direct radiator speaker that could approach the quality of sound I strive for. The reason the horns have the potential of sounding so good is that they are so efficient. If you double the efficiency, you cut the distortion in half. This is because the harder the drivers have to work, the more distortion they produce. In horn type speakers the drivers work very little to produce lots of loudness. Direct radiators need to work around 10 times as hard as horn drivers and thus can be expected to produce 10 times the distortion or more.

A further reduction in the speaker distortion called modulation distortion, in which the distorting frequencies are not harmonically related to the sound, can be obtained by dividing up the spectrum and making the speaker a two-way system. Two-way systems have been the standard in theatres right along. If two-way is good then is three-way or four-way better? Many professional sound reinforcement experts think so. But are they

necessary in theatres?

Before Dolby noise reduction came to the motion picture world the range of frequencies or bandwidth of the soundtracks was limited to about 200 to 4000 Hertz, or about 4 1/3 octaves. Limited bandwidth was the noise reduction system of the past. Dolby's noise reduction system allowed the bandwidth of film sound to be greatly increased. Today we required to reproduce (through a movie screen mind you) virtually the entire range of frequencies that humans can hear, about 30 to 12,000 or 15,000 hertz. This is 9 octaves.

In my opinion, two-way systems are not adequate in this environment. I have been regularly using three-way full horn loaded speakers in every theatre sound system I've designed. This means that even the woofers are a full horn and not the familiar short horn / vented box combinations.

Distortion in the three-way systems is audibly lower. It can be lowered still by going to a four-way configuration. The four sections are called woofer, sub-midrange, midrange and tweeter. The four-way system is now offered by Klipsch as the TMCM-4. The Plitt Century Plaza is the first theatre in the world to be equipped with the TMCM-4 loudspeakers, which by the way cost about the same as the large conventional two-way systems.

Another way to look at these four-way systems is to remember the 200 to 4000 Hertz bandwidth of Academy mono and the two-way speakers that were designed to reproduce it. The sub-midrange and the midrange portions of the four-way system cover this spectrum just the way the older systems did. But rather than forcing those limited bandwidth designs to play the wider frequency range by boosting the bass and treble controls, as is common practice, the four-way system adds the bass and treble speakers sections. This results in a loudspeaker capable of playing the entire frequency range of the modern recordings without the bass and treble boosting.

As stated the Century Plaza is a very large room. The massive woofer section of the TMCM-4 is a 7 foot long folded horn driven by two heavy duty 15 inch drivers. These woofers can even play sensurround™. Ordinarily we use these units alone for the left-extra and right-extra bass extension channels. But in this case these channels will also have the high frequency sections and be full range speaker systems. For normal 70 MM Dolby stereo the left-extra and right-extra channels will function as bass extension. For conventional 70 MM or any full six track recording requiring five full range screen speakers, the left-extra and right-extra channels will be ready.

We are including two additional woofers fed from the low frequency output, in other words a sixth screen channel. This will provide an even cleaner bass from the system by reducing the work load of the bass extension woofers. This will also give full flexibility to the studio engineers and producers who regularly use this theatre for previews and premieres.

The 24 surround speakers are full range three-way systems which employ horn loading in the midrange and tweeter sections. Though compact, these systems are selected because of their unequaled output and sound quality for their size and price. The horn loading is necessary in surround systems for lower distortion and power requirements, but also to project the sound down to the audience where it belongs, and not waste it all over the room. As I wrote in the March, 1983 BOXOFFICE, most surround systems currently operating in movie theatres are a joke. Too often theatre owners seem to automatically compromise their entire sound presentation by installing horrible speakers and totally insufficient amplifier power. The surround sound should match the screen sound.

This can be accomplished by employing enough power and by a careful speaker design that uses treble drivers identical to those used in the screen speakers.

The rear grandstand area at the Century Plaza is covered by 16 surround speakers, the floor section by eight speakers. Since the ceiling and thus the surrounds are so low in the back of the theatre the number of speakers must be increased to keep the coverage even and prevent sound localization. The computerized Allen Surround Array™ formulas provided the exact location and angle of each speaker. The mathematical approach assures even coverage with a minimum of speaker systems and cost.

A theatre's loudspeakers, 31 in this case, must have only the finest in power amplifiers. There are several available. The new BGW 8000-4's were chosen. These are the first commercial grade power amplifiers I've heard which sound like good home high fidelity amplifiers. Yet they deliver 250 watts into 8 ohms and about 400 watts into 4 ohms. The 4 ohm TCM-4's are then driven by 400 watts which is enough to deliver 107 dB sound pressure level (SPL) per channel in the center of the theatre.

The passive crossovers of the Klipsch speaker systems have only about 1/2 dB insertion loss and waste little power. The sensitivities of the four sections are within 1 dB of each other versus 11 dB for some other theatre speakers. So it seems unnecessary to go to the added expense of tri-amping or even quad-amplification. The resulting installation is far less costly, and by virtue of its greater simplicity, more reliable.

One very important and often overlooked item in theatre sound systems is speaker wire. All wire has resistance. The greater the resistance between a power amplifier and a speaker, the less the damping factor. This in essence is the amplifier's ability to accurately control the motion of the driver without overshoot. Usually horn loaded speakers are more forgiving in this area because the drivers move so little to begin with. The drivers are also mechanically damped by their sealed back air chambers - another advantage of horns. However, sensitive ears can hear the an improvement in damping if speaker wire losses are kept to 1/4 ohm or less, round trip, In this long a theatre we are required to use heavy No. 6 THHN copper wire from the amplifiers to the stage speakers. Since THHN wire is very stiff and difficult to maneuver, we terminated the speaker cables in the rear of the amplifier rack and ran the very flexible monster cable up to the output terminals. Gold plated connectors were used here to guard against corrosion.

It is my hope that this High Performance Stereo™ installation may come to serve as a new standard for the digital soundtracks which seem to be in our future. Already Glen Glenn Sound has produced the very first film with a digital soundtrack and others are following suit. "METROPOLIS is the first digital feature film.

Is this the "ultimate" system? No not really. Nothing is. It does take Dolby stereo as far as it can go. But who knows what is yet to come. It's hard to imagine the need for more dynamic range than we achieve here as it is doubtful that audiences would tolerate the loudness. However, future formats could require full size speaker systems at the rear or some other part of the theatre. Maybe that's the ultimate, though I doubt there is such a thing.

We are planning to hold a demonstration of this system and are gearing up to play several examples of well recorded films as well as Glen Glenn's DIGITAL DREAM. All those interested are cordially invited.

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