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MAINTAINING LEGENDS

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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The audio press is becoming more enlightened and increasingly critical about the sound quality encountered in movie theatres. Having been spoiled by compact digital discs, video laser discs and home theatre for over 10 years, critics have come to expect more when attending theatres. Whether the theatres be old or new, large or small, complaints are constantly being voiced about shrill sound, dull sound, “flat” sound, gross distortion, terrible surround speakers, as well as muddy and distorted bass. Worst of all, dialog problems continue to be found.

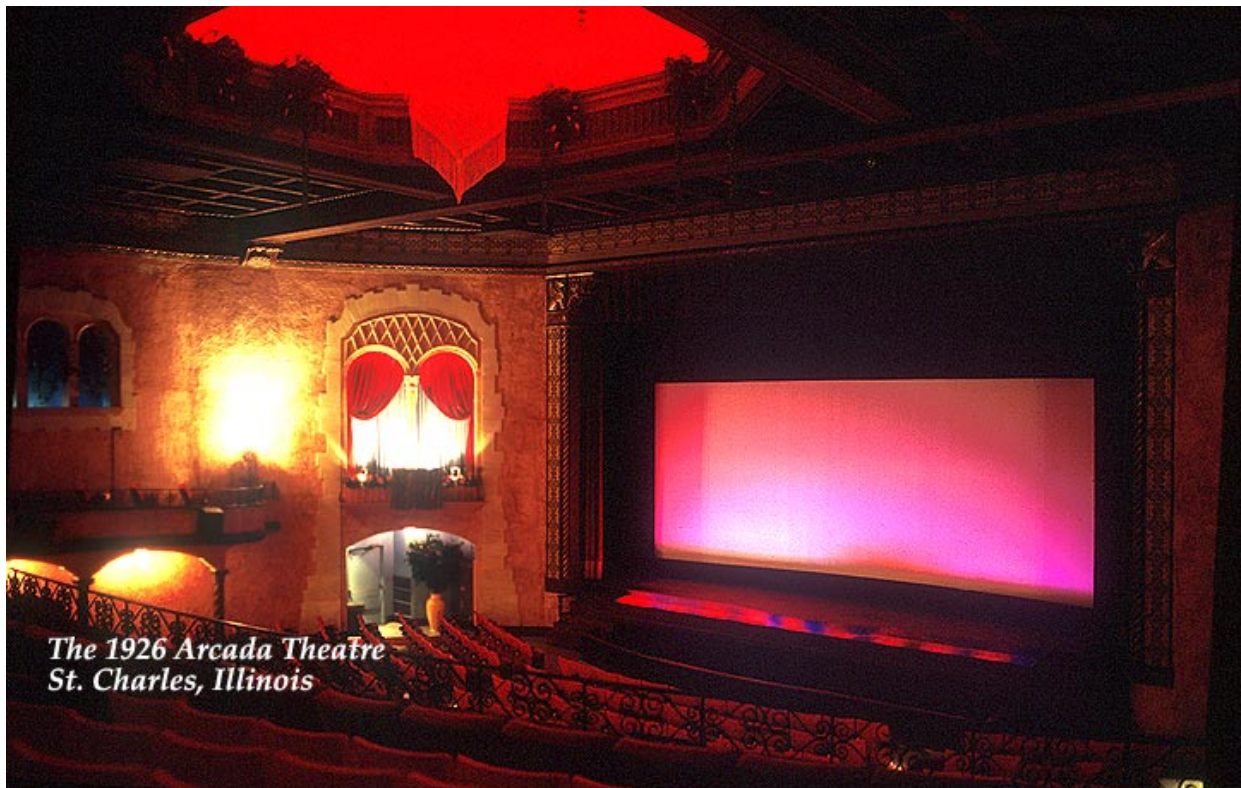
I try to visit as many theatres as I can during my travels. To be honest, I’ve heard the same things and find these complaints are all too valid all too often. This situation is not unique to the motion picture business. In my experience, the audio industry often ignores the reality of just how big real sound is, and how powerful a sound system has to be to reproduce it in any space, let alone a room the size of a theatre. Theatres, of course, represent one of the largest spaces where audiences listen to sound; outdoors being the largest.

Few movie theatres bigger than 500 seats are being built today, most are less than 300 seats. Yet even these theatres appear to be too big for most of the installed sound systems in use today. If the critics are right, if these systems are failing to provide a satisfying experience in 500 seat theatres, how can digital sound be successful in very large theatres? When these issues are not properly addressed, digital stereo in movie theatres winds up as a giant *missed* opportunity for everyone, exhibitors and moviegoers alike.

CHALLENGES

Since I began focusing my own professional audio activities on motion picture sound in 1979, I have been asked to deal with the challenges poised by theatres of all sizes, including some very large theatres. This has proven to be very hard work, but ultimately very satisfying. For if conventional practices in average theatres fail to impress the critics, then success in the very largest theatres must mean something. Indeed, I’ve found that such challenging theatres defy the conventional wisdom of sound system design. If one is to be successful in the field of large motion picture sound systems, particularly with today’s new digital recordings, one must find or, more often than not, create new solutions.

Readers of this column may recall previous articles describing installations for large theatres in Chicago, Hawaii and Kingston, Jamaica. (The installation in Kingston is still the most powerful of its kind ever assembled, with the unbelievable acoustic power of 1400 acoustic watts, or 20 symphony orchestras). With the exception of Jamaica's Carib Theatre, none of these previously described theatres has a balcony. In other words, most large theatres are just that, big shoe box shaped rooms requiring lots of acoustic power, but still typical in their overall design.



Balconies, however, change everything. And balconies with large seating areas underneath them change things even more. Such rare and often landmark theatres present the most complex, not to mention expensive, obstacles to a sound system designer. Last year my company was awarded contracts for new sound systems in two more of these legendary theatres.

The first was the Arcada Theatre in St. Charles, Illinois. The second was the Dealey Center Theatre, located within the United States Naval Submarine Base in Groton, Connecticut. Both theatres were designed for live performances as well as film presentations. Each has a full stage-house and a small orchestra pit. The 900 seat Arcada

is the more ornate of the two, but Dealey Center is four times larger in volume. In fact, this latter theatre required the largest number of surround speakers ever for any HPS-4000™ sound system anywhere in the world: 38 !

Among several factors which must be faced when contemplating a sound system in theatres such as these, the most important is the fact that the acoustics and decor cannot be changed in any way. You take what you get. If you intend to use loudspeakers which require dead rooms to provide intelligible speech, you're in big trouble. The challenge is to install a sound system which can perform in a more reverberant space.

THE ARCADA THEATRE

Originally opened on Labor Day in 1926, the Arcada Theatre is today listed in the National Register of Historic Places. Built by a local millionaire, the idea was to build a theatre "of which the city would be proud." The decor is Spanish, complete with ornate columns, a wooden beam ceiling, a small loge, box seats and, of course, an organ. Special trains from Chicago brought people out to the theatre on opening day. Over the years the Arcada has hosted the most famous acts of the day: Fibber McGee and Molly, George Burns and Gracie Allen, Edgar Bergen and Charlie McCarthy as well as the John Phillips Sousa Band and many others.

When the building's current owners decided to have the theatre restored, they solicited proposals. Willis and Shirley Johnson, owners of Tivoli Enterprises and Classic Cinemas in nearby Downers Grove, Illinois were selected. The Johnsons are particularly well suited to the tasks of restoring and operating such a theatre. As members of the Theatre Historical Society (Shirley also serves as secretary), they literally travel throughout the country, visiting and studying historic theatres, often purchasing artifacts for their own theatres from those theatres being destroyed. They have accumulated a warehouse full of such items. The Johnsons brought in the best craftsmen they could find and along with their own highly experienced staff, have now restored the Arcada, including all new projection and sound systems.

THE DEALEY CENTER THEATRE

The Dealey Center Theatre at the Navy's Groton base was built in 1945. If any one thing can be said of this building, it must be that it was constructed with the toughest and hardest concrete ever created. Boring a hole through the booth wall for the new wiring, burned up one electrician, two heavy-duty hammer drills, countless bits and took two days just to get through the first 6 inches. Just hearing the nightly reports of all this wore me out.

There were also other problems. A narrow stairway prevented us from carrying the new projector console up to the booth. So we asked for a crane to lift it through a window. Now when you ask the United States Navy for a crane: you get a *CRANE* ! The outriggers alone were two foot by two foot bridge-grade steel “I” beams which covered an area of 1600 square feet. The tires were seven feet in diameter, dwarfing anyone who stood near them. Watching the seemingly tiny console being hoisted 3 stories by a crane capable of lifting 100,000 pounds was both amazing and hysterically funny at the same time. The skill displayed by the operators and riggers, who are used to installing missiles in nuclear submarines, was most impressive. Needless to say, equipment and crew survived without a scratch, but what a sight.

The Groton base serves as the Navy’s main submarine training school. The theatre is in the recreational center. Primarily used for motion pictures, it is also regularly used for naval seminars, ceremonies, concerts, ballet and other performances. The room is 125 feet long, 85 feet wide, 45 feet high and seats 1376. The balcony bisects the rear 1/3 of the theatre. Until this upgrade, projection facilities were limited to 16 MM, which is standard for the Navy.

This theatre has had a notorious reputation for bad sound. Upon my first visit, I noticed a speaker mounted above the stage. It was a modern design widely sold for movie theatres and public address systems. It was powered by good quality amplifiers, located in the proper position and tuned with 1/3 octave equalization. The only problem was understanding speech through this loudspeaker in this large and somewhat reverberant room. I was questioned time and time again about whether a sound system could be designed to work in this theatre without adding any acoustic treatment. Such an expense was prohibitive.

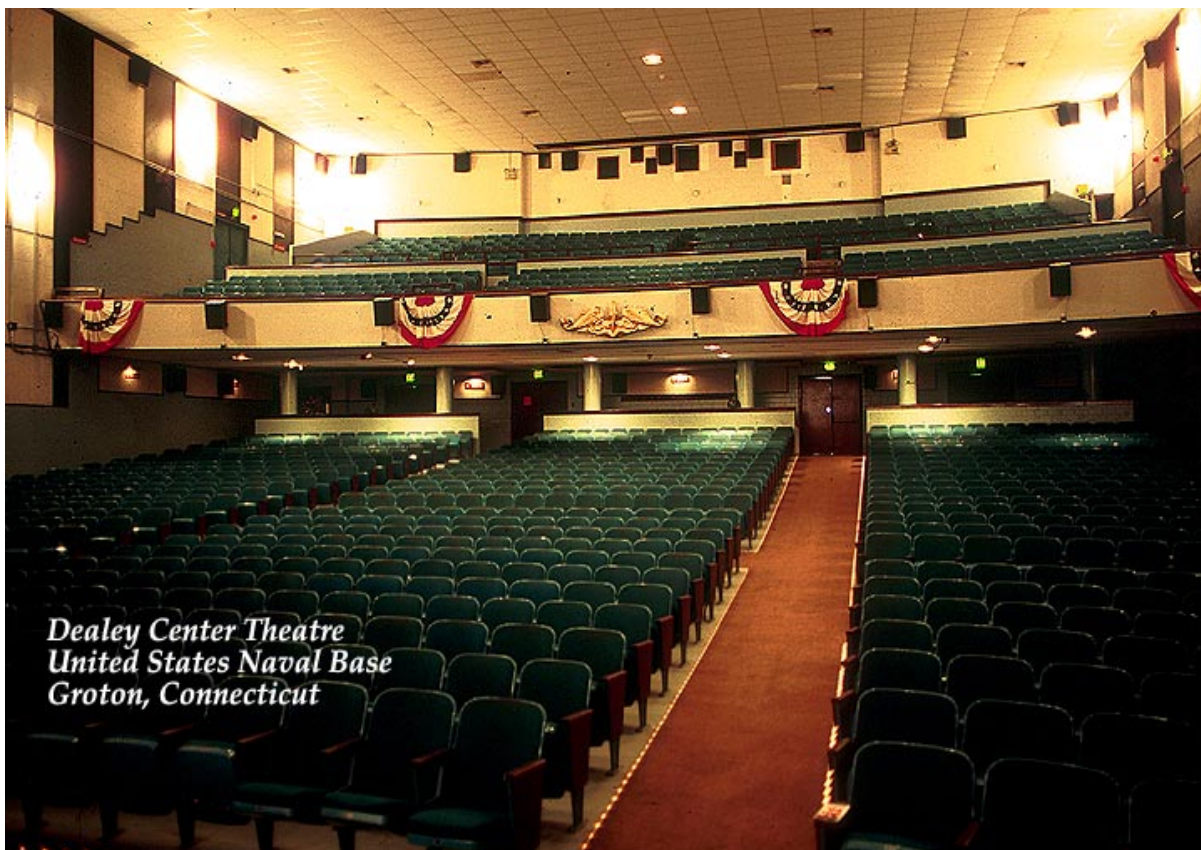
Since live speech from the stage was perfectly intelligible everywhere in the room, there was nothing acoustically wrong. As in most situations like this, the historic problems were with the previous sound systems. In the end the new sound system worked perfectly, exceeding my own expectations. In fact, this theatre’s acoustics, though mistakenly criticized for years, are actually very good. This may be the best sounding large theatre I’ve ever been asked to work in. All this, and not one square inch of acoustic treatment was added to what was already there.

THE SOUND SYSTEMS AND COPING WITH MULTIPLE SURROUND CHANNELS

With two exceptions, the sound systems installed the the Arcada and Dealey Center theatres are identical. The larger Dealey Center requires four more surround speakers and

four times more subwoofer power than the Arcada. Each system was installed for digital stereo and wired with “split” or stereo surrounds. At first thought, one might believe that getting good coverage and sound quality from the screen speakers would be the most difficult problem in such theatres. While this is by no means a trivial matter, it is actually the surround channels which are by far the most complex.

A surround system is supposed to be an omnipresent sound source. No localization to any single surround speaker should exist anywhere in the theatre. The sound quality, tone and combined acoustic power output of the surrounds should equal one of the screen channels. This can be hard enough in smaller theatres. It is certainly rather rare to say the least. Imagine how difficult it can be in theatres with balconies. In truth, it’s impossible with conventional surround techniques.



BALCONIES

To a sound system designer a theatre with a balcony is, in reality, three different rooms, each with its own acoustics. We have the area of the main floor in front of the balcony, the area under the balcony and the balcony itself. Each of these separate spaces requires its own separate surround array. Since each of these arrays is located at a different distance

from the screen, each must be delayed by a different amount and, thus, powered by separate amplifiers. This initially adds up to three stereo surround arrays, or six surround channels.

In order to avoid single speaker localization, the Allen Surround Array™ formulas provided the precise height and spacing for locating each individual surround speaker. It is here, however, where conventional surround approaches fall short. While proper speaker placement can eliminate single speaker localization, no placement technology by itself can eliminate localization to the sidewall speaker groups for those sitting off center, in other words, the majority of the audience.

This is because the surround speakers in such a theatre are always too low for even coverage. The height of the balcony rail fixes the height of the rear surround speakers covering the main floor. The ceiling heights both in and under the balcony limit the heights of the surrounds in those areas as well. One can sit in the middle of a “low ceiling surround array” and feel fully surrounded. However, as one moves away from the center, side wall localization is immediately recognized as a problem. This is simply because in moving away from the center when the surround speakers are too low, one gets too close to the sidewall speakers relative to both the rear speakers and those on the far side of the room.

As I have described in previous columns, carefully adding a certain amount of delay to the sidewall speaker groups virtually eliminates this problem. Of course, this means doubling the number of delays and amplifiers, bringing the total of surround channels up to 12. That’s right, 12 surround channels. Theoretically this all makes enough sense. However, balancing twelve acoustically interactive surround channels with each other as well as the screen channels, is a very, very hard thing to do. Typically it requires two people two full days of painstaking tedious work. That’s two days if you have done it before, much longer if you have not.

Once the initial setup completed, I’ve found the Klark-Teknik DN-716 digital delays (which I have selected for these applications) to be so stable that the total left and right surround levels can be easily checked in the future with the same methods used in small theatres. This is a great relief in as much as the inter-surround channel balance in such a large theatre is so critical, any drifting over time would quickly ruin the intended effect.

When all is finished, the surround effect in these difficult theatres can work perfectly. Even in the most problematic areas directly under the surround speakers, listeners at the Arcada and Dealey Center theatres still feel surrounded to a remarkable degree. Single

speaker and sidewall group localization is not a problem. Nor can one detect any change when walking from one array to another, such as from under the balcony onto the main floor. Considering the 12 different delays involved, this is rather fortunate. Throughout the theatre the surround quality sound is crisp, clear, matched to the screen sound and completely uniform yet with full reproduction of any intended directional effects.

Both the Arcada and Dealey Center theatres now have 12 separate, properly balanced surround channels. Four Klark-Teknik DN-716 digital delays are installed, each providing three separate outputs with individual level and delay controls. Each of these sound systems uses six BGW stereo amplifiers to power the surround speakers. The Arcada installation is equipped with the BGW 7500-T, while the larger Dealey Center employs the heftier model GTB with the new theatre input modules designed for us by BGW.

THE STAGE SPEAKERS

Though the Navy's theatre is four times the volume of the Arcada, the coverage geometries of the two theatres are identical. For theatres of this size and type, I always specify the Klipsch® Professional TMCM-4 4-way loudspeakers behind the screen. Like all of the Klipsch® theatre speakers, the TMCM-4 features Klipsch's exclusive beamwidth shaping to compensate or equalize for the beam-spreading effects of the screen. At the same time, the vertical beamwidth is further contoured to overcome the atmosphere's tendency to absorb more high frequencies over distance. These unique and ingenious features allow for a far more consistent and smoother frequency response throughout a movie theatre. By concentrating more of the treble frequencies towards the rear, proper frequency response in the back of the theatre is now possible without sacrificing the sound in the front by making it too bright.

Such unprecedented and complete control of the loudspeaker's horizontal and vertical radiating patterns through a movie screen, allows this speaker to be used in reverberant theatres and provide 100 percent dialog intelligibility. An A-B comparison of the TMCM-4 to the Dealey Center's standard overhead theatre speaker, clearly shows the benefits such sophisticated beamwidth contours can provide. We can now confidently install modern digital sound of the highest quality in these legendary theatres without having to make them into acoustically dead rooms, ruining their character and decor.

BEHIND THE SCREEN ITSELF

Since these theatres are used for live events and performances, all the stage speakers are mounted on movable platforms. The speaker wires which run across the stage floor are connected to a backstage terminal with heavy-duty twist-lock connectors and are flexible

enough to be coiled up. The screens can be flown in, the speakers placed and connected by one person in about 10 minutes.

THE *BOOM* CHANNEL

Each of the left, center and right channels in these sound systems use the 4-way (woofer, sub-midrange, midrange and tweeter) TMCM-4's. The subwoofer or "boom" channel consists of the full size woofer section alone of the TMCM-4, called the TMWM. This not only provides full bass capability for each of the main screen channels, it ensures that the tone and power of all the speakers behind the screen will be matched. In other words, when the subwoofers play, you won't find yourself thinking "there are the subwoofers." To my ears at least, such a discrepancy is a crowning signature of poor sound system design. Real bass *never* sounds that way.

The Arcada Theatre required only two TMWM woofers and one Stereo amplifier in order to provide 4 times the acoustic power needed in that theatre to play the full dynamics of today's digital subwoofer soundtracks. The Dealey Center subwoofer channel required four times more acoustic output than the Arcada in order to deliver the same levels in the larger theatre. Fortunately, just doubling the number of woofers and amplifiers yields a four times increase in sound power output. This is due to the "mutual coupling" phenomenon found in the bass frequencies. Hence, the Dealey Center needed only four TMWM's and two stereo amplifiers. Yet this combination still delivers four times the digital subwoofer acoustic power required for a theatre 125 feet long and 85 feet wide.

The four times extra power noted here is one of our specifications. It sounds like a lot but is only 6 dB; not more than a minimal safety margin needed to prevent amplifier clipping, distortion and probable speaker damage.

The peak levels required in the center of a theatre for digital soundtracks are 105 dB Sound Pressure Level (SPL) for the screen and surround channels, and 115 dB SPL for the subwoofer channel. Each of the main channels as well as the combined surround channels are powered to deliver at least 111 dB SPL in the center of these theatres. The subwoofer channels will reach a total of 122 dB SPL without limiting of any kind, which is unheard of in most theatres. All this without the need for bi-amplification, thanks to the extra high efficiency of these loudspeakers. Such high efficiency slashes the number of power amplifiers needed for each of the TMCM-4's from four to one, a savings of nearly \$6,000.00 per sound system. The equally high efficiency afforded by the TMWM subwoofers yields an additional savings of over \$20,000.00 from what typical lower efficiency subwoofers *delivering equal output* would cost.

SPEAKER WIRING: KEEPING LOSSES LOW

Every one of the over 30 surround speakers in these theatres was wired with its own pair of No. 14 stranded wires from a terminal cabinet in the booth. For the Dealey Center, this cabinet measured three feet square and ten inches deep. This is necessary to accommodate the extra heavy stage speaker wires.

The HPS-4000™ sound system specification for screen speaker wiring states that the loss due to the round trip resistance of these wires will not exceed 1/4 ohm. The round trip path in this theatre is over 500 feet long. This forced us to use No. 8-4 THHN cable. This is equivalent to a pair of No. 5 wires and adds up to a loss of somewhat less than 1/5 ohm. When added to the loss of the smaller, more flexible on-stage speaker wiring, the total resistance is just under 1/4 ohm. Speaker wire resistance this low is essential to maintain a high damping factor: the amplifier's ability to completely control the piston action of the speaker's drivers. In other words, the bass is better.

No. 8-4 THHN cable is over an inch in diameter and represents the largest speaker wire I've ever had to use. It's so dense and heavy that a one foot length used as a club could kill. In addition to the seven stage speakers cables at the Groton theatre, we also installed two additional runs in anticipation of the Sony eight channel SDDS system.

A JOB WELL DONE

Finally, a word must be said for the installers of these major sound systems. Grand old theatres such as these not only have the most stairs, they also produce the most headaches and present the greatest concerns for worker safety. The renovation and sound system installation in Willis and Shirley Johnson's Arcada Theatre was done by their own Tivoli Enterprises technicians. Ed Dobbs, Joe Ducibella, Ron Paulson, Evans Robicheau and Brian Schneider all did an outstanding job.

The Navy's Dealey Center system was installed by Bright Star Systems, Inc. of Woburn MA. Bright Star owner Doug Teetor along with his technicians Andy Doyle and Jon Rhind did an equally terrific job, particularly under the incredible circumstances presented by such a difficult building. Electricians Gary Bresnan, Herbie Buchanan, Steve Mitchell and George Skidmore performed a heroic task pulling all the heavy speaker and power wires.

Since these people work so hard and never seem to get the appreciation they deserve, I took the time during the Navy's opening rededication program to bring them all on stage to receive their thanks.

While these installations have shown that digital stereo of excellent quality is indeed possible in our legendary theatres, one may ask if it's worth the trouble and investment required. If these theatres are any indication, the results are most encouraging. Attendance is up and steadily increasing. The renewed Arcada's success is particularly startling with an attendance increase of over 300 percent in just the first year.

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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.