WSR's Holosonic™ Home Theatre System
Part VII — The End Result

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Widescreen Review's New State-Of-The-Art Reference Theatre At New Facility

This is Part VII, the last part of a series of articles on the design, development, and execution of a new state-of-the-art Reference Holosonic™ Home Theatre Lab, built from the ground up, at *WSR's* new facility in Temecula, California (north of San Diego, southeast of Los Angeles). The new facility serves as *Widescreen Review*'s and SurroundMusic.net's review laboratory. Part I appeared in Issue 48 (May 2001).

This last part of the series will cover some of the lessons learned pertaining to the performance of a home theatre and surround music audio system, how to select individual components, and guidance in the setup of a holosonic sound system in the context of your own situation. We'll also look at what constitutes good sound performance, and how to maximize performance and value in the selection of components. As well, I will recap our approach to the *WSR* theatre's video system. Finally, I will summarize the performance of the *WSR* theatre, which is the end result of everything I have learned over many years of trial and error, and education.

I conceived *WSR*'s Reference Holosonic Home Theatre Lab to be a performance-driven venue in which to experience good surround sound and widescreen motion pictures, sourced from DVD and HDTV components. I have strived for the highest fidelity sound, whether music listening or movie viewing. The end result represents all that I have learned about reproducing good sound and pictures in a home environment. While certainly not an "everyman" home theatre, throughout this seven-part series I have shared with you techniques that have worked for me, and other techniques that have been promised to work (and indeed do).

Since the age of nine, when stereo had not yet been introduced, I have been a serious music lover and listener. At that early age, I was exposed to the Stan Kenton Orchestra by my aunt and uncle, which completely overwhelmed me with its unbelievable dynamic power, distinguished instrumental jazz voicings, and chord structures. I was so influenced with the sound of the Kenton Orchestra that I took up saxophone, and played alto and baritone saxophones later on in my teens and twenties, in big bands and orchestras. As a huge jazz fan, particularly of the big band jazz orchestra genre, I eventually became a major artists' jazz producer and recording engineer, specializing in on-location "live" performance projects. I then became a music video producer with concert projects produced for HBO, PBS, and Pioneer Artists among others, using multi-track analog and digital audio tape recorders to capture surround sound on six to twelve camera shoots. As well, I have always been a movie nut.

"Stereo" And "Holosonic" Imaging

To me, sound is at least 87 percent of the movie experience! Why? Because, our hearing and our visceral feeling is far more sensitive than our visual capacities, and influences us on a more emotionally subliminal level. Our hearing allows us to precisely locate the direction and distance to the source of a sound, anywhere around us, including its height in relation to the space we are in. That is why "surround sound" has the "potential" to produce an incredibly close encounter with real-life.

Since founding *Widescreen Review* in 1992, I have written extensively about and advocated great sound when it comes to producing movies—with the same level of high fidelity performance associated with the finest music recordings, when reproduced on a good audio system.

In the earliest days of stereo, and for some time thereafter, up to the advent of multi-track recording (which is almost always multi-track mono with no real spatial dimension), stereo recordings were produced with minimal microphone setups and the artists performed "live" in the recording studio or performance space. The two stereo channels were always acoustically related (the same instruments and voices could be heard in both channels, though with differences in amplitude and phase). Those recordings supported a much wider loudspeaker spread than is now common with multi-track mono recording and mixing (though multi-track mono recording and mixing in and of itself does not preclude this, if the tracks are acoustically related, and uniformity between the left and right loudspeakers is maintained).

Two loudspeakers, both reproducing an acoustically-related signal with small differences in amplitude and phase, are required to create a stereo image. That same condition applies to holosonic surround sound-field recreation, when all adjacent loudspeakers are at the same included angle relative to the listener, correctly positioned equidistant from the listener, and an acoustically-related signal is fed to all the loudspeakers so that a sense of inter-channel coherency can be recreated by the loudspeakers. For this to work well, the loudspeakers at each channel vector, as well as the amplification and cable, need to be identical. This is so that the multichannel signals produced by the source and amplification components are equal in sonic quality and reproduced with equal quality, when the loudspeakers convert the electrical signals into acoustic energy, and output them into the room with equal energy, to the benefit of a listener, correctly positioned equidistant from each loudspeaker. In past writing, I have referred to this approach as an acoustically-integrated, uniform, "holosonic" "circle of sound," supported by perfectly-matched discrete channels and loudspeakers.

When I am speaking of "stereo" imaging, I am referring to the dimensional sonic image in front of you, recreated from a high-quality stereo recording, played back on a properly-configured stereo system. The image should exhibit dimensional spatial soundstage width and depth, with precise image focus clear across the front, between and behind the loudspeakers, to a listener who is positioned correctly, equidistant from each loud-

speaker. Such depth and dimension reveals the specific position in space of each instrument and voice in a frontal hemisphere. Loudspeaker designs that excel at spatial resolution do a remarkable job at creating the illusion that the sound source is somewhere other than the position of the loudspeakers, in either a stereo or multichannel system.

While stereo listening is limited to recreating a sonic image in front of you, "holosonic" surround listening can add three-dimensional layering and definition along the front, side and back walls, for far greater realism, if the channels are acoustically-related and the recording is well-produced.

Setup Options

This is important to understand because where you can place the loudspeakers and your listening chair is (other than room dimensions and the loudspeaker's drivers minimum required path distance to the listener), to a degree, dependent on the nature of the recording. Some recordings support a much wider spread without compromising phantom image focus, while others are recorded and mixed, such that phantom images are not supported well beyond a seven- to ten-foot loudspeaker spread. Of course, the quality and accuracy of the loudspeakers also will be a limiting factor on the width of the stereo image. To produce a wide stereo image, loudspeaker pairs need to be precisely matched in frequency response.

Since today's modern recordings, for the most part (with the exception of classical, and some pop and jazz recordings, particularly from so-called audiophile labels), don't support "wide" loudspeaker spreads beyond seven to ten feet, enthusiasts are presented with a dilemma. What is the ideal loudspeaker setup—squeezed or wide? I'll discuss this topic later, and share my experience with striving to come up with a setup that produces good results most of the time.

Loudspeaker accuracy and room acoustics are the two principal factors that will determine the extent to which any particular setup can be supported, and experimentation is required to reach the result that will work best in your room.

Good Sound Starts With System Setup And Room Acoustics

There is no denying that component choices will have a profound effect on the quality of sound recreated by an audio system, but just as important, or even more so, is system setup and room acoustics. While better components sound better under ideal room conditions, the sonic advantages they provide will be veiled by poor placement and poor acoustics.

Because the design of the *WSR* theatre is not "fixed," other than the structural composition and dimensions, it serves as a true laboratory, in which to experiment with sound reproduction, through various setup and acoustic treatment approaches. Some techniques I have tried in the past weren't successful, while others were. I continue to experiment with setup, but I have found that there is no audio utopia, as the variations in recording approaches are far too varied, and no one setup optimizes spatiality and image focus for all "recordings." I'll return to this subject later.

I can tell you this, though. When the *WSR* system is performing optimally with a particular setup that works well for the source recording, the sense of holosonic spatiality and image focus is magnificent. And, no matter what the setup, the resolution of the system is of such high quality, that the magazine's reviewers and I are able to hear even the most subtle differences between components and audio formats. That, of course, is a primary requisite for a magazine that evaluates all sorts of components used in a home theatre and/or surround music system.

An Accurate System

For a system to be accurate, the electrical signal that is retrieved from the recording medium must be accurately reproduced by the playback system, and converted to acoustic energy.

I chose the Dunlavy Signature Series SC-V full-range loudspeakers as the system's "speakers," because they are measurably and audibly accurate throughout their extended range. Most loudspeakers cannot produce an output signal that even remotely resembles the electrical input signal high-quality components create. For a loudspeaker to be truly accurate, the acoustical waveform produced by the loudspeaker, at reference listening level, should be an exact replica of the electrical waveform that enters the loudspeaker at the input terminals.

While all enthusiasts want the sound they hear at home to sound as much as possible like the "live" musical performances they enjoy, with no standards for what that "sound" should be (preferred listening perspectives vary radically, from on-stage, surrounded by the performance, or a proscenium up-close seat, to a distant seat in the audience), I wanted loudspeakers that could measurably perform well when reproducing flat frequency response, an impulse response or short duration cosine pulse (the time domain equivalent of frequency response), a step response (resembling the first half of a square wave), and a waterfall plot (cumulative spectral decay, which displays a graphic view of how well the amplitude components decay with time, for gauging to what extent a loudspeaker will obscure signal information). I also wanted loudspeakers that were accurate in the time domain, in which the phase (the timing of an acoustical waveform) response matched the phase of the electrical waveform. A loudspeaker that is time- and phase-accurate will deliver all frequencies to the listener at the same time—which is important in order to maintain the integrity of the electrical waveform, and not alter the amplitude and temporal relationships between the fundamentals and harmonics. This is especially important when reproducing acoustically-related signals in both a stereo and multichannel setup, and is required to replicate a three-dimensional "soundstage," with precisely accurate placement of sound sources from left-to-right and from front-to-back.

While there are two other loudspeaker manufacturers that can accurately reproduce an input waveform and measure well in the other parameters (Vandersteen and Thiel), the Dunlavy Signature Series SC-Vs, in my opinion, have a fuller-range response, lower distortion, and better-optimized, controlled angular dispersion, to simulate a point source. The SC-Vs are carefully matched to a reference standard, and to each other, within less than about 0.5 dB, up to 15 kHz! This assures that the loudspeakers will image perfectly in a proper stereo setup, even when spaced apart up to about 110 degrees (in a good, acoustically-treated room). Then, too, there is an art involved in their design, but first they started out with impeccably-measured performance, and the design was finessed from there, with real musical instruments and voices as the reference. (See the review of the Dunlavy Signature Series loudspeakers used in the *WSR* theatre in Issue 52, September 2001.)

This does not mean to say that other loudspeaker designs can't produce good sound, or even sound that mirrors the sound heard in performance spaces. Such designs just can't be classified as truly "accurate," however, omnipolar™, bipolar, and dipolar types are designed to use the room boundaries to produce their enhanced sound. I like the "realism" recreated by these designs, particularly omnipolar radiation, which succeeds at enhancing depth both in the back and to the sides of the loudspeakers. While the imaging is not as ultra precise as with a time- and phase-accurate loudspeaker design, the sound from the Mirage omnipolar loudspeakers (used in *WSR's* Reference

System L) in a stereo or surround music configuration approaches the sound heard at live performances. The sound imparts a sense of realism, induced by a series of environmental reflections, just as in a real performance space. But that is another subject that doesn't pertain to the loudspeaker application used in the *WSR* theatre.

The other components in the audio portion of the system were chosen as reference components, because they have been designed to be as accurate as possible. But nothing is static in the *WSR* reference system, as often we change components independently, and compare their performance to our current reference. Then, if merited, a particular component will be replaced with a new reference piece. We are constantly experimenting with "the very best that it can be." Yes, some audio components sound better than others do. We are constantly striving to assess the subtle differences between competing components. This requires a properly setup system in an acoustically-treated room, with critical resolution capability to distinguish subtle differences that otherwise will be all but inaudible, in systems poorly set-up and/or in rooms that sound bad.

In the design and acoustical approach to the *WSR* theatre, I recognized that there are two elements of good sound: the sound produced by the loudspeakers—which relates to the quality of the components in the signal chain (whether stereo- or multichannel-sourced), and the sound that is produced by the room—which is influenced by loudspeaker placement and room acoustics.

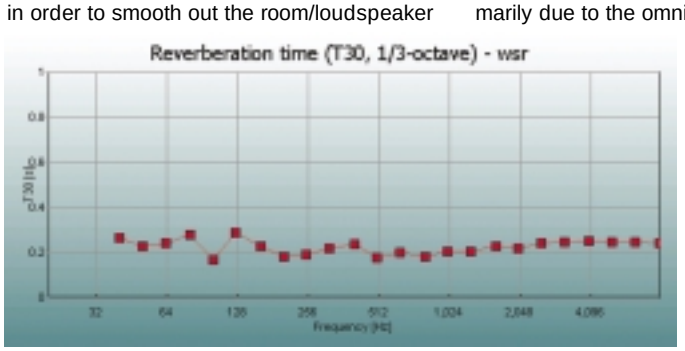
While I have experimented in the past with electronic equalization which alters the response of the loudspeakers positioned in the room, I have concluded that such so-called "room tuning" is not desirable. Instead, fixing the room acoustics is a far better solution. In the former approach, the amplitude response of the loudspeakers is electronically manipulated, primarily in the midrange and upper bass frequencies, to alter their response in a complementary way, to the reflected energy from the room boundaries, in order to smooth out the room/loudspeaker response. This alters the time and phase response of the loudspeakers as well.

As former Technical Audio Editor Richard Hardesty has explained in past *WSR* issues, readers need to recognize that our ear/brain differentiates between the sound of the room and the sound of the loudspeakers, because these sounds originate in slightly different places in the room and they arrive at our ears at different times. So, if you are out to create an "accurate" system, you want to minimize the commingling of the real signal, which originates directly from an accurate loudspeaker (analogous to a real instrument or voice), and the reflected effects of the room, which arrive later and originate from slightly different directions. (I recommend reading Hardesty's *Audio Perfectionist Journal* at www.audioperfectionist.com for a comprehensive analysis of this phenomena.)

I agree with Hardesty and RPG Diffusor Systems' Dr. Peter D'Antonio that if you don't like what the room does to your loudspeakers' performance, either acoustically treat the room for optimal response, or put the loudspeakers in a room that is better suited for good sound. Fortunately, most domestic rooms that provide a comfortable place for conversation, also will provide acceptable acoustics for home theatre and/or surround music listening. Fine tuning with absorptive or diffusive (and possibly reflective) acoustical treatment may be all that is necessary to achieve the best possible room sound, for the best possible loudspeaker performance.

In the case of the *WSR* theatre, I was able to build and acoustically treat a dedicated room, with optimal dimensions that spread resonances and minimize the frequency response aberrations. The room exhibits a lively characteristic, with a short T30 reverberant decay time across the audio spectrum. The end result supports the best possible performance from a time- and phase-accurate direct-radiating loudspeaker system (see Graph 1).

Speaking of electronic equalization as a fix, I have found that below 120 Hz, only (adjustable Q) parametric EQ can be effective at achieving smooth bass response, primarily due to the omnidirectional character of low frequencies. In the *WSR* theatre, though, no electronic equalization is used, even below 120 Hz. Ideal room acoustics are entirely achieved through the application of Owens Corning QuietZone® construction and SoundSelect™ treatment (in the rear-projection room), and RPG Diffusor Systems' VariScreen™, Skyline® and BAD™ acoustical treatment products. The end result of using these acoustical products, in conjunction with the QuietZone construction, is a room that feels comfortable to be in. It is a room that provides a comfortable place for conversation, with no outside noise interference or in-room noise from the projection or HVAC system. There are simply no distractions, and the room's dynamic capability is simply remarkable. The room is acoustically "tight"-sounding, without feeling closed-in and "dead"-sounding. It is truly one of the best sounding rooms I have ever encountered.



Graph 1

One of the things that I have written about for years is that sounds start to become directional at about 60 Hz. That is why I have always insisted on full-range loudspeakers for the surround channels, and argued in opposition to THX®'s approach to limited-bandwidth, dipole loudspeakers that provide no image focus, and re-radiate a delayed, out-of-phase recreation of the original signal, reflected off the room boundaries. I never supported the dipole approach, even for Dolby® Surround-encoded movie soundtracks decoded in Dolby Pro Logic. THX has reasoned that dipole surround loudspeakers simulate the commercial theatre experience in which there are several monopole (single direction) surrounds distributed on the rear and side walls to provide diffuse (indistinct) envelopment, so as not to otherwise distract the audience as would point source sound (effects).

Why THX Is Not A Good Solution For An Accurate System

I have never supported the idea espoused by the Home THX division of Lucasfilm (and Tomlinson Holman, the former guru of THX), that our home entertainment systems should be made to sound as much like a commercial theatre, or more precisely, a dubbing stage, as possible. (The dubbing stage is a theatre, similar in size and scope to commercial theatres, where the premix soundtrack elements are mixed together to produce the final mix from which are dubbed theatrical prints.) Why would enthusiasts, serious about sound quality, want to emulate the mediocre sound of the "public address systems," used in a dubbing stage representation of a commercial theatre system, and experience the non-image focus associated with large auditorium environments? With hundreds, even a thousand or so, comprising an audience, image focus is not possible, except marginally for a very few people seated on the center line of the screen (or projector), at a distance equal to

the width of the screen or slightly farther back. When you are "at the movies," always sit in seats located on the center line of the screen for the best sound the theatre has to offer.

In the commercial theatre environment, dialogue intelligibility is the primary attribute that the sound system must deliver. Sound quality, while an increasingly important consideration in the making of a soundtrack's elements[1], suffers overall in this "auditorium" environment, due to generally mediocre sound system quality and poor acoustics, and the adverse sonic effects of a perforated screen. The end result has been the lack of good sound overall, though unquestionably, some theatres impart better sound than others.

The commercial theatre must rely on the use of more channels and more loudspeakers than is necessary in the home theatre, to create a sense of dimensionality and "envelopment," which otherwise could not be achieved through optimal holosonic phantom imaging. The center channel (otherwise referred to as the "dialogue loudspeaker") has always been the prominent loudspeaker since the days of mono soundtracks. In the early Cinerama® and Todd-AO® 70mm "stereo" presentations, two loudspeakers were added on each side of the center channel loudspeaker, to reproduce five-channel screen "stereo" (with two-channel, discrete analog surround). This was short-lived (though Sony Dynamic Digital Sound® or SDDS,® and DTS®-8 in special venues still offer such) before just one loudspeaker on each side of the center channel loudspeaker was used to provide "stereo" for those sitting in the few seats that are positioned to hear a stereo presentation. This "stereo" was pretty much limited to the music score, "pot" positioned and panned (mono) sound effects (using a mix console), and directionalized (mono) dialogue. Then, matrix three-channel "stereo" with mono surround transformed 35mm prints to provide "stereo" and "ambiance envelopment," with absolutely no true three-dimensional holosonic image focus to define an acoustical space represented on the screen. When discrete digital capability was introduced, the mono surround arrays along the side and back walls were divided into two discrete surround channels, with each channel produced by a side and a half-back loudspeaker array. Lastly, a matrix Surround EX™ back surround was created using the back wall surround loudspeakers (leaving just the sidewall arrays to reproduce the two discrete surround channels). It is this configuration that is now standard as a production monitoring system in today's dubbing theatres. It is this channel and loudspeaker configuration that filmmakers use to create their soundtracks. And according to THX, this is the configuration that we should use in our home theatres to "accurately replicate the sound of the dubbing stage" and reproduce "the intent of the filmmaker." That configuration for Home THX consists of three identical loudspeakers in the front, a dipole loudspeaker positioned to each side of the listener (so that the listener sits in the null of their diffuse radiation), and two back surround loudspeakers, with electronic equalization applied to "timbre" match the dissimilar loudspeakers.

I don't have a problem with this channel/loudspeaker configuration as a concept per se, but I do have a problem with setup geometry and the loudspeaker types specified by THX to replicate the sound, and the poor fidelity and spatiality that results. As I have repeatedly written, the home is NOT a movie theatre, nor is a movie theatre a home. Because the home environment can be so superior to the dubbing stage or commercial theatre environment in terms of scale and acoustics, when equipped with even a modest home theatre system, the natural sound reproduction that can be achieved is far more satisfying than the poor spatial imaging and fidelity of the theatrical sound systems used in commercial theatres.[2]

I have strived with the *WSR* Reference Holosonic Home Theatre Lab to achieve the highest fidelity possible, and THX-style dipole loudspeakers do not support that desired end result. Dipole loudspeakers used for the surround channels are seriously limiting when focus-specific imaging is

1 While dialogue creation still remains less than perfect in terms of its acoustical integration with the other sound elements, overall fidelity of Foley sound effects, special effects and music scores is often quite good on modern-day soundtracks. Increasingly, filmmakers care a lot about these sound elements that add so much realism to the experience, when recorded properly and effectively integrated acoustically. It's just that the signal chain that is "fitted" together becomes "distorted," once the printmaster is encoded to an exhibition, data-reduced, compressed sound format—Dolby® Digital, DTS® Digital Sound and Sony Dynamic Digital Sound® (SDDS®)—and played back through the fidelity-deficient theatrical public address system. That is not to say that movie sound fidelity is not on par with the sound quality of the very best music recordings, but that the originating fidelity of soundtracks often approaches and even attains those high standards. Still, for the most part, with the exception of music scores, Foley and special effects are recorded in mono, and used as source elements in multi-track mono movie sound production.

Music scores are typically recorded in multichannel to provide envelopment enhancement. Some of the best music score recordings are made using the Decca Tree microphone arrangement in both the front hemisphere and back hemisphere, in which the six match omnidirectional (partially cardioid) microphones are equidistant to the listening (recording) perspective, and the channels are acoustically related. But overall, imaging between loudspeaker pairs is not considered important in movie sound, because imaging is virtually impossible in a commercial theatrical venue. But music scores, on their own, have value as "soundtrack" recordings released on CD, DVD-Audio or SACD, as part of the greater marketing effort tied to a motion picture project. And they succeed best when their recording quality is on par with music releases recorded as music performances.

Sound effects and Foley (which are recreated from real sounds or artificial sounds to simulate "real" sounds or enhance dramatic effect) are artificially imposed into the mix to provide ambiant sound support to the action on screen. Such recordings are typically wanting in acoustical integration in the soundtrack. Most of the dialogue is not the original dialogue recorded on the set or on location, but inserted in post-production through a process known as Automated Dialogue Replacement. Re-recording dialogue in the controlled conditions of an ADR studio eliminates ambient sound distractions during filming from interfering with the actor's spoken lines. The extent to which this process is successfully integrated into a soundtrack and the level of fidelity achieved is unbelievably varied. These disparities, while often subtle, between the sound of the environment on-screen and the sound around the actors' voices, can be easily discerned in a home theatre incorporating a good surround sound system. Interestingly, it seems the smaller budgeted pictures do a better job of dialogue integration, because they tend to rely on the original dialogue captured on the set or on location where possible. Bigger budget studio productions use ADR, often to appease actors who want their dialogue inflection to be as perfect as possible, which ends up deficient in acoustical integration with the other elements. Why don't they care enough to make sound elements seamlessly integrated? Because commercial theatre sound systems can't resolve nuances that would otherwise call attention to this sonic degradation. So the operative becomes "it's good enough."

Increasingly, bass is spread across several channels, as well as used as a low frequency effect in the .1 LFE channel, to increase low frequency dynamic range. Low frequency response to below 25 Hz is not uncommon in all the channels, even the center and surround channels. That is why I have always demanded "full range" response at every channel vector. Applying bass management is a compromise, since bass becomes directional at about 60 Hz.

With the exception of bass usage and the music score, there is seldom any common information in two or more channels, though increasingly there are soundtracks that excel in holosonic dimensionality, that do convey a sense of multichannel acoustical integration and balanced acoustical space

Of course, whatever the original signal quality, that quality is always data-reduced, in absolute quality terms, when encoded into the Dolby Digital and DTS Digital Surround™ compressed digital formats for distribution to the home. While the DTS Digital Surround 4:1 data-compressed format (which is superior to an entirely different codec format known as DTS Digital Sound used in commercial theatres), consistently sounds better than Dolby Digital's 12:1 data-compressed format, still, in absolute terms compared to the original master, signal information has been discarded. DTS' new 24-bit/96 kHz home distribution format may offer the potential for virtually no-lost resolution using lossless compression whenever possible, along with its superior system for allocating data among the various channels.

desired in a three-dimensional holosonic soundfield. I have always advocated using matched, direct-radiating (or bipolar or omnipolar) surround loudspeakers for imaging at the sides and across the back hemisphere, matched to those across the front hemisphere. In the case of the *WSR* theatre (and all the other reference systems at the magazine that use other loudspeakers), I use identical loudspeakers at each channel vector, except for the "conspicuous" center channel, which, even with optimized rear- or front-projection video systems, always results in a sonic compromise.

In past issues (particularly Issue 15, March/April 1995, in the article "Home Theatre Surround Sound—Doing It Right"), we have argued that a center channel loudspeaker depreciates spatial effect, when the center channel signal is not acoustically related or integrated with the other channels (which is the case with virtually all movie soundtracks and multichannel music recordings, with exceptions). Turning off the center channel loudspeaker can be advantageous to spatial imaging in such cases. The reason for this channel is to anchor dialogue at screen center and provide a solid center for music recorded in true multichannel.[3] This works best when the channel is acoustically integrated with the other channels, and provides a true center channel for listeners sitting well off-axis (though inter-channel balance will be different for anyone seated off-axis, compared to the single-person "sweet spot" listening position.) With good setup and good loudspeakers that can produce good soundstage imaging, two people seated very close together will perceive dialogue reasonably at screen center. I say "reasonably" because, in absolute terms, there is only one true "sweet spot" listening position in a home theatre presentation (or for that matter, a "stereo" or surround music presentation), which supports an equidistant setup. But do not expect all loudspeakers or rooms to support this. Why, then, not use the center channel loudspeaker? Because, when the setup is optimized, the person in the "sweet spot" will perceive a far better sense of dialogue integration with the sonics of each scene, and greater spatial depth and dimension, particularly when the channels are not acoustically related or integrated, as is typical in movie sound. But to repeat, in purist terms, there is only ONE ABSOLUTE "sweet spot" listening position that delivers "the best that it can be," for one person whether listening in "stereo" or "multichannel" surround. The "sweet spot" is defined as the seated position in which the path distances of all the loudspeakers coalesce at a precise, equal distance to the listener. That is why in my theatres in which I use a love seat, I always position one seat precisely in the "sweet spot." (The significant other's experience is good, but not as good as listening from the "sweet spot.")[4]

Now, if the loudspeaker system maintains phase and frequency coherence between all five or six channels in a surround music system and or home theatre, and the recording's multiple channels are acoustically-related and integrated, one may enjoy multichannel playback from many different listening positions, even outside of the direct soundfield reproducing space.

In the commercial theatre, a center channel loudspeaker is absolutely essential to anchor dialogue to the screen for EVERY seat in the audience.

If you must use a center channel loudspeaker because you or your guests must sit off-axis and sounds meant to locate at screen center tend to pull to one or the other of the front loudspeakers, then match it to the other loudspeakers in the system, which should all be identical. But remember that the soundfield will sound unbalanced to those seated off-axis. Of course, using an identically matched loudspeaker, in purest terms, is not possible with front- or rear-projection, unless you use a perforated screen for front-projection (which has its own sonic problems), or the loudspeakers are small enough to be positioned below and across the screen "wall," and aimed at an upward angle to the listeners ears (which also is problematic). Only in the case of a surround music-only presentation, with no screen to interfere with the setup, can a loudspeaker that is identical to the others in the system be used for the center channel. I do so in the *WSR* theatre when listening to multichannel DTS CDs, DVD-Audio, and Super Audio Compact Disc (SACD), or "stereo" recordings enhanced with Dolby Pro Logic II, using an identical Dunlavy Signature Series SC-V loudspeaker.

Some surround processors and active electronic crossover components permit you to blend the "hard," discrete center channel signal with the phantom center image, created from the left and right front loudspeakers (or vary the effect from hard center channel to phantom center and vice versa). This feature allows you to maintain a lot of the phantom image spatiality, while providing a slightly perceived anchoring of the hard center channel signal to screen center. In *WSR's* Reference System L, I use a Mirage LFX-3 electronic crossover with this feature, and it works extremely well in this regard.

In the *WSR* theatre, when monitoring movie sound, I use a Dunlavy Signature Series HRCC, which is matched to the Dunlavy Signature Series SC-Vs, and positioned it farther back from the otherwise equidistant positioning of the other loudspeakers relative to the "sweet spot" or "the chair." If you cannot physically accomplish the desired delay, use your processor to add electronic delay to the center channel signal. This tends to assist with alleviating most of the "dialogue-in-your-face" syndrome, and result in better integration of dialogue and disassociated scene sonics.

Another problem with movie sound is that the soundtracks are prepared to sound "good" in the large commercial theatre environment. One favorable aspect of this is that many original music scores (especially orchestral scores) tend to be recorded and mixed in a wide stereo soundstage perspective (sometimes using the equidistant Decca Tree microphone configuration), not typical of modern, narrower-width, image-focused music recordings. This allows for a far wider spread of the stereo loudspeakers than can be typically supported with music-only stereo (or surround music) listening using most modern pop, rock, hip-hop, blues, and jazz recordings. Unfortunately, the other elements are usually not recorded in the same manner nor acoustically inte-

2 While the performance of a home system in some respects can already rival, and even surpass, what we experience in a commercial theatre, I will say this in favor of the movie experience that the home cannot impart—that is, the matter of scale. We can easily match theatrical viewing angles in the home, but not quite the sense of being in a very large room, in front of a very large screen.

3 By true multichannel, I mean channels that are acousically related—not consisting of mono elements that are not acoustically integrated with the other channels, such as dialogue or track-isolated elements in multi-track surround music.

4 If you have ever shopped at a high-end specialty audio and/or home theatre dealer, you will probably have been asked to sit in a chair positioned in the precise "sweet spot." Or perhaps you have been to a friend's house, and your friend insisted that you sit in a particular chair position to maximize the home theatre and/or surround music experience. This is inescapable, if you want to fully experience the presentation, as created at one monitoring position and as intended to be experienced. While surround music listening is very much similar to traditional one person "stereo" listening, the soundfield has so much more depth that other listeners can be satisfied as well, even though they cannot sit in the "sweet spot" chair position. With home theatre, family members comprise the audience, and typically, with the exception of the enthusiast member, are not critical as to seating. They want, like the majority of the audience at a commercial theatre, just an unobstructive view of the screen, and to hear dialogue centered at the screen, with ambiant envelopment of secondary importance to them. That is why home theatre has a much wider appeal than one-person "stereo" or surround music listening, which tends to attract a more serious listener. Of course, home theatre enthusiasts are the exception to this generalization. And, of course, not everyone needs to be strapped into "the chair" to get musical satisfaction.

grated. Typically they are mono-sourced. Multichannel soundfield recordings are not yet the norm in producing movie sound special effects and ambiance soundscapes. The industry would benefit significantly by employing soundfield microphones with matched time- and phase-accurate capsules, to achieve seamless, holosonic, image-specific soundscapes as the underlying foundation of each scene in the picture.

When the printmaster (the final mix) is completed and the soundtrack is encoded directly to a data-reduced home audio format, and played back through even the most modest high-fidelity home theatre system, unless your surround processor/controller has the capability to electronically alter the recorded signal that was equalized in the printmaster, made for theatrical exhibition, the sound will be brighter and harsher-sounding than intended by the filmmaker (as monitored on the "equalized" dubbing stage). (See *WSR*'s *THX Special Edition* for a thorough examination of movie sound equalization and the consequences for home playback.)

Since I founded the magazine, it has been my position, expressed in numerous issues of *WSR*, that the filmmaker has the responsibility to put the sound "intended" to be heard on DVD, LaserDisc and broadcast formats, so an accurate home playback system can reproduce it without re-equalization? This is the case with CD, DVD-Audio, and SACD music score soundtrack releases, so why shouldn't it be the case for movie soundtracks on video media? Increasingly, filmmakers are addressing the problem and rectifying it with movie soundtracks on home media that are pre-re-equalized to play properly in the home theatre. Some filmmakers are even realizing that, by remixing the source elements in the theatrical soundtrack, they can create a better focused and seamless, 360-degree, holosonic soundfield that is startlingly far more dimensionally real-sounding, than anything achievable on the dubbing stage or in the commercial theatre. This new development holds the promise for the potential of home theatre to be realized. This approach also is sensible, considering that home theatre-distributed video media produces significantly more revenue for the studios than theatrical exhibition. As more studios embrace home theatre-style mixing rooms in which to tailor special sound mixes specifically for home theatre playback, we can look forward to a day when the studios will realize the benefit of creating an optimized home theatre version as the primary soundtrack, and altering those elements for theatrical exhibition. After all, the very nature of theatrical exhibition prevents recreating the subtleties and image-focus spatiality that a good home theatre system is capable of. Your support of *Widescreen Review*'s advocacy position will greatly advance the demands that studios produce optimized, acoustically-integrated, holosonic soundtracks, engineered for home theatre playback, on home theatre media. But until the studios adopt the practice universally, you will need to use the re-EQ provision on surround processors/controllers to re-equalize a soundtrack, when appropriate. In *WSR*'s DVD reviews, we point out whether re-EQ is necessary or not.

With the *WSR* theatre, I intend to emphasize our position, by demonstrating to entire DVD divisions of studios the faults inherent in the soundtracks put on their DVDs.

For more reading on this subject, please refer to *WSR*'s *THX Special Edition* and to past issues, particularly, Issue 48 (May 2001), "The THX Approach" in Part I of this series.

Room Treatment

The purpose of optimally positioning time- and phase-accurate loudspeakers and the listener, relative to the room boundaries, is to make the direct sound from the loudspeakers more prominent and the reflected sound, or re-radiated energy, from the room less prominent. Omnipolar, dipolar and bipolar loudspeakers are designed to use advantageously the re-radiated energy from the room boundaries to enhance spatial "realism," but in such a way that the first-arrival direct sound is not scrambled, or smeared and confused by reflected sound that becomes too prominent, and thus blur transient response and image focus. Both approaches necessitate a fine balance in the positioning of the loudspeakers and the listener, relative to the room boundaries.

The ideal room is one in which reverberation energy is not bounced back and forth between parallel reflective surfaces, yet is not dead-sounding. This is the role of acoustical room treatment, making the room a comfortable place to be in. Most typical American living rooms provide reasonably good acoustics with the exception of the upper ceiling areas, which tend to exhibit excessive slap echo. Excessive application of absorptive treatment will make the room sound dead and bass prominent, because the midrange and high frequencies will be sucked up. When using dipolar, bipolar or omnipolar loudspeaker designs, excessive absorption will degrade the spatial performance these loudspeaker types are meant to recreate.

While I use absorptive treatment in the *WSR* theatre, most of the acoustical treatment diffuses the response to reduce reverberation time, without degrading tonal balance. I also chose to use RPG Diffusor Systems VariScreen products, which provide flexibility in acoustically tuning the room to optimize omnipolqr, bipolar and dipolar performance when reviewing these loudspeaker types. Dr. Peter D'Antonio, President of RPG Diffusor Systems, Inc., who specified the room's dimensions and the acoustical treatments on the walls and ceiling, covered this subject in Issue 50 (August 2001) in an article entitled "Minimizing Acoustic Distortion In Home Theatre."

Loudspeaker Positioning

In the *WSR* theatre, the face of the Dunlavy Signature Series SC-Vs are positioned about six feet away from the front screen wall, to optimize their symmetrical radiation patterns and controlled angular dispersion at mid and high frequencies in both the horizontal and vertical planes. Three feet is the minimum the front face of any loudspeaker should be near a wall surface (which is the case in the positioning of the SC-V used for the back surround vector, and about four feet for the center-positioned SC-V when used in music-only playback). Also, the distances loudspeakers are positioned out from their adjacent boundaries that form a room corner should not be identical. If you are using small loudspeakers, always put them on stands and position them out into the room (and use a complementary subwoofer). If you cannot use truly "full-range" loudspeakers (as I do), capable of low-frequency extension equal to that of good, amplified, sealed enclosure subwoofers, then, redirect the bass energy to a pair of good subwoofers.

In the *WSR* theatre, the setup may be envisioned as a simple, circular clock formation, with the the listening "sweet spot" equidistant to each SC-V—a SC-V at vector clock points 10:30, 1:30, 4:30, 7:30, a pulse-coherent-matched HRCC or SC-V at 12 o'clock, and a SC-V at 6 o'clock. Thus, the left front and left back, and right front and right back are at 90-degree included angles relative to the listening position at a 10-foot, equidistant radius. (Or as a current experiment, the left front and right front SC-V loudspeakers are positioned at a 70-degree included angle with the left back and right back at a 90-degree included angle relative

5 As a note, remember that a time- and phase-accurate loudspeaker is ONLY truly accurate at a prescribed distance to the listener, which is the path distance required of the drivers and dictated by the designer. This is true for height as well. Your ears must be at precise tweeter height for optimum results. There is very little vertical latitude in listening—too low or too high relative to the tweeter height will result in the high frequencies sounding rolled-off.

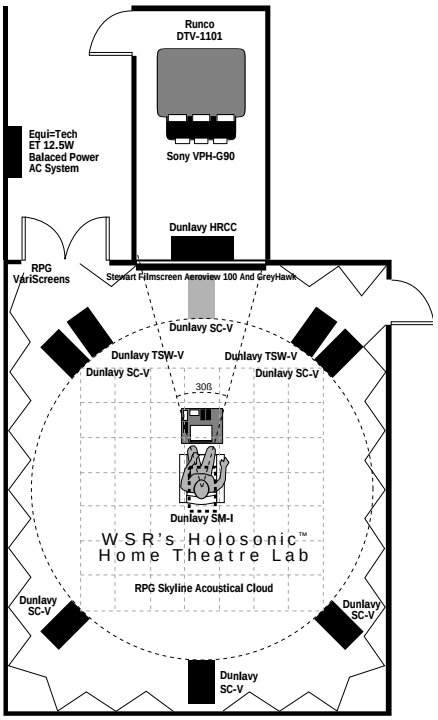


Diagram 1: Theatre Layout

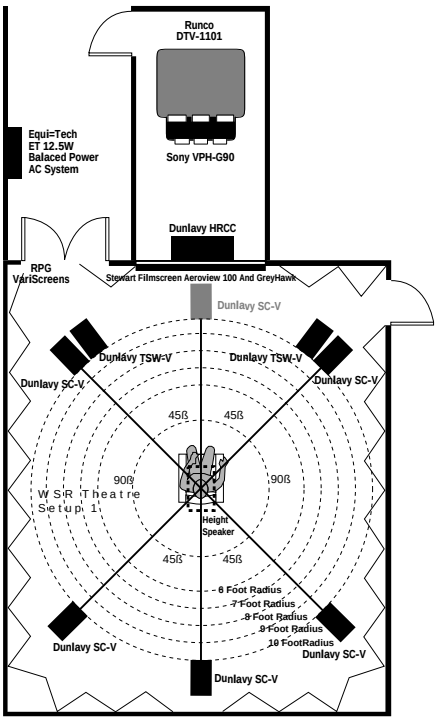


Diagram 2: *WSR* Theatre Setup 1

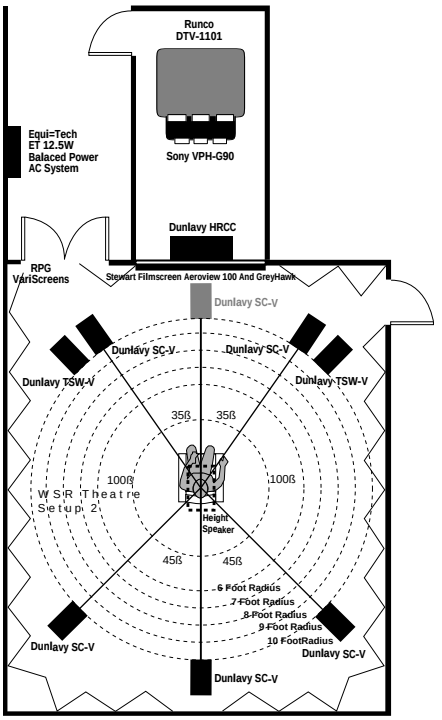


Diagram 3: *WSR* Theatre Setup 2

to the listener.) This placement optimizes the inherent time and phase response accuracy designed into these loudspeakers.[5] (See Diagram 1: Theatre Layout, Diagram 2: *WSR* Theatre Setup 1, and Diagram 3: WSR Theatre Setup 2.)

Sealed Enclosure Powered Subwoofers

As discussed in previous *WSR* issues, a good subwoofer should be evaluated on the basis of transient response and how well the subwoofer response integrates with the "full-range" loudspeaker. A good, sealed enclosure subwoofer is preferred for critical music listening and should be able to reach peaks of 105 dB at 35 Hz and 100 dB at 20 Hz, and exhibit excellent transient and phase response. Vented or bass reflex powered subwoofers can play louder and can produce thunderous bass output, but they are deficient at reproducing music's rhythm and pace.

At least two powered subwoofers are required, but I recommend that each channel vector position be supported with a matched powered subwoofer, to attain absolute "full-range" response with otherwise partially "full-range" loudspeakers. Low-"Q," sealed enclosure designs and passive, first-order filters are preferred for the most accurate music reproduction. If you want a subwoofer to play at loud 120 dB levels, invest in a vented or bass reflex subwoofer, but don't expect such designs to blend as well with your "full-range" loudspeakers or to sound as good.

As former Audio Technical Editor Richard Hardesty has explained in previous *WSR* issues, implementing a sealed enclosure powered subwoofer, in combination with a "full-range" loudspeaker, in which a single driver is used to reproduce bass frequencies and the lower midrange, will allow the amplifier driving the loudspeaker to maintain tighter control in the mid-bass and lower midrange, and, at the same time, lower bass distortion due to lessened current demands on the amplifier to reproduce low frequencies. This results in better sound, while using less power to drive the "full-range" loudspeaker. Let the dedicated powered subwoofer do the work of extending bass response to infrasonic frequencies.

Former Audio Technical Editor Richard Hardesty has written extensively in *Widescreen Review* about subwoofers, and summarizes the case for a powered subwoofer as follows: "With more cone area, greater linear excursion capability, more amplifier power at low frequencies, and electronic compensation for falling output at the lowest frequencies, a quality powered subwoofer does a remarkable job in reproducing the small range of frequencies at the lowest audible range."

When possible, use a passive (non-electronic), first-order (6 dB per octave) high-pass filter for optimum results. Set the cut-off, or crossover point, as low as your "full-range" loudspeaker will allow—above the loudspeaker's lowest audible range. Even at a crossover point at about 80 Hz, smooth bass response is achievable in most rooms with good acoustics. The high-pass filter will allow frequencies above the cut-off point to pass, and block frequencies below that cut-off point.

Placement of sealed enclosure powered subwoofers in the corners or pressure zones behind the principal full-range loudspeakers in a surround system (as recommended by former Audio Technical Editor, Richard Hardesty, in *WSR's Essential Subwoofer Buyer's Guide* and his own *Audio Perfectionist Journal*, www.audioperfectionist.com), can work well to attain smooth bass response if the "Q" factor of the subwoofer is 0.7 or less. Position the powered subwoofers behind their respective "full-range" partner, in the corner, for best results and use the subwoofers, along with acoustical treatment to fine-tune the low frequency performance of the system in your room.

In the case of the *WSR* theatre, no powered subwoofers are used, because the sealed enclosure Dunlavy Signature Series SC-Vs are capable of time- and phase-accurate response from 16 Hz to beyond 20 kHz, ±1 dB (-3 dB 16 Hz)! The SC-Vs do not require an augmented powered subwoofer, because they use dedicated drivers, each optimized in cone area to reproduce deep and powerful bass, and midrange accuracy. In essence, the subwoofer is built-in (though passive). I use a matched pair of Dunlavy Signature Series TSW-V passive tower subwoofers, driven by the same 1,000-watt per

channel California Audio Labs power amplifiers used for the other Dunlavys, to reproduce the dedicated .1 LFE (low frequency effects) channel (often improperly referred to as the "subwoofer" or "bass" channel). These sealed enclosure subwoofers are designed to be time- and phase-accurate when placed to the sides of a pair of SC-Vs. Their response is an incredible 20 Hz-120 Hz, ±1 dB (-3 dB at 16 Hz)! While the HRCC is an excellent bass performer, I am planning on complementing it with a new, sealed enclosure powered subwoofer, soon to be introduced by Dunlavy Audio Labs that promises to reproduce deep extended bass as well as the TSW-V.

I use no bass management in the system, which, in my opinion, is a serious compromise in a true high-end home theatre and/or surround music system. Using small-sized, non-"full-range" loudspeakers at every channel vector, or in the surround channels, negates the truly-optimized articulation of a high-performance, full-range system, especially those designs that are time- and phase-accurate. Bass management is a compromise and does not facilitate the coherent response of the system to be fully optimized, nor take into account the directionality of bass. As minimum, as discussed previously, a home theatre and/or surround music system not based on single-structure, truly full-range loudspeaker systems should have a sealed enclosure powered subwoofer paired with each loudspeaker at each channel vector (so that each loudspeaker position is capable of full-range playback), plus a dedicated subwoofer(s) to reproduce the .1 LFE channel. Each full-range SC-V and each TSW-V has no problem providing the THX-recommended output level of 105 dB at 35 Hz.

See *WSR*'s *The Essential Subwoofer Buyer's Guide* special edition for a comprehensive education on subwoofers, and their effective use and placement in a high-end audio system. *WSR*'s former Audio Technical Editor, Richard Hardesty, who authored most of this special edition, shares a wealth of knowledge and experience in attaining near-perfect bass in any room. At www.audioperfectionist.com, further education on the subject of subwoofers can be found.

The Optimum Included Angle

Now, the difficult challenge is to determine, for your room and tastes, the optimum included angle at which your loudspeakers should be positioned, relative to the listening position. This is entirely loudspeaker-, room- and recording-dependent. Unfortunately, recordings are all over the map in terms of the spatial width they will support, without compromising phantom image focus within the stereo spread between two loudspeakers. For stereo-only listening, a 60-degree included angle, as determined by the distance between the front centers of the loudspeakers, works well overall for most small- to medium-sized rooms, and is a good place to start experimenting. Included angles of less than 60 degrees begin to seriously compromise image width. While a 60- to 90-degree included angle, or greater in some cases, can be supported in medium-sized and larger rooms, the recording media will begin to define the limits of good sound imaging.

Why? Because, when recording engineers mix multi-track, microphone-isolated track elements (that are acoustically unrelated and even recorded at different locations), monitoring over narrow-spread loudspeakers, they tend to "pot" position instruments across the "stereo" soundstage, harder right and harder left of phantom center than they would if they monitored the mix on wider-spread loudspeakers and achieved a more uniform soundstage spread. With wider spread loudspeaker monitoring, the imaging gaps between center phantom and hard right or hard left are all too obvious, and the recording engineer can adjust the mix (with precise track position assignment) to compensate, by prominently positioning instruments in between the phantom center and far right and left loudspeakers. The end result supports a much wider and uniform performance space, when played back on loudspeakers spread widely apart at 60- to 90-degree, or greater, included angles.

At a 60-degree included angle, the distance between the center of the loudspeakers will be equal to the distance from each loudspeaker to the listener—an equilateral triangle. Thus, if your room supports a seven-foot spread (allowing for at least three feet out from the adjacent wall boundaries), your listening position, at the 60-degree included angle, should be seven feet from each loudspeaker, assuming that your loudspeakers will produce a coherent wavefront at that distance, based on the minimum path distances required for coalescence of its drivers. Listening in stereo slightly further back works as well. But beware, while it is fine to sit up against an acoustically-treated back wall when listening to stereo music, you do not want to be backed up against the back wall for optimum holosonic home theatre and/or surround music listening. Otherwise you will be forced to position your surround loudspeakers directly to the sides of your listening position, at the wall, rather than to the sides, further behind the listening position. With extremely wide included angles for the surrounds, relative to the listening position, you may experience a height sensation with center phantom imaging over your head, similar to listening to headphones. Such positioning also may degrade sidewall imaging.

Of course, you will want to position all the loudspeakers in the system at equidistant (and equiangular and "equiheight," if possible) positions relative to the listening position for best results. If such positioning is not physically possible, you will have to use electronic time delay, but that too will be a compromised solution if your loudspeakers are "full-range" and require, to produce a coherent wavefront, a minimum path distance to the listener greater than what your room size can support. This is because loudspeaker positioning is dependent upon the relative path distance between each of the drivers (tweeter, midrange and woofer) and the listener to produce a flat frequency response and a time-coherent wavefront.

Using a 90-degree included angle, as I do in Setup 1 with the Dunlavy Signature Series SC-Vs in the *WSR* theatre, supports a 10-foot listening distance from each loudspeaker, which is the distance used to design and perform measurements of those loudspeakers.[6] The corresponding width that separates each loudspeaker is approximately 14 feet. While this works perfectly well with many movie soundtracks and well-recorded classical and jazz recordings, it tends to reveal the limits of multi-track mono recordings. With a 70-degree included angle, image width narrows to approximately 11 feet with the same 10-foot distance between the listener and each loudspeaker. The wider the loudspeaker spread at any included angle, the more problematic the setup becomes with in-phase and out-of-phase image focus degradation. (See Diagrams 2 and 3: *WSR* Theatre Setups 1 and 2.)

Thus, image focus can suffer with mediocre recordings, producing seams in the soundstage that call attention to hard left or hard right, and hard center positioning in the mix. This occurs, because the mixing engineer does not hear the imaging gaps, when monitoring on closely spaced loudspeakers—a typical monitoring setup today in too many studios—and therefore does not know to adjust the mix for a more uniform spread. And further, because multi-track mono recording is a prevalent style with isolated tracks that are not acoustically-related or integrated.

6 I should also mention that I use a Dunlavy Signature Series SM-I professional monitor loudspeaker, to reproduce a height "channel" that is found on some multichannel DVD-Audio and SACD recordings. Tthis works also remarkably well when the Surround EX/ES or matrix-derived back surround signal is reproduced by the SM-I, along with the back surround SC-V. This combination adds a satisfying height dimension to the surround hemisphere.

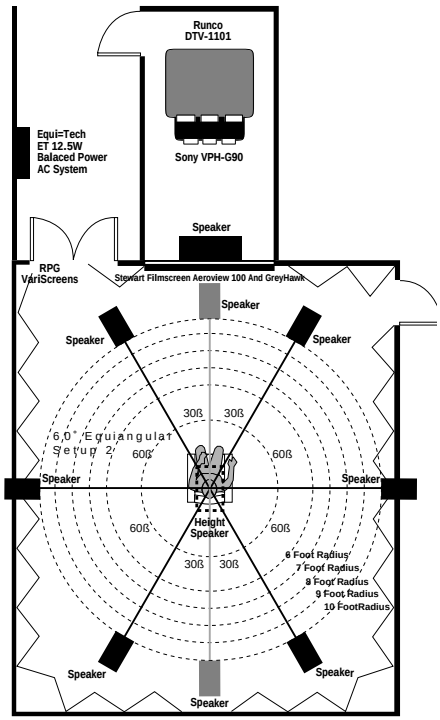


Diagram 4: 60˚ Equiangular Setup 3

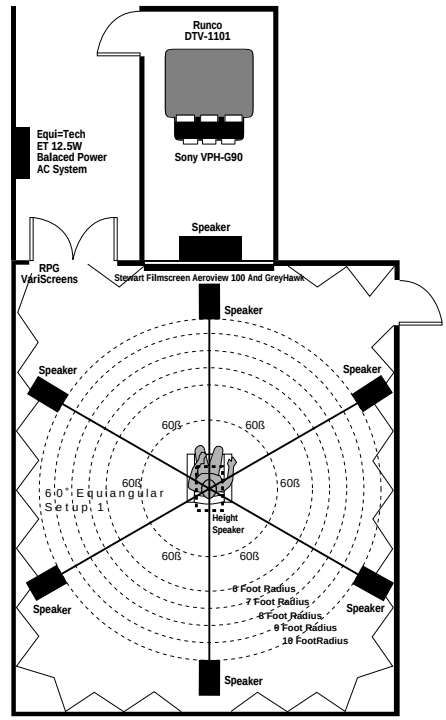


Diagram 5: 60˚ Equiangular Setup 4

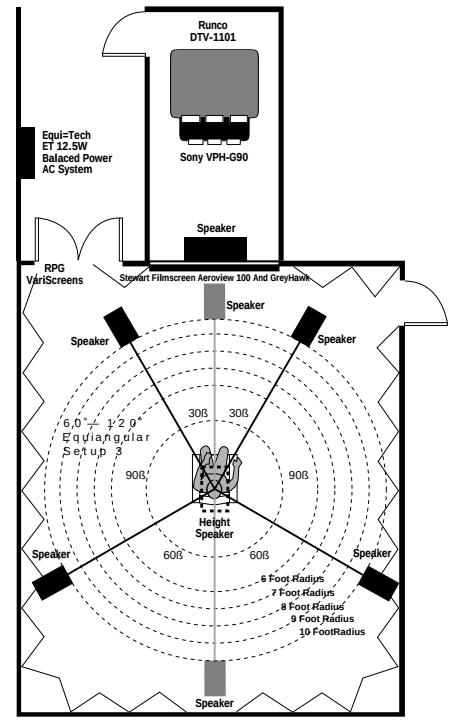


Diagram 6: 60˚—120˚ Equiangular Setup 5

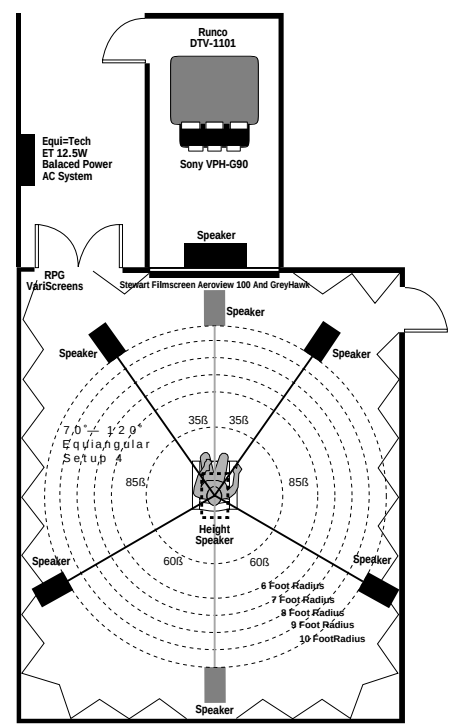


Diagram 7: 70˚—120˚ Equiangular Setup 6

While time- and phase-accurate loudspeakers, such as the precisely-matched Dunlavy Signature Series paris, support spreading the loudspeakers much farther apart than other designs, the limits of the recording still dictate the extent of support for optimum stereo reproduction.

Placing the loudspeakers closer together than the distance from each loudspeaker to the listener will diminish image width, but improve image focus up to a point when stereo separation starts to degrade. And placing the loudspeakers farther apart than the distance from each loudspeaker to the listener will enhance image width (with good recordings) and widen the defining boundaries of where the performance is occurring, but diminish image focus with recordings mixed with closely-spaced monitoring loudspeakers and acoustically-unrelated or non-integrated channels. Then, too, the loudspeakers in your setup will dictate the limits of the image width that can be supported. All of this presents a dilemma. What to do?

Acoustically-Related, Multichannel Recording

At present, surround recordings (with exceptions) are not produced or mixed (or monitored) in which an acoustically-related signal is fed to all the loudspeakers in the setup. Instead, the front hemisphere and the back hemisphere are almost always (with exceptions) treated as distinctively unrelated. If one was to feed an acoustically-related signal in stereo pair sections and the front and surround loudspeaker pairs were placed 90 degrees apart relative to the listener, four signal pairs (formed as a square with four discrete channel vectors) would be required to create the illusion of phantom imaging in a 360-degree, holosonic soundfield. This was the essence of quadraphonic positioning in which the listener was located at the center of a circle of four matched full-range loudspeakers positioned equidistant and equiangular and at “equiheight” relative to the listener.

Placing the loudspeaker pairs at 60 degrees apart would require six stereo pair sections (six discrete channel vectors). (See Diagram 4: 60˚ Equiangular Setup 3) The problem with six-pair positioning is that the loudspeaker spread between 11 and 7 o’clock and between 1 and 5 o’clock (otherwise forming the imaging on each sidewall) is a far greater “stereo” spread than the width of any one “stereo” loudspeaker pair at the front hemisphere (between 11 and 1 o’clock) and back hemisphere (between 7 and 5 o’clock), and would require all new recording and mixing to a new discrete multichannel palette with discrete side channel loudspeakers, to create an acoustically-related holosonic soundfield. Of course, if the 60-degree included angled configuration is represented by loudspeaker pairs located between 12 and 2, 2 and 4, 4 and 6, 6 and 8, 8 and 10, and 10 and 12 o’clock, then the front and back hemisphere “stereo” pairs would be positioned, each at a 120-degree included angle relative to the listener. (See Diagram 5: 60˚ Equiangular Setup 4) This 60-degree equiangular configuration also would require a new recording palette, because such a 120-degree “stereo” spread is far too wide to support good imaging without both a center front and center back

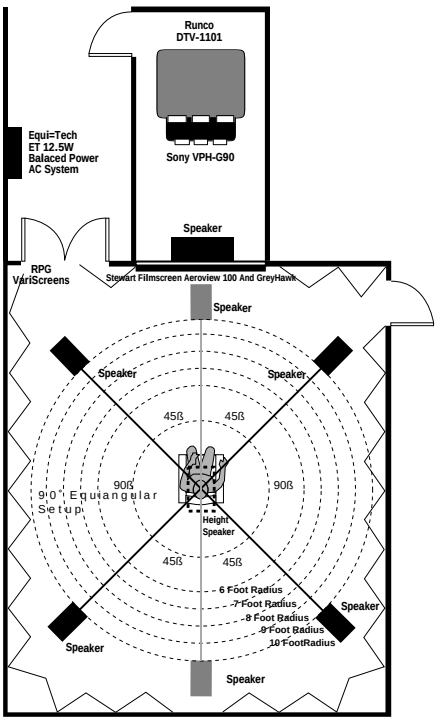


Diagram 8: 90˚ Equiangular Setup 7 [1]

channel loudspeaker positioned in between. Another version with similar limitations is the 60-120-degree equiangular setup. (See Diagram 6: 60˚-120˚ Equiangular Setup 5) This is a workable setup using a 60-degree configuration for the front "stereo" loudspeaker pair, a 120-degree back hemisphere spread using a surround back loudspeaker channel positioned at 60 degrees relative to the left and right surround loudspeakers, and a 90-degree included angle relative to the listener for the sidewall loudspeaker pairs. Setup 4 works even better with a 70-degree included angle relative to the listener for the front "stereo" loudspeaker pair and 80 degree angles for the sidewall loudspeaker pairs (See Diagram 7: 70˚-120˚ Equiangular Setup 6)

With the 90-degree included angle setup, the width of the four pairs can be scaled to virtually any room dimensions, to support the relative, optimized path distances of the loudspeakers to the listener. Thus, if the path distance is six feet and you sit at that distance from the loudspeakers, the pairs can be spread approximately seven feet apart, while maintaining the desired equidistant/equiangular/"equiheight" setup, and still be accommodated in medium- or smaller-sized rooms. (See Diagram 8: 90˚ Equiangular Setup 7 [1])

The 90-degree included angle setup requires no radical change in recording or mixing and can use the existing discrete 5.1-channel palette. But to work as intended, artists, producers and engineers need to think in terms of uniform acoustically-related pairs and balanced inter-channel integration when recording and mixing, so that they create a sense of seamless holosonic spatiality.

In either setup configuration described, a spatial effect will be created by each pair's respective two sources reproducing related signals that differ slightly in amplitude and phase. And in either case, the setup can be scaled to any room dimensions, with the appropriate support required for the minimum path distance between the loudspeakers and the listener.

In the *WSR* theatre, I am experimenting at the present with included angles of 60-90 degrees at an equidistant listening position of 10 feet. All the Dunlavy Signature Series loudspeakers are positioned not only equidistant, but the front and surround pair are equiangular at each channel vector when using the 90-degree included angle setup.[7] This was the fundamental basis of four-channel discrete recording in the 1970s, otherwise known as the quadraphonic format (a format that never delivered to the consumer the discrete recording articulation of original masters that were recorded and mixed with monitoring loudspeakers, positioned at a 90-degree included angle relative to the engineer mixing.

The principal was to setup four matched, "full-range" loudspeakers in an equidistant, 90-degree equiangular (and "equiheight") orientation to the listener seated in the "sweet spot" or "the chair," the term I use. Thus, recordings mixed in this format were monitored at 90-degree included angles and recording engineers took greater care in producing a seamless-sounding, 360-degree soundfield with all the channels acoustically-related and uniformly integrated. In simple terms, each wall, represented by two loudspeaker vectors, were treated as full-on stereo perspectives relative to the whole holosonic soundfield. The mixing consoles in those days had various capabilities to achieve the integration of the four "stereo" perspectives into a holosonic, 360-degree spatial image that was more or less acoustically-related depending on the nature of the recording technique (minimal or multi-track mono recording). Soundfield microphones with matched time- and phase-accurate capsules also were used in some recordings to achieve a seamless holosonic image-specific balanced soundfield.

Quadraphonic, or "quad" as it was called (and a related matrix-derived technology called Ambisonics), was much more than just "stereo" on four walls. It attempted to utilize a four-channel discrete palette to recreate a sense of spatial dimensionality. While there were recordings produced for motion effect, the intent was to emulate real-life spatial dimensionality. Of course, fidelity was not at the quality level it is today, but a study of these recordings, using the preferred 90-degree setup, revealed that the potential for recreating a holosonic soundfield was achievable.

That experience was largely lost when quad failed to satisfy the expectations of the consumer, who, because of unperfected matrix steering logic, never, and I mean never, experienced on vinyl records (the prominent media) the true spatial quality of discrete, four-channel surround music delivery. Interestingly, eight-track quad tapes did deliver a reasonably discrete presentation. (Some of the original quad master recordings have been re-released on DTS CDs.)

By 1979, quad was dead, and the music industry returned to recording multi-track mono and mixing to stereo. By this time, 16- and 24-track professional analog tape recorders (and later 32- and 48-track digital recorders) were the prominent means for capturing music performances. In large measure, such performances were recorded in studios without all the artists performing "live" together at the same time, or, for that matter, even in the same studio together. The end result was a new era of advanced signal processing-assisted recordings that were produced to emulate a "live" recorded event in a studio performance space, but with artificial reverberant characteristics (electronic or large chamber-derived echo), to simulate a real "live" event recorded with acoustically-related channels and natural reverberation. True "stereo" recordings did not provide the flexibility that multi-track mono recording afforded artists (who couldn't achieve "perfectionist" satisfaction playing live "takes" together) and were passed over. This brought about the arrival of "audiophile" labels, which sought to embrace the "old" minimal, natural acoustical approach to "stereo" recording. Such labels as Sheffield used advanced direct-to-vinyl recording. Then Telarc pioneered all-digital "stereo" recordings on CD, followed by DMP, Chesky, Delos, and others. These labels still produce outstanding quality "stereo" recordings that often support a wide loudspeaker spread, with 90-degree or more included angles. But the recordings from these labels are generally the exception, with the majority of major labels adopting multi-track mono recordings and narrower-width monitoring, with limited if not non-existent acoustically-related channels.

When listening to a well-recorded multi-channel recording with acoustically-related channels, you will hear all the instruments

7 When using, for example, a 70-degree included angle for the front pair, I still use a 90-degree included angle for the back "stereo" pair. Experimentation is necessary to achieve the best compromise overall.

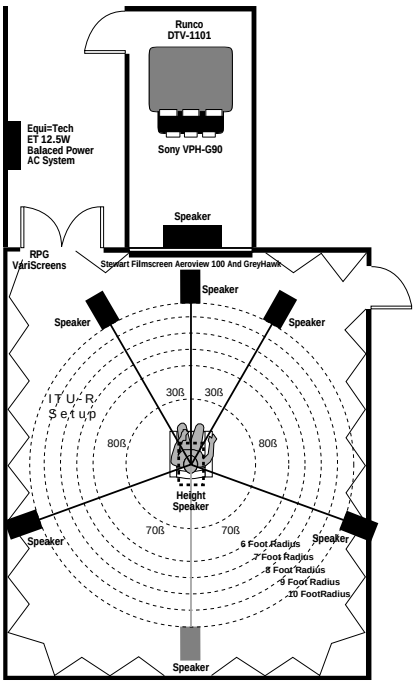


Diagram 9: ITU-R Setup

and/or voices in the recording in every channel, just at different amplitudes and phase relationships relative to the positioning of the instruments and/or voices in the recording space. This would be true of movie sound effects as well, when presented in an acoustically-related holosonic soundfield.

The Compromised ITU Setup

I do not favor the International Telecommunications Union (ITU) specification for surround sound (a setup recommendation published in 1994 for multichannel sound systems with and without picture, and used widely in the industry).[8] The ITU locates the listener at the center of a circle of loudspeakers (as I do, but) with the front loudspeakers positioned 30 degrees left and right of center, or at a 60-degree included angle relative to the listener (too narrow, in my opinion, and impossible to duplicate in an equidistant/equiangular setup using the present 5.1 format), and surround loudspeakers positioned 110 degrees left and right of the center channel loudspeaker, or at a 140-degree included angle relative to the listener. Such a surround hemisphere spread could not be supported by any loudspeaker pair, yet the ITU does not specify a surround back loudspeaker. This results in a compromised, equidistant/equiangular loudspeaker setup relative to the listener, and prevents optimum holosonic soundfield image focus. While the distance along the sidewalls (between left front and left back and right front and right back) is not unreasonable, the back wall spread is too far apart to produce optimum image-specific phantom images. (See Diagram 9: ITU-R Setup)

8 I have used the ITU myself with good results, but always with a surround back loudspeaker to provide image "fill." I prefer though a 90-degree or 70/90-degree equidistant setup when the room can support such. In my opinion, the sense of holosonic spatial imaging sounds better integrated.

Movies In "Stereo" And "Surround"

The motion picture industry shifted from optical mono to optical Dolby Stereo® in 1976, utilizing a compromised re-working of the mono-compatible quadraphonic matrix to support three loudspeaker positions behind the screen, and mono surround spread over an array of loudspeakers hung on the side and back walls in commercial theatres. The release of *Dick Tracy* in Cinema Digital Sound in 1990 introduced the first application of compressed discrete digital audio to motion picture sound. By 1992, this was superseded by Dolby Digital, followed by DTS Digital Sound and SDDS.

When I founded *Widescreen Review* in 1992, the digital sound wars were just heating up. The Home THX Program was already in place since 1990. Home THX was an attempt to introduce the sound of the commercial theatre (or dubbing stage) into the home environment under the guise of "home theatre" (actually a term first coined back in 1992 by Sam Runco of Runco International). This, to other audiophiles and me, meant disaster would result to quality sound, and rob the potential for true high fidelity holosonic surround sound in the home. Thus, in those early years of *Widescreen Review*, I advocated against embracing Home THX, except for the practical application of re-EQ (not originally attributed to THX) to tame otherwise bright- and harsh-sounding soundtracks, and encouraged equipment manufacturers to embrace the highest standards of high fidelity sound reproduction for home theatre. I remain an avid crusader for this cause, as regular readers of the magazine know.

During the same period that discrete multichannel digital audio formats were being formulated and introduced, I crusaded for using the discrete 5.1-channel palette to create true 360-degree holosonic soundfields, acoustically matched to the changing scenes in the picture. While not fully realized, the movie soundtracks today are far more spatially enveloping, sometimes with even excellent image focus. Anyone who has been a movie nut can fully appreciate just how far filmmakers have come in just a short period of time. Still, as discussed previously, there is a need for further support, so that filmmakers completely switch to producing and mixing movie soundtracks with acoustically-related channels, for an optimized holosonic presentation in the home theatre.

Two Hemispheres, No Integration

Now, that brings me to the current situation, which has no standards for loudspeaker setup to optimize an acoustically-related, holosonic soundfield experience. Unfortunately, soundtrack re-recording mixers still think in terms of two hemispheres: the front screen wall or soundstage, and the surround field. Sidewall perspectives are ignored. Thus, the two hemispheres are not yet integrated as a balanced, seamless, holosonic whole, though the discrete channel palette when setup optimally, fully supports such. What I believe is necessary is for movie sound mixers to embrace the principals espoused in the quadraphonic era that sought to recreate a seamless, three-dimensional soundfield, with image focus-specific spatiality created from uniformly spread and acoustically-related channels. This can really work with movie sound because spatial sound sculptures can be tailored to enhance the "suspension of disbelief" with the changing scenes in the picture.

Thus, I am an advocate of 90-degree included angle mixing and monitoring to achieve this desired three-dimensional holosonic image. And that is the basis of the parameters of the *WSR* theatre setup as the preferred option, recognizing that not all soundtracks or music recordings fully support this setup. But when they do—WOW!

The Six-Channel Palette Under-Used

Now, how does this relate to discrete six-channel digital audio, whether DTS CD, DVD-Audio or SACD? Once again, we are faced with a dilemma. For the most part, surround music-only producers and recording engineers have embraced the discrete 5.1-channel format used in consumers' homes to reproduce movie sound, but with no agreement on the setup parameters for the loudspeakers. This, of course, is not a good compromise. With the exception of DMP, Telarc and some other audiophile labels and some DTS CDs, recordings are typically made using bass management, rather than monitoring over truly full-range loudspeakers at each channel vector. Nor is there any standard for equidistant, equiangular, or "equiheight"

positioning of loudspeakers relative to the listening position. Too often, vocals and solo instruments are placed in the hard center channel (rather than created as a phantom center image from the acoustically-related stereo pair), which seriously depreciates image focus, depth, and spatiality. There is no acoustical relationship between the front "stereo" hemisphere and the surround hemisphere. They sound isolated, unbalanced and thus call attention to their non-cohesiveness during a musical performance.

I like to test multichannel music recordings (and for that matter, movie soundtracks as well) using our Martin MultiMAX controller, which allows me to monitor any one or combination of discrete channels in the recording. Just listening to the left front and the left back channels, or the right front and right back channels, for example, tells me how the recording was produced and mixed. Rarely is there an acoustical correlation between the two hemispheres, with no "stereo" phantom imaging present on the sidewalls. How can you produce a coherent soundfield if the two hemispheres are divorced from one another? You can't!

In some pop multichannel recordings, there are evident good stereo perspectives in both the front hemisphere and the back hemisphere, but virtually never along the sides. A recent multichannel recording of Steely Dan's *Two Against Nature* released on DVD-Audio is a prime example of the six-channel palette under-used. Perhaps the tools just aren't there yet which is causing artistic barriers, or the creative community just hasn't realized what's lacking in their multichannel surround music-only recordings. Could this also be due to their compromised monitoring setup? I believe so, partially, and as well, it is due to the problems associated with excessive multi-track mono recording, with no regard for acoustically-related tracks and balanced inter-channel integration to create a holosonic soundfield.

The exception to this situation is concert hall venue multichannel recordings (which are recorded in real performance spaces), or for that matter any recording done "live" in a real performance venue or space. But even so, the two hemispheres are most often (with exceptions, notably DMP and Telarc) not optimally integrated or coherent (even though they are recorded in real-time in the same space), though the potential exists to accurately reproduce the "venue sound" and improve the reproduction of the original performance. This has to do primarily with ignoring the equidistant/equiangular/ "equiheight" principals of microphone placement and recording monitoring I discussed previously. With everyone in the recording industry using different microphone placement and monitoring setups, this further aggravates the setup deficiencies in the home. Unfortunately as well, the professional audio production community has yet to "standardize" on loudspeaker system types, loudspeaker placement and setup. Nor have they realized the importance of using time- and phase-accurate loudspeakers for monitoring their recordings.

A Holosonic Approach

I propose that the entire professional recording industry (both music and movies) embrace an all-matched, truly full-range (minus bass management), equidistant/ equiangular/"equiheight" setup that supports coalescence (at no closer than the minimum recommended path distance to the listener) of the loudspeaker drivers in a time- and phase-accurate configuration, with the four principal discrete channel vectors at 90-degree included angles relative to the "sweet spot" listening position to achieve a seamless image-focused, 360-degree, acoustically-related holosonic soundfield. For movie sound, the four principal discrete channel vectors (left front, left back, right front, right back) should be enhanced with center and center back surround vectors, directly in line with the listener's center of head, to lock the center channel to screen center and enhance surround spatiality with discrete directionality. That setup can work for surround music-only creation as well. Artists, producers, filmmakers, and engineers should record and mix so that all the discrete channels are acoustically-related, yet, in the case of movie sound, be dramatically enhanced with directionalized effects to emphasize the action on-screen. That would allow all other compromised setups to still produce good sound, while allowing the serious listener to experience optimal realism, and greater dimensional space, in both movie sound and surround music-only presentations. With this approach, "stereo-only" perspectives will be mixed with the "wider" soundstage perspective that would not be compromised by a narrower-spread pair of loudspeakers setup in the home environment, and, at the same time, allow serious listeners with accurate loudspeakers to experience the fullest width of the defining boundaries of where the performance (or scene) is occurring, with optimum wide image focus. With such a setup, the loudspeakers should disappear, leaving your mind to experience the soundfield or performance, which appears to occur behind, between, and beyond the loudspeaker boundaries in an all-inclusive, acoustically-related holosonic soundfield. (Good examples of a quasi dual Decca Tree approach are the new DMP multichannel SACDs, especially the Warren Bernhardt with Jay Anderson and Peter Erskine *So Real*, the Pilhofer Jazz Quartet *Full Circle* and the Joe Beck and Ali Ryerson *Django* releases available at www.dmprecords.com. Two other recommended multichannel SACDs are Telarc's *The Film Music Of Jerry Goldsmith* and *Tchaikovsky 1812* available at www.telarc.com)

A Symmetrical System

As a further descriptive note, keep the setup symmetrical in relation to the acoustical environment. Never place surround loudspeakers above the tweeter line of the front hemisphere loudspeakers; otherwise they will call attention to their position above when reproducing image-focused surround. Arrange furniture and select "the chair" on the basis that the chair backs and other furniture will not obstruct your ears, or be positioned between you and the surround loudspeakers. Always use matched, "full-range" loudspeakers at each channel vector for optimum sonic results. That means the surround loudspeakers, including the back surround loudspeaker, should be identical to the front loudspeakers. If you use a Surround EX/DTS-ES setup, use only one (not two as THX recommends ala the commercial theatre) back surround loudspeaker for better image focus, just as only one center front loudspeaker is recommended. Do not space surround loudspeakers too far apart, or their ability to create a phantom center back image spatial effect will be degraded, and/or the phantom image may appear above your head (as a headphone effect).

If you use a height loudspeaker, ensure that it is identical in its upper bass through high-frequency response to that of the principal loudspeakers, and enable it to be activated along with the surround back signal, or with only a dedicated height signal.

I use the SMART® Devices Center Surround 3X™ (CS-3X, Jr.), a Surround EX-type matrix adapter, to send a matrix-derived signal to the Dunlavy Signature Series SC-V back surround loudspeaker (and to the SM-I height loudspeaker). This unit provides level-matching with the other loudspeakers for equal energy, and derives a "back center" channel based on the in-phase signal present in the two discrete surround channels. The SMART uses Circle Surround® technology. While the Dunlavy Signature Series SC-Vs used for the two surround channel vectors will image perfectly to create a back center surround image, when the surround loudspeaker pair has to be spaced apart at distances that do not support a good phantom center back image, a matrix decoder can create an effective image fill signal fed

to a center back surround loudspeaker. You can activate at will the effect for not only media containing an encoded surround back channel, but also any media that has two discrete surround channels. Or, if your processor/controller has built-in THX Surround EX or DTS-ES (matrix or discrete), you can simply put the CS-3X in bypass mode.

The rumor circulating around Hollywood's pro sound community is that the out-of-phase signal, that presently is not used in the matrix-derived Dolby Digital Surround EX format, will be used as a height channel in the upcoming theatrical presentation of *Star Wars: Episode II*. This will certainly serve as the basis to create a height channel in the home theatre for filmmakers and music artists for further enhancing the realism of an acoustically-related, holosonic soundfield.

Checkpoint Sound Alignment System

For precise setup, I use the Checkpoint Sound Alignment System (SA-S) to precisely match loudspeaker placement in an equidistant/equiangular/"equiheight" setup. If Checkpoint's SA-S is not available through your specialty dealer or experienced custom installer, you can experiment with fine-tuning the positioning of the loudspeakers and the angle between the loudspeakers using a protractor and string. Move the furniture out of the way or out of the room for ease of experimentation. Starting with the loudspeaker manufacturer's recommend minimum path distance to the listener (which with "full-range" loudspeakers will be at least six-to seven feet), configure the front loudspeaker spread positions that your room and screen width will support. Stoop down to tweeter (or recommended listening) height and move backward and forward while listening to the stereo music you listen to most. (Remember that different recordings will support different loudspeaker spreads.) Position "the chair" where image focus is best with the front loudspeaker pair, and build-out respectively to the other loudspeaker vector positions using the equidistant/equiangular/"equiheight" principal. You can test the holosonic capability of your setup simply by listening to each pair of loudspeakers in stereo to evaluate how well the pairs image along the side and back walls, as you sit facing the front or screen wall. You will have to adjust the angular positioning, or "toe-in," by ear if you do not own or have use of Checkpoint's SA-S. When you change toe-in, you'll need to adjust the spacing between the loudspeakers to arrive at the optimal image focus for your situation.

Run Cables At Short Distances

In the *WSR* theatre, I have positioned our components on massive Billy Bags Pro-Stand™ racks in close proximity to one another to enable the shortest possible cable runs. I use 1,000-watt per channel California Audio Labs amplifiers, two in a single chassis, positioned on Billy Bags Pro-Stand amplifier stands, at the side of each Dunlavy Signature Series loudspeaker, so that I can use short loudspeaker cable lengths. Long interconnects and short loudspeaker cables sound better than vice versa.

The "Weakest Link"?

While most loudspeakers remain the "weakest link" within the chain of components that comprise typical audiophile and home theatre systems, a measurably and audibly accurate loudspeaker's performance (or for that matter any loudspeaker design) will always be limited by the quality of the signal delivered to it. An accurate loudspeaker should accurately produce the signal that appears at its input terminals. If that signal is bad, the sound the loudspeaker produces must be bad, no matter how accurate the loudspeaker.

It is the source components that produce an electrical signal, not the loudspeaker. Loudspeakers cannot improve signal quality, though omnipolar, bipolar and dipolar designs do enhance spatiality after the signal reaches the loudspeaker terminals (using re-radiated room energy), which some people prefer. The quality of the original recording or broadcast sets the absolute limit for system resolution or fidelity, regardless of the quality of the components in the audio system (or video system). The components that translate the electrical signal, so the loudspeakers can convert it to mechanical (acoustical) energy, can make the signal sound worse. This is true of source components in a video system as well. Signal degradation occurs in every component prior to the electrical signal reaching the loudspeakers (or video display). Noise, distortion and coloration are additive degradations. Degradation in the form of loss of information or resolution, and compression of dynamic range and contrast are subtractive.

The performance of each component is dependent on those that precede it in the system. That is why the quality of each component is so important to the end result. Better components inserted into the signal chain will provide better sound and picture performance. Improving any component will improve overall sound and picture quality.

The Basic System Stages

The sound quality of an audio system can be improved through its source components, its amplification components and its loudspeaker components. Likewise, this is true of the video system via components that uncompress and process the video signal, and output the signal to the display device. The cables that interconnect these basic system stages are important to overall sound and picture quality as well. Cables should not lose information or add distortion and coloration. I use quality cables from Dunlavy, Extron, Monster Cable, and Transparent Audio in the *WSR* theatre. Over time, I intend to switch out various cables to evaluate other quality cables from other manufacturers.

The Source Components

The source components set the limit for signal resolution for the entire system, both audio and video. With respect to the audio system, no component in the amplification stage can recreate signal information that was lost or damaged by the source component. With respect to video performance, picture quality is dependent on maintaining signal integrity as it is processed through various stages and interfaces before being output by the display device. In the *WSR* theatre, source components include two Sony DVD players that are two-channel SACD-capable, a multichannel Sony SACD player, a DVD player that is DVD-Audio-capable, a Pioneer Elite LaserDisc player, a Panasonic D-VHS player, a broadcast and DISH Network™ satellite receiver, and a Linn Sondek® LP 12 Cirkus turntable with an Ekos arm, Arkiv cartridge and Lingo power supply. In a surround music system, a turntable, CD, DVD-Audio, and/or SACD player are the source components.

Some of these components are both audio- and video-capable as is the case in any home theatre system. Not every component on the market offers the best performance in both categories. In order to get the best picture performance possible, a particular DVD player, for example, may be the preferred choice, but that player may be deficient in audio performance when compared to other DVD players. Typically, high-end DVD players will provide both exemplary audio and video performance, though, as with all comparable components, there will be subtle performance differences you'll have to consider.

The Amplification Components

The amplification components in an audio system process the low-level signal from the source components to raise it to a level that loudspeakers can convert to acoustical energy. The preamplifier stage in surround processors or controllers provides switching, buffering, and volume control for all six or more channels, along with some low-level signal amplification. The power amplifier receives the preamp's elevated signal and further "amplifies" it to a level that can drive loudspeakers. An accurate amplifier delivers an accurate replica of the preamplifier output to the loudspeakers. The amplification process occurs continuously as the signal passes from one stage to another, until it is at a sufficient level to drive loudspeakers. The performance of the loudspeakers is dependent on the condition of the electrical signal that they receive, after numerous stages of amplification through all the other components in the audio system.

The Loudspeaker Components

The loudspeakers in a home theatre and/or surround music system convert the amplified electrical signal into mechanical (acoustical) energy to move air and produce sound. Signal resolution that is degraded or lost in the source and amplification stages cannot be recreated by the loudspeakers, but additive noise, distortion and coloration can be.

The least number of components in the signal path results in the best sound quality.

The Display Components

The display components in a video system can be direct-view CRTs, all-in-one rear-projection sets based on CRT, DLP™, D-ILA® or other technologies, and video projectors of various technologies setup to project either in front- or rear-screen configurations.

As with the audio system, the least number of components in the signal path results in the best picture quality.

Vigilant Evaluation

At *WSR*, we consistently evaluate numerous components representative of each of the three basic system stages. As we discover better-performing components, we upgrade our Reference Holosonic Home Theatre Lab system (and our other reference systems) so that the *WSR* theatre can maintain its "the best that it can be" stature. This quest for the very best performance is always measured in the context of the complete system. Fortunately, because *Widescreen Review* is a premiere home theatre publication, we are afforded opportunities with equipment manufacturers who want us to evaluate and use the very best they have to offer. That allows us the opportunity to compare, and when advantageous, upgrade our own reference components used in our reference systems.

As a reader of *Widescreen Review*, you can learn from our equipment reviews and extensive education-purposed articles (such as this series of articles), how to consider individual components in the context of your situation, and how to maximize performance and value in their selection.

The DVD Player

A DVD player in a home theatre system is where sound and DVD picture quality starts. Unfortunately, DVD players, used also as a CD player connected to the analog inputs of an amplification component, perform poorer than a quality-purposed CD player. While virtually all DVD players have both digital and analog outputs to interface with a surround processor's or receiver's digital or analog connection, the quality of the digital-to-analog converters (DACs) prior to the analog outputs are not usually of audiophile quality no matter what the bit rate of the DACs. (Many DVD players incorporate 96 kHz/24-bit DACs while others have lower bit rates and still can sound better because their signal-to-noise performance is better.) This results in poor-quality analog stages necessary for high fidelity CD playback. DVD players with built-in Dolby Digital and/or DTS Digital Surround decoding also do not provide quality DACs at the output stage.

To use a DVD player also as a CD transport requires that the raw digital signal be fed to a high-quality, outboard DAC or fed to a digital processor/controller that contains high-quality DACs. Most DVD players contain the mechanical disc drive unit and the related electronic components to support the drive mechanism, plus video circuitry and DACs to support PCM stereo audio. There are a few excellent DVD players that contain just the transport and necessary video circuitry that provide exemplary performance when connected to outboard DACs. Do not expect to obtain the same results in an inexpensive, mass-produced, flimsy, massless plastic DVD player using the same outboard DACs. Player transports are not created equal. Robustly-built DVD players with a metal chassis and substantial power supplies provide much better mechanical and electrical isolation, and thus exemplary performance. Such DVD players also may utilize separate power supplies and may further isolate the video circuitry from polluting the audio signal. Inexpensive DVD players power all circuits from a common, usually inexpensive switching power supply, thus providing less isolation. Good quality-built DVD players usually exhibit exemplary video performance as well, though this cannot be automatically assumed.

In large measure, the quality of the DACs in a DVD player will determine the quality of Dolby Digital, DTS Digital Surround, and CD playback, through the analog outputs. When you use the DVD player's digital output to connect to a high quality digital processor/controller or receiver, the internal DACs in the player are not engaged, and the resulting sound quality can be quite good if the DACs in the amplification component are of excellent quality.

Video quality in a DVD player is primarily determined by the quality of the video digital-to-analog conversion circuits. This includes the digital filters before the video DACs, the DACs, and the analog filters after the DACs. Separate, higher speed DAC circuits are used In progressive scan DVD players, and deinterlacing circuits also play a critical role in progressive video performance. The MPEG decoder, with special MPEG noise reduction circuits in newer DVD players such as the Sony DVP-S9000, also plays an increasingly important role in video quality. Reviews of DVD players in *WSR* report on these aspects of performance.

The Surround Processor

A surround sound processor or digital controller is an amplification stage component, which incorporates a computer, DACs and a line-stage preamplifier. Other features often found on processors include video switching (though I do not personally use this feature regardless of the circuit quality, as it adds an unnecessary pass-through stage to an otherwise direct interface with the display device), on-screen display generation, RF demodulator (necessary to retrieve the Dolby Digital AC-3® bitstream of LaserDisc players), multi-zone audio and video outputs, and various triggers to operate screen, curtain, and lighting controls in a home theatre from a remote control. A surround sound receiver adds amplification to power up to six loudspeakers. Some incorporate an AM/FM tuner as well.

I have always favored separate components that do not compromise sound quality, to process the three basic system stages in a home theatre surround system. In less critical systems though, where convenience is a prime consideration, I do use a high-quality surround sound receiver.

The quality of the digital audio signal, when extracted from the DVD player, as previously discussed, is entirely dependent on the

"I do want you to know that I was just blown away by what you had set up for our local members. The new *Widescreen Review* office is incredible. I have never seen a home theatre room like the one you guys have. It was an awesome experience going through the music and DVD demos in that environment."—Ron Epstein, Co-Founder, Home Theater Forum

"*Widescreen Review* has the ultimate home theatre. If you could sit down and design the perfect home theatre from scratch with an unlimited budget, you might come close to what they have. The room is soundproof, and totally floating, disconnected from the main building (Think the Magneto prison at the end of *X-Men*). Add to that Huge Friggin Speakers™, and a razor sharp rear-projection screen, and you are beginning to get the idea. They blasted the sound, on the demo of *U-571* DTS, one of the depth charges literraly blew the grille off of the speaker! Other demos included, *The Fifth Element*, *The Haunting* DTS, and some Audio DTS and SACD."—Jeff Cooper, Home Theater Forum

"Every comment I heard during or after your presentation expressed how delighted each person was to experience your state-of-the-art reference theatre. I do believe you convinced a few members to begin planning their own home theatre systems, or, for others with home theatres, to consider upgrades. For me, seeing it in person greatly added to what I've learned from reading your construction/installation articles to date."—Tim Price, San Diego Music And Audio Guild Board Member

"The *Widescreen Review* staff treated us like family even as I feared our large group would overwhelm their facility. The film-like images on their theatre's 7-foot-wide screen were stunning with dead-on colors, flesh tones and blacks. My adam's apple was vibrating during the *U-571* depth charge scene. I found the calibration demonstration very interesting and particularly enjoyed seeing a high-definition broadcast on their screen."—Mike Levine, Home Theater Forum

"It was truly a treat to experience the state-of-the-art home theatre/audio system developed by *WSR* While this may be far beyond the dreams of most enthusiasts, it is encouraging that Gary and his staff have raised the bar so high. Now if only industry producers and engineers will come and audition this system, their enlightenment may result in better software for all of us."—Tim Price, San Diego Music And Audio Guild Board Member

"Gary Reber and the gang at *WSR* really went out of their way to make us all feel welcome. And my my, that quarter-million dollar home theatre room they've put togther! Absolutely incredible! No bass shakers needed in this place... you could literally feel the expansion of the depth charge blasts in *U-571*!"—Mark Booth, Home Theater Forum

build quality of the player and DACs in the surround processor/controller used to convert the digital signal to analog. Most surround processors/controllers are built around sub-assemblies manufactured by a few companies, such as Momentum Data Systems and Sample Rate Systems, that use either Analog Devices, Cirrus Logic (Crystal), Motorola or Zoran digital signal processing (DSP) chips. As former Audio Technical Editor Richard Hardesty has repeatedly reported in previous reviews, there is little or no difference between the components inside. Thus, the differences in sound quality between different models tend to be subtle, if not perceived at all when listening to Dolby Digital, Dolby Pro Logic or DTS Digital Surround soundtracks, when the DSPs and DACs are the same.

What truly distinguishes one processor from another, which otherwise uses identical DSPs and DACs, is the quality of the analog stage that follows the digital-to-analog conversion. This is because after the conversion process, at the moment the signal enters the analog domain, the traditional rules for fidelity apply.

The three elements that impact the potential for quality analog sound at the output of the processor/controller are the DACs, the line stage analog circuitry and the power supply. These three elements will distinguish quality differences among surround sound processors/controllers. This is applicable to both stereo and multichannel source playback.

In the *WSR* theatre, I use the Theta Digital Casablanca II as our reference processor/controller. Our particular unit is not equipped with video circuitry, because I did not want any potential video switching to compromise picture quality and degrade audio performance. Nor did I want added noise interference associated with video circuitry. Instead I use a professional Extron® Matrix 128 HV/ Crosspoint/Component Converter video switcher to route various video source signals to our Runco 4404 Ultra/DTV-1101 and Faroudja DVP-5000/ Sony VPH-G90U projection systems.

I did have our Casablanca II equipped with high-performance, linear multi-bit DACs. Lesser-quality surround processors/controllers use sigma/delta (1-bit) DACs that cannot achieve the resolution quality of linear DACs. Our Casablanca II is also equipped with true, stereo analog pass-through. And soon Theta will provide six-channel analog pass-through. (Upgradability is a benefit of the Theta design.) Other processors/controllers that do not provide for analog pass-

"Mei and I just got back from the tour and all I can saw is WOW! Gary and his editors Perry, Mike and Suzanne explained the details of their new reference studio, while we all lounged in plush leather sofas. The equipment is all state-of-the-art including Dunlavy front and rear speakers that would dwarf most kitchen refrigerators. I hope everyone had a great time and can still enjoy their own home theatre-setups after sampling Gary's theatre."—Steve Kinkead, Home Theater Spot Forum

"What a day! *WSR* couldn't have treated us better. I thought their theatre was beyond belief. If I had access to something like that, I would never see another commercial theater. (It did make it hard to come home to mine, though.) Then to top it all off, the lunch at Wilson Creek was really fun. One of the things, though, that really impressed me was that Gary Reber invited us back to the offices after lunch. To me, that was 'above and beyond.'"—David_D, Home Theater Forum

"It was one of those 'Got to have it systems' if we win the lotto (yeah right huh?)"—Mike858, Home Theater Spot Forum

"*Widescreen Review*'s reference studio and Gary's mix of audio and video demos left me awestruck. I'm new to home theatres, and won't even have my Mits [Mitsubishi] until next week and now I'm depressed because my setup is going to be light years from being that cool."—Mikejl, Home Theater Spot Forum

"This *WSR* tour was unbelievable. What an ear- and eye-opener. Talk about the ultimate RPTV and 'Sound To Die For!' Everyone at *WSR* was extremely friendly and very forthcoming with answers to our questions—Information Overload! Wow. Their hospitality was also way over the top. Along with everything else, coffee, brownies, and lunch too! But the real treat was the Holosonic Home Theatre Lab—you've got to hear it and see it for yourself. I learned a great deal on this tour and I have a newfound respect for *WSR*'s reviews. Thank You Gary, Suzanne, Perry and everyone at *WSR*! The downside to his tour is that I've spent the last couple of days tweaking the heck out of my audio system and I've got it about 99 percent on par with *WSR*'s Holosonic Home Theatre Lab...(yeah right, in my dreams)"—CraigM, Home Theater Spot Forum

through digitalize all analog signals at low resolution, thus degrading the sound quality from a high-end CD player, outboard DACs, or SACD player in a home theatre system that serves double-duty as a high performance stereo and/or surround music system. (See review in Issue 49, June 2001.)

For surround music playback I use the SCPA 1 six-channel preamplifier from R.E. Designs. This is a simple device that offers six inputs, six outputs, a master volume control and trim pots for each channel. A power switch is the only other feature in this high-end analog preamp which provides a pure signal path between the multichannel DVD-Audio and SACD players in the system. The SCPA has the ability to adjust channel levels between 6 dB and 18 dB to within .025 dB, to assure precise, inter-channel balance with acoustically-related holosonic recordings. (See review in Issue 50, July 2001.)

The amplification stage of the *WSR* Reference Holosonic Home Theatre Lab system uses custom-built California Audio Labs 1,000-watt per channel amplifiers, configured in a two-channel chassis. These amplifiers are based on the CL-2500 MCA five-channel amplifier design, and employ a unique "zero voltage transition" digital switching power supply and microprocessor control over all operational parameters. They are extremely high-powered, effortless, distortionless amplifiers that operate mainly in true Class A bias, and won't distort or melt down handling sustained 100 dB-plus levels when monitoring movie soundtracks at a standard reference level. This CAL amplifier is one the most powerful amplifiers in the world, and competes sonically with the very best, cost-no-object mono and stereo designs. (See review in Issue 38, May 2000.)

Video Integration

As defined in previous parts of this series, particularly Part V, the size of the *WSR* theatre room was determined by the requirements for optimal audio reproduction using truly full-range loudspeakers that are time- and phase-coherent, and measurably and audibly accurate throughout their 16 Hz-20 kHz range. This set the parameters of the "sweet spot" listening position and "viewing" position (which optimally should be one-in-the-same). Once determined, I used a factor of "listening distance from the screen divided by two" (or conversely, "screen width times two") to determine what the "optimal" screen width should be, to support the highest picture resolution using 9-inch CRT projectors in a mirrorless rear projection setup. [The eye's critical viewing distance to resolve the theoretical maximum resolution of a 1080i or 1080p picture is actually 1.8-screen widths. But the practical maximum resolution is about 10 percent less, which yields a 2-screen width rule of thumb that works better in a theatre that also includes scaled standard definition video.—Video Technical Editor, Greg

"*Widescreen Review*'s reference studio and Gary's mix of audio and video demos left me awestruck. I'm new to home theatres, and won't even have my Mits [Mitsubishi] until next week and now I'm depressed because my setup is going to be light years from being that cool."—Mikejl, Home Theater Spot Forum

"The single most impressive home theatre setup I have ever seen. Dunlavy speakers the size of Shaq. Okay, bigger. An awesome projector that renders near-filmlike quality of DVDs onto a 7-foot-wide screen. Laser adjusted speaker placement. Isolated, "floating" room. Sound treatment like you wouldn't believe. Top-o'-the-line equipment that would have made Obi weep. I know I got teary."—Carlo Medina, Home Theater Forum

"This *WSR* tour was unbelievable. What an ear- and eye-opener. Talk about the ultimate RPTV and 'Sound To Die For!' Everyone at *WSR* was extremely friendly and very forthcoming with answers to our questions—Information Overload! Wow. Their hospitality was also way over the top. Along with everything else, coffee, brownies, and lunch too! But the real treat was the Holosonic Home Theatre Lab—you've got to hear it and see it for yourself. I learned a great deal on this tour and I have a newfound respect for *WSR*'s reviews. Thank You Gary, Suzanne, Perry and everyone at *WSR*! The downside to his tour is that I've spent the last couple of days tweaking the heck out of my audio system and I've got it about 99 percent on par with *WSR*'s Holosonic Home Theatre Lab...(yeah right, in my dreams)"—CraigM, Home Theater Spot Forum

"Gary, Laurie, Suzanne, Perry, and all the folks at *Widescreen Review* really gave us a warm welcome and a day to remember. The screening room has to be seen because words don't do it justice. Let's just say that none of us went home and looked at our systems the same way after that. PS. Gary, where do I send my resume?"—RIN, Home Theater Forum

"Experiencing *WSR*'s approach to DVD reviews first-hand convinced me to pay for a subscription."—AllenD, Home Theater Forum

Rogers] I was able to support the maximum seven-foot screen width recommended for 9-inch CRT projection. That puts our "eyes-in-the-chair" position at about 13 feet, 6 inches from the screen, which produces a desirable 30-degree viewing angle in the *WSR* theatre using a Stewart Filmscreen AeroView® 100 rear-projection screen. To use a picture width greater than seven feet with a CRT projector (either front- or rear-projected) is not recommended, because such setups ignore the limits of the real capability of the projector, in terms of light output.

Use this rule of "two times screen width" as the viewing distance from the screen, then scale your holosonic home theatre system, using the 60-90-degree included angle configuration to size. In the *WSR* theatre case, I scaled the holosonic surround system, so that the front hemisphere would present a wider sonic perspective than set by the limits of the picture on the screen. But, if you prefer, you can actually scale the sound image to the recommended maximum seven-foot width limit of the picture, so that the left and right front loudspeakers will just be positioned at the edges of the screen, without blocking the viewing of the picture. Of course, with narrower screen widths, you do not want to compromise the optimum soundstage width your loudspeaker system and room can support. Always opt in favor of soundstage and holosonic soundfield dimension.

If you want a much wider screen size, then a high-output DLP or D-ILA projector would be a better choice. And I have that option with front projection in the *WSR* theatre at any time, by installing a 10-foot-wide screen, optimized for displaying video projected from fixed-pixel displays, such as the GrayHawk® from Stewart Filmscreen. This would produce a much wider, 40-degree viewing angle. I do use a GrayHawk screen, which at the same seven-foot width, is housed in a Stewart motorized roller-drop, Luxus Model A ElectriScreen enclosure, mounted above the AeroView 100 fixed screen. However, for DVD picture reviews, I opted for CRT projectors, because this technology still provides the best picture quality with the richest color and blacks.

Since the magazine is "the essential home theatre resource™" for reviews of picture and sound quality relating to DVD and HDTV formats, as well as the equipment to deliver the video and audio of those formats, I insisted on optimizing the parameters necessary for the end result to be truly reference quality.

As we've indicated in past *Widescreen Review* issues, the potential for picture quality in a rear-screen configuration using a CRT projector is as good as anything we can accomplish in front-screen. Done right, it will actually have a slight advantage in contrast ratio over the front-screen configuration, yet still have virtually all of the picture resolution quality associated with a front-screen.

One of the real benefits to a quality audio system using rear-screen projection is that projector noise can be virtually eliminated. In the *WSR* theatre implementation, I used

Owens Corning Black Acoustic Boards from the SelectSound™ product family, and covered them with Guilford of Maine 408 Black Panel Fabric (FR 701 Style 2100), the same acoustically-transparent fabric used on the RPG Diffusor Systems' VariScreen and BAD acoustical panels in the theatre. Additionally, the Dunlavy Signature Series HRCC center channel loudspeaker is draped with 16-ounce black "commando cloth" (available through a local supplier named Rose Brand at www.rosebrand.com). Thus, the entire projection path is lined with black fabric-covered acoustical treatment, which, in addition to preventing stray reflections from behind the screen, serves to silence any noise from the CRT projectors escaping into the home theatre room.

As previously mentioned, our primary CRT projectors are the 9-inch Runco DTV-1101, coupled with Runco's VHD-4404 Ultra multi-function video processor, and the 9-inch Sony VPH-G90U, coupled with Faroudja's DVP-5000 digital video processor/scaler. These two projectors represent the "top-of-the-line" models from Runco and Sony (though Runco will have released their new DTV-1200 9-inch CRT projector by the time you read this). These projectors are remarkably close in performance when driven correctly. The Runco exhibits superior color fidelity, but the Sony exhibits just slightly better resolution. Each represent absolute reference quality in a component projector.

For a detailed investigation into our projection system, please refer to Part V in Issue 52, September 2001. For a review of the Runco DTV-1200 and 4404 Ultra, please see Issue 52. For a review of the Sony VPH-G90U, please see Issue 36, January/February 2000.

Lighting And Aesthetic Environment

I decided on an "all-black charcoal" environment to optimize picture contrast, black level, and shadow delineation, and also to provide an intriguing high-tech, aesthetic environment.

I enlisted ImageCrafters (IC) to work with me on the design of the lighting treatment in the *WSR* theatre. Together, ImageCrafters' Spencer Kalker and I determined what needed to be lit and what could not be lit (i.e., the screen). These considerations were based on how the room was to be used. We listed numerous scenarios, including critical viewing; critical listening; testing of loudspeakers, electronics and projectors; writing articles on a computer; reading; presenting seminars; and holding meetings. Each of these scenarios has different requirements with regard to how the lighting is placed in the room, what type of lights are used and how each circuit is controlled and dimmed. A feature of the lighting scheme is a "circle of light," which matches the 20-foot diameter "circle of sound," but positioned about 10 feet above floor level, and mounted onto the suspended RPG Diffusor Systems' acoustical cloud. This is accomplished with IC Lights' LiteRail system, in conjunction with the Lutron Graphic Eye and the latest in halogen bulb lighting technology.

Lighting and the "feel" of the environment should not be compromised, or you will end up with a result that could compromise the investment in effort and money to build your home theatre. With color selection, stay with blacks and charcoal with gray accents for optimum video performance. A monochromatic "black" room will disappear when viewing movies, or even when listening to music, with no distractions, for optimum visualization of the performance. Designing the lighting system properly has enhanced every aspect of the *WSR* theatre and helped ensure that all the elements involved in the space are maximized and enjoyed to their fullest.

Seating was all custom-designed with low backs so as to not interfere with listeners' ear heights. Two IC Chairs are currently used in line with a single "sweet spot" IC Chair or a First Impressions chair.

The End Result

The audio system in the *WSR* Reference Holosonic Home Theatre Lab measures and sounds audibly accurate throughout its flat 16 Hz to 20 kHz range. Reverberation time is an optimum T30 across the audio spectrum. This was achieved through judicious use of RPG Diffusor Systems VariScreen, Skyline and BAD panels on the wall and ceiling surfaces. To provide a tight bass response in the theatre, generous amounts of additional Owens Corning QuietZone Acoustic Fiberglas Batts were applied behind the RPG VariScreens in selected locations, and packed four-feet high between the 10-foot height of the RPG Skyline acoustical cloud and the 14-foot-high ceiling. There are no aberrations in the frequency response throughout its wide range!

The Dunlavy Signature Series SC-Vs respond as a transparent "window" to the other source and amplification components in the system, and then back to the recording. Recordings are easily dissected when listening through the SC-Vs. Poorly-recorded material, or recordings with poor lateral and depth imaging, can be clearly detected when listening to the SC-Vs. Great recordings with wide defining boundaries of where the performance is occurring, on the other hand, are so exciting to listen to that the experience is often truly mesmerizing. Whatever the character of the different components in the system, the SC-Vs reveal every nuance. These loudspeakers exhibit no altered spectral-balance or other "pizzazz" qualities. They are absolutely neutral throughout their frequency response range. Bass response is stunning—extremely tight, clean, and controlled, from the deepest octave up through the lower midrange. Definition of instruments, voices and sound effects in this range is superb. These loudspeakers also provide superb reproduction of rhythm and pace. And when it comes to reproducing ultra-low, deep bass, the SC-Vs (and TSW-Vs) excel down into the region where you feel it more than hear it. The SC-Vs simply sound more transparent, and are closer to perfect than any loudspeaker system I have ever experienced.

With a good stereo recording, the SC-Vs are remarkable at recreating a truly realistic image of "performance space," with accurate rendition of depth and soundstage dimension, clear across the front hemisphere of the *WSR* home theatre room, with a wall-to-wall spread (depending on setup) of 10 to 14 feet! (The manufacturer-specified on-axis listening range spans a wide 8-40 feet.) They have much more dynamic life than just about any large loudspeaker system I have experienced (with the exception of the larger SC-VI). This loudspeaker is capable of accurately reproducing complex musical transients, and playing at levels needed to recreate the illusion of live music. The SC-Vs are exceptionally capable of handling rapid dynamic contrasts and transients with no sign of compression at any reasonable level—even at the reference level we use to review movie soundtracks.[9]

A pair of Dunlavy Signature Series SC-Vs can create a stable and precisely-focused, three-dimensional image that is very convincing and lifelike in stereo. Four SC-Vs in a surround system, based on an equidistant/equiangular/"equiheight" setup, make a virtual reality of the signal, putting you in a holosonic soundfield, with excellent three-dimensional layering and superb definition along the front, side and back walls. When the inter-channel coherency is acoustically related, the same lifelike, focused image that you hear from the front pair can be heard from the sides and the rear, too! With the right source material and amplification components providing the signal, these

9 Movie sound reference level is standardized at 85 dB, with peak sound pressure levels (SPL) reaching 105 dB. Remember that there is no volume control in a commercial theatre. Soundtracks are intended to be play back at this specified reference level. Playing at lesser SPL levels will alter the harmonic and fundamental nature of the soundtrack recording, and depreciate the audible impact relative to the on-screen action.

loudspeakers totally disappear.

The SC-Vs are truly remarkable in their ability to reproduce the music and complex sounds, found in many movie soundtracks, with breathtaking realism. Indeed, within a good listening environment, such as in the *WSR* theatre, four SC-Vs (in a equidistant/equiangular/"equiheight" setup) with their ultra-flat spectral balance and precise, stable soundstage can produce an incredibly close encounter with real-life experiences. They not only sound harmonically neutral, but also are remarkably and dynamically effortless at any reasonable level.

In our multiple SC-V system setup, with the right material, they impart a holosonic three-dimensional soundfield that is fully capable of suspending disbelief.

They are absolutely effortless and totally authentic in their ability to recreate the illusion of reality, with distortion-free dynamic range that mimics live music and film effects. The system is simply a killer at extracting the best possible fidelity and spatial qualities inherent in good recordings, and in source and amplification components.

Three matched pairs (six in all) of SC-Vs, as in the *WSR* Reference Holosonic Home Theatre Lab, driven with high-quality, reference performance-level source and amplification components in the system, is additively one of the ultimate home theatre experiences that I have ever created or experienced. As the magazine's most accurate reference system, everyone who experiences it says, "listen to how real it sounds." If you want an ultra-accurate, true "reference standard" home theatre and/or surround music system that delivers clean and transparent musical sound and motion picture soundtracks, at real-life levels with astonishing realism in your home, use this series of articles as a reference resource.

Conclusion

Thank you for your support of this educational series on how to build a no-compromise, holosonic home theatre system from the ground up. I look forward to readers' letters referring to the principals espoused herein, but please, no specific "how to" questions with your specific components, as our staff is limited in time and energy to answer such questions. Such questions should be directed to qualified and experienced specialty audio and home theatre dealers, and custom installers from whom you purchased your components. Instead, formulate readers' letters, whose response will serve to provide further enlightenment as to approaches and principals for optimizing the home theatre and surround music experience.

To your success! ■

Recommended Reference Resources

Widescreen Review Issues 48-53.

Widescreen Review Special Edition: *The THX Story*, or Issue 2 *Part I* and Issue 3 *Part 2*

Widescreen Review Issue 15: "Home Theatre—Doing It Right"

Widescreen Review Special Edition: *The Essential Subwoofer Buyer's Guide*

Widescreen Review Special Edition: *Imaging Science Theatre 2000*

Audio Perfectionist Journal, R.L. Hardesty, www.audioperfectionist.com

Note: *Widescreen Review* back issues and special editions are available at www.widescreenreview.com or by phoning toll-free 1 888 WSR SUBS (977 7827) or 909 676 4914. Not all back issues and special editions are available as some are sold out.

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M-Audio, 45 East Saint Joseph Street, Arcadia, California 91006, 626 445 2842, www.m-audio.com

Kay Dorrough, Dorrough Electronics, 5221 Collier Place, Woodland Hills, California 91364, 818 998 2824, www.dorrough.com

AccuPel, P.O. Box 1891, Tualatin, Oregon 97062, 503 524 9870, www.accupel.com

CinemaQuest, Inc., 3551 South Monaco Parkway, Suite 301, Denver, Colorado 80237, 303 740 7278, www.cinemaquestinc.com

Sencore, 3200 Sencore Drive, Sioux Falls, South Dakota 57107, 605 339 0100, 800 736 2673, www.sencore.com

AV Standards, 6825 Madison Avenue, Indianapolis, Indiana 46227, 317 784 1358, www.avstandard.com

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