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Speakers

PART 3

Introduction

*This is the eighth **Audio Perfectionist Journal**. Here we will conclude the discussion of speakers that began in **Journal #5** and continued through **Journals #6 and #7**. The articles in this issue will complete a series on stereo loudspeakers and add information that applies specifically to center channel and surround speakers in a multichannel audio system. The articles about time domain performance will restate some facts presented earlier and then I'll share some subjective observations regarding these facts.*

Speakers

Speakers are a favorite subject for every audiophile, and everybody—audiophile or not—has an opinion about speakers. I'd like to assure readers that if your opinions differ from mine you are not alone and you are not necessarily wrong. Listening to music is an emotional experience and people are as emotionally diverse as the shapes of snowflakes. Our choice of speakers provides a path to emotional satisfaction and it stands to reason that our choices will be as varied as our personalities.

I believe that loudspeakers should accurately reproduce the recorded signal. Accurately reproducing the recorded signal includes preserving the timing relationships between various ranges of frequencies, in my opinion.

Early on I defined high fidelity as maximum adherence, or faithfulness, to the recorded signal and stated that the **AP Journal** would follow the tenets of this philosophy. I write exclusively from that perspective but there are other viewpoints and I respect them.

Many people prefer loudspeakers which embellish the recorded signal in some way. They feel that the enhancement provided by their favorite speaker system helps to create a sound that is more like a live musical performance and provides them with a more satisfying connection to the music. Who can argue with that?

If connecting with the musical message is our goal, there will always be differences of opinion about how to achieve that connection and people will choose a variety of paths because music speaks to different people in different ways.

I've found that the best path for me is the one that most accurately presents what the artists created when they made the recording but others want more—more ambience, more "detail," more spectacular spatial effects, more bass.

More Than Accuracy

Many of today's popular speakers are designed to do more than accurately reproduce the recorded signal. They are engineered to produce sound that is bigger, more spacious, or more "detailed" than the sound that is captured on the recording. Examples include direct-reflecting, bipolar and dipolar types and speakers with large shimmering radiating surfaces like ribbon, planar-magnetic and electrostatic designs.

High-end speakers that emphasize parts of the frequency spectrum provide "more" of certain things at the expense of others. Simulated line-sources made from arrays of dynamic drivers have a unique sound all their own.

I don't find these speakers satisfying because I'm accustomed to, and prefer, hearing the recordings without this embellishment but others find these effects pleasing. If you're one of them stand proud. You are entitled to your preferences in personal matters and nothing is more personal than your emotional response to music. How you achieve it is your business and none of mine.

I must write from my perspective. Some of what I present in the **Journal** is simply factual information and some is opinion based on my interpretation of the facts. I may point out that the shimmering movement you see when you shine a flashlight on the diaphragm of your electrostatic hybrid speakers is producing sound that is not on the recording. If you like that sound, then I accept your preference.

In this issue

The article titled *Value?* is a think piece to remind readers about the current state of the high-end and to keep us in the right frame of mind. This article was rejected by one of the high-end print magazines but I think it needs to be published and you deserve to read it.

The title *CES Report* is self-explanatory. I thought you should be able to read something about the Consumer Electronics Show that wasn't predicated on pleasing big advertisers. I'm impressed by good sound, not by high price tags and I don't sell advertising. Size does matter but, when it comes to loudspeakers, size is often inversely proportional to sound quality.

The articles about speakers that follow conclude a series of discussions about speakers that started in **Journal #5**. *Loudspeaker Time Domain Performance* restates some facts, and some opinions, about the importance of time domain performance. This piece is followed by three articles that present my subjective listening impressions of three time- and phase-accurate speaker systems: the Dunlavy SC-IV.A, the Thiel CS6 and the Vandersteen 3A Signature/2Wq.

The articles *The Truth About Center Channel Speakers* and *The Truth About Surround Speakers* present facts that readers should consider when choosing speakers for a surround sound or home theater system.

This **Journal** concludes with an article titled *High-End Speakers and High SPL* that explains how to protect your hearing and your equipment from damage caused by excessive loudness.

Value?

by Richard Hardesty

Can an $80,000 pair of loudspeakers or a $20,000 pair of speaker cables represent good value? Do hyperexpensive products really perform better?

While astronomical price tags have become commonplace in high-end audio, few reviewers have questioned whether these ever-escalating prices can be justified on the basis of actual manufacturing costs or if the highest-priced products offer any real performance benefits when compared to well-engineered components which cost far less.

Instead, it has been generally assumed that those components which cost more are built to higher quality standards and sound better than those components which cost less. These assumptions are not necessarily true, and they have taken a toll on the high-end audio industry.

In fact, retail prices for high-end audio components are often completely unrelated to manufacturing costs and may be used solely as market positioning tools. In the instances where hyperexpensive products actually do provide some audible advantage, the gain is likely to be small and may be achieved at the expense of some other aspect of performance.

When an industry is filled with a variety of products which are artificially priced to position them in the marketplace, that entire industry becomes suspect. Customers get less for their investment in a market where manufacturers are vying for prestige rather than competing to provide value for money.

Why Make it Better When You Can Just Claim That it is?

As is true in most industries, high-end audio manufacturers used to vie for market share by trying to offer more for the money than their competitors. Originally "more" meant audibly superior performance but eventually "more" evolved to include better cosmetics or industrial design and/or enhanced prestige.

Some manufacturers discovered that, while it was difficult to produce products which actually sounded better, it was easy to generate lots of attention from magazine reviewers and dealer sales people by simply claiming to offer higher performance and attaching a high price tag to new products.

Many inexperienced listeners fell into the trap of assuming that a high price was a guarantee of high construction quality and high performance just as they (often falsely) assume that an expensive car is made better and performs better than a less expensive model.

High-End Audio Magazines Contribute to the Problem

Because it is entertaining to read about the most esoteric products available, the high-end audio press has emphasized coverage of extremely expensive components and devoted less attention to the high value high-end products that most people are actually interested in purchasing.

When an industry is filled with a variety of products which are artificially priced to position them in the marketplace, that entire industry becomes suspect.

Super expensive audio components have often been subjected to far less scrutiny by the high-end press than these products deserve. Readers have been led to believe—falsely, in my opinion—that affordable audio components can't really perform at the highest levels and that true state-of-the-art performance is reserved exclusively for the wealthy.

As specialty publications have focused more and more on products that most people simply can't afford, the high-end audio industry has suffered. Many music lovers have been turned away from our hobby because they felt excluded from a club where components they own or can hope to obtain are subtly denigrated in print, and components with ridiculous price tags are accepted with little skepticism.

Many readers of the high-end audio publications have become dissatisfied with components which offer outstanding performance simply because these components sell for only a fraction of the cost of those esoteric products lauded by the magazine equipment reviewers.

Time for a Reexamination

While designers will always experiment with components on the fringe of practicality in order to advance the state of the audio art, you don't necessarily have to participate in their experiments in order to achieve true high-end audio performance.

I'm in favor of experimentation and I look forward to enjoying the superior audio components that experimentation may help to develop, but the high-end audio industry must survive and prosper in order for this progress to occur. I believe that it is time to reexamine many of the products at the upper limits of the price spectrum to determine whether they are fairly priced—as defined by a selling price which has some reasonable relationship to the cost of making the product—and whether they represent good value to the consumer in terms of actual performance. While both issues involve some subjective judgments there are some guidelines to help you decide for yourself.

Fair Market Value

There is an industry benchmark for establishing the fair market value of an audio component—the five-times ratio of parts cost to selling price. According to this standard (which, of course, is merely a guide and not an absolute), the cost of the parts in a fairly priced audio component should represent about twenty percent of the retail selling price of that component.

A five-times ratio of parts costs to selling price provides a lean but acceptable profit margin to the manufacturer and the retailer. The manufacturer must make sufficient profit to remain in business in order to service and update the products you buy and to develop new products with improved performance. The dealer must make sufficient profit so that he can afford to provide comfortable demonstration facilities stocked with the demo components that you use to make your buying decisions.

Product development costs are incurred by the manufacturer and these must be recovered before any profits are retained. Special parts may have to be purchased in large quantities before manufacturing can begin. An inventory of these parts must be kept on hand for future repairs.

The manufacturer must provide advertising support and printed literature for the dealer so you'll know what products are available for your selection. The dealer must provide assistance in the setup and troubleshooting of the system you choose.

An audio component that performs at the highest level is not likely to be cheap. Less consumer demand means lower production numbers and higher costs. Products which are made in very small quantities will have to sell for much more so that the makers, and the dealers, can recoup their costs from a smaller group of buyers. Higher performance is partly achieved by greater attention to detail and that costs money, too.

Products are assembled by people and labor costs are not considered in this ratio of parts cost to selling price. Products like cables, which have higher labor costs, will have a lower cost of parts relative to the selling price. After considering all these additional factors, the five-times ratio of parts cost to selling price still allows an efficient manufacturer to succeed and prosper. What about those products that sell for much more?

An audio component that performs at the highest level is not likely to be cheap.

Many high-end audio components are overpriced when judged solely by the cost of manufacturing. When the selling price to parts cost ratio gets to be 10:1, or more, you are surely buying something other than high quality materials and you should be aware of it. That "something" may have value to you.

Prestige

Many expensive watches are sold not because they keep better time but because they represent a symbol of position or achievement. There may be only a small quantity of gold in a very expensive watch. These watches are not necessarily purchased because they offer superior performance or because they contain expensive materials. Does a Rolex keep better time than a Timex?

Scarcity and pride-of-ownership may add value to a watch or an audio component. Reviewers of ultrahigh-end audio components should help to make consumers aware that, in many cases, these consumers are paying for prestige or exclusivity rather than performance.

Pricing for Market Position

Based on the five-times ratio, a loudspeaker system assembled from $400 worth of component parts should sell for $2,000, not $20,000, yet speaker systems that sell for $20,000 or more are common. Factors other than cost of manufacturing have come into play.

Many audio products are priced to position them in the marketplace, not simply to enable the manufacturers and dealers to make a fair profit. Why overprice a product to position it as high-end? Because products with higher price tags are likely to get more attention from reviewers and dealers. Let me give you some examples to illustrate how pricing for market positioning works.

Paradigm, a high value manufacturer, decides to bring a powered subwoofer to market. They put a high quality cast basket 15-inch driver in a heavily braced MDF enclosure with a real wood veneer finish, include a 400-watt, high current amplifier with a sophisticated servo system and offer the product to consumers for the fair market value of $1,500 (Paradigm Reference Servo 15).

B&W, an upscale manufacturer, wants to offer a similar product but they want to position their subwoofer as a "higher-end" component and they have a larger advertising budget to promote the product. They put a high quality 15-inch driver in an MDF enclosure, include a 450-watt amplifier and price their product at $3,000 (B&W ASW4000).

Aerial has established a reputation as a "high-end" manufacturer. Their powered subwoofer utilizes a smaller 12-inch driver in a vented enclosure much like the B&W (except that the Aerial cabinet is made by a high-end Danish furniture maker). The Aerial SW-12 subwoofer includes a 400-watt amplifier and sells for $5,000.

Wilson Audio is a "prestige" manufacturer. They put a 12-inch driver in a vented enclosure, include a 400-watt amplifier and price the product at a whopping $10,000 (The Wilson WatchDog)—double the cost of the Aerial SW-12 and nearly seven times more than the Paradigm Reference Servo 15.

Now these are all high quality products and I'm not trying to disparage any of them but, as you can see, the relationship between the manufacturing cost and the selling price of the more expensive units is not a linear progression.

Performance Value?

If the retail prices of many high-end audio components aren't based solely on manufacturing costs, perhaps they can be justified on the basis of performance. Do audio products with inaccessible prices really sound better?

I believe that runaway pricing has damaged our industry. Many products are vastly overpriced based on manufacturing costs and few of the overpriced products offer better sound than what can be had for less. Often far less. In the best cases, where a hyperexpensive product actually does offer some audible performance benefit, that benefit is likely to be a small incremental improvement over products that are more reasonably priced.

Many reviewers subtly denigrate the performance of affordable high-end audio components when reviewing hyperpriced components. Reviews often suggest to the reader that extremely expensive components offer dramatically better performance than that available from components at the upper midrange of the price scale. Based on my experience, and I've had a lot of it, this is seldom the case.

A Balancing Act

Engineering is a balancing act. An engineer balances compromises. One of the many compromises to be considered is cost versus performance.

Audio components, like other products for other purposes, are designed using the evolving knowledge of materials and technology. No one has a monopoly on this knowledge. A good engineer can design a product to the knowledge and materials standards of the day and achieve perhaps 80 percent of the performance that is currently possible. An engineer who listens and tweaks a product may be able to improve that performance by another 10 to 15 percent by adding some "art" to the design process.

Throwing money at the design will not necessarily improve its sonic performance. A top designer may be able to squeeze an extra performance improvement of perhaps five percent by tripling the cost of the product. Often an improvement in one area of performance will result in a reduction in performance in another area.

Those who naively believe that a $20,000 speaker system sounds twice as good as a $10,000 speaker system may be in for a shock if they take the time to do a direct comparison.

If you have unlimited funds and want the best possible performance then the very best sounding product available is probably a good value regardless of the price. If you think that the highest price guarantees the best performance you are likely to be disappointed.

I've been selling and reviewing audio products for nearly thirty years and I can tell you from experience that, in many cases, the most expensive products offer performance that is actually inferior to well-designed products costing far less. In the few circumstances where a hyperexpensive component actually does offer some performance benefit, the margin of improvement is likely to be relatively small and may involve trade-offs. Let's compare two of the previously mentioned subwoofers for example.

…few of the overpriced products offer better sound than what can be had for less.

The Paradigm Reference Servo 15 subwoofer is a sealed enclosure design. The B&W ASW4000 is a vented design. The B&W costs twice as much as the Paradigm but it will perform better in only one area: maximum output in the 30-40Hz range. Its performance will be inferior in virtually all other areas. Here's why.

A vented subwoofer uses a resonating column of air to minimize cone excursion and boost output level at frequencies near the tuning frequency of the vent (port). The trade-offs for this increased output over a limited range of frequencies are reduced output below the tuning frequency, and depreciated transient and time domain performance.

If all else is equal, a vented subwoofer will have twice the phase shift and twice the group delay of a sealed enclosure design. The vented subwoofer will oscillate (ring) twice as long after the signal stops. Compared to a sealed enclosure design, a vented subwoofer will roll off twice as steeply below its nominal cut-off frequency. What does all this mean to you?

If you are seeking maximum slam in the range of 30-40Hz for movie sound effects, the B&W offers slightly better perform-

ance (an increase in output level of 5dB at 35Hz). If you are seeking superior transient response, deeper bass extension and a seamless blend with the main speakers for music reproduction, the Paradigm is likely to perform better even though it costs half as much.

You should not assume that a high-priced product will perform better than a lower priced one…

The Aerial and Wilson subwoofers are also vented designs. They too will trade high output capability over a limited range of frequencies for transient response, time- and phase-linearity and low frequency extension. You have every right to desire a subwoofer finished in genuine Ferrari Blue paint, like the Wilson WatchDog, so long as you have not been led to believe that this provides some performance benefit. You should not assume that a high-priced product will perform better than a lower priced one in all areas, and it may not offer better performance in any area.

Conclusion

Value is not a forgotten artifact of the past. There are many audio products available today that are fairly priced based on manufacturing cost and some of these products provide performance that was unattainable at any price just a few years ago.

The very best performance available is often provided by components that are affordable to common folk like you and me. If you listen and compare before you ask for prices you may find that you can afford a lot more performance than you expected. APJ

CES Report

by Richard Hardesty

I began attending the Consumer Electronics Shows in the early 1970s. There used to be a winter show and a summer show each year and I'm sure that I have been to over forty of them so far, but who's counting? Things have changed a lot since 1970.

Over the years I have watched the high-end audio industry evolve and fragment into two distinct camps. One segment of the industry continues to pursue the original goals of the high-end—presenting a more accurate reproduction of the live musical experience while offering better audio performance for the money. And the other portion, which I like to call the silly segment, continues to pursue notoriety through excess.

High-end audio magazines have concentrated their coverage on products from the silly segment of the industry because manufacturers who are making big profits have big advertising budgets and it's easier to write entertaining prose about hyperbolic performance claims and outrageously extravagant components. There are no signs that this will change anytime soon.

At this year's CES I was asked to evaluate and comment on high-end loudspeakers for *The Absolute Sound*. This was a challenging mission for me because many of the hyperexpensive loudspeakers that have received lots of attention in the pages of *TAS* are less than credible designs, in my opinion.

I chose to incorporate into my article speakers that actually produced good sound in show demonstrations rather than limiting my evaluation to speakers which were simply big and/or expensive. Apparently my article missed the mark of what the editors wanted and it was rejected. I have added some material and edited the article to make it appropriate for the **Audio Perfectionist Journal** and here it is.

What is a High-End Speaker System?

Can a high-end audio system be identified solely by how much it costs? Most magazine reviewers seem to think so. Read the show reports in *Stereophile* or *The Absolute Sound* and you'll find one reviewer after another mentioning Rockport, Wilson and Wisdom Audio as if the products from these companies actually produce good sound.

If a system sells for a million dollars it must be really good, right? At CES this year, Wisdom Audio demonstrated a million dollar system with appropriate fanfare. It failed to provide high-end sound by my definition. All the other prestige brands were well represented at CES, too. Systems with startling price tags were assembled and demonstrated to rapt audiences of dealers and equipment reviewers. Few of these systems offered sound quality that was musically satisfying to me. Has the high-end audio world gone completely mad or have I become a curmudgeon?

This year most of the "silly segment" of the high-end was isolated at an outboard facility under the banner of T.H.E. Expo (The Home Entertainment Expo). T.H.E. Expo, which is a parasite and not an official part of CES, was headquartered at the brand new Tuscany Hotel, where every guest room is a 600 square foot suite.

Most of the extremely expensive stuff was demonstrated in the even more spacious conference rooms one flight above the main lobby. The large conference rooms and the living room-sized guest rooms at the Tuscany provided excellent acoustics (in hotel terms) in which to evaluate high-end audio systems and components. Any exhibitor who cared could make good sound in these rooms and some did.

While I had experienced them all many times before, I took the time to listen again to seven speaker systems priced on par with entry-level condominiums but inappropriately sized to fit in such a dwelling—or a normal house. Manufacturers included Wilson Audio (the X-1 Grand Slam, and Maxx), Rockport Technologies (Hyperion), Nearfield Acoustics (two models of PipeDreams) and Wisdom Audio (two models from the Adrenaline Series).

In each case, I could identify serious sonic aberrations and design flaws. In no case did I hear anything reminiscent of my live musical experiences. The price tags were high in the upstairs rooms at the Tuscany but the fidelity was not. I did, however, manage to find some genuine high-end loudspeakers with musical and practical relevance elsewhere at T.H.E. Expo and at CES.

Good Sound at T.H.E. Expo

The Audio Physic Avanti III speakers ($10,995 a pair) provided a plump but pleasing presentation, driven by Herron electronics from a Burmester CD player source. A certain selection brought tears to my wife's eyes demonstrating that the message of the composer had indeed been delivered with the intended emotional impact. Imagine that. A satisfying musical experience provided by a practical, affordable loudspeaker system.

The Audio Static Wing DC-1 full-range electrostatic speakers ($6,995 a pair) offered an airy, detailed presentation from Copland electronics including CD player, tube preamp, and solid-state amplifier. The Audio Statics sounded slightly cold in this demonstration due mainly to a lack of low frequency energy and the system was dynamically constrained. Both shortcomings could be ameliorated by adding two good powered subwoofers, which could create an excellent biamplified stereo speaker system with a total cost of under $10,000.

Good Sound at the Official CES

Over at the Alexis Park Hotel, the official CES venue for Specialty Audio products, I heard some good sound too. Most rooms at the Alexis Park are small and reverberant but some demonstrators managed to overcome these challenges and make good, goose bump-raising sound.

The venerable B&W Nautilus 801 speakers (about $12,000 a pair) sounded very musical and right, driven by a NIRO (Mechanical Research Corporation) 1000 integrated amplifier ($6,990) sourced from a mid-line Sony SACD player. The slightly bass-heavy character of the B&Ws was well controlled by the NIRO amp and the resulting warm tonal balance was complimentary to the small, hollow-sounding demonstration room.

Jim Thiel showed his latest model CS1.6 speakers in a multichannel system using Boulder amplifiers and a VTL 6-channel tube preamp. Thiel was in a large conference room with good acoustics and used multichannel SACD and DVD-Audio sources.

At about $2,300 a pair (depending on finish) the Thiel CS1.6s fall substantially under the price category that I was supposed to consider for the magazine article but the sound in this demonstration was far better than what I heard elsewhere from speakers costing much, much more.

Richard Vandersteen demonstrated his Reference Monitors ($6,995 a pair) for the third straight year. This speaker system, which should enter production soon, has evolved substantially over that time and now features a revised version of the patent-

ed Vandersteen open-frame midrange driver and a removable aluminum casting on the front baffle to facilitate future driver upgrades. The pedestals have been effectively redesigned to improve the overall appearance of this compact speaker system.

The Reference Monitors have limited deep-bass capability and sounded just a little thin in the untreated room but the sonic potential of these speakers was still apparent to experienced listeners. The Vandersteen Reference Monitors driven by Audio Research Reference tube electronics using analog and SACD sources sounded more like music and less like hi-fi than many other demonstrations I heard using far more costly loudspeakers.

I really enjoyed listening to the Verity Audio Fidelio speakers ($7,995 a pair). They were powered by Nagra VPA tube amps driven by a Nagra PL-P battery-powered, tube preamp. The source was a dCS Verdi transport with output from "red book" CDs "upsampled" to DSD by a dCS Purcell and converted to analog by a dCS Delius. The sound in this demonstration was detailed yet smooth and musically involving.

I preferred the sound of the Fedelios driven by tube electronics to the excellent sound of the more costly Verity Parsifal Encore speakers ($15,500 a pair), which were demonstrated with Nagra solid-state components.

Albert Von Schwiekert was powering his VR-4 Gen III speakers with a Spectron Musician II Class D amplifier ($3,495) and a Hovland tube preamp. The source for this demonstration was a Genex GX-8500 DSD recorder playing some of Mike Pappas' live jazz recordings direct from hard disk through a Meitner DSD D-to-A converter. Pappas had faithfully captured the feeling of a live musical performance with these outstanding recordings, and this was a very impressive presentation indeed.

Bad Sound at the Show

I heard some demonstrations with appallingly bad sound, too. Some exhibitors just didn't seem to care about sound quality and didn't take the time to tweak their systems to the environment. Some products are simply hopeless.

Manger, the latest German manufacturer to promote a bending wave transducer, was demonstrating their Zerobox speaker system and producing sound that was completely foreign to my experience. To call the Manger sound "musically unnatural" would be a gross understatement. The Manger driver looks like a hub cap for a 1956 Oldsmobile and the sound I heard reminded me of a steel hub cap being tapped by a ball peen hammer. Although there were several contenders, I'd vote for the Mangers as the worst sound at CES.

The Joseph Audio speakers in the Ayre room were bright enough to heat-seal plastic bags across the hall. At high volume levels this system could make my ears bleed but two magazine reviewers were happily listening to Sheryl Crow sing *If It Makes You Happy* at rock concert levels as I made my exit.

Magnepan presented a multichannel demonstration that sounded dreadful. The words thin, harsh, shrill and nasty come to mind as I recall the experience. What were they thinking, "If we make really bad sound through more channels nobody will notice"?

Two old friends, Jim Smith and Casey McKee, demonstrated the Avantgarde Hornspeakers for me using single-ended triode amplifiers. The appeal of this product eludes me. The sound was dynamic and relaxed but extremely colored and musically unnatural. Except for a vague sense of center focus on solo instruments and voices, imaging was virtually nonexistent. Imagine listening to music played through a pair of megaphones and you'll have a pretty good idea of how the Avantgarde speakers sounded.

There were a number of other horn speaker designs at the show. Several used the Lowther full-range driver. None produced sound that I could relate to and I used to build horn speakers. I guess that I can no longer tolerate speaker systems that can't deliver flat frequency response within a ±10dB window of error and, believe me, none of these could.

There is certainly something for everybody in today's audio market and you may be pleased by products that don't ring my bell. You have just read some of my candid opinions, which will never see the light of day in a magazine that accepts advertising. Now go and listen and let me know how you feel.

Good Value is Alive and Well

In a world of audio components with ever-escalating and often astonishingly high price tags, great sound and good value can still be found and often these elusive qualities come in the same package. Audition some of the products mentioned here, and elsewhere in this issue, and see for yourself. API

Loudspeaker Time Domain Performance

by Richard Hardesty

***Audio Perfectionist Journals #5 through #7** presented information about loudspeakers with particular emphasis on time- and phase-accurate designs. I want to conclude that discussion by again defining what a time- and phase-accurate speaker system is. I'll tell you why I think time domain accuracy is important and I'll compare my listening impressions of time- and phase-accurate speakers versus conventional speaker systems. Later I'll offer some personal opinions about three specific speaker systems and how they compare sonically. Then you can do some listening and see if you agree.*

We've discussed many of the theoretical aspects of speakers in general, and time- and phase-accurate speaker designs in particular. In this issue we'll talk about the practical effects, both positive and negative, of such designs.

What is a Time- and Phase-Accurate Speaker?

It is generally agreed that an accurate loudspeaker should reproduce the audible frequency spectrum without altering the amplitude relationships between various frequencies or ranges of frequencies. In other words, an accurate speaker should have flat frequency response.

A time- and phase-accurate speaker also preserves the *timing* relationships between ranges of frequencies but experts disagree about the importance of time domain performance.

A time- and phase-accurate speaker also preserves the timing relationships between ranges of frequencies…

Some say that presenting all the frequency components in the proper balance is all that matters and some feel that any alteration in the relative timing of these components alters the sound. Changing the timing relationships between various frequency ranges definitely changes the shape of a musical waveform.

Waveform Integrity

A time- and phase-accurate speaker system preserves the integrity of the recorded waveform. That means that the acoustical waveform emanating from the speaker will be a reasonable facsimile of the electrical waveform entering the speaker at the input terminals.

In other words, if you capture the sound from a time- and phase-accurate speaker with a microphone, and compare the electrical waveform created by the microphone to the waveform of the input signal to the speaker, the two will be similar in appearance. If we assume that the input signal to the speaker is an amplified replica of the recorded signal, and we determine that the output from the speaker looks like the input, then the integrity of the recorded waveform is preserved and recreated acoustically by a time- and phase-accurate speaker system.

The timing relationships between signals at various frequencies will be preserved by a time- and phase-accurate speaker. High frequencies will not arrive at the listener before midrange frequencies and bass. These facts are objectively demonstrable.

An Objective Gauge of Time Domain Performance

The step response graph demonstrates whether a speaker is time- and phase-accurate. A time- and phase-accurate speaker should produce a step response graph that has a triangular shape with a steeply rising leading edge followed by output that gradually falls back to zero or slightly beyond.

The step response test signal (stimulus) is like the positive-going portion of a square wave. It contains a wide range of frequency components. The shape of the step response graph describes much of the transfer function of the speaker under test, displaying both frequency response capability and timing, or phase, information.

A perfect step response graph won't look exactly like half a square wave because speakers have bandwidth limitations. High frequency capability determines the shape of the leading edge and low frequency capability defines the slope of the top of the step response trace.

Even the best speaker designs will produce step response graphs with a leading edge that is slightly less than vertical and a top line that slopes downward.

Most loudspeakers divide the frequency spectrum among two or more drive elements and the step response graph shows how the output from these drivers integrates. If high frequencies arrive at the listener first, the step response graph will start with a spike, representing the output from the tweeter, followed by a hump (or two) representing the output from the midrange and woofer drivers. If a portion of the trace goes negative all drivers are not operating in phase acoustically. If the various positive output signals don't combine to make the correct triangular shape, the frequency components of the signal have been displaced in time (smeared).

Refer back to **Journals #5 and #6/7** and compare the step response graphs to see the differences between speakers that are time- and phase-accurate and those that are not.

Is This Important?

There is no debate that some speakers are phase-coherent and some aren't. The argument concerns whether this makes an audible difference that is meaningful to most listeners. Preserving the original waveform seems like a good idea but does it really matter?

Must the shape of a recorded waveform be maintained for accurate reproduction? Do waveforms that look different, when viewed on an oscilloscope screen, sound different? Experts disagree about the answers to these questions.

Helmholtz studied the properties of vibrating strings 150 years ago and found that the phase relationships between the various components of the resultant tone produced by a vibrating string were not detectable to listeners. His conclusion is the basis for the common belief that phase is inaudible but is this really true with modern two-, three- and four-way loudspeakers?

We know that the ear is extraordinarily sensitive to arrival time differences and step response graphs show that high frequencies from conventional speakers often arrive at the listener well before midrange frequencies, which often arrive before bass frequencies. I'm convinced that this time smear is audible.

Perhaps the phase relationships between various parts of a vibrating string are irrelevant when listening directly to a string instrument because the various frequencies that combine to produce a tone are not smeared over time. Perhaps the phase relationships between the various drivers in a multiway loudspeaker affect the tonality of sound reproduced by the speaker because of time smear. My experience suggests that this is the case.

Time Smear in Other Audio Components

Any component in the signal chain can affect time domain performance, or transient response. Excessive feedback causes time smear and increases transient intermodulation distortion in amplification circuits, for instance. There is evidence that time domain performance at ultrasonic frequencies has an audible effect.

The Ayre D-1 DVD player and the Wadia 861 CD player both allow the user to select between digital filter algorithms with different characteristics. In each case the algorithm that sounds best trades some frequency response extension for improved time domain performance.

Electronic components have a subtle effect on time domain performance in comparison to speakers.

The Ayre player has a two-position switch labeled "Measure" and "Listen" clearly conveying this manufacturer's preferred choice. The "Measure" position provides slightly extended high frequency response and the "Listen" position provides improved time domain performance.

The Wadia player defaults to an algorithm that sacrifices a couple dBs of frequency response at 20kHz for improved time domain performance. It sounds better that way. Many people believe that high sample rate digital formats sound better because of improved time domain performance.

Electronic components have a subtle effect on time domain performance in comparison to speakers.

Speakers Affect Time Relationships More

The crossover networks in multiway speakers disassemble the frequency components in a musical signal and direct the various ranges of frequencies to various drive elements for repro-

duction. If these frequency components are reassembled with altered timing relationships, is the sound changed?

I'm convinced that it is. I could continue to postulate about why I believe that time and phase relationships are important in music reproduction but instead I'm going to describe my experiences and let you listen and decide for yourself whether this aspect of performance is important (or even perceptible) to you.

How Do They Sound?

I have auditioned thousands of speakers of all types and descriptions, under controlled conditions, in my own listening rooms. I have measured, tested and repaired hundreds of speakers of all types. I have installed a wide variety of speakers in homes and struggled to produce good sound under a wide range of acoustic conditions. As a result of these experiences I have come to some conclusions about the general sonic characteristics of various speaker types.

In my opinion, time- and phase-accurate speakers tend to sound smoother and more tonally neutral than conventional speakers that exhibit similar frequency response characteristics. Speakers with steep-slope filters tend to sound sharper and more mechanical, regardless of configuration. Time- and phase-accurate speakers tend to deliver sound that is more relaxed and natural.

Speakers with steep-slope filters will generally sound brighter than comparable time- and phase-accurate speakers even when both types have similar frequency response characteristics. Some speaker systems with steep-slope filters have high frequency response that is intentionally rolled-off in an attempt to compensate for this phenomenon.

To observe these effects for yourself compare speakers with steep-slope filters from Revel or Aerial to time- and phase-accurate speakers from Dunlavy or Vandersteen. All these products have flat frequency response within narrow limits but sound quite different.

How Do They Image?

Do time- and phase-accurate speakers image differently than conventional speakers? I believe that they do. Many factors affect imaging, of course, but I'm convinced that time- and phase-accuracy has a significant influence on stereo imaging.

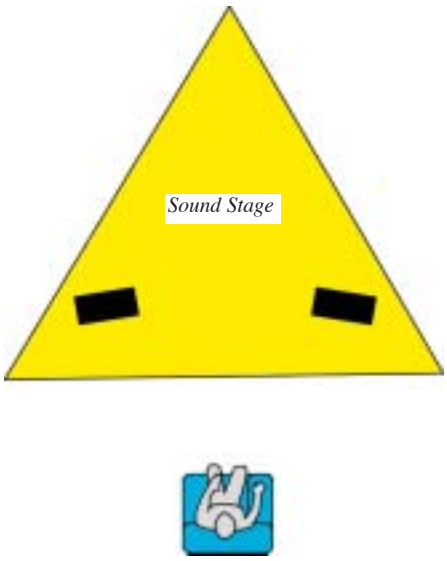


Image from conventional speakers

The brain locates the source of a sound in space partly by calculating differences in amplitude (loudness) perceived by the left and right ears and partly through timing cues—differences in when sounds arrive at each ear. Time- and phase-accurate speakers preserve the timing cues better and consequently image better—particularly towards the sides of the sound stage and for listeners seated off-center.

Speakers with steep-slope filters tend to produce a stage with a triangular shape, as viewed from above, with decreasing depth of image at the sides of the stage.

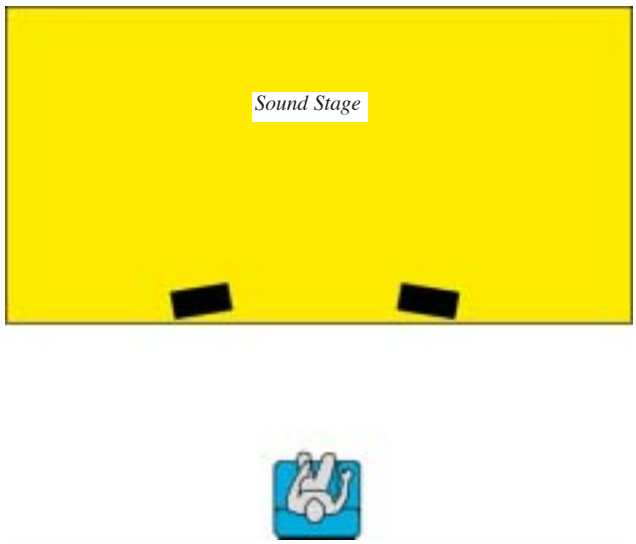


Image from time- and phase-accurate speakers

Time- and phase-accurate speakers tend to produce a stage that is more rectangular, with image depth all the way out beyond the speaker boundaries (with proper system selection and setup).

With analog or SACD source material, time- and phase-accurate speakers can create a focused image for listeners seated as much as a foot or two off-center to the right or left. This is not as apparent when playing regular compact discs because CDs have time domain problems exceeding those of some time- and phase-accurate speakers.

Listen to a good SACD or analog recording on B&W speakers and then listen to the same recording through a pair of Vandersteens. Both brands have good frequency response linearity and both use cabinets that minimize baffle reflections, but the Vandersteens are time- and phase-accurate and the B&Ws are not. Is the difference in imaging perceptible to you? Is it meaningful?

Should Everybody Choose a Time- and Phase-Accurate Speaker System?

There are many arguments against the use of the first-order crossover slopes required for time- and phase-accuracy. These include a reduced vertical listening window due to limited vertical dispersion, interference effects caused by overlapping output from various drivers and reduced maximum output levels. The last one—how loud they'll play—is the only argument with any real validity in my opinion.

The limited vertical dispersion of speakers with first-order filters is often mentioned as a drawback but I consider this to be a benefit rather than a negative aspect of these designs. It's true that you must be seated in order to hear the best performance from a time- and phase-accurate speaker (unless coaxial drivers are employed) but most of us do our critical listening from a seated position so this point becomes moot. Limited vertical dispersion tends to minimize floor and ceiling reflections at midrange and higher frequencies, and this is generally an advantage. Fewer reflections mean better imaging and sound that is more accurate and less colored by the environment.

A time- and phase-accurate speaker design does place extraordinary demands on drivers, which must operate over a much wider range of frequencies. The extended frequency range that each driver must cover in a speaker with first-order crossover filters is a negative aspect that does matter.

Gentle crossover slopes mean more overlapping output between drivers. This may place more strain on midrange and tweeter drivers, which will be required to accept frequencies far lower than the same drivers would encounter in a speaker system with steeper filter slopes. Low frequency drivers will produce more high frequency output than they would if steeper filter slopes were employed. Neither situation—low frequencies coming from high frequency drivers or high frequencies coming from low frequency drivers—is desirable and both lead to increased distortion.

The distortion created by excessive diaphragm excursion in midrange and tweeter drivers probably won't be audible at low to moderate volumes but, when things start to get really loud, that distortion will increase rapidly. Sound may become strained or harsh and the loudest peaks may be compressed.

My Vandersteen speaker system, as an example, provides impeccable performance for music and will reproduce movie soundtracks at "reference level" without distress, but I have five subwoofers (including one dedicated to LFE) and high-pass filters on each channel. Without the filters and subwoofers to relieve the main speakers of the high energy demands of low frequencies, I'd have to reduce film sound levels by 3 to 5dB in order to avoid distortion and potential damage. The choice of time- and phase-accurate speakers should be based on your personality and lifestyle, not simply on theory.

If you enjoy really loud rock-and-roll, or have extended parties, or if you watch action films and want to hear explosions at realistic (or louder) levels, you may be better off sacrificing some potential sound quality and trading it for increased output capability. High quality speakers with steep-slope filters may be your best choice. You'll sacrifice tonal accuracy and image focus, in my opinion, but your system will play louder with increased dynamic contrast and you'll be less likely to suffer speaker damage.

If you listen to music at moderate levels (under 100dB SPL), this should not be a concern. If you also want to use your audio system for home theater you may have to take additional steps to increase the output capability of a time- and phase-accurate speaker system, as I have, or simply reduce the volume slightly for movies. APJ

Dunlavy SC-IV.A Loudspeakers

by Richard Hardesty

The SC-IV.As are my favorite Dunlavy speakers. The smaller models in the line, which incorporate essentially the same dual-midrange and tweeter arrangement, have less body in the lower midrange and lack weight in the bass for a sound that is slightly thinner and less balanced. The two larger Dunlavy models, which have enormous cabinets with large baffles around the drivers, seem slightly bass heavy and sound too boxy and closed-in for my tastes. The SC-IV.A model provides a good balance of compromise and is the most pleasing to my ears.

Descriptions of the engineering and construction features of Dunlavy speakers in general, and the SC-IV.A model in particular, can be found in **Audio Perfectionist Journal #6/7**. This article will concentrate on how these features affect sound quality and my subjective impressions of the sound of the SC-IV.As.

Big

Dunlavy speakers are big and size does matter. The SC-IV.As are a phased-array design and each speaker utilizes five drivers, including two 10-inch woofers. A large baffle is required to hold these drivers and a large enclosure volume is necessary to properly load the two big woofers. There are some positive aspects to large enclosures and some drawbacks.

The large enclosures allow deep bass output to be achieved from sealed boxes while maintaining relatively high sensitivity, but large enclosures have large baffle surfaces surrounding the drivers and large panels at the sides and back.

Large baffles reflect energy, depreciating imaging and altering tonality. Large enclosure panels have the potential to store and release energy at low frequencies. Dunlavy has placed damping material (felt) around the tweeters to minimize reflections at high frequencies and added extensive bracing to the enclosures for increased rigidity but these efforts have not been entirely successful. The SC-IV.As still sound like big speakers to me.

Thiels, with their contoured, cast baffles and robust cabinet construction, provide a more spacious and open sound. Vandersteens, with baffleless enclosures made from small, stiff panel sections, sound even more open than the Thiels. Both Thiels and Vandersteens image with more precision and a greater sense of depth than the Dunlavys.

The Dunlavy SC-IV.As have input connections that allow biwiring or passive biamplification but John Dunlavy doesn't advocate either. I think that both techniques provide as much benefit to Dunlavys as they do to other speakers.

Technical Features

Dunlavy speakers produce graphs that are almost textbook-perfect when tested with the impulse stimulus or an impulse derived from the MLS stimulus. These near-perfect measurements are achieved in part by incorporating design features which may compromise audible performance in other ways. These features include the use of soft diaphragm materials with high internal damping, and the use of two relatively large full-range drivers to reproduce midrange frequencies.

The phased-array configuration, which includes dual midrange drivers mounted above and below the tweeter and dual woofers arrayed above and below the midrange drivers, is supposed to simulate a point source with controlled vertical dispersion but a very large baffle is required to implement this design and drivers are widely separated.

Softer diaphragm materials provide high internal damping, which can eliminate ringing and overshoot on step response and impulse response graphs, but some of the energy that gets absorbed may be low level signal information that you want to hear.

Soft tweeter diaphragms are free from the ultrasonic resonance and ringing that can be observed on tests of speakers using diaphragms made from stiffer materials like aluminum and titanium. But tweeters with soft diaphragms have limited bandwidth when compared to metal diaphragm tweeters and the softer materials break up (fail to perform as a perfect piston) at relatively low frequencies.

Early diaphragm breakup and the absence of ultrasonic output combine to obscure high frequency detail and "air" and to raise distortion in the audible range.

Dual midrange drivers will provide a smoothing effect on frequency response graphs because each driver will have slightly different response characteristics. These deviations in response

Dunlavy SC-IV.A speaker

will tend to shrink amplitude peaks and fill in gaps to make a flatter trace on the graphs but these variations in response will prevent the two widely separated drive units from sounding like the single point source they are claimed to emulate.

Dual drivers will create some time smear due to response variations and varying path lengths from each driver to the listener. Even with the listener's ears positioned exactly equidistant from each driver, which is unlikely to be the case most of the time, reflected paths from the drivers to the room boundaries to the listener's ears will vary in length. Signals from two midrange drivers will arrive at the listener over an extended period of time, depreciating transient response and resolution.

The Sound of the SC-IV.A

The Dunlavy SC-IV.As are big speakers and they sound like big speakers. They have a warm tonal balance with rich, full bass. The SC-IV.As are fairly sensitive and can play quite loud (for a time- and phase-accurate design). The Dunlavys deliver smooth, musical sound but can't equal the resolution, image focus and depth of either the Thiel CS6s or the Vandersteen 3a Signatures.

The Dunlavys have more extended bass response and will play somewhat louder than either the Thiels or the Vandersteens (without subwoofers). Dunlavys provide a little more punch creating the impression of increased dynamic range. Actual dynamic range, which is the difference between the softest and loudest musical signals that can be heard, is limited by a lack of low level detail.

Dual midrange drivers positioned above and below the tweeter are supposed to perform like a single point source located midway between the two midranges, coincident with the tweeter. It doesn't work for me. To my ears, the dual drivers sound like a larger, oval shaped source with a vague vertical position rather than a single point source. The situation becomes worse at lower midrange frequencies. These frequencies are produced by the woofers, which are even more widely separated.

Response differences between driver pairs are exacerbated by reflections from the large baffle required to support the driver array and the result is imaging that is distinctly less focused, especially towards the sides of the soundstage, than what you'll hear from Thiels or Vandersteens. The Dunlavys image with substantially less depth than the others and I am always aware of the position of the speakers.

I can hear the Dunlavy enclosures. I suspect that baffle reflections are primarily responsible but the SC-IV.A enclosures have very large panels, which may sing along with the drivers. A knuckle wrap on the side of an SC-IV.A produces a hollow thunk. Tapping a Thiel CS6 is like tapping on a stone. It's hard to find a place to knuckle test a Vandersteen but I've been inside the grille socks and can attest that the cabinet structure is very rigid and well damped.

The SC-IV.As have a low-Q, sealed enclosure bass system incorporating two 10-inch woofers in each speaker. They deliver good quality bass that extends to frequencies that few other full-range speakers can equal. The woofers benefit from boundary reinforcement—one woofer is near the floor and the other is near the ceiling.

The Dunlavy SC-IV.As are very forgiving of associated components.

Bass is plentiful but well controlled and musically natural. I hear a distinct box sound in the bass from the Dunlavys that is less apparent (although still audible) with the Vandersteens and almost absent from the Thiels. Without subwoofers, the Dunlavys will go lower and play louder at low frequencies than the Thiels or Vandersteens.

The Dunlavy SC-IV.As are very forgiving of associated components. They are slightly more sensitive than the Thiels or Vandersteens and will perform well with lower-powered amplifiers. The SC-IV.As are slightly less revealing and will be somewhat less critical of other system components, including cables.

Conclusion

The Dunlavy SC-IV.As have been skillfully engineered and are well made. They add little to the recorded signal but fail to reproduce subtle nuances that can be clearly resolved by the Thiels or Vandersteens. Some listeners may prefer not to hear these nuances and they are sure to be pleased by the smooth, natural sound of the Dunlavy SC-IV.As.

Dunlavy SC-IV.As outperform B&W 801s and Aerial 10Ts, which are fairly priced and honest products. SC-IV.As are vastly superior to the overpriced and heavily-promoted speakers you read so much about in the magazines that are supported by advertising.

The SC-IV.As image better than speakers which are not time- and phase-correct but they can't provide the focus or depth offered by the Thiels or Vandersteens. The position of the SC-IV.As is always evident and the sound of the cabinets is audible to me.

Despite my criticisms, an excellent audio system based on the Dunlavy SC-IV.As could be assembled using a wide variety of associated components. The forgiving nature of the speakers allows good performance to be achieved with modestly priced electronics.

Instruments and voices sound very natural through the SC-IV.As. The Dunlavys may prove to be the perfect speaker system for you. Only a careful audition will allow you to make this determination. APJ

Thiel CS6 Loudspeakers

by Richard Hardesty

The CS6 is my favorite Thiel speaker. CS6s provide the satisfying deep bass that is lacking in the smaller Thiel models. The CS6s sacrifice little in terms of bandwidth and output capability to the larger CS7s, which cost about one-and-a-half-times as much, and the CS6s sound slightly more coherent and open to me.

Descriptions of the engineering and construction features of Thiel speakers in general, and the CS6 model in particular, can be found in **Audio Perfectionist Journal #6/7**. This article will concentrate on how these features affect sound quality and my subjective impressions of the sound of the CS6s.

Thiel CS6 Loudspeakers

Time- and Phase-Accuracy + Contoured Baffles

Thiel speakers are distinguished from conventional designs by complete time- and phase-accuracy. They can be distinguished from other time- and phase-accurate speakers by their sloped and contoured front baffles, aluminum diaphragm drivers and coaxial midrange/tweeter elements.

Thiels have elegant cabinets with great attention devoted to construction quality and appearance. Gently sloping baffles bring the drive elements into temporal alignment. The contoured shape of the baffles minimizes edge diffraction effects while diffusing coherent reflections for an open, spacious sound and precisely focused imaging.

The CS6 baffles are formed from a mineral/polymer material similar to cast granite and are several inches thick. The other enclosure panels are made from 1-inch thick, heavily braced MDF, which is veneered on both sides. Thiel enclosures are dead quiet.

Aluminum driver diaphragms reproduce all voice coil movements, converting the smallest signal details into sound. If information has been captured on the recording you will hear it through the Thiels. If other system components add colorations, you will hear them clearly through the Thiels.

Coaxial midrange/tweeter drivers provide increased vertical dispersion and make listener ear height less critical than it otherwise would be with a first-order speaker system. CS6s actually are a point source radiator from the midrange up.

Technical Features

Thiel CS6s are high-resolution speakers. The ability to resolve micro detail is achieved in part by incorporating engineering features that may involve some sonic trade-offs. These features include drivers with short, underhung voice coils and long magnetic gaps, the use of aluminum diaphragms on all drivers, and the coaxial arrangement of midrange/tweeter drivers.

Underhung voice coils can reduce distortion caused by magnetic nonlinearities but short coils concentrate heat in a smaller area and have minimal exposure to air for cooling. Overheated voice coils are subject to failure and, as voice coil temperatures increase, sensitivity decreases, which may cause dynamic compression.

If diaphragm excursion exceeds the linear range, distortion increases rapidly. Enormous and costly magnet structures are required to concentrate magnetic flux in the extended gaps.

Stiff metal diaphragms ensure that all voice coil movement will be translated into sound output. Metal diaphragms can perform like perfect pistons over a wider bandwidth and produce less distortion in this piston range than softer materials with more internal damping.

All diaphragms in the CS6s are made from aluminum. Aluminum provides little internal damping so small signal details will not be damped out along with minor resonances but when an aluminum diaphragm does break up it is likely to produce a sharp, high-Q resonance with undamped oscillation (ringing). I believe that aluminum diaphragms have a distinct sonic signature when used to reproduce midrange frequencies (which is not to say that other materials don't).

Coaxial drivers produce a point source radiation pattern but generally exhibit response irregularities because of interaction between the drive elements. A moving midrange cone is not an ideal surrounding environment for a tweeter and a low-mass tweeter dome is not an ideal center piece for a midrange driver.

Jim Thiel has done a remarkable job of overcoming the potential negative aspects of these design features. This could be accomplished because Thiel is a vertically integrated company and Jim is one of the most thorough and imaginative engineers in the industry. Virtually everything in the CS6 speakers has been designed and built in the Thiel factory. No compromises were required in order to work around the limitations of off-the-shelf drivers and other components.

Thiel has created specially designed drivers with extremely wide bandwidth to place resonant frequencies well above the range of frequencies over which woofers and midrange drivers are utilized. Thiel tweeters have long excursion capability to extend low frequency response and a primary diaphragm resonance above 25kHz, which is well above the audible range.

Coaxial drivers have been designed holistically to optimize the performance of the individual elements. I think that Thiel has been largely, if not completely, successful in his efforts.

The metal diaphragms produce some overshoot and minor ringing on impulse response tests but you'll hear surprisingly little evidence of this when listening to Thiel speakers. Response irregularities through the midrange have been reduced to inaudible levels by carefully engineering the midrange and tweeter drive elements to work in concert.

The Thiel CS6s have only a single set of input connectors and can't be biwired or biamped. They have vented bass loading utilizing passive radiators rather than ports. Alignment is unusual and bass is tightly controlled with little evidence that the enclosures are not sealed.

Jim Thiel at work on a prototype driver.

The Sound of the CS6

The Thiel CS6s are significantly smaller than the Dunlavy SC-IV.As but they are still moderately large. The CS6s disappear almost completely when music is playing.

It is difficult to localize the position of the speakers in the sound stage and I never hear any structural or boxy sounds coming from the Thiel enclosures. Vandersteen 3A Signatures (without subwoofers) have a more boxy sound in the bass but still sound slightly more open and spacious to me. I believe that the contoured baffles of the CS6s reflect some energy identifying the source of sound as a speaker. The physical position of the Thiels in the sound stage is far less evident than the position of the Dunlavys but more evident than the position of the Vandersteens. I think reflected energy is the source of these audible differences.

Thiels image with precision and depth. Instruments appear behind and beyond the speaker boundaries. Images are focused in a three-dimensional space with a precision that beats the Dunlavys and shames speakers which are not time- and phase-coherent. Image depth extends quite far back if the electronic components and the room permit. The Thiels rival the Vandersteens in terms of lateral image focus.

The Thiels have a cool tonal balance with lots of midrange and high frequency energy and lean, tight bass. They sound much brighter than Dunlavys or Vandersteens on first listen. Detail is not achieved by exaggerating high frequencies and the CS6s sound smooth and musically natural but transients are sharp-edged rather than rounded.

The high resolution of the Thiels will expose inferior components in the signal chain preceding the speakers.

Bass can be a little dry and lightweight with amplifiers that are unable to deliver high power into the low impedance load. Amplifiers that can't deliver high current or those that tend to be bright or harsh will be mercilessly revealed as inadequate.

The Thiels are lean in the lower midrange and bass where the Vandersteens and Dunlavys are full and warm. Tightly controlled bass and lots of high frequency information add up to a tonal character that is cool and detailed. This character may produce sound that seems too bright and/or edgy when combined with associated components with similar tonal characteristics, but in a carefully chosen system the Thiels sound neutral and revealing rather than cold and analytical.

The high resolution of the Thiels will expose inferior components in the signal chain preceding the speakers. They should be used only with the finest quality associated components and cables. The CS6s present a demanding load that requires a high-current, high-quality amplifier that can provide powerful bass response to balance the high resolution in the midrange and highs.

Conclusion

The Thiel CS6s are great speakers. They offer true high-end performance and elegant good looks. These high-resolution speakers demand the finest associated components for best performance. Even with the best associated equipment you may still hear a touch of the distinctive sound of aluminum in the midrange.

Thiel CS6s easily outperform Wilson Watt/Puppies and Revel Salons, neither of which is time- and phase-accurate, yet the Thiels cost less than half as much as the others.

Don't consider speakers that cost more than $8,000 a pair without first listening to the Thiel CS6s in a system assembled from the best source and amplification components. You can't get higher resolution by paying more. If someone tells you that a more expensive brand is built to higher quality standards, don't believe them. APJ

Vandersteen 3A Signature/2Wq Speaker System

by Richard Hardesty

The Model 5s are my favorite Vandersteen speakers but I'm going to write about the Vandersteen 3A Signature/2Wq subwoofer combination that I am currently using as a reference speaker system. The Model 3A Signature speakers in combination with a pair of 2Wq subwoofers can provide about 90 percent of the performance of the Model 5s for about 60 percent of the cost.

By themselves, the Vandersteen 3A Signature speakers can be fairly compared to the Thiel CS6s and the Dunlavy SC-IV.As. Adding a pair of 2Wq subwoofers, with Vandersteen X-2 passive high-pass filters, raises the performance capabilities of these high-value, full-range Vandersteen speakers to a new level.

The combined 3A Signature/2Wq speaker system becomes a true state-of-the-art contender yet still costs about $2,000 less than a pair of Thiel CS6s or Dunlavy SC-IV.As without subwoofers. (See **Audio Perfectionist Journals #2 and #3** for information about the 2Wq subwoofer and the performance benefits of adding subwoofers to high-end audio systems.)

Descriptions of the engineering and construction features of Vandersteen speakers in general, and the 3A Signature model in particular, can be found in **Audio Perfectionist Journal #6/7**. This article will concentrate on how these features affect sound quality and my subjective impressions of the sound of the 3A Signatures.

The 2Wq subwoofers were reviewed earlier but I'll describe how the subwoofers change the performance characteristics of the 3A Signature speakers.

Less Furniture, Less Money

Furniture grade cabinetry represents a substantial portion of the cost of most speakers. Vandersteen has minimized this expense in many models in order to provide higher performance for less money. The 3A Signatures cost half as much as speakers with comparable performance yet they incorporate design features that can't be found in competing products at any price.

The only wood finish visible on the Vandersteen 3A Signature speakers is at the top and bottom where you'll find veneered end caps about three-quarters of an inch and one inch thick, respectively. These end caps, which are not part of the actual speaker enclosure, are separated by dowels and the entire assembly is wrapped in acoustically transparent grille cloth. The look is simple, unobtrusive and functional but not elegant.

The speakers appear to be large but what you see is simply grille cloth enclosing what is actually a much smaller functional structure. The baffleless design of the actual Vandersteen enclosure is angular and unattractive and the acoustically transparent cloth wrap makes the speaker take on the familiar rectangular shape of a tower loudspeaker.

A connector plate on the back of each speaker features heavy-duty barrier strip terminals that allow spade lug connections and biwiring or passive biamplification. Contour controls are provided to tailor response in the midrange and treble.

Vandersteen Model 3A Signature speakers

Sound Anchor braces made from heavy steel extend from the back of each speaker to increase the size of the footprint and brace the speaker against movement in the fore and aft directions. The whole assembly, which is quite heavy, rests on three machined cone points, which are furnished.

Time- and Phase-Accuracy and More

Vandersteen speakers are distinguished from conventional designs by extended bandwidth and complete time- and phase-accuracy. They can be distinguished from other time- and phase-accurate speakers by an exceptionally open sound which has been achieved by virtually eliminating reflected energy.

Vandersteens incorporate "baffleless" enclosures and patented open-frame midrange drivers (used in 3A Signatures and Model 5s) to prevent edge diffraction and baffle reflections which smear the signal over time.

Eliminating reflected or reradiated energy results in a speaker system that presents a transparent window to the performance. The speakers seem to vanish and all that remains are instruments acoustically focused in space. While it may sound like a cliché to say that you can't hear Vandersteen speakers, I believe that is an appropriate description.

Vandersteens incorporate "baffleless" enclosures and patented open-frame midrange drivers…to prevent edge diffraction and baffle reflections…

I find that Vandersteen speakers reveal more about the quality of recordings and the sound of other components in the system while imposing little sonic signature of their own. Over the years I have used a wide variety of speaker systems to perform product reviews and to provide listening pleasure in my home. While I have successfully assembled satisfying audio systems around many different speaker systems, I have come to prefer Vandersteens for both work and pleasure. I am also frugal. I never pay more than I have to for the performance I require.

When I was a retail merchant and had a store full of expensive speakers to choose from, I often used the modestly-priced Vandersteens to evaluate the sound quality of other components and to demonstrate the differences I observed to customers. It was simply easier to hear differences through Vandersteen speakers. The 3A Signature/2Wq speaker system is an ideal tool for an equipment reviewer and a joy for a music lover, and I am both.

I currently use the 3A Signature/2Wq as a reference speaker system because it is so revealing and because I can disconnect the subwoofers and operate the speakers full range when evaluating the bass performance of amplifiers.

Vandersteen Model 5s, which use essentially the same midrange and tweeter drive elements as the 3A Signatures, provide even better performance. Model 5s have an elaborate cabinet structure that is far more acoustically inert, and a superior integrated subwoofer system, but the Model 5s are less suitable for reviewing purposes because they can't be used without the built-in subwoofers. The smaller models in the Vandersteen line offer amazing value for money but can't perform at this reference level.

Technical Features

All Vandersteen speakers feature "baffleless" enclosures with drivers mounted as closely together as possible to minimize reflective surfaces and reradiated energy.

There are no reflective baffle surfaces surrounding the tightly grouped drivers allowing the 3A Signatures to simulate an ideal point-source radiator for seated listeners. Radiation from the temporally-aligned drivers can coalesce into a time- and phase-accurate signal at a distance nearer to the speaker improving the spectral balance of side wall reflections and allowing the listener to sit closer to the speakers.

Vandersteen uses metal diaphragms for sub-bass (active bass coupler) and tweeter drivers in order to provide high resolution and extended bandwidth to beyond 30kHz. The critical midrange frequencies are reproduced by diaphragms made from mica-filled polymer, a material that offers the best balance between high resolution and high internal damping according to Vandersteen.

Metal tweeter diaphragms (with a primary resonance above 25kHz) produce some overshoot and minor ringing on impulse response tests but the Vandersteens are essentially free from resonances in the audible frequency range.

The patented open-frame midrange driver provides detail and resolution that is unequalled by other dynamic driver speaker systems I've heard, regardless of price. The open-frame driver has no magnet structure directly behind the diaphragm to cause reflections which smear subtle midrange details.

The Sound of the 3A Signature/2Wq System

The Vandersteen 3A Signatures are moderately large but you'd never know it if you listen with your eyes closed. Sound never seems to come from the speakers. Instruments appear on a stage behind and beyond the speaker boundaries. Images are focused in a three-dimensional space with a precision that other speakers can't approach. Image depth extends back as far as the electronic components and the room will allow.

The Vandersteens have a warm tonal balance with rich, full bass. Detail is not achieved at the expense of smooth, natural sound but every nuance is presented to the listener. Novice listeners may initially think that the refined musical presentation lacks detail in comparison to speaker systems which exaggerate parts of the spectrum, but a careful audition with familiar recordings will reveal that the opposite is true.

The Vandersteen 3A Signature/2Wq has broader bandwidth and higher resolution than any other speaker system under $10,000

The 3A Signature speakers alone deliver lots of bass and go quite low. Bass quality is amplifier-dependent and bass can be a little too full with tube amplifiers or solid-state amplifiers that are not up to the task. With a CAL MCA-2500 or a pair of Linn Climax or Levinson 33H mono amplifiers driving the speakers, bass is tightly controlled and powerful.

While bass from the 3A Signature speakers varies from very good to excellent (depending on the amplifier), combining the speakers with a pair of 2Wq subwoofers improves everything. Bass with the subwoofers is tighter and more controlled and extends to lower frequencies. Distortion is reduced in the bass and midrange and dynamic range is increased substantially.

The subwoofers operate primarily below system resonance and are essentially aperiodic, eliminating resonances in the bass frequencies. (See **Audio Perfectionist Journal #2** for more information.) Sound from the speaker structure is greatly reduced when the subwoofers and high-pass filters are added. Music becomes more rhythmically involving with a better-defined sense of pace.

While the Vandersteens will provide good sound with modest associated components they are very revealing of the sound quality of other components in the system, including cables. The finest quality system components should be used in order to hear the speakers at their best and they are seldom demonstrated that way by dealers who tend to demonstrate modestly priced speakers with modestly priced system components. If you want to experience what these speakers are capable of, demand to hear them in the best system your dealer has to offer.

Conclusion

The Vandersteen 3A Signature/2Wq speaker system is capable of outstanding performance and represents an exceptional value for money. The system with subwoofers can be driven by low-powered amplifiers because each subwoofer includes an internal 300-watt amplifier, but the best performance can only be achieved with the very best associated components.

The Vandersteen 3A Signature/2Wq speaker system has broader bandwidth and higher resolution than any system under $10,000 and it images better than any system I've heard besides the Vandersteen Model 5.

Because I own this speaker system it should be obvious that it suits my tastes well. I am not suggesting that the Vandersteen 3A Signature/2Wq speaker system is without flaws but I find its performance to be exceptionally well balanced for my purposes as a product reviewer and as a music lover. You may find that it suits your needs, too.

This speaker system may not prove to be the ideal choice for your situation and tastes but you should hear it before spending more on anything else. The Vandersteen 3A Signature/2Wq speaker system is a benchmark to which more expensive speakers must be compared. Most will come up short. APJ

The Truth About Center Channel Speakers

by Richard Hardesty

Our ongoing discussion of loudspeakers has concentrated on stereo reproduction but all of the information that has been presented applies equally to the left and right front speakers in a surround sound or multichannel system.

Multichannel systems may utilize a center channel speaker and there are some unique factors that should be considered when choosing a center channel speaker if high fidelity is your goal. This article will present some simple facts about center channel speakers.

High Fidelity for Stereo or Surround Sound

The **Audio Perfectionist Journal** advocates a high fidelity approach to audio. Although many would like you to believe otherwise, a high fidelity playback system can deliver a more lifelike and satisfying musical presentation from stereo recordings and can provide a more involving home theater experience, too.

A high fidelity audio system is one that can accurately reproduce the recorded signal regardless of what that signal represents. An accurate system can be utilized to reproduce stereo or multichannel recordings of music or movie soundtracks. Although the concept of accurate reproduction is generally accepted by stereo music enthusiasts, the high fidelity approach to surround sound and home theater has been overshadowed by the heavily promoted THX licensing program, which has questionable value for home theater and is entirely worthless for music.

High fidelity principles require that the audio system accurately reproduce the recorded signal without alteration. The ubiquitous THX approach to home theater mandates that the recorded signal be substantially altered, both electrically and acoustically, in order for the home system to emulate the sound of a movie theater. Those who advocate surround sound for music are still arguing about how it should be done.

There are several competing approaches to surround sound for music. Some use the ITU standard for speaker positioning and some use other speaker arrangements. Some incorporate a center channel speaker and some don't. Some aim for a natural representation of music and ambience and some discard all previous ideas about how instruments and voices sound in the real world in favor of a spectacular "new audio experience."

Here's my view on music surround: I have had extensive experience with all forms of music surround sound dating back to the days of "quad" and matrix encoding. I have heard every type of DSP surround sound process, including ambisonics, and all the discrete, multichannel processes—with and without compression algorithms. While I like surround sound for movies, it is my opinion that reproduced music sounds more natural in stereo and I believe that a center channel should never be used for music. Others disagree.

The **Audio Perfectionist Journal** is devoted to the subject of high fidelity audio reproduction for any recorded signal. Because many **Journal** readers want to use their audio systems for home theater and some want to experiment with various surround music formats, I wanted to include a discussion of center channel speakers, but don't assume that I'm an advocate.

Identical Speakers Across the Front?

According to THX, a surround sound system should have three identical speakers across the front. In a movie theater that may be a good idea but at home there are some serious problems.

In a movie theater, the front speakers are placed behind the screen and the sound comes through perforations in the screen material. In a home theater system, the center channel speaker must be positioned above a direct view or rear projection television or below a front projection screen because nobody uses a perforated screen. (Which is a good thing because listening to speakers through a perforated screen is like eating watermelon through a sheet.)

Using identical front speakers in the home would require that all three be small satellites and that bass frequencies be redirected, a practice supported by THX.

Using satellite speakers with bass management is not a good idea if high fidelity is your goal, and the center speaker will still end up in a position that is higher or lower than the left and right speakers in most systems. The center speaker will probably be closer to the front wall and may be sitting on top of a big RPTV.

For a music-only system, three identical full-range, floor-standing speakers could be utilized in a large room. This suggests that listeners will hear identical sound from three locations, but that probably won't be the case if the speakers are equidistant from the listener and there is a wall behind them.

If the left and right speakers are positioned well away from the front wall—as they should be for good stereo reproduction—the center speaker will be much closer to the wall if it is equidistant from the listener.

What is actually needed is a center channel speaker that sounds the same as the left and right speakers when it is positioned where it will have to be used.

Positioning the speaker closer to the wall will change its sound significantly. (A mono signal doesn't sound like a stereo signal anyway, even when both come from identical speakers. See **Audio Perfectionist Journal #1** for more info and experiment suggestions.)

While the use of three identical speakers across the front may seem like a good idea, this implementation is impractical in most homes and usually doesn't succeed in providing identical sound from three locations.

What is actually needed is a center channel speaker that sounds the same as the left and right speakers when it is positioned where it will have to be used—that is, closer to the front wall and probably near to, or on top of, a television.

In the real world, the center speaker may have to use a significantly different design approach in order to sound the same when positioned in a significantly different acoustic environment.

Identical Drivers Across the Front?

If the speakers can't be exactly the same, at least they should use exactly the same drivers, right? This seems logical but it's difficult to do and it probably won't help to provide matched sound from all three speakers. Here's why.

Well-designed speakers have drivers arranged in a vertical line so that seated listeners will be equidistant from each driver regardless of each individual's lateral position in the room. A center speaker with vertically arrayed drivers sitting beneath a front projection screen, or on top of a direct-view or RPTV, would be tall and awkward-looking. This situation is exacerbated when additional drivers are added to a center channel speaker in order to increase power handling capability.

Using identical drivers won't make a center channel speaker sound like the left and right speakers if the center channel speaker is positioned in a different acoustic environment, which it probably will be, or is lying on its side.

Horizontal Center Channel Speakers

Tall main speakers look good and integrate well with other furniture. Tall center channel speakers look peculiar and don't sell. To improve appearance, most manufacturers simply lay the center channel speaker on its side and make it a horizontal array.

There are innumerable problems to this approach but the biggest one is that the center channel speaker will now sound different to each listener in the room because each listener will have different path lengths to each driver in the speaker.

This negates the primary purpose of a center channel speaker, which is to compensate for the change in sound that listeners experience when they are forced to sit anywhere other than centered between the left and right speakers—a position that only one person can occupy.

The Purpose of a Center Channel Speaker

The purpose of a center channel speaker is to anchor dialog at the screen for listeners seated off-center in the room. A listener seated in the "sweet spot"—centered between the left and right front speakers—doesn't need a center channel speaker.

Most people who take the time to actually try it will agree that, for a listener seated in the sweet spot, sound is improved when the center channel is turned off and center channel information is reproduced by the left and right speakers (phantom image).

If a center channel speaker is supposed to improve the sound for listeners sitting off to the sides, what good is a center channel speaker that sounds different when you move from side to side? It certainly won't sound like the left and right speakers to anyone who is not seated dead center and the person seated in the center doesn't need a center channel speaker.

Despite these simple facts, almost all center channel speakers are horizontal arrays because they look better that way and people buy more of them. Most center channel speakers don't perform very well as high fidelity transducers. None that I've heard sound like the main speakers made by the same manufacturers. If you doubt this, visit a dealer and listen to the pink noise test signal that all surround processors can output for level adjustments.

As the sound shifts from the left to the center to the right note the change in quality at each position while you are seated in the center. If you move to the left or right of center, the sound from the center channel speaker will change much more than the sound from the left and right speakers. Try it.

Thoughtful manufacturers have attempted to overcome this problem by a variety of techniques. Polk uses a "tapered array" crossover that rolls off some drivers at low frequencies to minimize the change in tonality that listeners will experience with changes in lateral position.

Several manufacturers position the midrange and tweeter drivers in a vertical array with woofers arrayed horizontally at the sides. These are partial solutions which can improve the situation but don't completely eliminate the problem. None of these arrays are time- and phase-accurate.

Some center channel speakers are actually out of phase with the same manufacturer's main speakers over much of their range.

Phase

In order to improve amplitude response linearity, a typical 3-way loudspeaker with a third-order crossover will have the midrange driver wired in opposite polarity from the woofer and the tweeter. Most speakers have the woofer wired in phase with the input signal so the midrange driver in a typical 3-way speaker will be out of phase with the input signal.

A typical 2-way loudspeaker with a third-order crossover will have the woofer wired in phase with the input signal and the tweeter wired in reverse phase. In a 2-way speaker the midrange frequencies are reproduced by the woofer so a typical 2-way speaker will be out of phase with a typical 3-way speaker in the midrange and highs if both are connected in correct polarity to the input signal. What do you suppose happens when a 2-way center channel speaker is combined with 3-way main speakers?

What good is a center channel speaker that sounds different when you move from side to side?

In a configuration that combines 3-way main speakers and 2-way center channel speaker, the center channel speaker may be out of phase with the left and right speakers over most of its range. If the crossover points are different, and they most likely will be, the problem becomes even more complex and the results even more unpredictable.

I have frequently laughed out loud when reading descriptions of "coherent sound fields" across the front stage from speaker systems that I know have center channel speakers which are not in phase with the left and right speakers in the midrange.

How can one be assured of phase compatibility? Use three identical speakers or buy a time- and phase-accurate center channel speaker.

Time- and Phase-Accuracy

Making a time- and phase-accurate center channel speaker is a difficult task. An aligned vertical array won't work because the center channel speaker must be located above or below the screen. The vertical position of a time- and phase-accurate speaker is critical to temporal alignment of the drivers.

You can't make a temporally-aligned horizontal array because the path lengths to different drivers will vary with listener position. So how can a time- and phase-accurate center channel speaker be constructed? With a coaxial driver arrangement, of course!

A coaxial configuration allows the relative positions of the midrange and tweeter drivers to remain constant when the speaker is positioned almost anywhere in the line of sight to the listener. The speaker will sound about the same to listeners seated almost anywhere in the room. Coaxial midrange/tweeter drivers are an ideal solution to the problem of driver alignment in center channel and surround speakers that must be positioned above or below the vertical position of the main left and right speakers.

Thiel makes time- and phase-accurate center channel speakers with coaxial drivers and so does Vandersteen.

When all drivers are electrically and acoustically in phase, problems caused by different speakers having different crossover points are eliminated. Time- and phase-accurate speakers are always in phase at all frequencies.

Thiel makes time- and phase-accurate center channel speakers with coaxial drivers and so does Vandersteen.

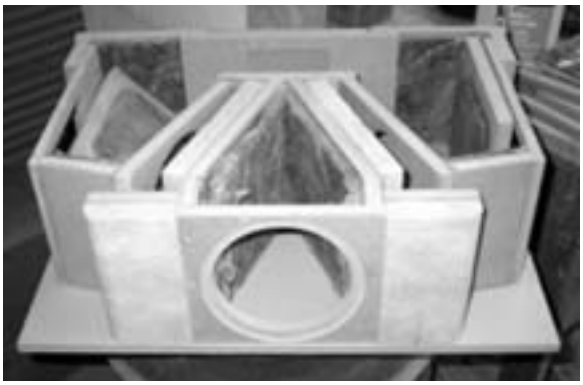
The Thiel SCS-3, with a coaxial midrange/tweeter driver, can be used horizontally or vertically for center or surround channels. The Thiel MCS-1 has a four-driver array with a coaxial midrange/tweeter. It handles more power and plays louder than the SCS-3.

Vandersteen's VCC-1, VLR-1 and VCC-Signature speakers have a coaxial midrange/tweeter driver and are very compact. The Vandersteen VCC-5 has four drive elements, including a coaxial midrange/tweeter, arranged in a patented configuration that provides time- and phase-accurate point-source radiation, full-range response and high power handling capability.

Choosing a Center Channel Speaker

If you have time- and phase-accurate main speakers you should have a time- and phase-accurate center channel speaker. If you have conventional speakers you should carefully audition center channel speakers in combination with your main speakers and in a configuration that simulates your home system. If you have a big RPTV and the center channel speaker will sit on top of it, that's the way you should audition center channel speakers in the dealer's showroom.

All center channel speakers don't sound the same. All center channel speakers won't blend well with your main speakers. Listen and compare. APJ



Interior of Vandersteen VCC-5 center channel speaker

The Truth About Surround Speakers

by Richard Hardesty

With the exception of the preceding article on center channel speakers, our discussion of loudspeakers has concentrated on stereo reproduction. This information applies equally to stereo speakers and to the left and right front speakers in a surround sound or multichannel system. The information about stereo speakers may also apply to speakers used for the surround channels in a multichannel system, or it may not—depending on your objectives.

The requirements for surround speakers may be very different from the requirements for stereo speakers depending on how you use your system and who you believe. THX says that surround speakers must be radically different from front speakers in order for a home theater system to simulate the sound of a movie theater. Some promoters of surround sound for music advocate the use of identical speakers all around and some don't. There is no agreement about what type of speakers should be used for the surround channels or where they should be placed. This article will present some simple facts about surround speakers to help you decide.

The THX Approach

THX mandates the use of dipole surround speakers placed directly to the sides of the listener and radiating along the side walls. One side of the dipole speaker is against the wall and the other is aimed at the listener. Dipoles have no output to the sides due to cancellation and in a THX home theater system the listener sits in this null region so no direct sound from the speaker is perceived.

All signals in the surround channels will reach the listener indirectly as reflections off the walls. This is supposed to simulate the sound heard on a dubbing stage or in a movie theater or, as THX calls it, the sound the filmmakers intended for you to hear. This archaic concept dates back to the days of matrix surround.

Before discrete digital surround sound processes became the norm, movie theaters used several surround speakers arranged down the sides and across the back of the theater. All these speakers received the same mono signal producing a diffuse sound with no specific directional cues. Matrix surround has just four channels: discrete left and right channels, a center channel that is created by combining the left and right channel information that is in phase, and a surround channel that is created from the left and right channel information that is out of phase. No directional effects are possible in the back hemisphere.

In the opinion of the architects of THX, a home theater system using dipole surround speakers, reproducing an equalized and decorrelated signal, simulates the sound that the filmmakers heard when creating the soundtrack, or the sound heard in a movie theater. I don't agree.

In modern movie theaters the surround speakers are divided into two or three groups: left rear, right rear and back (in some theaters). In addition to the three front channels and a limited bandwidth channel for low frequency effects (LFE), digital surround formats provide discrete left and right surround channels and the back channel can be created from information that is in phase in the surround channels. This gives filmmakers an expanded palette for soundtrack creation. It also makes the THX dipole surround idea for home theater obsolete.

A THX system imposes a vague, diffuse, "enveloping" surround effect, whether that was intended by the filmmakers or not, and eliminates the possibility of placing effects in the back hemisphere with specific directional attributes. Many of today's artists refuse to accept these limitations and use directional effects in the rear channels.

You'll never hear what they're doing if you use dipole surround speakers in your home theater system. EQed dipole surrounds blur the effects of the best film soundtracks and are a ridiculous concept for music.

Speakers with a dipolar radiation pattern sound distinctly different from point source radiators, especially when you are hearing only wall reflections from the dipoles. No amount of equalization can "timbre match" a dipole to a conventional front speaker. I don't think that dipole surround speakers provide the best sound for matrix surround sound and they are clearly inferior for reproducing discrete multichannel sources.

The Music Surround Approach

The surround-sound-for-music crowd is still arguing about how to use this new multichannel capability. The most practical approach, and the one that's easiest to sell, is simply to adapt

music recording to the 5.1-channel playback systems that were developed for movies and have become the norm for home theater. Others propose using the six available channels in different ways that are more appropriate for music reproduction.

Most proponents of surround for music recommend identical speakers all around but there is disagreement about where the speakers should be positioned and how the available channels should be utilized. Some advocate full-range speakers and some are willing to accept the compromised performance of satellite speakers with bass management.

Every Sony multichannel SACD comes with a package insert describing the ITU standard for speaker positioning. The ITU standard for multichannel sound has the left and right speakers positioned at ±30 degrees left and right of the center channel speaker and the surround speakers positioned at ±110 degrees from the center channel speaker.

Most DVD-audio supporters recommend the ITU speaker placement standard which is also used by many post-production facilities in the movie industry.

David Chesky advocates eliminating the center channel speaker and subwoofer and using these channels instead for additional wide-front speakers placed at ±55 degrees from center and elevated to reproduce a sense of height.

DMP's Tom Jung likes a hard center channel but proposes that the subwoofer channel be utilized for a height speaker placed directly overhead. While there is little chance that these unusual approaches will find wide acceptance you may want to experiment with them.

Achieving full-range response in the surround channels, while highly desirable, presents a challenge in the average home. Floor-standing, full-range speakers are usually not the best solution.

The Real-World Approach

In the real world we have rectangular rooms filled with furniture. We sit on sofas and chairs with backs that rise to ear level or above and are not acoustically transparent. We may have others sitting beside us when we listen, blocking the path of sound from one or both of the surround speakers.

I have visited thousands of rooms in conventional homes and I can count on my fingers the number of rooms that would accommodate full-range, floor-standing surround speakers arranged equidistant (with the front speakers) from the listening position and in the ITU-standard positions. In the rare circumstances where full-range speakers could be used for the surround channels, a direct path from these speakers to the listener(s) would be blocked, at least partially, by chair backs and/or other listeners. Very few rooms are wide enough to allow the rear speakers to be as far from the listeners as the front speakers—typically 8 to12-feet.

What we really need are surround speakers that sound like the main speakers when positioned where they will actually be used

The only practical solution to these problems is to elevate the surround speakers above the height of the chair backs and other heads. This allows a direct path from the speakers to each listener and increases the distance from the speakers to the listeners.

While the use of surround speakers that match the front speakers seems like a good idea, this is impractical in nearly all domestic rooms. What we really need are surround speakers that sound like the main speakers when positioned where they will actually be used—above and slightly behind the main listening position.

Phase

The same phase problems that were mentioned in the article *The Truth About Center Channel Speakers* apply to surround speakers. Mixing 2-way and 3-way designs may mean that midrange and high frequencies in the front and rear hemispheres will be out of phase.

A typical 3-way front loudspeaker with a third-order crossover will have the midrange driver wired in opposite polarity from the woofer and the tweeter. A typical 2-way surround loudspeaker

with a third-order crossover will have the woofer/midrange driver wired in phase with the input signal and the tweeter wired in reverse phase. If you combine the two types, midrange and high frequency sounds in the front and rear hemispheres will be out of phase. If the crossover points are different, and they most likely will be, the problem becomes even more complex and the results even more unpredictable.

I have often been amused when reading descriptions of "coherent, three-dimensional sound fields" from speaker systems that I know have center channel and surround speakers which are not in phase with the left and right speakers in the midrange.

How can one be assured of phase compatibility? Use identical speakers, an impracticality, or buy time- and phase-accurate surround speakers.

Time- and Phase-Accuracy

Making time- and phase-accurate surround speakers is as difficult as making a time- and phase-accurate center channel speaker. An aligned vertical array won't work because the surround speakers are usually elevated above the height of the other speakers in the system. The vertical position of a time- and phase-accurate speaker is critical to temporal alignment of the drivers.

So how can time- and phase-accurate surround speakers be constructed? Temporally-aligned vertical arrays can be aimed down at the sweet spot so that the drivers are correctly positioned for one individual, or a coaxial driver arrangement can be used to make surround speakers that work for everybody.

A coaxial configuration allows the relative positions of the midrange and tweeter drivers to remain constant when the speakers are positioned above and behind the listeners. The speakers will sound about the same to listeners seated almost anywhere in the room. Coaxial midrange/tweeter drivers are an ideal solution to the problem of driver alignment in surround speakers which must be positioned above the vertical position of the main left and right speakers.

When all drivers are electrically and acoustically in phase, problems caused by different speakers having different crossover points are eliminated. Time- and phase-accurate speakers are always in phase at all frequencies.

Thiel makes time- and phase-accurate surround speakers with coaxial drivers and so does Vandersteen.

The Thiel SCS-3, with a coaxial midrange/tweeter driver, can be used horizontally or vertically for center or surround channels. The Thiel MCS-1 has a four-driver array with a coaxial midrange/tweeter. It handles more power and plays louder than the SCS-3. The Thiel PowerPoint and PowerPlane models can be surface or in-wall mounted.

Surround speakers can be augmented with subwoofers to provide full-range response and increased output capability

The Vandersteen VSM-1, VSM Signature and VLR-1 models each have a coaxial midrange/tweeter driver. The VSM models can be wall mounted.

All of these surround speakers can be augmented with subwoofers to provide full-range response and increased output capability.

Choosing Surround Speakers

If you have time- and phase-accurate main speakers you should have time- and phase-accurate surround speakers. If you have conventional speakers you should audition surround speakers in combination with your main speakers. Matching surround speakers to the main speakers is desirable but not as critical as matching a center channel speaker to the main speakers. APJ

High-End Speakers and High SPL

by Richard Hardesty

People often ask me why expensive high-end speakers can't play as loudly as other types that cost far less. The answer becomes fairly obvious when the following factors are considered: speaker sensitivity, the distance from the speaker to the listener, the radiation pattern of the speaker, the available amplifier power, the amount of heat that is generated in the speaker and how long that heat persists. Let's examine each one and look at some numbers.

Sensitivity

Sensitivity is a gauge of how much sound pressure a speaker can produce for a given input power at a given measurement distance. Sensitivity is usually expressed in decibels with the input power and distance referenced. The expression 91dB/1 watt/1 meter means that the speaker will produce 91 decibels (dB) sound pressure level (SPL) at a distance of one meter (39.3701-inches) with an input signal level of one watt, which is equal to 2.83 volts RMS into an 8 ohm impedance. Note: the same input voltage will produce 2 watts into a 4 ohm impedance.

The typical range of sensitivity for high-end loudspeakers is between 80dB and 90dB/watt/meter with most falling in the range of 83dB-88dB/watt/meter. A full-range guitar speaker might have a sensitivity of 96dB/watt/meter. Sound reinforcement or horn-loaded theater speakers may produce over 100dB/watt/meter.

Distance and Radiation Pattern

Sound pressure level from a point source radiator falls in proportion to the square of the distance from the source. In other words, if you sit twice as far from a speaker the sound will be one fourth as loud. If the distance between you and the speaker is increased ten times, the sound will be only one one-hundredth as loud.

The inverse square rule applies to a measurement microphone as well. A measured level of 90dB SPL at one meter won't be very loud at a normal listening distance of three or four meters.

The radiation pattern of the speaker can affect the drop in sound pressure level with distance. Sound pressure falls in direct proportion to distance with line source radiators, for instance, but few high-end speakers act as true line sources and all speakers become point sources at low frequencies. A stack of sound reinforcement speakers with a narrow radiation pattern can produce high levels at great distances but that's a story for another publication.

Power

To get more sound pressure out of a speaker you have to put more power in. A large increase in power is required to produce a small increase in sound pressure, but a big increase in power means a big increase in heat.

Input power must be doubled to raise the sound pressure level by 3dB. A speaker with a sensitivity of 87dB/watt/meter would require an amplifier with eight times more power to play at the same sound pressure level as a speaker with a sensitivity of 96dB/watt/meter.

In other words, a guitar speaker driven by a 50-watt amplifier may play as loudly as a high-end speaker driven by a 400-watt amplifier, but the high-end speaker probably won't be able to dissipate the heat created by 400 watts for long. If the 400-watt amplifier clips, the tweeter in the high-end speaker will be destroyed almost instantly.

Heat

Watts are watts whether we're talking about a toaster, a hair dryer or a power amplifier. A 1,500-watt hair dryer gets a lot hotter than a 1,000-watt hair dryer. If you want to know how much heat 100 watts can produce, hold your hand near a 100-watt light bulb. You don't want to put your hand anywhere near a 500-watt halogen bulb, which can produce tremendous heat and be a real fire hazard. A 500-watt amplifier can create a fire hazard inside a speaker that can't withstand the heat created by this power.

A compression driver in a horn-loaded theater speaker may have a 3-inch voice coil which can handle 50 watts all day long, but the same 50 watts of continuous power will eventually melt the delicate 1-inch voice coil in a high-end dome tweeter and the high-end speaker won't be playing nearly as loudly when it fails.

Why is the high-end tweeter so delicate? Because it has to respond to subtle nuances in the audio signal and have bandwidth to perhaps 30kHz. The horn-loaded compression driver, with its massive voice coil, will be lucky to reach 15kHz and subtlety is a word that is seldom associated with sound reinforcement or theater speakers.

A full-range guitar speaker may use a single 12-inch driver and have a bandwidth of 50Hz to 2.5kHz. This rugged driver may have a 3-inch or even a 4-inch diameter voice coil made from heavy wire. The guitar speaker will blow you off your bar stool but it won't resolve midrange details like a hi-fi speaker system and it won't produce deep bass or high frequencies at all.

You can enjoy Chopin, Miles Davis and Megadeth on a high-end hi-fi system.

Time is an important factor when considering heat build-up and dissipation. The dome tweeter in the high-end speaker may be able to dissipate the heat created by 1,000 watts for a few milliseconds but the small, lightweight voice coil required for high-end performance can't withstand sustained power and the heat that accumulates over time.

The Porsche and the Dump Truck

In **Audio Perfectionist Journal #1** I wrote a little allegory about a Porsche and a dump truck. That analogy applies here. Different tools are required to perform different jobs.

A sound reinforcement speaker system sacrifices bandwidth and sound quality for high output capability. A high-end audio speaker sacrifices sensitivity and high output capability for extended bandwidth and improved sound quality.

A high-resolution speaker system can accurately reproduce every detail of a string quartet in your living room but that same speaker system may not be the best choice if you want to listen to loud rock-and-roll through the open sliding glass door while you're having a party out by the pool.

No Rock-and-Roll With a Good Hi-Fi System?

A good hi-fi system can play rock-and-roll and other types of music which are best enjoyed at loud listening levels. I love piano concertos and small ensemble classical works but a system that won't play Led Zeppelin and Pink Floyd would be worthless to me.

I like Mary Chapin Carpenter and Shawn Colvin but I also enjoy Meredith Brooks and Sheryl Crow. I listen to all these artists and many more but I use common sense.

When I listen to Joe Satriani or Jeff Beck I play the music loud but I sit in the normal position about 8-feet from my speakers. I don't try to make the sound loud in another room or out on the patio and I don't play three rock CDs back to back—I let the speakers (and my ears) cool down by interspersing softer, gentler material.

Loud is a relative word that means different things to different people. I never listen at levels that would damage my hearing or my equipment. In objective terms that means average levels of 90dB or so at the listening position and peaks of perhaps 100dB SPL.

You can enjoy Chopin, Miles Davis and Megadeth on a high-end hi-fi system if you use restraint and exercise good judgment. Armed with the information presented in this article you should be able to enjoy all kinds of music without ruining your ears or your speakers. APJ

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Addendum to Journal #8

by Richard Hardesty

***Audio Perfectionist Journal #8** was written in 2002 and time has continued to march onward but not necessarily upward. Overpriced products are still readily available and the magazines continue to heap praise on them. High value, high performance audio components are still available but you'll have to seek them out because good engineering and products that are simply well designed and functional don't seem to garner much press coverage.*

I've just returned from CES 2005 and not much has changed there if you ignore video and concentrate only on audio components and systems. I could write a report about the audio portion at this year's show very similar to the 2002 CES report in **Journal #8**, dividing exhibits into groups representing high performance and silliness.

Dunlavy Audio has closed and the SC-IV.A speakers reviewed in **Journal #8** are available only in the used market. Thiel has upgraded the CS6 speaker to CS6A and introduced a line of powered subwoofers. Vandersteen Model 3A Signature and 2Wq subwoofers are still available and this speaker system continues to represent one of the best values in audio today.

Vandersteen has introduced the Quatro speakers, which are like a combination of 3A Signature speakers and 2Wq subwoofers, combined in just two enclosures. Quatros have slightly better midbass (smaller woofer) and slightly less cone area for deep bass (only two subwoofer drivers per speaker).

Vandersteen has introduced the Model 5A speakers, which set new standards for loudspeaker performance (see **Journal #12** for a complete review). Both Shane and I have assembled systems around these speakers and achieved remarkable improvements in resolution.

Mainstream manufacturers have failed to recognize the importance of time-domain performance in loudspeakers but Pat McGinty has entered the fray with a complete line of time- and phase-accurate Meadowlark speakers. (See interview in **Journal #12** and product review in **Journal #13**.)

Surround sound for music has become a mid-fi phenomenon and few high-end companies demonstrated with more than two channels at CES 2005. APJ

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