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Room Correction, Volume One

The next frontier of system tweaking, in gear almost everyone can relate to.
by Chris Lewis

Audio truth number one: You can spend all the money in the world on equipment, but your system is never going to sound any better than your room lets it. It's admittedly a sobering thought, but it's one that you'll have to accept at some point as you make your way along the audio trail, or you'll find yourself traveling uphill the entire way. The sooner you accept the fact that the room itself is the single most important component of any audio system, the better chance you have of making your room and system like each other, and the less likely you'll be to waste a whole lot of blood, sweat, and frustration—not to mention money—in the process.

Here's another sobering reality: Most of us have relatively bad rooms. The vast majority of audio enthusiasts don't have the luxury of setting aside dedicated listening rooms in their homes, in which they can fully control the environment, let alone have the money left over to properly outfit such rooms by the time they're done paying for the audio equipment itself. Thus, most

listeners are stuck with what they've got, which means putting audio systems in rooms that are usually not prepared for them in any way.

Unfortunately, so many of the things that we like to have in our living environments—lots of windows, hardwood floors, etc. cause serious problems from an acoustic standpoint. Different degrees of relief are available, of course. You can put thick curtains on the windows and use area rugs to deaden live floors. Well-placed acoustic materials can do wonders for bad rooms if the money—and the inclination to accept some possible aesthetic compromises—is there.

However, the inclination to spend extra money and/or accept aesthetic compromises usually isn't there. As a result, more A/V manufacturers are starting to realize that building some level of effective room correction/equalization into their receivers, pro/pros, speakers, or even source units is an avenue that warrants exploration—and could lead to an explosion in sales.

Room correction in audio products, or as a standalone audio product, is nothing new. Even some of the most basic components have had built-in equalizers, tone controls, etc., for some time now, and stand-alone equalizers are hardly a new concept. But the interest in implementing electronic room correction, especially that of the built-in variety, has never been higher, thanks to the digital signal processing (DSP) and home theater revolutions. We can expect a lot more of it in the coming years across all product genres.

In this initial piece, we'll look at some of the ways room correction is already being implemented in products that are more accessible to the average listener. Down the line, we'll look at some high-end room-correction systems and implementations.

Room Correction at the Bottom Line

Naturally, there are a number of different ways to address the problem of room interactions and deficiencies, in both the analog and digital domains. There's also considerable debate over how effective room correction can be in different regions of the frequency range. One point few will argue, though, is the effectiveness of equalization in the low frequencies. It is with subwoofer systems that most home theater listeners are initially exposed to some form of room correction.

Two such systems are Infinity's Room Adaptive Bass Optimization System (R.A.B.O.S.), one of the better systems from the analog domain, and Velodyne's Digital Drive system, one of the better from the digital domain. They're executed in different ways but chase the same golden ring of combating low-frequency anomalies and flattening response in problem rooms—which most are.

Like many of the next-generation room-correction systems are certain to do, Velodyne's Digital Drive system leans on the considerable (and ever-growing) power of DSP. Digital Drive is controlled through an onscreen interface generated by the sub itself (it's not often you'll see an S-video output on a subwoofer's back panel) and a supplied microphone that uses the internal test signals to take room measurements and adjust its filters accordingly. The user has considerable flexibility to easily tweak the frequency response using the system's eight parametric EQs, being

represented graphically onscreen and the ability to easily adjust the individual EQs, via remote control.

You can literally watch your adjustments take effect as the system continues to plot a real-time frequency curve as you work. Crossovers (frequency and slope), phase, and contour (frequency and level) are all controlled digitally by the DSP and are highly adjustable. Six presets are also aboard: two for movies, two for music, one for the user's custom preferences, and one that defeats all equalization. Digital Drive puts a serious amount of control in the user's hands and makes a complex process rather easy. You'll find it throughout Velodyne's new Digital Drive line, with models at various price points.

Being analog-based, Infinity's R.A.B.O.S. requires a little more legwork than a digital correction system, but it's no less effective in flattening low-frequency, in-room response. R.A.B.O.S. keeps things relatively simple, with a single parametric equalizer built into the sub (or sub section of a powered tower) that only looks at roughly 20 to 100 hertz. It's an attenuation-only filter, so it doesn't try to fill dips caused by acoustic cancellations, which Infinity contends is futile and only causes dynamic limitation and distortion. Essentially, it's a spike hunter, and you can tune it to specific frequency of the most serious problem and adjust it to match the spike's bandwidth. By adjusting the filter to match the shape of the peak and then flattening the response, it also accounts for phase aberrations—the addition of phase shift has been one of the knocks on standard equalizers for a long time.

R.A.B.O.S. makes the process relatively easy with the included SPL meter, test-tone CD, and level, frequency, and bandwidth controls on the sub woofer. Instructions, worksheets, and a bandwidth-selector tool are included, as well. The test tones are used to manually plot a frequency curve for the sub in your room; R.A.B.O.S. then applies the bandwidth selector to the curve and makes level, frequency, and bandwidth adjustments based on the results, using the supplied charts. If you don't want to look up the adjustments yourself, head to Infinity's Website (www.infinitysystems.com), enter the data you compiled from the test tones, and they will determine the proper settings for you. Currently, R.A.B.O.S. is found in a couple of Infinity's less-than-\$1,000 subs, one of their higher-end HTIB systems, and in the Prelude MTS sub.

Democratic Room Correction

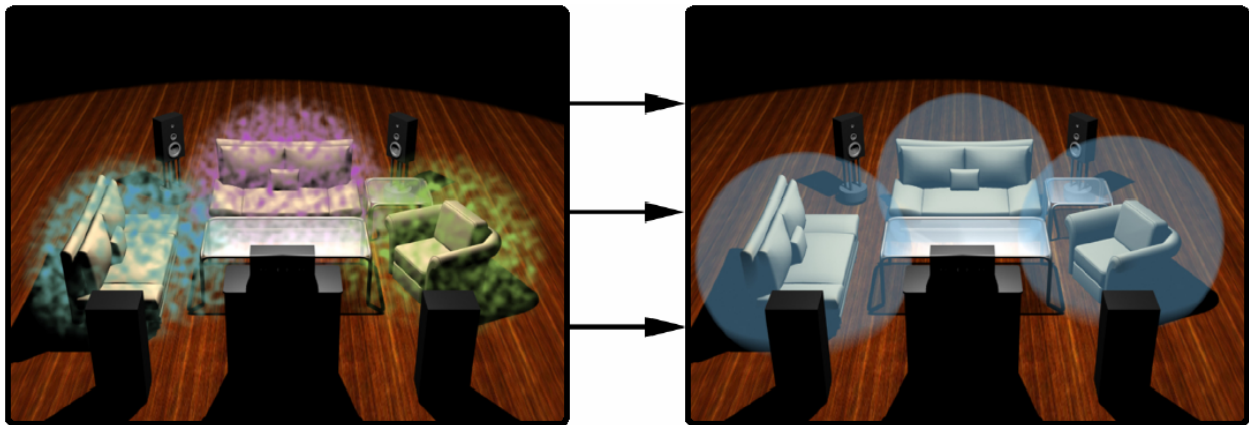
One of the more-interesting solutions for addressing not only frequency response within the room but issues surrounding sweet-spotting and the widely varying experience that different listeners have at different room locations is a new system called MultEQ. MultEQ is the brainchild of well-respected Audyssey Laboratories, who is working in conjunction with Texas Instruments to harness the aforementioned, and considerable, capabilities of DSP.

In its standard form, MultEQ is essentially an automatic calibration procedure that does some serious room correction throughout the audible frequency range for multiple listening positions. It will automatically find the optimum crossover frequency for proper bass management, set speaker and subwoofer channel levels, and set delays. It can be piggybacked onto existing DSP processors across a wide variety of platforms while still allowing the processor to perform its

other encoding and decoding duties. MultEQ should start appearing in pro/pros, receivers, and even HTIBs and car-audio systems soon.

The idea behind MultEQ basically emerged from the simple truth that sound, even from properly designed speakers, is affected by room interactions differently for each listening position. Audyssey points out two problems with standard equalizing-filter approaches. First, they usually operate by attempting to invert the room response, which Audyssey contends is not effectively invertible because it's not minimum phase. Second, even successful equalizing filters apply only to a single listening position and can degrade performance for all other listening positions in the room.

Audyssey asserts that comprehensive room correction can only be accomplished through a multiple-listener equalization filter that adjusts for room effects simultaneously at all listening positions. They are staking their claim that MultEQ will be the first technology in the industry that does so.



Audyssey's new MultEQ room-correction technology is designed to adjust for acoustic problems in multiple listening positions, as opposed to a single sweet spot.

Rather than basing MultEQ on parametric equalization over a few bands, they have based it on a finite impulse response (FIR) approach that analyzes room response at multiple locations. Each loudspeaker input uses an independent MultEQ filter. Because a multiple-listener equalization filter requires a statistical framework that describes spatial-response variations, Audyssey developed a framework based on pattern recognition, describing differences between responses by automatically grouping similar responses together and differing responses in separate clusters. A distance metric assigns non-uniform spatial weighting to the room responses measured at multiple locations. This is a considerable change from RMS spatial-averaging methods, which consider all responses to be equally important, causing the equalization filter to apply uniform weighting, which Audyssey believes leads to compromised performance at all listening positions.

Audyssey is also using a dynamic frequency-allocation method to provide higher resolution at lower frequencies, where standing waves and other room interactions make flat response more difficult. The filters are designed to provide effective equalization even with low-filter orders,

which makes it easier to implement them in existing DSP systems that also perform other functions.

Sure, it sounds complicated—most A/V technologies do when you take them apart. But MultEQ's implementation in a home theater should be anything but complicated. In most cases, it should be as easy as running an automatic calibration system, which consumers are starting to demand more of in receivers and pre/pros, anyway. In fact, because MultEQ sets crossovers, channel levels, and delays (using either a supplied microphone or one built into the remote control), it should be even easier than going through and making the basic settings by hand. You can almost consider the automatic room correction a bonus—a bonus that should make your system sound significantly better, no matter what environment you put it in.

With an offshoot system called PrevEQ, Audyssey has even the most calibration-phobic audiophile covered. Here, the filters are designed by measuring a preproduction sample in a typical listening environment and creating more-tailored "factory default" settings. This system naturally doesn't take the listener's actual listening environment into account, but Audyssey's tests show that the system can achieve significant gains nonetheless.