



## Making Loudspeakers And Control Rooms That Make Music “Sound Good”

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Anybody involved with the making of music or music recordings routinely asks themselves the question, “Does it sound good?” You know what I mean. “Does the guitar sound good?” “Does the edit sound good?” “Does the room sound good?” It goes on and on and on.

As a loudspeaker and studio designer, the question has always loomed large for me. As a designer, I have to ask, “What does ‘sound good’ mean, physically and psychologically?” Once I’ve got a handle on that, then I’ve got to answer the question, “What can I build that will make OTHER people will say, “It sounds good.”? (Actually, I prefer it when they say “It sounds totally f\_\_\_ing awesome!”) Seriously, if I’m about to spend a great deal of my client’s money building a recording facility that he or she expects to rent out on a regular basis to serious and solvent producers and artists, the studio damn well better “sound good!” Equally important, the finished recorded product that leaves that studio had better “sound good” elsewhere in the known universe as well, at least if I wish to continue to work in said universe.

The control room that most recently came out of my “sounds good” quest was pictured on the cover of the August, 1999 issue of Mix. Yes, I invented, designed and built those weird looking speakers and I created the oval shaped room to put them in. What I did with that room, combined with how “good” the room sounded when we fired it up, interested the folks at Mix enough for them to ask me to write this article for you. This is NOT another “How To Build a Home Studio” or “The Basics of Acoustics” article. This is more like “Zen and The Art of Control Rooms.” Let’s talk.

In professional audio, we use loudspeakers and the rooms they are in to make judgements about the quality of what was recorded and also to predict how a recording will sound when other people play it over other loudspeakers in other rooms. I think we can all agree that loudspeakers should do this accurately. But what does “accurate” in this context mean, anyway? Literal physical acoustical accuracy is out of the question – microphones and loudspeakers lose too much information for truly “accurate” reproduction to take place. So what we REALLY mean by accurate, it seems to me, is a playback that presents a compelling sensory illusion of the original event, an illusion that feels realistic, lifelike and, well, present in the same space with us. Also, we’d like the illusion to include the original space as well as the original sound source. When those things happen, we call the sound “accurate,” or maybe “totally f\_\_\_ing awesome!.”



Meanwhile, we have to keep in mind the nature of the relationship between the loudspeaker and the recording/mixing engineer. As engineers, we all learn the sound of our favorite loudspeaker played in our room. As our craft develops, we learn how to anticipate what the implications of various sound qualities as heard by us will mean to others listening in other spaces, so that when we get our recording to sound “right” to us in our environment, we can predict that others will say “it sounds good” when they play it back in their environment. Then we can get paid.

This is all fine and dandy, but what do we build if we want EVERYONE who walks into our room to say, “This sounds good. I can work here.”? Drawing upon our collective experiences as recording engineers, a lot of good published acoustical research and some very strong anecdotal evidence from our work with ultra-wide dispersion loudspeakers, my partners and I think we have pieced together a good bit of the “sounds good” puzzle.

Let’s start with the obvious. Loudspeakers and rooms form an acoustic transmission path. They both affect what we hear and how we perceive it (two VERY different, but related, things). Loudspeakers need to have low distortion and flat frequency response, and to be free of audible resonances. They also need to have good off-axis response. At the very least, rooms need to minimize standing wave problems and not have excessive reverberation times. On these basic points there is little, if any, disagreement.

However, (and this is not yet widely appreciated in the recording industry) loudspeakers ALSO need to have horizontal coverage angles of 140 or more across the audio bandwidth. Meanwhile, control rooms should have hard side walls to generate lateral specular reflections that make full use of the off-axis acoustic information and power generated by such loudspeakers. Control rooms also need to be very well damped at the front and on the ceiling. Non-specular diffusion (such as quadratic residue diffusers like RPG diffusers) should by and large be avoided for such applications, particularly on the rear wall. (No offense to the diffuser makers here. Diffusers are great devices, with lots of good uses.)

If we take a quick look at the photos of studios in this magazine, we are not likely to find many pictures of control rooms that look like this. That’s OK. Studio design is what it is today as a process of evolution, and the room designs are generally based on commonsense approaches to the apparently obvious solutions to some perplexing acoustical problems.

One of the most basic of these approaches has been what I like to think of as the “pseudoanechoic” approach. The basic principle here is based on the assumption that the signal emitting directly from the loudspeaker is some sort of “acoustic truth,” and that it would be best if we could listen to just that signal and nothing else. This seems like a reasonable approach. However, it turns out that we need an anechoic chamber to do this, and such chambers turn out to be unsatisfactory as control rooms for a variety of



reasons. So we rationalize a bit and allow as how we do need some reverberance maybe, but not “early reflections.” Some of us even characterize those reflections as “acoustical distortion.” So we attempt to suppress those reflections, or we use quadratic residue and similar diffusers to convert those reflections into “reverberance.”

Now this flies in the face of some 7,000 years of acoustical experience (the first “auditorium” was built around 5,000 BC), experience which suggests quite compellingly that reflections and reverberance are ESSENTIAL when it comes to listening to music. Musicians refuse to play without reflections and reverberance, as a rule, and the general acceptance of listening to music in reverberant spaces (i.e. rooms) is, well, universal.

If this is so, how can early reflections be thought of as “acoustical distortion?” The answer is that reflections are distortion insofar as measurement microphones are concerned. That’s why we need anechoic chambers to make measurements with microphones. However, for human hearing, such reflections aren’t distortion at all. Instead, those reflections are an important central part of the acoustical sound that us humans enjoy so much.

So, the specular early reflections that come from hard side walls in the control room provide the listener with full-spectrum, phase-coherent information that our ear/brain uses to localize the loudspeakers and their related phantom images, as well as to help determine the timbre of the sound. (Believe me, this is not snake oil. This is an essential part of how humans perceive and localize sounds in rooms.) The more closely those reflections match the direct sound in terms of frequency and phase response, the better we can perceive all the timbral, timing and ambience cues in the recording that the loudspeakers, especially in stereo or surround arrays, are playing back. This may seem a little counter-intuitive, but with strong, full-spectrum lateral reflections, phantom images become more stable and “palpable” and the depth of the stereo sound-field increases, with strikingly more resolution of the ambience and reverberance of the recording.

Let me take a moment here to rattle off a few pertinent facts and observations about how we hear. We are extremely good at localizing sounds in the area covered by our field of view. As sound sources go up, down and behind we are less good at localization. We use the high-frequency content of the reflected sounds to help localize the sources of sound and the low-frequency content of reflections to “localize” the boundaries of the room. Phase-locked volleys of early reflections up to approximately 50 ms. after the direct sound are “fused” together into a single perceptual construct. From a psychological point of view, then, a “sound” consists of a bunch of phase-locked early reflections that are integrated by the auditory system, rather than consisting of the single direct emission from the loudspeaker. Filtered early room reflections are more audible as being separate from the integrated sound than those with the



same timbre as the direct sound. Filtered reflections from above, below and behind seem to be more disturbing to the localization mechanism than those from the sides. Laterally reflected energy increases the sense of envelopment from music playback - live or recorded. Highly damped and anechoic spaces are unnatural and unmusical places to listen to music in - live or recorded. To go a little further with this, let me briefly consider loudspeakers. All loudspeakers radiate sound in every direction. If we soffit mount them, we constrain the output to a hemisphere, but the total acoustic power output is essentially the same. We tend to concentrate our attention on the axial response of the speaker as a matter of test convenience and simplification. And in fact, the direct sound of the speaker is very important. If there are response problems on axis, it will not be an excellent sounding speaker, period. What is frequently overlooked, also as a matter of engineering convenience, is the off-axis response, the extreme off-axis response and the overall power response of the loudspeaker. Anyone who is used to measuring loudspeakers knows that the performance specification I quoted above (140° horizontal dispersion across the spectrum) is pretty wild. Many have said, "Can't be done."

The correct answer is, "Couldn't be done until now." Those funny looking speakers on the August Mix cover have a horizontal coverage angle of over 180°. All the way up to 16 kHz, the amplitude response is smooth, even at 90° off-axis. This behavior, which we call Panoramic Power Response, is made possible by the use of a device I call an Acoustic Lens, a pair of which you can see sitting on top of the cylindrical woofer section. Panoramic power response is, to be slightly crass, the stuff of other loudspeakers' wet dreams. With this performance capability, the rules of the studio design game change.

Conventional loudspeakers have off-axis response curves that are increasingly rolled off as we move off-axis around the loudspeaker. Worse, because of the different directivity patterns of the individual drivers, most loudspeakers have increasingly lumpy response curves as we move around to the side of the speaker. All of this lumpy low-pass sound is emitted into the room. And yes, we hear it. You better believe we hear it. Just because we've gotten used to it doesn't mean we don't hear it!

Conventional wisdom says that directional loudspeakers and rooms that damp or diffuse early reflections are good. Usually, all that is being done with such a treatment is to add even more low pass filtering to the "lumpy low-pass" reflected sound and to the room tone in general. The loss in high-frequency information particularly hurts the localization of phantom images and phantom reverberance cues, as well as darkening the overall perceived timbre. However, with a loudspeaker that does not have the limitations in its dispersion that conventional speakers suffer from, accurate lateral reflections are maintained, yielding better images, particularly of ambience, and a brighter, more open, more spacious and natural range of timbres.



Still with me? Good. It's payoff time. Here's my explanation of what happens in most control rooms. The loudspeakers will emit sound in every direction despite the best efforts of the designer to limit their directivity. Those which pay no attention to directivity issues will also suffer from lumpy off-axis and power response as mentioned earlier. If the side walls of the control room are damped, they will further low pass filter the room reflections. The net effect is to remove, reduce or distort the room reflections that the ear/brain uses to help localize the sound sources (i.e. the loudspeakers and their related phantom images). If there is diffusion in this transmission path, then the reflected energy is robbed of its phase coherence and becomes useless in both the localization process and for the maintenance of timbre, blurring images and timbre. If the reflected energy comes from behind or the same direction as the direct sound, it will not support the localization process as well as laterally reflected energy does. Without sufficient laterally reflected energy, the sound will generally lack a sense of envelopment and, dare I say, musicality. If the decay time of the room is not short and reasonably similar in each octave band from 63 Hz. through 8 kHz., the playback room will impart its own "color" upon the perceived sound.

Us humans are very adaptive. We CAN work in rooms constructed like this. BUT, we struggle, and have these ongoing debates about rooms and loudspeakers. One guy loves this room and hates that loudspeaker. Another guy hates this room and loves that loudspeaker. Whatever. We all manage to adapt to a particular playback system in a particular room. Once we have learned "the sound" of "our particular" system, and have learned to produce predictable recordings with that setup, other sounds often seem unnatural and the readjustment process can be time consuming and unpleasant. (This is exactly how the NS10s-on-the-meter-bridge phenomenon works, and this is why some engineers end up mixing to pain cues.)

Now, here's what happens in The Plant's new mix room, "The Garden," with the weird-looking loudspeakers. These monitors emit sound in every direction like any other speakers, to be sure. However, there is NO low pass filtering of their output in the horizontal plane until we are over 90 off axis. The directivity is reduced in the vertical plane only. The reflective and non-diffusive side walls of the room provide full-spectrum lateral reflections that aid in the localization process. The rear wall is absorbent at low frequencies and spectrally reflective at higher frequencies by use of a large cylindrical reflector that directs energy back toward the side walls of the room. The front wall is a very efficient broadband absorber. The room has a constant decay time of less than .2 sec from 250 Hz all the way to 8 kHz. It doesn't sound the least bit overdamped. Normal speech in the room sounds normally ambient. With the ultra-wide dispersion monitors, the sweet spot is ridiculously huge. The key word to describe how all this sounds with music playback is clarity. It's almost like not listening to speakers at all (indeed, in some controlled double-blind listening tests of these ultra-wide designs using professional listeners, one listener stopped the test, allowing that she got confused and thought she was listening to



a live player, for an unprecedented first time in her testing experience!). Everything in the recording is utterly revealed, but without sounding analytical. As a matter of fact, playback sounds extremely musical and entertaining - and very "clear." Those are not adjectives that are usually used to describe a single playback system, but they describe The Garden and its monitors well.

"How do mixes travel?" you may ask. In fact, speakers of similar design have been in daily use at a small post-production/mastering facility in New England for several years now and the answer has consistently been, "Very well, thank you." Experienced engineers that hear the room immediately recognize that, however different all this looks, the mixes made with these ultra-wide dispersion speakers will travel to other environments extremely well, without significant problems, and that has proved to be the case.

Please keep in mind that none of the stuff I've described here negates most basic criteria for good room and speaker design. However, one of my pet peeves is that many people regard listening room acoustics as an exercise in damping or diffusing reflections. This is a questionable practice in general. Properly managed, full-spectrum reflections provide "good data" for our auditory system to use in processing the information provided by the recording.

In conclusion, I need to stress that the ideas that I've put forth here are not all that new, nor are they necessarily all my own. My partner David Moulton, for instance, has developed a very simple, very effective low-cost control room topology suitable for all types of speakers using this reasoning. There are plenty of people who recognize that wide dispersion loudspeakers and rooms like the one I've described here are an excellent approach to room design. What is unique and special here, and of importance to the professional audio community, is that these ultra-wide dispersion loudspeakers are now installed in a world-class room that can take full advantage of them, and this is in one of the foremost mainstream pop/rock recording studios in the world. In an industry filled with lemmings, this is no small achievement. One thing is for sure, though. So far the voting is unanimous - it sure "sounds good!"

*Manny LaCarrubba is the president of Sausalito Audio Works. He wishes to thank his partner David Moulton, from whom he appropriated much of the information for this article.*