Control Room Acoustics – LEDE/RFZ/ESS Rooms

How can adding randomness to your monitoring improve its accuracy?

When planning a control room design, acousticians are often told, "I don't need anything fancy, I just want to be able to rely on what I'm hearing." It doesn't matter whether the budget is a couple of hundred or a couple of hundred grand, the requirement stays the same, it's just the degree of precision that changes.

Whether it's a shoestring home setup or a fully featured commercial studioplex, the primary requirement is one of monitoring accuracy, with all the other requirements following on after that. (You don't, for instance need high levels of isolation if you're happy to work entirely on cans).

Of course, it's never quite that simple. You probably also want the room to be comfortable enough to work eight hours at a stretch, big enough to fit the whole band in for the final mix, able to have its equipment changed without altering the monitoring accuracy, sound the same in all parts of the room, and provide mixes which sound the same when you take them to another studio, take them home, or play them in the car.

Over the years, various attempts have been made to design control rooms which tell the absolute *truth* about the music. Consensus now seems to be that, in fact, *there is no such thing as absolute truth*, because what you hear is always going to depend on the environment in which you listen to it. So instead, room designers seek to create "*neutral*" rooms, which impose as little as possible of their own character on a sound, yet still providing a viable working environment for the engineer.

Acoustically Dead Rooms

In the beginning was rock and roll. And perfboard and Rockwool. And the producer said "Let there be the direct sound and nothing else." And it got the job done.

But it sounded horrible, and engineers could only work in them for twenty minutes at a stretch because they were almost anechoic, and the human ear hates that.

Bringing Dead Rooms to Life

Stereo happened, and people started getting interested in knowing what was actually going on in the room. The best rooms had rough stone front walls with the monitors set flush into them, and very deep absorption at the back. The front side-walls and ceiling were raked to prevent flutter echoes. The hard front end provided the occupants with a few reflections, giving them some acoustical perspective, so it didn't feel like they had their heads in boxes of cotton wool.

But no two rooms sounded quite alike, nor did any two places in the same room. They tried equalizers, and made them look the same on an analyzer, but still they sounded different.

LEDE Room and Reflection Control (RFZ)

Live End Dead End (LEDE) was the next answer. By making the area at the front of the room almost dead, Davis and others opened up a new realm of realism in studio monitoring. The secret lay in the initial time gap, between the direct sound and the first reflections; make this long enough and the brain can separate off the room acoustic, and ignore it. Result: a truly neutral room, where what you hear is exactly the same in any other LEDE room. To preserve operator comfort, the rear wall had to be hard, but not cause a slapback echo. New diffusion treatments were developed to break up the echo from the rear wall, but still return the energy to the room as a short decay.

In order to have a totally dead front-of-room, you can't have *any* reflective surfaces in front of the console. BUT, that's where most studios put a window between the control room and the main recording room! Reflection control was basically the same concept as LEDE, and helped to address this contradiction. If carefully planned, you can arrange for the reflections off the glass to miss the mix position, giving the illusion of complete absorption. With more planning, you can have many reflections from the front surfaces of the room, all of them carefully aimed to mixx the mix position, forming a **reflection free zone (RFZ)**. For the zone to remain reflection free, the rest of the room needs to be dead, or at least highly absorbent.

The result is excellent, provided you sit in exactly the right place and nobody puts a rack of keyboards behind you and you don't want any effects racks or tape machines or anything else in the rear half of your control room. Good results, but inflexible!

LEDE and RFZ rooms all seek to achieve essentially the same objective: a room which imposes none of its own character upon the signal. They do this primarily by not allowing any of the early reflections to reach the engineer's ears. This poses a problem when you want to put any gear in the room, because you unavoidably get reflections off it which the room designer wasn't expecting.

Early Sound Scattering (ESS)

One logical alternative to the LEDE/RFZ approach is to build a room in which the reflections are so smooth and random that they have no character to impose. This can be accomplished using Early Sound Scattering, or ESS.

The ESS control room is one which features a very diffusive front end, including the walls into which the monitors are built, which scatters the early sound. The body of the room is absorbent. The room can be made fairly live compared to older control rooms, with a flat frequency response and good stereo imaging, both of which remain stable right to the rear corners of the room.

ESS & Stereo Imaging

A common assumption about diffusion is that, by smearing the signal in time as well as space, the stereo image is bound to be destroyed utterly. The information of most interest to the brain is the level difference between left and right ears, but timing is also very important because it helps us to localize the sound source (i.e. the loudspeaker).

But that's not the aim when trying to form a stereo image using two speakers. Yes, scrambling the timing information makes it more difficult to localize the loudspeaker itself, but you still leave the volume information to provide the image.

This works in ESS rooms, because the resulting stereo image, while not as dramatic as that found in an RFZ room, is reliable regardless of changes of equipment in the rear of the room, and extends the full width of the console and right to the back wall.

ESS & Frequency Response

The most easily understand measure of a control room's "quality" is its frequency response, as shown on a spectrum analyzer with a pink noise signal source.

Although popular in the late seventies, the use of equalizers to compensate for room acoustics is now generally frowned upon, except in certain circumstances. In particular, if you flush mount speakers which were designed to be free standing, a bass boost will result, because the speaker is radiating the same energy into a hemispherical space which it ought to be radiating omnidirectionally.

Provided your speakers have been built right, the frequency response of your room depends mainly on the room's decay time response. To achieve a flat frequency response the decay time of the room must be approximately equal in each octave band.

Where the early reflections are from a diffuse surface, the reflections will be noticeably reduced in level, because the energy is spread out in many directions. This means that much smaller cancellations will be produced.

And, because the spatial diffusion is accompanied by temporal (time-based) diffusion, the notches of the rooms resonant frequencies are dramatically damped, to the point of non-existence.

This translates into the frequency domain as exchanging deep, narrow notches in the HF region, of up to about 15dB depth, for about 2dB of gentle ripple. The improvement in HF phase coherence that removing the deep notches provides is hard to qantify, but hifi-buff words like clarity, naturalness and transparency spring to mind.

ESS & Spatial Uniformity

Acousticians know that two point sources in phase produce *fringing* effects, which will cause a room to have a different frequency response at every point in space. If you haven't ever noticed this, try listening to some 1kHz tone in mono on two speakers, and move your listening position from side to side by a foot or so. The level changes dramatically, as does the apparent direction as you move through the fringes, or hot spots.

The big difference with the ESS room is that this fringing is almost completely absent. The diffusers close to the speakers effectively convert the speakers (point sources) to large flat sources, which do not suffer from the same constructive and destructive interference effects, removing the biggest obstacle to achieving consistency of frequency response throughout the room.

Repeatability

If the accuracy of the room relies upon freedom from early reflections, one reflection from behind the engineer makes a huge difference to the overall sound, and

variations in position or size of the racks, trolleys, and keyboard stands will cause no end of variation in the room acoustic. This means that a mix played back in one control room can sound MUCH different played back in another control room, even if both rooms are acoustically treated.

If, instead, these reflections are just a small part of a cloud of diffuse arrivals, the effect of changing them, within reasonable limits, is negligible. So two quite different room layouts can sound almost identical.

So there you have it. Add enough smooth randomness to any imperfect system, and the imperfections virtually disappear. These rooms really work, and give a good representation of what your mix will sound like away from the studio. They're pleasant to work in, and can be tailored to suit even quite modest construction budgets without greatly compromising performance.
