The basic principles of control room design start well before you start hanging acoustic treatment (Excerpts)
By Dave Moulton – Recording Magazine

Most of the articles we read on acoustic design of control rooms and studios seem to center around materials we might use to treat wall surfaces. In this article, I'd like to take a different approach, and present what I believe to be some basic principles of control room design.

You'll find that these are actually pretty straightforward, and you can apply them almost anywhere, including your own home studio. And where you can't apply them successfully, you'll hopefully come to understand a little better what sort of problems you have, and how to cope with them more effectively.

I've got seven principles that need to be addressed in the construction of any control room, including your bedroom, basement, minivan or closet. If you systematically work through these and do your best to optimize your particular setup with the resources you have at hand, you can actually get surprisingly decent monitoring quality, often for very little cost. You'll see.

The seven issues you need to deal with are: noise floor, room symmetry, early reflections, decay, time in the room, standing waves, loudspeaker placement, and loudspeaker behavior. We'll deal with each of these, briefly.

Noise floor

Noise floor can be defined here as the level of noise in the control room when it is "at idle," which is to say nobody is talking, no music is playing, all the equipment and air conditioning is turned on, etc. This is an important issue, because it pretty much defines the audible dynamic range of music that you can hear in your particular control room. Naturally, you'll want to make your noise floor as low as possible, so you can hear as wide a dynamic range as possible. Right?

There are two parts to dealing with reducing such a noise floor. First, you've got to shut out noises from elsewhere in the building or outside. Then you have to reduce noise from machinery in the room.

Room isolation (shutting out the noise) can be difficult and expensive. However, in your bedroom control room, you can usually make big initial improvements for very low cost simply by "weatherproofing" all of the doors and windows, as it is through these passages that the bulk of the sound leakage occurs. Certainly, that's where to start, and see how far you can get.

A big problem here has to do with air conditioners. Aside from the noise that window air conditioners make when they're running, they also allow sound to fairly freely pass through them, severely compromising isolation. Solutions to this vary widely, including using a "split" unit (that isolates the compressor outdoors in a separate unit and puts a separate heat exchanger on the inside wall), the construction of baffles around the air conditioning unit to reduce the noise of both the unit and from outside, installing central AC with oversize ducts and baffles, etc.

You will to have to suss out what works for you in your particular case. Just keep in mind that it can be difficult to achieve a quiet room while keeping it nicely cool for really cheap! Also, keep in mind that the very simple option of going without AC is usually an unpleasant way to go. You can try it, of course, but be prepared to change your mind after your first 12-hour session.

So what's a reasonable noise floor? Below 40 dBA SPL with all the machinery on. That's not easy to do, but it's worth shooting for. Assuming you can hear audio down to 10 dB below the noise floor, that 40 dBA noise floor gives you a signal-to-noise ratio of something like 60 dB from the standard calibrated mix level used by the film industry (85 dBC from one speaker, as heard at the mix position). This spec will also yield an overall acoustical dynamic range of approximately 75 dB. Doesn't sound like much, I know, but you'll be surprised by how good it actually is, when you get there!

Symmetry

Room symmetry is hardly ever mentioned, yet it turns out to be critically important for the reliable monitoring of stereo images. Without getting into "why" this should be so, I suggest to you that it is usually the single most effective thing you can do to make your control room start sounding really good and turning out decent mixes.

What you want here is "lateral" symmetry, which is to say that both sides of the control room are identical in shape and materials, that there is a "median plane" down the middle of the room, and that the two sides of the room constitute "mirror images" of each other. Needless to say, the loudspeakers need to also use this median plane (see below).

Unfortunately, such symmetry by necessity includes furnishings, windows, etc. The good news is that most rooms are rectangular and rectangular rooms are symmetrical by definition. I generally recommend that you set up the median plane along the long axis of a rectangular room. You'll have to fiddle with furnishings, etc., and it can be a pain to deal with doors and windows, but you can usually obtain decent symmetry with a little effort in any rectangular room.

Again, the solutions here are common-sense ones, and you simply are going to have to both figure out and then negotiate how to get your layout symmetrical (as in "The bed goes *where*? Hey listen up, Billy Bob Rock Star, if the bed goes there guess where *I* go?! I don't *care* what Moulton said!!").

Early reflections

Early reflections are the group of reflections of a sound that arrives at the mixer's ears within 50 ms after the direct sound (from the monitor loudspeaker) arrives. I believe the behavior of these early reflections is critically important.

Based on research that I and others have been doing, I now believe that the best possible array of early reflections are broadband untreated reflections from the side walls, and no reflections (especially no high frequency reflections) from behind the loudspeakers (the front wall) or overhead.

This, it turns out, is actually fairly easy to deal with. Put lots of absorbent material on the front wall, and some on the ceiling. Use a carpet. See below for more.

Decay time

Decay time is the amount of time it takes for sound to die away in a room. In a small room it is usually pretty short, and so it is generally not a problem. Nonetheless, you'd like to help the decay along (it's called "tightening" the room), and you'd like to encourage the sound to decay equally quickly in all audible frequency ranges.

I like to make the front wall absorbent at all frequencies (this can require some moderate carpentry, building a flexural absorber for low frequencies and covering it with foam or fiberglass for high frequencies). Also, make at least the front third of the ceiling absorbent down to 500 Hz (4 inches of fiberglass covered with fabric or any 4″ foam panels will do fine). This usually gets the decay time down to under 150 ms, and with other absorption in the room it is possible to get the decay time under 100 ms, which will yield really good results.

Interestingly, if you do it right, the room will still sound pretty natural, and not particularly dead, absorbent or weird.

Standing waves

Standing waves are the long low frequency waves supported by the room dimensions. They add a resonant signature to the room and are generally problematic at low frequencies. At mid and high frequencies, standing waves are everywhere in great profusion, and they don't matter for our purposes here.

Happily, standing waves are dependent on the room walls being reflective at low frequencies. If you make the front wall absorptive at low frequencies, you will pretty much take care of any standing waves that would be a problem. Further, openings like doors and windows can make excellent bass traps, if isolation is not an issue—for instance, I use a big atrium window as a bass trap in my room, and it works very well.

Loudspeaker placement

Loudspeaker placement is often as important as the choice of the loudspeaker itself in determining the overall sound quality of a system. There are a couple of principles to get you started, and if you've done your homework on the room as described above, placement of the monitors is going to be a lot more benign, not to mention easier.

To begin with, the loudspeakers need to use the same median plane as the room has—this is a key ingredient for symmetry.

Secondly, the tweeters need to be at ear height, and/or directly aimed at the ears (unless the manufacturer specifically tells you otherwise).

Third, the speakers need to be either mounted "in" the front wall (or soffited) or be far enough "from" the front wall to keep low frequency response from being seriously disrupted by interfering reflections from the front wall. Mounting "in" the wall is a pretty nice thing to do, and it is moderately easy if you build something like my absorbent "monitoring shell" for the front wall that includes cutouts for the speakers.

If you want the speakers to be out in the room, it is good to get them several feet (at least 3 feet, 5 is better) from the front wall, unless that wall is really absorbent at low frequencies. Similarly, you should avoid placing the speakers too close to the side walls (I'd suggest 3 feet as a minimum distance). Finally, you should avoid having the speakers at the same distance from the front and side walls, if possible.

For the rest of it, there is a common practice tradition of listening to speakers that are each 30° off the median plane (and we do our serious listening on the median plane), so that the two loudspeakers and our listening position constitute an equilateral triangle. This setup works pretty well, but the 30° part is fairly informal and so long as the phantom images and spaciousness are working well, you can have wider or narrower spreads without much problem. What you definitely have to have is symmetry, and you must be listening on the median plane.

Loudspeaker behavior

Ah, yes. The loudspeakers. They are part of the system, aren't they? What do we need from the loudspeakers themselves? I've been working hard on this question over the past couple of years and have some suggestions, as you can probably imagine.

First off, loudspeakers need to have reasonably flat frequency response on axis. They also need to have pretty benign off-axis response, which is to say that even though the high frequency output will fall off dramatically off-axis (except on my loudspeakers, of course), it needs to do so smoothly. It would also be nice if it doesn't fall off too much over ±15° at, say, 10 kHz.

Low distortion is another issue for loudspeakers. Transducers, which are mechanical devices, generally have a pretty narrow range of linear behavior. Keeping speakers with small woofers out of significant distortion is hard.

The point here is that you need to pick your speakers with care. "Any old speaker" is no longer good enough, particularly once you've gone to the trouble to get everything else right. Without a doubt, you will also need something crass like Auratones to check your mixes on, but you really do need something better, something really good, with which to do your tracking, mixing and maybe a little pre-mastering. The loudspeaker is your musical instrument. It is also a lab instrument. Yikes! Enough said!

Where the rubber hits the road

As you can see from the above, this is all actually pretty straightforward stuff, although you can get into some serious carpentry projects if you are so inclined. In short, you've gotta get your room quiet, make it symmetrical, get the decay time down, buy good loudspeakers and place 'em carefully.

Dave Moulton is trying to build the perfect loudspeaker. You can check out his website at www.davemoulton.com.