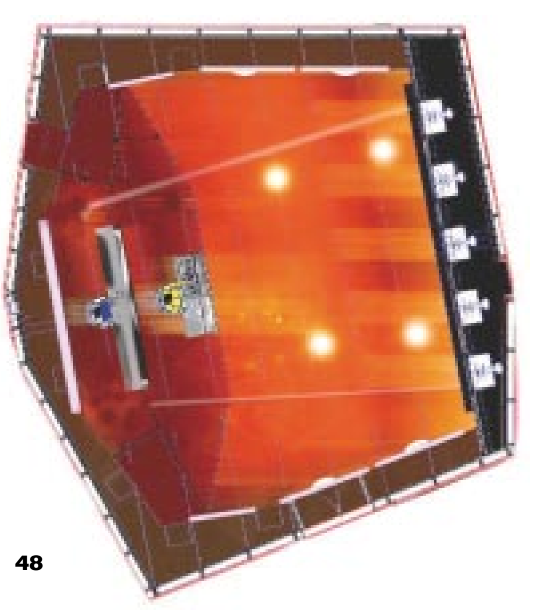
Are you hearing it right?

As with all tools, their inherent usefulness is determined primarily by the hands that use them and in the case of control room monitoring environments, the ears that refer to them. SOOCH SAN SOUCI from Audio Engineering SARL discusses multichannel control room issues and considerations.

CONTROL ROOM ACOUSTICS for multichannel 5.1 intend to offer the engineer and the production team a clear account of levels, timbre, spectral content, dynamic range, intelligibility and spatial considerations in a partial 3D sound field.

Without going into a discussion of monitor technologies and presenting their influences on surround perception, which is a very interesting subject in itself, I'm going to look at control room acoustics for multichannel work with particular attention to structural influences, and the choice between soffit mounted monitors or free field placement. First, let us agree on one basic reality. The direct sound from the monitors is what you have recorded plus the non linearity of your monitors and the electronics up stream. If you have faith in the choices you've made for monitors and the electronics and signal path before them, then let us continue.



The placement of monitors and the acoustics around them have perhaps the greatest influence on the usefulness (acoustical precision) of the system. There are hundreds of thousands of audio people on the planet, millimeters or seconds away from going crazy due to the acoustic environment in which they work. Every day acoustic problems mask detail in severe ways. The masking effect of modal problems and major reflections cause the most common mistakes yet creative decisions are made based on acoustic phenomenon related to the room and not on the work recorded. The bottom line is that this sort of work does not travel well.

With time we all adapt to less than ideal work conditions, but guessing, or using trial and error, is slow, costly and often disappointing.

So direct sound from your monitors plus all reflections equals what your ears hear and thus what you understand from your hearing mechanism. Within the boundary of your acoustical shell, all reflected sound energy from walls, ceiling, floors, furniture, racks, video monitors and other structures will combine to form a coloured (modified) version of the direct sound.

Speaker placement, listening position, and volume are easily recognised as important factors. NS-10s on stands will never sound the same as they will when placed on a console, as the console work surface enhances the travel of low frequencies toward the listening position. The NS-10 profits from a low-mid and bass lift that offsets its very nasal mid-range frequency response. With time, engineers became accustomed to the results.

All hard surfaces within the room reflect sound energy. These reflections alter the direct sound, or become standing waves between any and all parallel surfaces. A useful demonstration: send wide-band pink noise through one monitor and with an omni microphone (1/4-inch diaphragm if possible) connected to an RTA (real time analyser) wander around the room, microphone in hand and watch the changes in energy per 1/3-octave band on the RTA. Measurement from the following positions will be revealing. All sitting and standing positions along the console, all sitting and standing positions 1m behind the console, above tables or flat surfaces, under tables, between all parallel surfaces, in fact all sitting positions commonly used within the room.

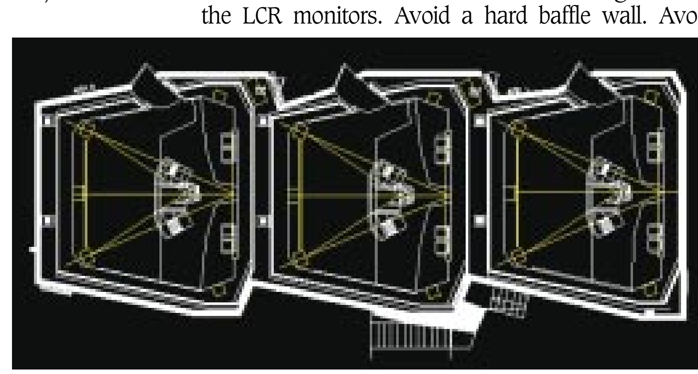
Many modal artifacts will be observed and any major reflections will be evident. The smaller the difference between the results of measurements throughout the listening area (the sweet spot) the better the room. The fewer the resonant bumps, created by tables, racks or room geometry, the better.

When the direct sound and the reflections combine, they either add or subtract depending on frequency/phase and distance travelled (time) relationships. Standing waves set themselves up between all hard parallel surfaces and contribute as a constant. Room modes (standing waves) and local resonance are stimulated differently as the monitor position is modified.

A simple illustration is to measure pink noise via an omni mic at the engineer's head position. Watch the 1/3-octave band level changes on the RTA while moving, for example, a Genelec 1031 (set to normal) on stands, from its original position out towards the nearest wall and then on to the nearest corner of the room. After all this moving around you might ask: What is best and what is normal? That which is useful is a fair response but we are discussing masking caused by room acoustics, and the 'best' reply is acoustic transparency.

The big question is how to achieve transparent room acoustics that yield the highest clarity possible within the budget. You reduce the reflections, reduce the modal problems, and avoid resonant problems for a given working monitor level.

In real terms, there is a list of simple yet logical criteria. Avoid hard surfaces between the engineer and the LCR monitors. Avoid a hard baffle wall. Avoid



glass in front of the engineer. Avoid doors in front of the engineer. Wood or tiled floors are preferred and absorbent ceilings compliment hard floors. Avoid any reflections from above. Avoid flat tables that reflect sound directly towards the engineer and avoid placing vertical surfaces that will reflect sound toward the engineer, either from behind or in front of the listening positions.

To bring this discussion full circle, we add surrounds at 120° (110°–130°).

They are full range monitors, mounted either at the same height from the floor as the LCR or slightly higher. All reflections from the surrounds must meet the same criteria as LCR to avoid localisation confusion and to limit the acoustic diffusion of the control room that could mask the spatial details inherent in the recorded sound.

The real acoustic goals are continuity and transparency from specific room colouring or acoustic masking. You need to ask yourself when panning from left to centre to right to surround, does the sound of a bee transform itself from bee to fly to killer wasp to mosquito as it moves from one monitor to another, or does it just move around the room? Try panning various timbres – solo oboe, solo cello, piano in stereo, classical guitar – and listen to the results.

Projects built by very good people in the recent past have included many attempts to obscure localisation cues from the surrounds. Dipoles with their null point pointed at the listening position, each surround aimed towards a diffuser and the diffuser aimed toward the listening position, and multiple surrounds all aiming in various directions – each of these systems has merit toward the goal of a diffuse surround space significantly obscuring localisation of the surrounds. But each of these designs is critically linked to every detail of the structures that are near to the surrounds.

Apparent loudness is very hard to calibrate and control from room to room due to the infinite variation of the diffuse spectral content, and the interaction of the surrounding structures. Keep in mind that a wide-band signal can sound very much louder by simply adding a small amount of gain between 2kHz and 4kHz. Also imagine the perceived and measured level differences with pink noise and an RTA, while comparing each of the preceding configurations with a discrete direct radiator.

The engineer is trying to make critical judgments about relative levels of L, C, R, LS, RS, spectral energy, discrete timbres and envelopment densities created between the 5 channels. However, remember that a fundamental goal identified earlier is that the work travels well. Therefore, the risk involved in an acoustic configuration that is specifically and technologically original, or highly masked by reflections, would present itself as dangerous.

Diffusion in a control room offers solutions and problems. Simple mild enhancement of lateral frequencies above 2kHz from the centre and rear of the side walls can be useful. An over-abundance of spaciousness created by the control room acoustics will mask the true sensation of the recorded envelopment and the recorded enhancements.

The perception of EDT differences (Early Decay Time), ASW differences (Auditory Source Width), prerecorded decorrelation, 3D enhancement programs that can cause severe deformation of live recordings, and auralisation enhancement, are all examples of decisions requiring low masking levels.

Diffusion from the rear can also cause much confusion. Hard surfaces directly behind an engineer will return energy from behind (scattered or not) to both ears with a time delay due to the distance travelled. This energy is made up of many frequency/pressure/phase differences that will again modify aspects of L, C, R, LS, LR direct sound. The more high frequency energy returning from the rear of the control room, the more confusion the engineer will experience due to the time delays between direct, rear reflections, 2nd reflection from video monitors, hard baffle walls, video screens, LCD screens, micro perf screens, plasma screens; all the things necessary for viewing images and sound control data.

Most of these screens are aimed at the engineer. In some control rooms, diffusion makes panning ASW (Auditory Source Width) and phantom mono (between two monitor sources) almost impossible to judge and control with precision.

Diffusion elements like QRD (Quadratic Residue Diffusers) designs also exhibit a frequency/efficiency curve that offers a performance spec that is very useful in music performance acoustics. But for music recording rooms the control of low frequency energy and, more importantly, the overall design criteria are very different from control rooms.

With most QRD designs, the limit for low frequency control is basically determined by the well depth and thus requires additional attention for usefulness below 200Hz. 30Hz to 200Hz is the range where most control rooms have major problems unless they were designed to avoid it.

What we have arrived at is a requirement for direct radiating monitors, the same type, age, size and distance (or time distance) from the listening position, and from the centre line of the control room positioned 30º left and right, 120º LS and RS (110º-130º), centre 0º. With a micro perf screen, only the centre channel goes behind the screen and left and right should be placed to reduce the frontal acoustic glare of the screen. Then a LFE channel, the sub and its placement is worthy of another article.

In all cases, it is important that the direct sound levels measure 15 to 25dB higher than the first major reflections. The greater the difference the better. Calibration should be done with a 1/4-inch capsule omni pointed towards an absorbent ceiling. MLS measurements are reasonably accurate for time alignment, ETC (energy time curves) and detailed measurements of reflections.

Delay should be used to recover distance limits imposed by room geometry. Mild EQ can help with small standing wave problems, but the best results are achieved by avoiding electronic correction for architectural acoustic problems.

Common room volumes and monitor choices often dictate average listening levels. The absorption characteristics of structures and materials is not a linear function. Engineers quickly determine at what level the monitors offer the coherence they deem useful for the type of work they do. Although there are differences in styles, content, personal taste and hearing disabilities, it is common to find that a large percentage of engineers rely on one or two room monitor levels in a given room with a given system. Monitor level for music is personal but monitor level for dialogue should be discussed further.

During dialogue recording, listen as loud as is necessary but when mixing dialogue for DVD, engineers would benefit from using 75-78dBA as a reference monitor level for good reason.

The home listening environment has a very restricted dynamic range for sound with picture programme due to many factors. Ambient noise is generally high but high sound levels might annoy others. The reduced speed with which the ear changes sensitivity (or gain) with age and other hearing impairment conditions also contribute to lower levels of dialogue intelligibility. Add the masking effects of average living room acoustics and we see why music and sound effects levels often mask dialogue in DVD mixes.

Surround sound enhancement suffers the same fate if the monitor levels are high during the final mix. This refers to the common disappointment experienced when listening to a surround sound mix outside the control room and finding that all the fine detail has disappeared. One must have a clear understanding of 'dynamic range limits' when evaluating the fun of music, the boom of sound effects, and the soft and tender passages of dialogue. So let it be clear, working in an environment that is rife with acoustic problems is harder with five channels than it is with two and the result is very unlikely to travel well.

After many years and many discussions with audio engineers, designers, acousticians, and music colleagues we have come to the conclusion that control room acoustics for 5.1 need to be revised in criteria over pre-1990 design thinking. Hard baffle walls, in which the LCR are encased, might no longer be valid.

In a 5.1 environment, if possible, avoid hard walls, glass and doors in the front half of the control room.

Live-end/dead-end designs (LEDE) found favour among many, but when TEF test gear was available from 1985 we noticed that many problems arose from the hard walls and by 1990, with multichannel approaching, we decided that there was a better way. We started to develop the design of encasement with low frequency absorption in the front wall and extended low frequency absorption in the rear wall. Much attention was paid to avoiding standing waves or resonance. And with 5.1 encasement or free field, all monitors are treated the same way.

As an alternative during the 1990s, we have started to suggest an economical system with all monitors on stands, not encased, and treatment throughout the control room to be symmetrically equivalent, based on quadrant analysis from the centre line of the control room. The result is a transparent and low cost installation.

Placement and monitor choices can be modified, with mid field monitors being popular, and less trapping is involved for low frequencies, which allows larger interiors to be realised from the available slab dimensions. We've now built a number of free field, mid-sized monitor, multichannel installations around the world and we believe it is the way ahead. ■

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