AUDIO UPDATE

Why stereo doesn't work

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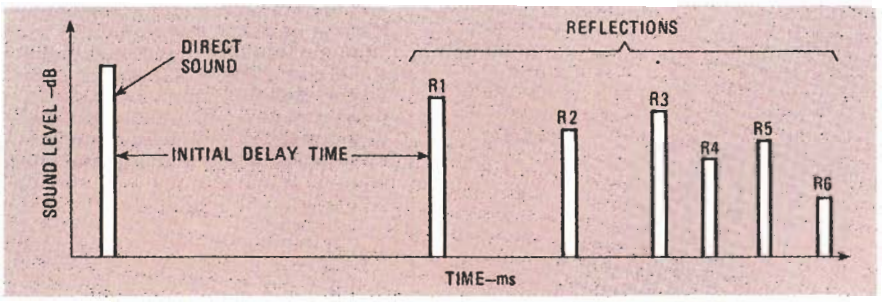

FIG. 1

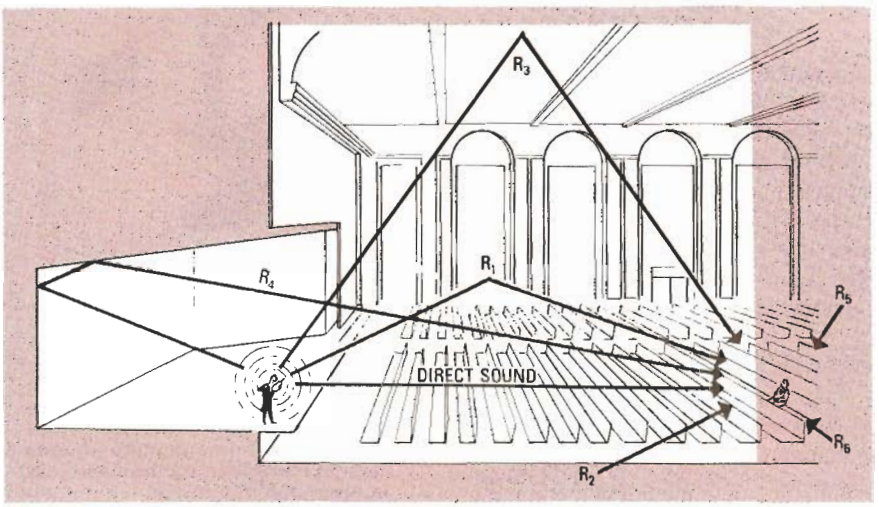

FIG. 2

DESPITE MORE THAN 35 YEARS IN PURsuit of the "Holy Grail of Hi-Fi" (i.e. *perfect* sound reproduction), I've experienced it something less than a dozen times. By "perfect" I mean that with my eyes closed, I sonically seem to be in the same room or hall with the performers. Aside from a few impressive experiences with binaural headphone listening, which is another acoustic ballgame altogether, the only times I've experienced the "I am there/they are here" phenomena have been when there was specially recorded program material and/or when two or more extra channels have been involved.

For some of us, quadraphonic sound reproduction, which was introduced in the early 1970's, had a potential that was never fully realized. A combination of bad marketing, bad engineering, and bad demonstrations condemned quadraphonic sound to an early demise, despite the fact that the basic concept was valid.

Live *vs.* reproduced sound

To appreciate the reasons why multichannel sound is, by its very nature, far superior to the best that conventional stereo has to offer, it's necessary to understand the differences between live sound heard in a hall and recorded sound reproduced in a living room.

There are few acoustic similarities between the two listening environments. The sheer size of most live-performance venues means that the sound reflected and re-reflected from the boundary surfaces (walls, floor, ceiling) are going to reach a listener's ears substantially later than the sound coming directly from the performers. See Fig. 1. Since sound travels roughly 1,100-feet-per-second, or 1.1-feet-per-millisecond, time delays of more than 50 milliseconds between the direct and reflected sound are not uncommon. And when the sonic environment is both large and hard surfaced, such as in a church, the reflections multiply, blend, and take several seconds to die away. Furthermore, the reflected and reverberant energy, which can account for better than 80 percent of the total sound impinging on the audience, comes at the listeners from all directions. See Fig. 2.

Even when perfectly set up in a normal listening room, a conventional high-quality stereo system is functioning with a host of handicaps. First of all, the sound comes from a more or less flat plane whose area is roughly defined by the location of the two speakers. Whatever hall reverberation is captured by or synthesized into the recording is also coming from the same space.

Of course, there are reflections of the speaker sound taking place

within the listening room, but compared to any live recording environment, the listening room walls are usually much too close. That means that the reflections arrive much too quickly (have too short a delay time), and the reverberant sounds that would normally be heard from the sides and rear essentially all come from the front. In fact, unless the chosen speaker systems are very carefully set up with due consideration for their specific dispersion characteristics and their proximity to the adjacent room surface, early room reflections are likely to distort the stereo image and to introduce frequency-response irregularities through cancellation and reinforcement of the direct signal.

To my ears, most speakers sound best when at placed least three or four feet away from any reflecting surface, including the back wall, and are, in general, situated in a fairly absorptive part of listening room. Carpeting in front of the speakers, wall hangings behind and between the speakers, and soft chairs flanking the speakers are all means to that end.

In my view, it is the audible, but usually only unconsciously perceived disparity between the acoustic environment embodied in the recording and the actual acoustic environment of the listening room that is primarily responsible for the lack of sonic realism of even the best stereo system.

My theory is supported by the fact that a good system almost always sounds more realistic when heard from an adjacent room, where you hear a blend of the two contradictory acoustic environments. A very large listening room can give rise to the same effect; when you listen far enough away from the speakers some of the same acoustic blending can take place. But in no case does the recorded early and late reflections (reverberations) surround the listener in the same way it does under live conditions.

The sound field

From the psychoacoustic viewpoint of a single listener, the complex acoustic interactions taking place throughout the concert hall or listening room don't really matter. What is significant is the ever-changing sound field occurring directly at the listener's two ears. Even an untrained listener hearing a well-recorded live performance for the first time has a sense of the size and the nature of the recording space. Assuming that the engineers were competent, the acoustic ambience of a recording of Orff's *Carmina Burana* performed in a church is going to sound quite different from that of a small jazz group playing in a night club. Our ear/brain computers are constantly analyzing the similarities and differences in phase, timing, amplitude, and frequency occurring in the sounds reaching our two ears. That information is used unconsciously to construct a mental image of the acoustic environment in which the sound is taking place. I say "unconsciously" because we are not talking about a deliberate mental process. But the fact that we are

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able to make judgments about the recording environment when listening to a good stereo recording is a far cry from experiencing an I-am-there sonic illusion.

If we could perfectly record and store the two separate sound fields that impinge on a listener's right and left ears at some specific seat in a concert hall and then accurately reproduce the two fields directly at another set of ears, the second listener should experience exactly what the first listener heard. Many such recordings have been made using carefully constructed dummy heads with wide-range microphones implanted in the equivalent of their ear canals. Of course, the material has to be listened to through headphones to prevent the introduction of a confusing intervening acoustic environment. I've heard many such binaural recordings, and while they are a definite step towards realism, for obscure reasons they don't achieve quite the I-am-there perfection that theory seems to promise.

A practical approach

Late last year, I was asked by Yamaha to participate in the introduction of their *DSP-1* digital sound-field processor. I was particularly interested in the device because it used a completely new approach to recreating "concert-hall realism" in the home. It was neither an updated quadraphonic synthesizer nor a time-delay system, although in a sense it could be said to draw on both techniques in its digital manipulation of the signal.

After some discussion, Yamaha and I agreed on a presentation technique; I would first discuss the acoustic and psychoacoustic differences between the live musical experience and recordings reproduced at home—very much as I have done in my column. I would then introduce the *DSP-1* as one company's approach to enhancing the reality of home music reproduction. I'll discuss the specifics of Yamaha's digital processing techniques next time. **R-E**