US: Peter W. Mitchell

When I visited the Fried exhibit during the Las Vegas CES, I was surprised to encounter an old acquaintance—Chuck McShane, whom I met two decades ago when he was designing loudspeakers for Acoustic Research. He invited me to return after Show hours to hear a demonstration of a remarkably simple invention that reportedly provides a cheap and cost-effective way to broaden the soundstaging of stereo speakers. I'm a sucker for bargains, so I returned to hear the demo. [*Mr. McShane will be demonstrating his system at Hi-Fi '94, due to take place Friday April 29 through Sunday May 1 at Miami's Doral Report.—Ed.*]

Knowing McShane's history as a skilled engineer, I was certain that whatever he was doing would be based in solid science, not hype. Before I report what I heard, let me give you a bit of background on psychoacoustics, concert-hall acoustics, "shuffler" circuits, and woofer manufacturing:

1) Our perception of direction varies with frequency. At high frequencies, where the wavelengths are smaller than the human head (*ie*, above 2kHz), we depend on intensity and arrival time. If a source is located to the right, its sound arrives first and louder at the right ear, then later and weaker (because of the shadowing of the skull) at the left ear. At low frequencies, below about 800Hz, the skull is smaller than a wavelength and doesn't block soundwaves, so we depend on the phase difference between the signals the soundwave produces as it passes the two ears.

2) A few years ago, acousticians discovered that our perception of concert-hall ambience is strongly related to lateral soundwaves—*ie*, reflected wavefronts that travel sideways across the head. If a hall fails to produce lateral reflections, it's perceived as lacking ambient warmth, despite the presence of strong "medial" reflections (along the center-line) from the front, back, or above. It's no accident that the "rear" speakers in surround-sound playback tend to work best when they're mounted on the sidewalls (or are aimed to bounce sounds off the sidewalls), to produce lateral wavefronts at the listener's head.

3) After A.D. Blumlein invented stereo recording 60 years ago, he explored several miking arrangements for stereo. One, called "mid-side" miking (MS), employs a mono mike ("M") aimed to the front, and a bi-directional mike ("S") aimed sideways. Their outputs are combined in a sum-and-difference matrix to produce the left channel (M+S) and the right channel (M-S). Blumlein called the matrix a "shuffler" circuit. In recent years, both David Griesinger at Lexicon and Michael Gerzon in the UK have explored other uses for shuffler circuits. They found that strengthening the L-R content of a stereo signal below 800Hz broadens the soundstage and enriches its perceived ambience.

4) The largest segment of the audio business is not living-room stereo, but car audio. The single most dramatic upgrade for a basic car stereo is the addition of a subwoofer, driven in blended mono from the existing stereo amplifier channels. To serve this market, many woofers are manufactured today in two versions: one with a conventional voice-coil, for use with a single amplifier channel; and an alternate version with dual voice-coil windings (two 4 ohm coils interleaved on the same former), to receive the low-frequency outputs from both channels.

Now consider the challenge of getting a two-speaker playback system to produce lateral wavefronts in a living room: The first difficulty, of course, is that the majority of recordings don't contain appropriate signals. In most studio recordings, the left and right channels are substantially in-phase, with left/right localization determined by "pan-potted" intensity differences. When coincident (Blumlein or crossed-pair) microphones are used for concert-hall recording, the signals again are in-phase in the two channels, while intensity differences create the stereo image.

STEREO PLAYBACK USUALLY SHRINKS THE RECORDED SOUNDSTAGE.

Recordings made with spaced mikes contain phase and timing differences between the channels. Many orchestral recordings contain such signals, notably those on the London, Telarc, Delos, Philips, and DG labels. But when you're relaxing in your chair 8' from your speakers, they probably subtend an angle of only 60° or so. The wavefronts that they launch into your room are primarily medial (front-to-back), with only a small diagonal or lateral energy component. To make things worse, each ear hears the output from both speakers at nearly the same strength.

The usual result is that stereo playback shrinks the recorded soundstage. Not only is the hemisphere behind the microphones folded into the front, but the 180° front hemisphere also tends to shrink into the 60° or 90° span between the speakers. With careful design and a lot of luck, your speakers may project a soundstage that extends beyond the speakers, but this is often an artificial result of sidewall reflections. Two-speaker stereo does a poor job of reproducing the lateral wavefronts of the hall's real low-frequency ambience.

3 Note that JA's and my auditioning of HDCD involved a comparison of Keith Johnson's first-generation analog master tape and the tape playback with real-time HDCD encoding and decoding. Press demonstrations of other encoding systems, Sony's Super Bit Mapping, for example, have not been so clear-cut as to the source of the signals under comparison.

McShane's invention makes use of the factors enumerated earlier to reproduce the ambient warmth hidden in spaced-mike recordings. The principal attraction of the system is that it avoids the complexities and cost of surround playback, reproducing ambient warmth and a wide, 180° soundstage using only a stereo pair of speakers. The loudspeakers are conventional, except that the woofers have dual voice-coils. The "hot" signal from each amplifier channel is connected to both voice-coil windings in the same-side speaker, but only the primary voice-coil winding on each side is connected to ground. Thus, the primary winding in each woofer handles the normal left or right signal.

A third wire runs between the left and right speakers, connected to each woofer's secondary voice-coil winding. Filter elements in the speaker's crossover limit the crossfeed signal to frequencies below 800Hz, and the signals are passively matrixed in the voice-coil windings. The result: In addition to the normal left or right signal, each speaker receives the L–R stereo difference signal. Thus, the left speaker reproduces the L signal plus the L–R signal below 800Hz, while the right speaker reproduces the R signal plus R–L.

The effect of the crossfeed matrixing in the dual voice-coils is to provide Griesinger shuffling (L–R enhancement below 800Hz) without adding any electronics to the signal path. The magic is that, since it's passive, it's practically free. Dual-coil woofers are mass-produced at the same price as single-coil woofers, so the only added cost is for a couple of crossover components and an extra input terminal for the crossfeed signal.

Note that the crossfed difference signal is out-of-phase in the two speakers (L–R in the left, but R–L in the right), so it's heard as a diffuse, non-localized sound. If the recorded signals in the two channels had the same phase and timing, then the added energy below 800Hz would simply increase warmth. But spaced-mike recordings contain phase and timing differences that become part of the L–R signal. And in concert-hall recordings, the hall's omnidirectional ambience is captured by spaced mikes in random phase, so ambience is a strong part of the L–R signal.

In McShane's demonstration, I chose familiar recordings that I've heard through hundreds of stereo systems. In a studio recording of pop music (Jennifer Warnes's *Famous Blue Raincoat: The Songs of Leonard Cohen*, Private Music 01005-82092-2), the crossfeed circuit merely added upper-bass warmth. Since the recording was already well-balanced for stereo playback, the extra warmth thickened the sound. The system sounded better with the crossfeed wire disconnected.

THE SYSTEM PRODUCED A STRIKINGLY TRUE-TO-LIFE IMAGE OF THE SOUND OF HARVARD'S SANDERS THEATER.

But with a spaced-mike recording—a performance of Brahms's *Alto Rhapsody* that Brad Meyer and I recorded with three mikes (left, center, right)—the effect was magical. Without the McShane crossfeed circuit, the recorded ambience merely occupied the space between and behind the speakers. But when the crossfeed wire was reconnected, an extraordinary bubble of ambient warmth filled the front hemisphere, producing a soundstage that stretched from wall to wall. Irving "Bud" Fried, who has been listening to orchestras in concert halls for more than half a century, agreed with my impression that the system produced a strikingly true-to-life image of the sound of Harvard's Sanders Theater, where the recording was made.

While the impression of "envelopment" in the soundfield was not that of the best surround systems, it was the most spatially realistic two-speaker playback I've heard. The contribution of the crossfeed connection was mainly additive, without sacrificing the usual properties of stereo soundstaging. The mezzo-soprano solo was still tightly focused at stage center, while the male chorus was still imaged in the space between the speakers and behind the orchestra. What changed was the ambient field, which leapt forward and out from the speakers, filling the room—almost real enough to touch.

With the James Johnson performance of a Bach organ piece (on the first *Stereophile* Test CD), the expansion of the ambient field was less dramatic, but it still had a more realistic "being-there" impression than did conventional stereo. Since the effect of the McShane ambient-expansion circuit is recording-dependent, I recommend using a long wire for the crossfeed connection, with an on/off switch at your chair so you can use the crossfeed connection when it improves the sound, and switch it off when it doesn't.

McShane has applied for patents on the crossfeed circuit, and also on his design for a metal sleeve insert that speaker designers can use to improve the linearity of the magnetic field in a driver's voice-coil gap. Since he's a freelance engineer, these inventions are not the exclusive property of any one company—they're available for license to any speaker manufacturer. Interested designers can contact Charles McShane by phone or fax at (708) 298-4439. Fried Products has already announced plans to include the McShane ambient-expansion circuit in all new Fried speakers, and the system is also being used in speakers from a Chicago outfit named Van L. Speakerworks.

This is not the first use of crossfeed to improve soundstaging. Both Carver's "Sonic Holography" circuit and Polk's SDA used delayed crossfeed in an attempt to remove the blurring of the stereo image that occurs because both ears hear both speakers. The effect worked mainly at midrange frequencies, and it had some drawbacks: Listeners had to sit precisely on the stereo center-line, some listeners experienced an uncomfortable sensation of pressure in the ears, and there were occasional imaging oddities. The McShane circuit avoids these drawbacks, requires no delay, and is practically free. Its principal limitation is that you can't retrofit it into the speakers you already have. Manufacturers must build it into new speakers by using dual- rather than single-coil woofers.

Many of the products described in this magazine cost as much as a car. As JA suggested in the March '94 "As We See It," the real challenge for audio engineers is to create designs that we all can afford. Although the benefits of the McShane ambient-expansion circuit may apply only to spaced-mike recordings, it certainly qualifies for some kind of best-buy designation.