

Shuffle Play

KEITH HOWARD EXAMINES A NUMBER OF VARIATIONS IN STEREOPHONY

The dyed-in-the-wool hi-fi purist who rejects any manipulation of an audio source signal, whatever the circumstances, should perhaps turn to the next article now. Either that or be prepared for core beliefs to be challenged, because what I'm going to describe are three variations on the ancient art of tweaking stereo signals by first converting them to MS (sum and difference) form and then 'shuffling' them. The ideas are not new but with the increasing availability of digital signal processing (DSP) there is a case for saying they should be revisited, reassessed – and perhaps revived.

We habitually think of stereo signals as comprising a left channel and a right channel. After all, this is how stereo music is delivered on physical media or in downloads, for replay through left and right loudspeakers or the left and right capsules of a headphone. Amplifier inputs are labelled L and R, and so are their outputs. And, of course, we have left and right ears.

But the LR representation of two-channel stereo is not the only one. We can alternatively think in terms of sum (M) and difference (S) signals, typically defined as:

$$M = L + R$$

$$S = L - R$$

although to obviate overload a more practical definition is:

$$M = 0.5 (L + R)$$

$$S = 0.5 (L - R)$$

Michael Gerzon (who will appear later in this story) preferred:

$$M = 1/\sqrt{2} (L + R)$$

$$S = 1/\sqrt{2} (L - R)$$

as this preserves total signal energy ($L^2 + R^2 = M^2 + S^2$), which is not the case with the other definitions.

The above may appear to be mere arithmetical jiggery-pokery but the MS representation allows certain signal manipulations to be performed more easily, particularly stereo width control. A convenient way of regarding the M and S signals is that the first is the mono component and the second the stereo component (although this is *not* what M and S stand for – actually it is 'mid' and 'side'), so if we attenuate the S component relative to the M component and then convert back to left and right signals, the width of the stereo soundstage will be reduced (or *vice-versa*). In some circumstances it can be convenient to be able to narrow or widen the stereo image using a

single gain control; things become more interesting, though, when we make the manipulation of the M and/or S components frequency-dependent, *ie* when we apply filters to them.

The first person to appreciate the power of MS signal processing seems to have been Alan Blumlein of EMI, who describes an application of it to stereo recording in his famous 1931 patent (BP394,325), which established the mathematic and psychoacoustic basis of two-channel stereo as well as practical means of its creation and delivery. Today the term 'Blumlein stereo' is usually taken to mean stereo recorded with two near-coincident figure-8 (velocity) microphones with their axes aligned at right angles, but this wasn't the only method of recording stereo that Blumlein described. Also outlined in the patent is a method for processing the outputs of two closely-spaced omnidirectional microphones to convert their phase differences into amplitude differences, which first converts the two microphone signals into sum and difference (MS) form.

The terms 'shuffling' or 'shuffler' don't appear in Blumlein's patent and weren't used publicly by EMI to describe such processing until after WWII. (Blumlein himself died in an aeroplane crash in 1942 while developing airborne radar.) This quaint terminology doesn't conjure up the clearest picture of the applications to which the manipulation of M and S components has been put, which perhaps partly explains why it hasn't always been used in reference to the signal processing concepts I'm about to describe. It is also almost certainly the case that the Blumlein/EMI work and its associated terminology was less well known to later generations of audio engineers than it deserved to be.

First shuffle, 1954: Stereosonic

Given that shuffling was invented by Blumlein at EMI, it's fitting that EMI went on to be the first record company to apply it commercially, albeit over two decades later and not in the manner Blumlein envisaged. The first 45/45 stereo LPs went on sale in the UK in 1958 but, of course, record companies began experimenting with stereo recording some years in advance of this. By 1954 EMI (which had made its first stereo recordings under Blumlein in the 1930s) had done so sufficiently to believe that it had made an important discovery, for which it lodged a patent application that year (23989, granted as