

*A possible commercial revival prompts Barry Fox to look again at Ambisonics surround sound*

You could say that the history of surround or quadrasonic sound is chequered. You could better describe the story of surround sound as a miserable one, and its history a graveyard.

The hi-fi companies, broadcasters and record industry experimented and squabbled in public with a string of different, incompatible and inadequate systems. All failed commercially; all participants burned fingers. When the British Ambisonics surround sound system came along it stood little chance, for two reasons. Its pitch had been queered by the bad will and publicity generated by the failed systems and the hype which surrounded them; and by the fact that the Ambisonics inventors sold their rights to the NRDC (National Research Development Corporation), now the BTG (British Technology Group).

However, there have been behind the scenes negotiations on a buy-back for several years now, whereby the Ambisonics inventors could themselves try to sell the technology. In July a deal was struck between BTG and Canadian company Maple Technology.

It looks as if this may already be happening. Chessington company Troy, a subsidiary of AVS, is to sell an Ambisonics surround sound system for cars. Broadcasters may once again have to start thinking about whether or not to transmit programmes in surround format. For many it will be *déjà vu*, with the facts forgotten, so here is a brief factual reminder of what makes Ambisonics tick.

The old surround systems recommended four loudspeakers round the room, ideally fed with separately sourced signals—hence quadrasonic. Essentially the idea was quadruple stereo, the four speakers forming four stereo pairs, and as such was doomed from the outset.

Conventional stereo works properly only when the listener is facing a pair of loudspeakers, at an angle of around 60°. The system also works to a certain extent when the speakers are behind the listener. But pairs of speakers to the side produce no real stereo effect. Also when four loudspeakers are arranged in a square, each pair subtends a listening angle of 90°, which is wrong for stereo.

The SQ and QS matrix systems, developed by CBS

and Sansui, simply mixed two extra channels of rear sound in with the front stereo pair, adding extra phase shifts to help separate the signals again by addition and subtraction. So mono compatibility was suspect. JVC and Nippon-Columbia developed multiplex approaches, with extra channels of information recorded on high frequency carriers. Nippon-Columbia also had rights on a matrix technique patented by Duane Cooper, of the University of Illinois.

Meanwhile in Britain, two university academics, Professor Peter Fellgett of Reading University, and Michael Gerzon of the Mathematical Institute of Oxford University, were working on a matrix approach which turned out to be similar to Cooper's. The first thoughts struck both Fellgett and Cooper at around the same time in 1970, and both filed patents. Gerzon took the idea much further. Later NRDC struck a licence deal with Cooper to clear use of his patents.

The Ambisonics team always rejected the quadrasonic approach to surround-sound. Whereas recorded and transmitted quadrasonic signals are suitable for amplification and direct feed to a loudspeaker, with Ambisonics they are not. There is also no attempt at pairwise-blending, the technique of surrounding the listener with four loudspeakers, fed with four stereo signal feeds. In a nutshell, there is no desire to try and record or transmit four separate loudspeaker signals in a two-channel medium and then recover them as discretely as possible.

The object of Ambisonics is to create an illusion of sound from four, or more, loudspeakers around the listener. The loudspeaker signals are generated only in the final decoder. Two recording or transmission channels are adequate; but a better illusion is obtained if the speaker feeds are derived from three channels. As a compromise the third channel can be bandwidth limited, a so-called 'half channel'. If a fourth transmission channel is used, there is nothing to be gained (and in practice even something to be lost) from using it to produce the feeds for a simple horizontal loudspeaker set up. If a fourth channel is available, it can be used to convey height infor-

mation.

The signals recorded in the studio are so-called 'B-format'. They are a clutch of four, including height information, and suitable for recording and transmission on any four channel medium. They are not four playable loudspeaker feeds, and are best thought of as an archive format, from which a variety of user signals can be derived, in 2, 2½, 3 or 4 channel formats depending on the carrier medium available.

An Ambisonics microphone samples the soundfield in a studio or concert hall at a single point in space. However, it is physically impossible to have even two microphones located at precisely one and the same point. Even a few millimetres offset will cause phase discrepancies, at high frequencies.

The Calrec Soundfield mike has four cardioid capsules arranged in a tetrahedron. The four capsules are positioned so that their maximum response directions are left back down, left front up, right front down and right back up. The four capsule outputs are separately amplified and equalised to produce four outputs. One of these is an omnidirectional signal. The remaining three B format signals are equivalent to the signals which would be produced by figure of eight microphones pointing front-to-back, left-to-right and up-and-down. When related to the omni as reference, they carry directional information on all the sound arriving at the microphone.

Although classical recording engineers may be happy enough to use a single soundfield-sampling microphone located in front of the orchestra, it is not at all what the pop industry wants. Over recent years, the Ambisonics team have worked with British firm Audio and Design, to develop a studio desk bolt-on which will take an input of multi-track mono recordings and mix them into a reasonable equivalent of the B-format soundfield sample. This now allows engineers to make pop recordings with multi-track equipment, and mix down into Ambisonics surround-sound. Stereo and mono capability are good, because there is none of the brutal rear channel anti-phase coding used by the quadrasonic matrix systems.

For the foreseeable future, at least, the Ambisonics signals

delivered to the listener will be in two channel format. The consumer or C-format is known as UHJ. It's a hierarchy of compatible 2, 2½, 3 and 4 channels. The UHJ signals are decoded by an amplitude-phase matrix into signals generally corresponding to the B-format signals which originated in the recording studio.

The decoded signals are processed prior to amplification, in a way which depends entirely on the number of loudspeakers used, their angle around the listener, and their distance from the listener. The decoder has adjustment controls for this.

Processing is not simply a variation in the gain of the signal fed to the loudspeakers. If, for example, the layout is asymmetrical, the gain of the front-back difference signal is adjusted. The signals are also frequency filtered to compensate for distance effects. The decoder emphasises amplitude clues to direction at high frequencies, and phase clues at low frequencies, with smooth transition between the two processes.

Although there are records on sale which are encoded in Ambisonics UHJ format, they are bought mainly by people who do not know what Ambisonics or UHJ mean, and played in mono or stereo. Although there are decoders available, they are known mainly to hi-fi buffs. There has never been any attempt to exploit a valuable feature of Ambisonics, stereo decode, enhance, or super stereo.

Super stereo or enhance produces a surround spread of surround-sound from most stereo recordings, and is better than the clumsy wrap produced by old quadrasonic systems. People who buy decoders for the enhance effect could then try playing UHJ recordings.

This is what may now happen with the new Troy car decoder. It has a switch setting marked enhance which converts stereo recordings or broadcasts to a reasonable simulation of surround sound. The image stays firm at the front even for listeners in the back seat and close to rear loudspeakers. And if Troy can succeed in selling decoders to car owners for use on stereo program material, the company might also succeed where BTG has failed and persuade record companies and broadcasters to produce encoded material.