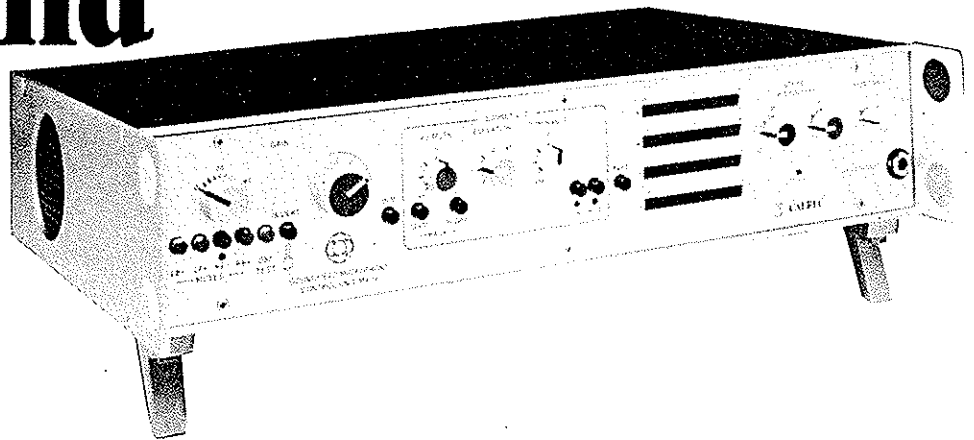# Surround Sound

In this article, Richard Elen gives a personal overview of developments in multichannel and surround-sound technology, concentrating on three main areas: the Tate developments of SQ technology; Ambisonic mixing and microphone developments; and Hugo Zuccarelli's Holophony.

The past few months have seen a fair amount of activity on the surround-sound front, in three major areas. First, there has been growing interest in the United States in enhancements to 'he CBS SQ system by Tate Audio; second, there ..re now Ambisonic mixdown systems available; and finally, there is the rather more contentious subject of Holophony.

The CBS SQ/Tate Systems surround-sound approach is based on the old SQ system marketed by CBS in the early 70s. Failing in the consumer audio market, the system was licensed to Dolby Laboratories for motion picture applications, and formed the basis of the 'Dolby Stereo' system. It turns out today that with several home video releases on the market which incorporate Dolby Stereo soundtracks, the home listener can extract surround information with the user of a decoder such as that marketed by Fosgate Research in Prescott, Arizona. Their *101A* decoder offers SQ and 'cinema' surround decode options, and has full level control on input and output, with LEDs indicating optimum signal levels. A remote unit is also available for the device. Fosgate also produce an in-car model of the decoder (the *201*).

The Tate system is discussed in detail in the Autumn 1982 edition of *MCS Review*. It appears that the system adds 'directional enhancement' circuitry to the basic SQ decode matrix (the .mpression given being that the Tate DES may be used to enhance *any* multichannel matrix system). The system was designed by Martin Willcocks, and although the system is getting increasing coverage in the US, most of the work on the theoretical aspects of the Tate system appears to have been done by Britons! Willcocks has published a good deal of material on the Tate DES, including two papers at the New York AES Convention in October 1983 (preprints 2017 and 2029). The former covers decoder technology and compares Tate and Ambisonic systems. With the Tate system's derivation from CBS SQ technology, it looks rather as if the old battle of words, equations and theories between Michael Gerzon (Ambisonics) and the late Ben Bauer (SQ) has now become a dialogue between Gerzon and Willcocks.

Unfortunately I have not had the chance to examine the theory of the Tate enhancements in detail, as we were only informed of it relatively recently (in a concerted approach by Greg Badger and Wesley Ruggles) and the recent AES provided the first opportunity to look at Willcocks' work in detail. Not being a theoretician of either Gerzon's or Willcocks' stature, a cursory glance tells me little, but it does look very much as if the Tate enhancements optimise SQ surround-sound most effectively. It

certainly looks good on paper, and I hope to be able to listen to the system in the near future.

Optimised or not, though, there are those who will point out that the idea of trying to get separate signals out of four speakers in a square to represent a soundfield is basically a false premise—that at least is what Ambisonic theory suggests. When I first heard Ambisonics in the mid-seventies, I had already had experience of mixing some quadrifontal material which was encoded into the Sansui QS system. I remember being rather unhappy about rear signals, which seemed to pull in dramatically. I never mixed in SQ, but the early examples I heard seemed to lack front/back distinction and were rather muddy in their localisation. By comparison, on hearing Ambisonics I did not suffer either of the same problems. I simply found myself listening to the music and not to the system, and that converted me. Since those days both Ambisonics and SQ have come a long way, and I would not judge the present state of SQ technology on my memories of the odd demonstration of ten years ago. Neither would I regard cinema reproduction of Star Wars effects as particularly indicative of the performance of a surround sound-system. I am looking forward to the experience. Indeed, we would have experienced it by now, were it not for problems including a bomb scare at the concert to which we were invited to hear the system in use on a recording!

Greg Badger, in his letter to us introducing the Tate DES, rightly accused us of not discussing their system, or even mentioning it in passing. This was true, mainly because we had never seen any information on it. Had I not made a point of keeping in touch with the Ambisonic fraternity, no doubt we would have ignored surround-sound altogether simply through lack of information from both camps. This was not the case, however, as having seen the potential of Ambisonics, some colleagues and myself did a great deal of experimentation and liaison with workers in the field, getting to know the subject inside out and doing our best to investigate the applications of the system to mixing rock music (it having been designed originally, by all accounts, as a means for recording and reproducing live performances more accurately). None of us ever got anything out of it, financially or otherwise (in fact quite the opposite—it *cost* us money to experiment) and I still don't. I give the system editorial support because I think it works and I enjoy using it; plus I think it is an important development. For exactly the same reasons we push CD and digital audio, various aspects of console automation...and so on. Thus in Ambisonics, as in most other things, I am biased (as Greg Badger suggests)—biased in favour of

things I know about which work! Now we are only too pleased to hear about the Tate DES, as we are certainly in favour of surround-sound.

Thus on to developments in Ambisonics, which have been several. Despite some people's suggestions that there are no popular panpotted multitrack-derived Ambisonic records because UHJ 2-channel suffers problems in rear channel 'separation' and stability (it doesn't), the real reason is that until very recently there hasn't been the gear to do it. The technology has been known for over a decade (some of Gerzon's earliest papers tell you how to make Ambisonic panpots) but nobody made any (commercially, anyway). Now the equipment which I discussed in prototype form in the September 1983 issue is available. And any interested manufacturer can get a licence to make their own. The first production gear is from Audio & Design Recording and goes under the generic title of the 'Ambisonic Mastering System'. It is in the form of rack-mounting modules which interface with a normal mixing console. They currently handle horizontal surround only and utilise the 'studio format' for Ambisonic signals, more correctly known as 'B-format'. The Transcoder and Decoder also handle 2- or 3-channel UHJ formats, 2-channel UHJ being a convenient release format for 2-channel media. The first batch of 10 systems has been made for the NRDC, and will end up in studios for people to experiment with rent, but ADR are also selling the units.

The Decoder accepts 2- or 3-channel UHJ or B-format and includes forward preference control, layout preset (2:1 to 1:2), distance compensation switch, mode selection and fail-safe relay bypass. The basic unit provides feeds for four amps and speakers but the internal decode circuitry is brought out on a 9-pin D connector on the rear panel, facilitating external converters driving six or more loudspeakers. Also on the rear panel are four male *XLR* outputs and three female inputs, a D-type remote control connector and a 5-pin *XLR* B-format input. The unit powers up in bypass, a 'decoder in' button on the front panel selecting 2-channel UHJ as the default input.

The Encoder/Transcoder takes a B-format input, and provides 2- or 3-channel UHJ output (two models are available). The 3-channel UHJ model is an encoder only but the 2-channel device also has Transcode facilities, enabling two stereo pairs to be input, with individual control of the stage widths of front and rear pairs. The output is in 2-channel UHJ and the unit can accept 4-channel and B-format signals simultaneously. The Transcoder can thus be used for basic ►

Surround Sound

mixdown applications (although without the flexibility of the converter and pan-rotate units) or for converting 4-channel 'quad' recordings to UHJ.

The Converter simply enables mixing console panpots and routing to be used Ambisonically. It contains two identical sections which each accept four groups and an aux send from the console, panning between odd and even groups giving localisation across a 90° quadrant.

The Pan/Rotate unit takes up to eight individual signals (eg from direct console channel outputs) and enables them to be localised anywhere in the horizontal plane. Each input has direction and diameter controls, the former being a 360° pot, setting the basic direction of the sound, and the latter varying the apparent distance of the source from the centre (varying from positive through zero to negative, it pans across a diameter of the field). The combination of localisations set up on the eight inputs can be rotated with a further 360° control, which can be switched in or out of circuit, and can operate either on the field generated by the eight inputs, an external B-format input, or both. Inputs are on bantams or *XLRs*.

All the units have IEC mains inputs with fuse and voltage selector and all *XLRs* have internal jumpers to select whether pin 2 or 3 is hot. Prices are quoted by ADR as £380 for the Converter, £755 for the Encoder/Transcoder, £850 for the Decoder, and £1,650 for the Pan/Rotate unit. All the units are 1U high except for the 2U Pan/Rotate unit.

The availability of this equipment means that it is now possible to produce multitrack-derived Ambisonic recordings; I have now done two albums this way and the results have been very exciting. In addition, the tracks sound exceptional in stereo, without decoding, having excellent clarity and image stability. I would say that it was worth mixing to 2-channel UHJ even if no-one in the world was ever going to decode it. We've already had some very good feedback on the material. Now other engineers can try Ambisonics for themselves and see if they like the results. I would certainly like to hear how people get on. To encourage people to have a go, there are apparently plans for a day-long seminar in a London studio in the near future for engineers and producers to hear about and play with the system.

Calrec are still the only company making a *Soundfield* microphone, and they have recently introduced the *Mark IV* model which offers even lower noise levels. It also concentrates on the benefits of the microphone in the stereo environment, and the resulting control unit is thus less complex and therefore more inexpensive. B-format outputs are still provided, though, so Ambisonic use is not compromised. But just as the production gear can be used to great effect even if the result is never decoded from 2-channel UHJ, so the *Soundfield* mic, although basically an Ambisonic device, has wide stereo applications. Overall, if Ambisonics is going to take off in the consumer environment (it is already gaining wide application in the audio-visual field), there now exists all the hardware to do the job and produce the software. I would expect significant moves this year if everyone pulls their fingers out.
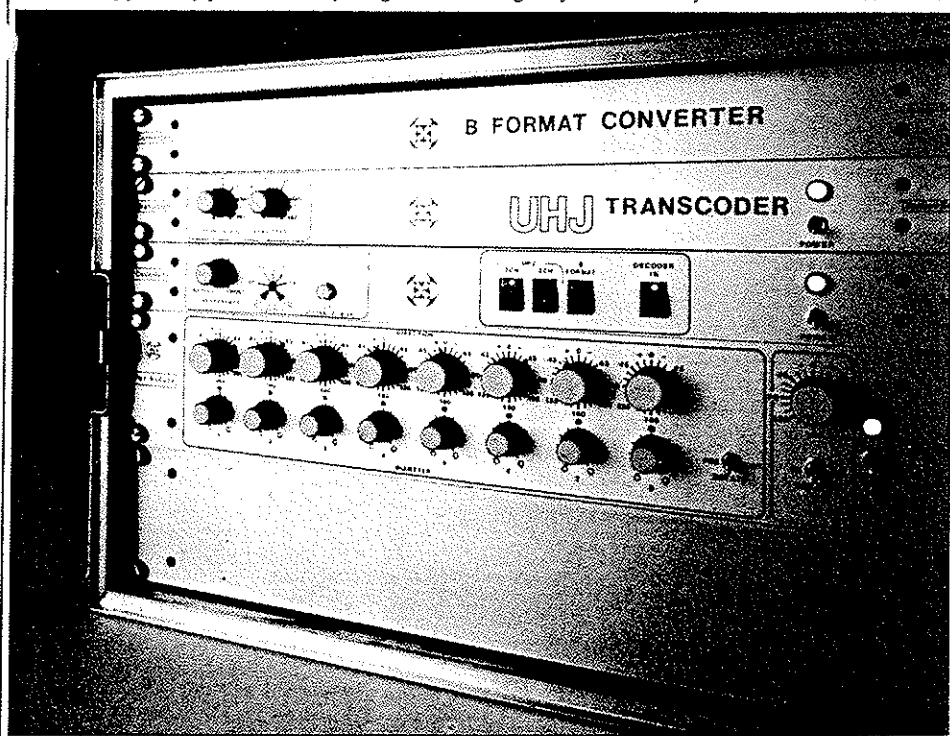
Finally, we come on to the somewhat vexed question of Hugo Zuccarelli's 'Holophonics'. At the time of writing, the man is in California, where he appears to be causing quite a stir. We have already had numerous phone calls from a Scottish gentleman, James A McShane, currently working on the West Coast, who is rather annoyed that Zuccarelli is taking the name of his invention, the 'Holophone', in vain. Unfortunately we don't yet know what the Holophone is, but we *do* know that it has been around for a good many years. There are also murmurs of the name 'Holophonics' being trademarked in Australia by yet another inventor, who is also claiming prior use. Zuccarelli's efforts in the UK to date have resulted in a set of record releases by CBS, compromising a Holophonics demo 12 in single, effects on the Floyd's *Final Cut* album, and, most recently, an album by Psychic TV which uses Hugo's binaural system extensively. While offering some unusual and original material which is interesting artistically, Psychic TV's album contains a number of effects not unlike conventional binaural material. Indeed, in a section in which the head is buried in a coffin sounds almost identical to a binaural recording on Godley and Creme's *Consequences* album of a few years ago. The album was recorded digitally with the Sony *3324* and claims to use no microphones (only 'Ringo', Zuccarelli's dummy head), thus indicating a rather limiting definition of the term 'microphone'.

Meanwhile, the system itself has been covered quite extensively in a number of publications including our own, culminating in an article by Zuccarelli on the theory of Holophony in the popular science weekly *New Scientist* (November 10, 1983, p438) which resulted in a number of letters in that publication including one from David T Kemp of the Institute of Laryngology and Otology, University of London. Kemp's Institute was the first to document sounds emitted by the ear, and has done a great deal of work on hearing mechanisms. He leads off his letter by saying that "Not since 1 April last have I read a 'scientific' article so devoid of scientific understanding, logic and rational thought... These sounds [emitted by the ear] are very weak. They do not create holograms in the inner ear...All of Zuccarelli's ideas (except holography and quantum particles) have been voiced years ago and have since been disproved by direct measurement. Many of his ideas are contrary to the laws of physics and make a mockery of his attempts to stick together fragments of auditory physiology just to add credence to a sound-recording technique. The ability of the ear to extract directional information is well understood by many..."

But despite apparent theoretical inadequacies, there is no doubt (as Barry Fox has pointed out) that the system works. *Why* it works is another matter. It appears to behave in all respects like a highly-optimised binaural dummy-head system, in which sense it definitely represents the best commercial exploitation of binaural recording to date. This apparent fact would be worthy of some praise, but it increasingly appears that Zuccarelli is damaging any respect for his results by claiming theoretical originality. Already, as Barry Fox predicted, the system is disappearing back into the woodwork as binaural techniques have tended to do every few years. Despite the widespread use of personal hi-fi units with headphones, it would appear that the system is not taking off this time either. It is incidentally worth noting here that work is going on to produce a small decoder which will take UHJ 2-channel Ambisonic signals and 'decode' them binaurally for headphone listening. I see no reason why the same approach could not be used with the Tate DES, in which case both systems would offer distinct advantages which would outweigh the disadvantage of requiring a decoder, however basic, namely that both SQ and Ambisonics can be generated by mixing from multitrack sources—the way most modern recordings are done, obviously—whereas binaural systems make this very difficult if not impossible, and the results often leave a lot to be desired.   **Richard Elen**