



Ambisonics ~

Circles of confusion

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CIRCLES of confusion is a term borrowed from optics and photography which I feel appropriate to certain aspects of the ambisonic experience in both studio and sitting room. My hope is that this article will elicit contributions from other workers 'in the soundfield' and help set up a positive liaison between the NRDC/BTG team, equipment manufacturers and professional end users. Without such liaison, I fear that ambisonic technology is unlikely to be accepted in the mainstream professional studios and will remain a 'specialist' technique applied in limited recording applications which do not appeal to the mass market.

Such a fate would be undeserved, for not only are ambisonic production facilities quite stunning in terms of artistic manipulation, they would certainly have some applications also in conventional stereo technique. In that which follows, I have identified specific areas where there is clearly a need for the kind of liaison and exchange of ideas already indicated. My comments are drawn from five years' active experimentation in ambisonics and its application in multitrack recording technique, undertaken as a private unfunded project with two colleagues in time spare from that necessary to earn the daily crust.

Learning circle

Just as there is a 'trick' in our learning to perceive a stereo image, so there is a further trick in learning to perceive and make sense of an ambisonic soundfield.

To judge by the early years of 'ping pong', schizophrenic orchestras (who fortunately played from the same score), and hurtling express trains, it took the professional recording industry a little time to learn about stereo image.

Cynically, I shall note in passing that the ultimate end users, the con-

Peter Carbines explores the potential, and pitfalls to be encountered, in the development of ambisonic techniques and equipment for multitrack recording.

sumer public, have never learned the trick if my own observations of domestic set ups are representative. Separation, certainly: how could it be otherwise with one loudspeaker (usually fallen over unnoticed) behind the sofa, the other stuck up flat on the wall not far from the ceiling? But image, hardly. I shall refrain from commenting on tone control settings. Never mind, the important thing is that people like music in their homes and that writing, performing, recording and otherwise distributing that music is our bread and margarine.

Meanwhile, back in the studio, the chances are that the engineer at the mixing desk probably has some sort of stereo image to work by. If something is wrong, it is usually evident and the cause usually quickly established and rectified (Murphy's Law of course will ensure that serious session stopping faults always occur when studio maintenance have gone home to bed). The inevitable click which just happens along may require a retake or editing out, but it does not impair perception of stereo image or disturb psychoacoustic 'filters' in the brain.

That something is wrong in an ambisonic soundfield may not be so evident, especially if the soundfield is incorrectly realised through wrongly set up decoders or compromised speaker layouts. If it is evident, the cause may not be so easy to pinpoint. Worse still, the engineer's perception of the soundfield may have been temporarily disabled or distorted by phenomena in the field itself. Simply taking five may restore perception, but not if the time-pressure of the session causes a frantic check through all

possible variables with hurried tests giving no helpful results. Actual faults may now arise through errors in repatching, switches moved, and probably worst of all, attempts to restore or 'correct' the soundfield by fudging the decoder settings.

There is evidence that switching transients, if reproduced within a soundfield, can have just such a disabling experience on the perception of all individuals monitoring the soundfield and thereby mislead everyone into chasing phantoms through equipment and circuitry.

No doubt, given time and ambisonic experience, perception disturbing phenomena can be accepted and ignored. In the meantime, the psychoacoustic and psychomotor properties of ambisonic soundfields, especially those synthesised and manipulated dynamically, are worthy of further study. Equipment manufacturers and circuit designers should be aware of these properties and an objective method of checking studio soundfields researched.

Delete the variable

In the immediate future, ambisonic mastering facilities are likely to be hired into studios; therefore there may be some need for fairly elaborate decoder design to meet most environments. Certainly, such a decoder would only make sense if adjusted with the aid of an objective measuring instrument. Complex decoders would be costly and not cost effective if offering comprehensive adjustment facilities and used in a permanent set up, where the controls would be redundant after initial adjustment.

There seem to be several options,

none of which is being met with present 'state of the art' decoders.

Option 1: Portable package

A basic package of phase-matched speakers and power amplifiers together with a simple decoder could be offered on hire to provide ambisonic monitoring. Because of the properties of the soundfield, high apparent SPLs can be achieved at modest drive levels from small speakers, which are certainly easier to position in idealised settings than four normal studio monitors. Mic stand mounting might be useful for the soundfield monitors. Full bandwidth checks on equalisation could be made by switching in the existing studio big guns as required when setting up the mixing desk.

The decoder would need only a 'layout' control as a variable, 'dominance' and 'preference' not being useful in a monitoring situation, and the circuits fixed as neutral in both cases. Even without a practised ear, and without an objective soundfield qualifying instrument, a reasonably accurate monitoring soundfield could be quickly set up using the basic "walkround" and phasing test recorded on the *Hi-Fi Sound Stereo Test Record* HFS81.

Option 2: Studio dedication

In situations where a fixed ambisonic installation is required, the monitoring of the soundfield may be undertaken using studio monitors (four for planar ambisonics) which should be phase-matched. A survey of the layout should facilitate a studio-dedicated decoder at reasonable cost. This decoder would incorporate a perfectly standard PCB, but with the variable controls replaced by fixed resistors on the board. The PCB layout could be designed with solder pads for wiring-in or board-mounting pots (variable decoder) and mounting tags for the fixed resistors (dedicated decoder). Thus, circuit design and decoder

manufacture is made easier since one standard board covers two options. The problem of accidental misadjustment of controls or "twiddling" is overcome in a dedicated situation. Interchange of decoders between different control rooms in a studio complex could be met by providing studio maintenance with the necessary information or resistors to allow such interchange. Obviously, control room parameters would have to be known. The dedicated decoder then would be a simple box in the rack and could be relied upon to do its job without fear of variables being wrong.

Using the objective soundfield qualifying instrument at the time of installation would verify correct decoding in that particular studio.

Option 3: Optimising compromises
Professional recording studio control rooms are often far from ideal in shape or furnishings. Large fixed objects such as multitrack racks, equipment racks and of course, the mixing desk will cause reflections and shadows in the field. These can normally be ignored or lived with when working in stereo. Holes in, or dead spots around the periphery of a soundfield may seriously affect any work attempted, even allowing for 'mental corrections'.

There is certainly no guarantee that four (or more) phase-matched monitors could be set out in positions regular enough to be within adjustment range of basic decoder controls or fixed resistor arrangements. For example, the speakers should all be on the same plane, subtending the same angle of shoot to full centre and on a direct diagonal path to the opposite speaker.

Based on as yet limited experience in a working ambisonic studio situation, I can foresee the need for decoders to have provision to correct 'smudges' and 'smudges' to overcome difficulties of this nature. It is certainly unreasonable to expect existing studios to make structural alterations in order to regularise speaker layouts, and this is another area where investigation is needed.

I would expect that it might be found possible to provide 'squint correction', 'refocus' and other delightfully-named control options by means of a retrofit daughter board on a standard PCB or by implementing an unpopulated area on such a standard board. Externally variable controls would be unnecessary since the decoder would very definitely be dedicated to one control room, yet costs would be kept down if the design of the 'standard' board made these options possible.

An overall approach along such a philosophy in decoder design would certainly assist the rapid penetration of this technology into existing

studios without the penalty of over-elaborate and costly monitoring requirements.

Ambisonic hearing aids

I have mentioned several times the need for an objective measuring device. Without it, there is no way to ensure 'soundfield compatibility' between studios, and subjective methods of using the traditional Golden Ear to distinguish a 'good east' from a 'bad south-east' when setting up a decoder using a recorded walkround test, are not really professionally admissible.

Some sort of 'soundfield vectorscope', set down in the monitoring position at the desk and used in conjunction with specific test signals would verify the accuracy of the soundfield and reassure engineers inexperienced in the ways and whiles of the same. Perhaps an array of LEDs could be used to display the (hopefully) circular sound field and any significant deviations or irregularities. A fully periphonic sound field could probably be verified in much the same way.

Attaching test meters to loudspeaker terminals only verifies electrical conditions up to the speaker. A sound level meter may be used to verify the acoustic pressure produced by individual loudspeakers but may be ambiguous at the monitoring position (ideally full-centre) and cannot indicate irregularities in the soundfield.

In a commercial studio, rapid and accurate alignment of equipment is vital. The present experience of taking upwards of one hour to get a workable, but not wholly accurate soundfield could not be tolerated. A test instrument, perhaps along the line of the vectorscope suggested, together with the decoder options I have described, would certainly help ambisonic technology adapt to the existing real world of commercial recording, rather than expect it to come cap in hand to the ambisonic front door. It won't.

Filter blocks and royalties

The superior performance of the latest professional ambisonic decoder (Abacoid 9211) over existing designs, especially 'domestic' types, almost certainly results from closer matching of the phase shift and phase compensated shelf filters. The actual operating frequencies of such filters could probably vary over quite wide manufacturing tolerances between decoders without affecting the soundfield, but the matching of the filters within the same decoder, is critical. Ensuring accuracy will account for a goodly proportion of the production cost of a decoder and is open to compromise at the penalty of degraded performance.

One possible way to keep costs down, yet improve matching, would be to use thick and thin film hybrid

techniques, with laser trimmed resistive elements, to produce encapsulated filter blocks. Original development costs would be met by the NRDC/BTG operating a royalties system similar to that in use by Dolby Laboratories. Ambisonic hardware could be granted type-approval and allowed to carry a distinctive logo identifying it as ambisonic.

Only those recordings mastered on type-approved equipment and issued to the public would be allowed to carry the same identifying logo. Royalties would be due on every piece of software, but this should not be reflected in a distinct price differential to conventional stereo software in the High Street.

Advertising, perhaps on a co-operative basis by the NRDC/BTG and hardware and software manufacturers could be aimed at the public to fix the identifying logo of ambisonics firmly in the public mind, it being the guarantee of conformity to whatever international standards are agreed. Behind the control room glass, advertising and 'awareness' aimed at studio clientele will educate them in the benefits of ambisonics and cause them to distinguish type-approved studios from those operating more cheap skate methods to produce some of the same kind of effects.

Approving hybrid chips and mastering hardware will not prevent manufacturers turning out equipment which evades the patents and thus any royalties, but it will be unable to carry the logo and ambisonic title, and thus avoid bringing the technology into disrepute due to poor or inconsistent results. An existing parallel is to be found in the domestic video cassette market, where inferior blank tape is manufactured in the two popular Japanese formats, *Beta* and *VHS*. To avoid prosecution and seizure of rogue non-approved cassettes, they do not carry the distinctive logos of either system, instead they are usually marked 'B system' and 'V system'. The inevitable problems which arise from these inferior products stand little chance of damaging public credibility of the actual systems they are aimed at.

The end-user

Professional acceptance of ambisonics depends very much on end-user demand. There is little point in going to the expense of equipping studios and developing soundfield controls if there is not public demand for the product.

So far, all recordings available to the public have been 2-channel UHJ, recorded in real time using the Calrec *Soundfield* microphone. Inevitably, these recordings cater for minority tastes, perhaps 90% of the mass music market being unexploited. It is clear that the

public ear is conditioned to music derived from multitrack and that money is where the energy is. The energy is with the various kinds of popular music, as it has been since the late '50s and seems set to continue for the foreseeable future.

Thus, the public must be convinced by multitrack-derived mass market oriented material, much of it incorporating the spectacular effects capable with ambisonic technology and which makes even the ultimate in stereo reproduction sound dull and lacklustre. The *Compact Disc* would enable 'with height' software to be available from the outset, albeit at reduced playing times.

I am concerned that the 'smudges', speaker dominance and other ear fatiguing effects noted by my colleagues and myself in using domestic decoders particularly with consumer format UHJ, will not convince the public that ambisonics is a working and realisable system whereas the various forms of quad were a set of compromises bounded by four loudspeakers. It may therefore be unwise for the public to be introduced to ambisonics by current state of the art domestic decoders, rather the early generations of such decoders should be built with few compromises and appear at a price as high as the market will bear. Because of the mass market implications, decoders should be integrated with audio preamplifiers as quickly as possible.

The fact that the public will certainly not put their speakers in optimum conditions and so probably never have a correctly reproduced soundfield in the sitting room need not concern us. But it is essential that in exhibitions, special presentations, hi-fi dealers with demonstration facilities and in the homes of their own audiophile friends, they do have the opportunity to hear at least planar horizontal soundfields correctly reproduced and socking it to them with music they understand. Technical arguments promoting ambisonics may persuade those lovers of the esoteric to indulge themselves, but it will take the *balls* of rock music and the *pazz* of ambisonic production techniques to get the mass market dipping into its pocket, already under attack from video, personal stereo *Walkman*-type devices, home computers and the like.

Reflection

The amount of money required to investigate fully the problems I have outlined, and to advance most of the way along the path of applying ambisonics in multitrack recording, was spent last year by the UK division of a certain Japanese domestic hi-fi manufacturer in equipping a 'listening environment' for some of its more esoteric audio products. ■