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PERIPHONIC SYNTHESIS: A NEW CHALLENGE

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Periphony brings a new completeness of spatial definition to reproduced music. The addition of height information to an already impressive surround-sound capability in the horizontal plane enlarges and fulfils the task of accurate directional reproduction first undertaken by Alan Blumlein some fifty years ago. From its earliest beginnings the gramophone industry has led on a promise of faithful representation of living music. With the arrival of periphony that pledge would appear to be redeemed. It is now going to be possible to reproduce a musical performance in the home (or indeed, in the family car) with precise recall of an original acoustic and disposition of players.

Nevertheless, the impact of periphonic audio on the listener remains a matter of some conjecture. Perception of space is itself an act of synthesis. It has to be learned. It operates along conventional lines. It is reinforced by musical example. Whether the periphonic experience is perceived as more realistic or simply as more of everything will depend on the music, the production, and not least on the listener's own attitudes and preconceptions. The technical achievement is remarkable. Its conceptual basis, aiming at reproducing human hearing on the way to reproducing sound, is a brilliant example of lateral thinking. But we live in an age where fidelity, of which Stravinsky observed "Fidelity to what?", is still regrettably a matter of taste. It can mean a faithful impression of a concert performance, to be sure, but it can equally be used to signify artificially-enhanced aural excitement. The contemporary music scene as a whole has little time for musical space. Those who supply music for film, radio and television entertainment gear their product to studio and engineering considerations which have nothing to do with the kind of experience one obtains in the concert hall. To them periphony offers the possibility not of a greater realism but of greater scope for musical contrast and invention.

Whether the selling point happens to be realism or psychedelia, it is all the same reasonable to suppose that periphonic audio will lead the public to a heightened awareness of acoustic space as a positive element of musical design. Equally, we should expect the creative musician, composer, and producer of records to be stimulated into employing spatial factors as a means of musical expression. The challenge in the first case is of agreeing on the reality, and in the second, of inventing it.

The key to convincing the consumer that a periphonic representation of musical space is a valid and interesting experience and one worth investing in, is the music itself. Having experienced UHJ reproduced classical music as well as UHJ transcoded multi-track pop, I have the impression that until engineers arrive at some kind of code of practice for manipulating multi-track space, listeners are going to prefer the reality of classical music. The question then arises, what classical repertoire will give the most favourable impression. If we look for overt spatial interest in the popular classics, it is all but impossible to find. The majority of symphonic and operatic works forming the mainstream of our present-day musical culture belong to a period of Western culture in which the relationship of the art work to the observer is essentially static. In the

theatre, concert hall, opera house, cinema, even at home watching television, the audiovisual image is virtually reduced to two dimensions defined by the proscenium arch or the screen.

This is not to say that the classical repertoire from Mozart to Mahler avoids the representation of spatial relationships. But such expressions are normally conveyed in formulae of dynamics or orchestration: distant events, for example, by the use of muffled sonorities. These conventions act as compensation for the fact that the listener at a concert is not allowed to explore the space for himself. With periphonic audio this situation may change. Not only can a given acoustic be heard, it may, up to a point, also be explored. The new medium calls for a music to encourage a more active engagement with the sound environment.

Given the conservative temperament of record and broadcasting industries, it is probably a foregone conclusion that the music to be selected for launching periphony into the public arena will be the same selection that has kept them in business for seventy-odd years. So what then? Of course, ambience alone has its virtues. One can foresee cults of favourite concert halls springing up to rival the personality cults of the music scene, and special bins marked 'Festival Hall' and 'Lincoln Centre' appearing in the record shops alongside those of Karajan, Klemperer and te Kanawa. But is this wise? If any question is to begged at all, surely it is why go to the trouble of re-creating an illusion of space in three dimensions, and then insist on confining all the real musical action to a single plane?

The fact is that there are abundant resources of classical music, modern music, and music of exotic provenance, in which physical space is dramatically articulated. We can start with such renaissance masters as Josquin, Lassus, the Gabrielis, Schütz, - composers for cathedral environments in whose music we find real contrasts of distance, direction and elevation of players, offset and counterpointed by artificially-contrived spatial illusions, expressed as contrasts of instrumental timbre, dynamic and pitch, and in polyphony imitating natural echo.

On a more intimate scale we find a repertoire of early vocal and chamber music to which periphony offers the prospect of more authentic reproduction than is possible in stereo, or even in the concert hall. Music which all the iconographic evidence suggests should be performed in the round, or while the players are moving or processing, or in the centre of the hall around a harpsichord. The practice of letting the listener take care of himself while the players get on with expression and intonation with maximum eye contact, has much to commend it. It is inconvenient for concert performance, perfectly adapted however for the medium of periphonic reproduction.

Striking examples abound of twentieth-century music composed with surround-sound performance in mind, and exploiting effects of distance, directional contrast and source movement. An example taken at random is the Schoenberg cantata Jacob's Ladder, at the close of which an ecstatic coluratura voice is heard floating heavenward (the composer could never work out quite how this was to be achieved). Or the Poème Electronique by Varèse, a multi-channel tape composition specially composed for transmission by relays of speakers installed through the length, breadth and height of a tent-like auditorium designed by Le Corbusier for Philips, in which the audience is kept moving as if on a production line. Two important London premières of recent date, the composition

PERIPHONIC SYNTHESIS: A NEW CHALLENGE

Répons for soloists, orchestra and computer-generated sounds by Boulez, and the music theatre piece Thursday from "Light" by Stockhausen, the latter making its debut at Covent Garden only last September, are both substantial compositions by senior representatives of the avant-garde. Both are fully composed in the round, and define spatial relationships in highly stylized and musically meaningful ways.

There is no lack, therefore, of existing music from different periods in Western musical history able to benefit in a unique way from periphonic recording and capable in its turn of animating a reproduced acoustic space in exciting ways.

Periphonic synthesis belongs, prospectively, to this more spatially active tradition. It means the creation of artificial sounds which reproduce periphonically in a manner analogous to the acoustic behaviour of real instruments in space. Sounds produced in this manner have a left and a right side, a front and a back, can be heard from above or below. They can be rotated on their individual axes and moved linearly in any desired direction within the reproduced sound field.

There are obvious attractions. Composers like Boulez and Stockhausen have been dreaming for this for years.(Back in the 1950s Stockhausen was toying with the idea of putting live instrumentalists in chairs suspended from the ceiling, and spinning them round manually. The unions wouldn't allow it, and for a most fascinating reason, which was that it was not in the nature of music to move in such a fashion.) There is also an irresistible fascination in the idea of being able to generate synthetic sounds in the equivalent of A-format. All the important conceptual work has already been done: the space dimension of electroacoustic music is solved by periphonic processing and the new digital room simulators. Another reason would be as an adjunct of acoustical research. Such a synthesiser would serve as a tool for modelling sound propagation characteristics of various sources in three dimensions.

When one thinks of the obvious attractions, even more compelling reasons emerge in the form of dissatisfactions with existing methods of synthesis. Let us summarize these briefly. Existing synthesisers produce dead sounds. The sounds have no dimension. They do not resemble the instruments they pretend to resemble. They cannot be expressively inflected in a manner resembling a real instrument. In short, they are practically useless except as originators of unnatural sound effects. They should not be allowed to describe themselves as synthesisers at all.

Ambisonics succeeded, remember, because its inventors realised that instead of worrying about sound reproduction they should really be concentrating on how acoustic space is perceived. In similar fashion we might ask whether the fault in present-day synthesis lies in too trusting a faith in the sound sample, and not enough attention to the way real musical instruments actually work.

Sound sampling has a respectable history. Whether the sample is a tone-wheel, a patch, a spectrum or a tone input from a real instrument via A/D converter, the principle remains the same. The instrument, real or imaginary, is defined by a particular fixed combination of harmonics. That waveform is recycled, transposed, enhanced and degraded to provide a range. For concert audition it emerges out of a loudspeaker; for studio recording it goes down on to one track of a multi-track tape.

PERIPHONIC SYNTHESIS: A NEW CHALLENGE

Why should a sample waveform, typically one cycle, convince anybody? To answer that, you will probably have to go back to the phonautograph of Léon Scott. It was a breakthrough, in its day, 1859; it gave the scientific world its first visible recordings of vocal and instrumental tones; it became the starting point not only for modern synthesis, but for the development of gramophone recording as well. People realised that the phonautograph was an imperfect instrument. The sound samples it provided were very short and extremely poor. But they were better than nothing.

Consider the digital synthesiser of today. Using an excellent microphone we sample by A/D conversion a typical tone played on a trumpet, violin, or other orchestral melody instrument. Excellent: but in what sense is it typical of the instrument? What we have taken is a single pitch, from a single point, representing a fixed distance and angle, in a particular acoustic, in a particular brief unit of time, at a particular time. The fact that it sounds like the same instrument is neither here nor there. That doesn't make it typical of the behaviour of the instrument over its entire range. The fact that we have it from 20Hz to 20KHz is also unimportant. We could take any number of sample waveforms with that degree of resolution and they would all be different.

Sampling is believed because it works for those who value the microphone more than their own ears (plural). It is also believed because the alternative is too horrible to think about.

Until now. Thanks to Professor Ellgett and his colleagues, the infinite number of samples required to characterise a wavefront in three dimensions has been reduced to four. We can therefore conceive of synthesising a wavefront representative of the acoustic behaviour of a real or imaginary instrument in the round. The logical way of doing so would then be to generate four synchronised waveforms instead of only one, equalize each in a different way, and incorporate the resulting four-channel output via a periphonic processor into a simulated auditorium.

Unfortunately this is not going to work. Even if the production of four parallel channels is solvable, which is unlikely given the phase and amplitude differences among them, we would still be left at the end of the day with a point-in-time sample valid only for a particular pitch and distance. The amount of digital memory required even for that would be substantial; if we were to extend the range to cover an entire pitch range it would be prodigious. Frankly the sample procedure is not on.

Which leaves us with no alternative but to forget about reproducing particular end-product, and turn instead to simulating the process by which a real instrument produces the end-product. Instead of wave-tables, a series of generators, digital modifiers and shapers. Instead of vainly trying to get it in one, a process designed to do it in stages.(Léon Scott had to get it in one; the Hammond organ has to get it in one; the analogue synthesiser has to get it in one. Why digital synthesis has to complete the whole job in one is a mystery. With virtually no information degradation from desk to reproducer there is no reason other than nostalgia for clinging to such a procedure.) These several stages correspond, in order, to: source excitation, cavity resonance, and dispersion. We can add a fourth stage, which is room response.

The source excitation corresponds to the noise of bow on string, to reed or lip vibration. Such sounds are rich and fairly random, and are subject to definable

PERIPHONIC SYNTHESIS: A NEW CHALLENGE

boundary conditions affecting ultimate pitch and dynamic. Cavity resonance is simulation of the action of the resonator on the source excitation. We think of it as a very small auditorium. In the case of a wind instrument, it can be tuned to a particular frequency; in the case of a member of the string family, the tuning is done by the string and the resonator capacity remains constant. The dispersion stage is where the signal divides into four: left, right, back and up. We make allowance for high frequency directivity, for the player's body, for possible instrument contact with the floor, and so forth. The process is designed to reproduce the manner in which a vibrating structure converts continuous energy into periodic motion which can be efficiently radiated as sound. Sounds produced by real instruments are constituted of harmonics of a common fundamental not because these have been previously spelt out but for the obvious reason that this is the way physics works. Of course it means that the waveforms obtained from the process will vary from moment to moment. That is in the nature of real instruments. It means that the user will have to tune and play his instrument with care to produce a better tone quality. That too is in the nature of learning to play a new instrument.

Such an instrument has a living sound quality. Because sound production is in stages, formants which are relatively constant features of timbre can be kept separate from pitch, the variable. In addition, changes of dynamic and pitch will liaise more naturally.

Synthesis occupies an odd no-man's-land between the arts and the sciences. To the medieval scholar the music of the spheres was an image of a sound the vibratory nature of which modelled the cyclic movements of the tides, the seasons and the stars. To hear a sound was to be persuaded of the underlying order of things. The connection with natural phenomena persisted through the nineteenth and early twentieth centuries, as wave analysis prospered and harmonic analysers were developed to predict the tides, the weather, and the rise and fall of currency values. Today fractal mathematics proposes a new mediation between knowledge and nature, the sample and the unpredictable. That, together with periphonic audio, offers tone synthesis a new chance of scientific respectability, and music the opportunity of new regions to conquer.