Sound, space, sculpture: some thoughts on the 'what', 'how' and 'why' of sound diffusion[1]

JONTY HARRISON

Reader in Composition and Electroacoustic Music, The University of Birmingham, Edgbaston, Birmingham B15 2TT, UK
Director, Electroacoustic Music Studios & BEAST
E-mail: d.j.t.harrison@bham.ac.uk   URL: http://www.bham.ac.uk/beast

Sound diffusion – the realtime (usually manual) control of the relative levels and spatial deployment *during performance* – is one of the most contentious issues in the field of electroacoustic music.[2] There are parts of the world where the practice is virtually unknown; in other places it is the norm and appropriate facilities would be provided as a matter of course for any visiting composer or performer. These 'local variations' are not merely ripples on the surface of a standardised performance practice but stem from underlying attitudes to what composition and performance in this medium are about and, ultimately, to a definition of music itself. What follows summarises observations drawn from fifteen years of working with the BEAST concert diffusion system in numerous performance spaces in the UK and Europe, as well as experiencing, both as listener and performer, other systems in Europe and North America. Scientific rigour, in the normally accepted sense of tables of measurements etc., is not my goal – my portable measuring equipment has been my *ears*, and my conclusions are based on what I have *heard*.

1. BACKGROUND

1998 marks the fiftieth anniversary of *musique concrete*, the name given by Pierre Schaeffer to the use of sound stored 'on a fixed medium' as the basis of composition. Among English speakers, the term *musique concrete* has usually been taken to mean only that the sounds used were 'real', recorded from acoustic sources *via* microphone. This definition then affords a convenient historical contrast with *elektronische Musik*, which emerged shortly afterwards in Cologne, in which the raw material originated inside electrical circuits rather than in the acoustic world of sound waves being generated in a particular space and causing the air molecules within that space to move in relation to each other. In the French-speaking world, however, where access to Schaeffer's writings is somewhat easier, it is widely understood that a further dimension of what was 'concrete' about *musique concrete* was also the method of working

and, by extension, the relationship between composer and material: as in sculpture or painting where the artist produces the finished product on or in a fixed medium by manipulating the materials (paint, wood, stone) directly, so in *musique concrete* the composer is working *directly with sound*. As Francis Dhomont points out, echoing Schaeffer, the musical process thus moves from '... the concrete (pure sound matter) and proceeds towards the abstract (musical structures) – hence the name *musique concrete* – in reverse of what takes place in instrumental writing, where one starts with concepts (abstract) and ends with a performance (concrete)' (Dhomont 1995).

Important issues are raised here. The traditional model of 'instrumental writing' described by Dhomont relies heavily on a visual device: musical notation. The encoding of 'ideas' into notation in the score is usually done without direct recourse to the *actual* sound, but relies on the composer's memory or imagination.[3] It should also be stressed that the

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[2] *Electroacoustic music* in the general sense and *acousmatic music* – predominantly 'tape' music, music 'on a fixed medium' (*sur support*) – in the more specific sense of being descended from *musique concrete* are my preferred terms in this article.

[3] As Trevor Wishart has pointed out (Wishart 1985), notation, by its very nature, posits what is musically possible *via* visual symbols, rather than by what is possible in *sound*; ultimately, the danger is that what is notatable will define what is imaginable in music. Furthermore, the basis of the traditional approach to education within western music – in composition, analysis, history and performance (as well as music criticism) especially in the Austro-German mainstream (see elsewhere in this article for more on the continuation of this hegemony, in which, incidentally, I would also tend to bracket practice in much of the English-speaking world) – illustrates the way notation is taken to be synonymous with music: in our logocentric and visually biased world, we take the 'text' of the score as being more accurate than any realisation in performance, leading to the idea among many music students that Beethoven's Fifth Symphony is actually sitting on a shelf in the library! Authority for this view is offered by the likes of Newman who wrote that '... we can hear a given piece of music a hundred times and yet, if we do not know it also from the sight of the notes the composer has put on paper, get no further than the outer rim of his [*sic*] thought' (Newman 1958). Notation also participates in the perpetuation of what might be described as the composition/analysis paradigm, by which composition is implicitly defined as the 'inverse' of analysis, and involvement in the former discouraged without prior studies in the latter. Music based on recorded sound, by bypassing 'the score' and democratising access to sound manipulation, challenges this paradigm (and with it, much of the edifice of Western music) and poses a threat to academia – ironic then, that so much 'dangerous' acousmatic music is produced in institutional studios (and doubly ironic that this fact, along with the frequent lack of regular pulse and other stylistic matters, leads many to regard acousmatic music as 'elitist' – i.e. part of the 'establishment').

elektronische Musik of the 1950s did not depart in any significant way from this 'traditional' model of composition. *Musique concrete*, on the other hand, was based on a fundamental rethinking of what composition actually was – and the key to it was, and remains, sound recording.

This is a long preamble to the interesting and, at first sight, possibly curious fact that, despite *musique concrete* being music 'on a fixed medium' (which might lead one to suppose that the *music* is fixed), Schaeffer himself included 'variable' elements in the very first public concert of *musique concrete* on 18 March 1950 in the hall of the Ecole Normale de Musique in Paris (Manning 1993). The performance of the work on the programme, *Symphonie pour un homme seule* by Schaeffer and his collaborator Pierre Henry, actually resembled something closer to what we might now think of as live electronics, with multiple turntables and realtime montage (all of which was evidently rather beyond its composer/performers on that occasion). By 1951 Schaeffer and his team had transferred their allegiance from the 'fixed medium' of discs to that of magnetic tape. One machine, capable of recording five tracks, was subsequently used in concerts, along with an interesting device called the *potentiometre d'espace*, developed by engineer Jacques Poullin. Four of the five tracks of sound were distributed to four loudspeakers (two at the front, to left and right, one at the rear and one in the ceiling); the fifth track was played 'live' by a performer operating the *potentiometre d'espace*, which allowed material from the fifth track to be sent to any of the four loudspeakers. Interestingly, after describing this early foray into multitrack playback, Manning makes no further mention of what Smalley has called the 'fragile art of sound diffusion' (Smalley 1986).

2. COMPOSITIONAL PRACTICE; PERFORMANCE PRACTICE

From my remarks above about the 'concreteness' of *musique concrete*, it follows, both logically and historically, that the means by which composers interacted with material were also 'concrete', i.e. *physical*. This physicality manifests itself in two important ways: *perceptually* and *manually*.

The assessment of material and processes is made through the *perceptual* response of the composer as 'first listener', in a process based on actual (concrete) aural experience, and using the ear/brain mechanism most immediately to hand (the composer's) as representative of the (presumably similar, though not identical) mechanisms of other human beings. The methods of developing and shaping raw sound material into musical structures are, historically at any rate, primarily *manual*. That many of these functions are

now performed using a computer does not contradict the essential physicality (for example, a sudden *sforzando* or a 'sweeping' frequency or spatial motion) of the gestural types involved (though the computer may offer additional possibilities beyond what can be done by the composer's two hands in the analogue studio) and puts sharply into focus the fact that elements which we would readily associate with *performance* were and remain embedded in the *composition* of *musique concrete* and its descendants.

Active listening entails many processes; one of the most important for making sense of a 'piece' is segmentation, in which the brain identifies and separates signifying units in the musical flow. The behaviour and shaping of such musical events in time has been described by Denis Smalley as 'spectro-morphology' (Smalley 1986). In order for listeners to identify a sound event as such a unit (for example, 'a gesture'), and to understand the function of such an object in a musical context, the sculpting of that unit clearly involves considerations of its spectral content (frequency) and envelope behaviour (amplitude) in time. But electroacoustic music, particularly that in which the cause of the sounds is not seen or necessarily implied, has also allowed *space* to participate in defining gesture to a degree impossible in instrumental music. Elsewhere, Smalley describes this compositional use of space as '. . . a means of enhancing the sounding properties inherent in spectro-morphologies and structural relations' (Smalley 1991). It is appropriate, therefore, that the same type of physical gestures (reinforcing a *sforzando* by 'nudging' the potentiometers, enlarging a 'sweep' to travel the full width of the listening space) that were used to shape material during the process of composition should be used again in performance to enhance further the articulation of the work's sonic fabric.

From this I would argue that the apparent contradiction between music 'on a fixed medium' and flexibility in performance to which I alluded above, is not in reality a contradiction at all because of the very bases of *musique concrete*: the composer proceeds by drawing out implicit larger structures from the explicit morphologies of individual sound objects (and, as Varese pointed out using the analogy of crystal formation, such organic growth has many possible outcomes). This is an empirical, pragmatic procedure, building on the organic characteristics of the materials being used, in a manner appropriate to their musical unfolding in time. The arbiter of this process is the ear – the composer engages in a 'feedback loop' with the material and the contexts in which it is placed at every stage, making adjustments until the material is 'right' – and it tends towards what I think of as 'organic structure'. If something 'works' or 'sounds right' it needs no further justification in that musical context, as the compositional speculation has

been proved experimentally[4] (experientially, perceptually). The fact that it works may well be subject to further proof through analytical observation and measurement, but this is incidental, rather than central to the perceptual imperative.

Insert 1: Organic vs architectonic structure

The apparent need for 'objective justification' of musical utterance, exemplified by the threads of analysis and 'measurement', is one of the central creeds of Western art music – especially in academia, where arcane knowledge unavailable to 'non-musicians' is passed on to the next generation (see footnote 2). The high modernist agenda of serialism (of which elektronische Musik *was, interestingly, a part) was heir to this tradition and continued the prevailing view that the 'text' of the score, amenable to 'out of time' analysis, was the 'true' representation of the composer's thoughts because it allowed for more accurate measurement of the distances between musical events. These distances may be expressed as 'intervals' of pitch (frequency), 'durations' of rhythm (time) and 'levels' of dynamic (amplitude). To these, the nineteenth and, particularly, twentieth centuries progressively added (fixed, instrumental) timbre, types of attacks and articulation and all the other parameters which integral serialism sought to control.*

If we consider for a moment one of the major icons of the post-war period, we can see that this obsession with measurement is behind Stockhausen's description of '. . . a hidden power of cohesion, a relatedness among the proportions: a structure. Not similar shapes in a changing light. Rather this: different shapes in a constant, all-permeating light.' (Stockhausen 1956, quoted in Worner 1973). Worner goes on to add that '. . . unity is created by means of relationships between proportion and mass. The proportion existing between given elements placed in conjunction may remain identical while what is actually placed in conjunction may be constantly changing.' To paraphrase this last sentence: musical events have no intrinsic interest; they exist primarily to articulate the distance between them, on the measurement of which distances rests the notion of 'structure'.

This seems to be evidence of what I call 'architectonic structure' and is diametrically opposed to the 'organic structure' generated by the materials and compositional strategies of musique concrète.[5] *Let us not forget that one of the primary reasons for the emergence of* elektronische Musik *was the need to be able to*

realise with absolute precision in the studio the kind of serialised dynamics presumably vital to the structure of works like Stockhausen's Klavierstuck I *(Stockhausen 1954). This piece, famously, features a simultaneously struck nine-note chord containing five different dynamic levels – a fairly unrealistic demand on any pianist; but if it cannot be accurately performed, the work becomes, in a very real sense, unintelligible, as the measurements between the five dynamics cannot be made aurally (perceptually). The same concerns are present in* Gesang der Junglinge, *which provides Robin Maconie in his book* The Works of Stockhausen *with the springboard for a remarkable outburst:*

> Soon after *Gesang der Junglinge* had acquired a reputation it was put about that since the work incorporates a boy's recorded voice it qualified as *musique concrete*. Since 1952 the prestige of the Paris school had diminished as that of Cologne had steadily been growing, and one suspects that the label represents an attempt either to transfer some of the credit for Stockhausen's achievement or alternatively to reduce the work in public eyes to the level of a Parisian caprice. But whatever the motive behind the label (and it has tended to stick), it is positively misleading. The manner in which Stockhausen integrates vocal sound into the electronic fabric of the piece would never have been sanctioned by the school of Schaeffer . . . , even if its members had been technically well enough informed to understand what he was doing. The qualities of intelligence and workmanship, that made Schaeffer so keen to claim the work in retrospect as musique concrete, elevate *Gesang* to an altogether higher plane. (Maconie 1976)

The spuriousness of Maconie's implication that Gesang der Junglinge *is a great work solely because of the conceptual force which drives it, and not because of the way it sounds (the 'whim' of the ear), is directly contradicted by Stockhausen's next and, arguably, finest electroacoustic work,* Kontakte.[6] *This piece, an early example of moment-form, only exists in its present shape because the date of the premiere was looming and Stockhausen simply stopped working on it (Worner 1973)! Technically, then, it is unfinished; moreover, because it is in moment-form, it could have been assembled in a variety of ways, with the 'moments' arranged in a different sequence. It is hard to imagine this possibility in the case of a work like* Kontakte, *which is so musico-dramatically convincing in the trajectory of its unfolding, so 'right' (indeed, it is hard to imagine it in the context of music 'on a fixed*

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[4] The word 'experimental' is employed here in the French sense, often used with reference to electroacoustic music (e.g. Groupe de Musique Experimentale de Bourges).

[5] Wishart develops a similar argument in *Audible Design*, where he observes that '. . . our principal metaphor for musical composition must change from one of architecture to one of chemistry' (Wishart 1994).

[6] Curious as it may seem for so committed an acousmatic advocate as the present author, I consider the *mixed* version of the piece, with piano and percussion, to be the definitive version; I do not feel the work is anything like as successful when considered purely as a tape piece. This probably reflects aspects of 'instrumentality' discussed here. *Kontakte* works best when the instrumental models to which the morphologies of the tape's sound world are being compared are also present in the *actual* listening frame – inference alone is insufficient.

medium' at all!). But it illustrates that, despite the rigour and complexity of its concept, Kontakte *was evidently assembled by ear, Stockhausen making countless experiments in the studio, testing the appropriateness of each 'moment', modifying his intentions in the light of what he heard and selecting only those sonic results which worked perceptually in a structure which* evolved *into its present form during the process of composition, rather than being preplanned. From this point of view*, *and notwithstanding its impeccable* elektronische Musik *credentials in its synthesis method, I would argue that* Kontakte *can therefore be considered a classic piece of* musique concrete.

The facts of the case of Kontakte *provoke major questions – principally: how was it that such an (allegedly) concept-oriented composer could be satisfied with an (apparently) arbitrary process of structurng a work, and: how do we reconcile the original compositional intent (concept, poiesis) with what we hear when we listen to the actual work (percept, esthesis)? There is a strong implication (embodied in the Austro-German paradigm for musical 'value' echoed, as we have seen, by Maconie, and still to this day underpinning the very basis of much computer music and algorithmic composition) that if the conceptual backdrop is sufficiently strong then a good piece is virtually guaranteed. Yet this is directly contradicted by* Kontakte *– a work by a composer who was thought to epitomise predetermination (but who was, in the late 1950s, and by his own admission, moving towards a much more perceptually oriented stance on material and form). Without doubt, there* is *a strong conceptual dimension in this piece – the impulse pattern/frequency rate basis of the synthesis springs not only from Stockhausen's obsession with the fundamental unity of the duration–pitch–timbre continuum (*Worner 1973, Cott 1974), *but is also a discovery, or at least an observation, of something which can be demonstrated at the perceptual level. This is both a key to understanding this period in Stockhausen's output (particularly the moment-form works and the move towards intuitive music), and indicative of the (at least equal) importance of percept alongside concept in composition.*

3. DIFFUSION – THEORY AND PRACTICE

Despite a number of works (witness all Stockhausen's studio output after *Studie I* and *II*) which use multitrack formats – especially four tracks – stereo has arguably been the 'norm' for compositional work in electroacoustic music on tape. This is probably because of the relatively ready availability of stereo tape recorders supporting the consumer stereo LP market from the late 1950s onwards. Multitrack recording of pop music came surprisingly late in the day and remained expensive. The move to digital

technologies all supported the (still stereo) CD market. For several decades the economic reality was that the consumer at home could not or would not invest in multi-channel amplification and loudspeakers, leaving stereo as the dominant format. Only very recently is there any indication of some kind of standardisation of multi-channel formats – but it is interesting, not to say ironic, that a possible, and perhaps most likely, standard for multichannel presentation of sound has been determined, not by composers or even by the music industry, but by the cinema! We shall return to the question of multitrack formats later in the discussion.

For most of the fifty years of its history then, most electroacoustic music has been stereo. I would argue that this is not so bad – it is, after all, a substantial improvement on mono. Combining the left/right and the distance/proximity axes creates the illusion of a plane between and behind the speakers – the image has width and depth. On a reasonable quality stereo system in an average home environment, most of these spatial auditory cues are clearly perceptible – even more so since the advent of CD. For most of the past fifty years, however, electroacoustic music has also been predominantly stored on analogue magnetic tape. This means hiss, hum, bias noise and other unwanted side effects, along with a disturbing tendency for a nominally 'flat' frequency response to 'roll off' at extremes of highs and lows. Attempts to correct these faults with noise reduction systems like Dolby, dbx, etc., often cured one problem, only to introduce others like 'breathing' or 'pumping' – particularly noticeable in long decays. The net result was that the full dynamic range was simply not available to composers, the signal-to-noise ratio of a professional analogue tape recorder being only about two-thirds of the available dynamic range of a symphony orchestra and barely more than half the range to which our ears can respond. Technological 'cures' tended merely to introduce different, but equally problematic side-effects.

These two issues – the integrity of the stereo image and the dynamic limitations of analogue tape – become major problems when a number of people gather together with the intention of listening to music attentively as some kind of group or social activity. Leaving aside the interesting but thorny question, not strictly relevant in the current context, of whether the 'concert', with its behaviour codes and anachronistic rituals, is the most appropriate format for electroacoustic music anyway, the last half century has nevertheless seen much of this kind of public presentation. And it is here that we find some rudimentary rationales for the practice of diffusion.

The dynamic range problem is the easier one to deal with. Even within the restricted dynamic range of magnetic tape, the composer will have indicated

relatively louder and quieter events. In performance I would, at the very least, advocate enhancing these dynamic strata – making the loud material louder and the quiet material quieter – and thus stretching out the dynamic range to be something nearer what the ear expects in a concert situation. In the case of an analogue piece, this also has the added benefit of reducing any hiss when it is at its most irritating to the listener – in the quiet moments! Of course, even such a simple operation is fraught with danger: increasing the level in a quiet passage will destroy the music by going against the composer's indications, as surely as an instrumentalist playing an unwritten *sforzando* in a *pianissimo* section or performing a *largo* at *allegro*. In other words, what is done in diffusion, as in any performance, has to be musically appropriate!

The stereo image question is more complex and leads us directly to the concept of the multichannel diffusion system. Even on a good domestic hi-fi system, with the listener in the 'sweet spot' (roughly in an equilateral triangle with the two speakers), the stability of the stereo image is notoriously fickle – moving to left or right by just a few centimetres, or turning or inclining the head can cause all kinds of involuntary shifts in the stereo image. So if a stereo piece is played over a stereo pair of loudspeakers (even large speakers) in a large hall, the image will be even less stable and controllable than in a domestic space, and will certainly not be the same for everyone in the audience – in the equivalent of the ideal listening position at home (see figure 1 – (a)), everything is relatively fine, but elsewhere the story is very different. Listeners at the extreme left or right of the audience (b) will receive a very unbalanced image; someone on the front row (c) will have a 'hole in the middle' effect, whilst a listener on the back row (d) is, to all intents and purposes, hearing a mono signal! Listener (c) will also experience everything as 'close', with listener (d) hearing it as 'distant', simply because these listeners are in those *real* relationships with the loudspeaker cabinets. Needless to say, the shape and size of the hall have a huge influence on how marked these effects will be and the old ploy of suggesting that people move into the centre of the seating area can often overcome some of these problems. But the fact remains that in large spaces and with even moderate audiences, some or all of these effects will occur. Events carefully oriented by the composer within the space of the stereo stage will simply not be reproduced appropriately in a large concert space unless something more radical is done.

4. BEAST BASICS

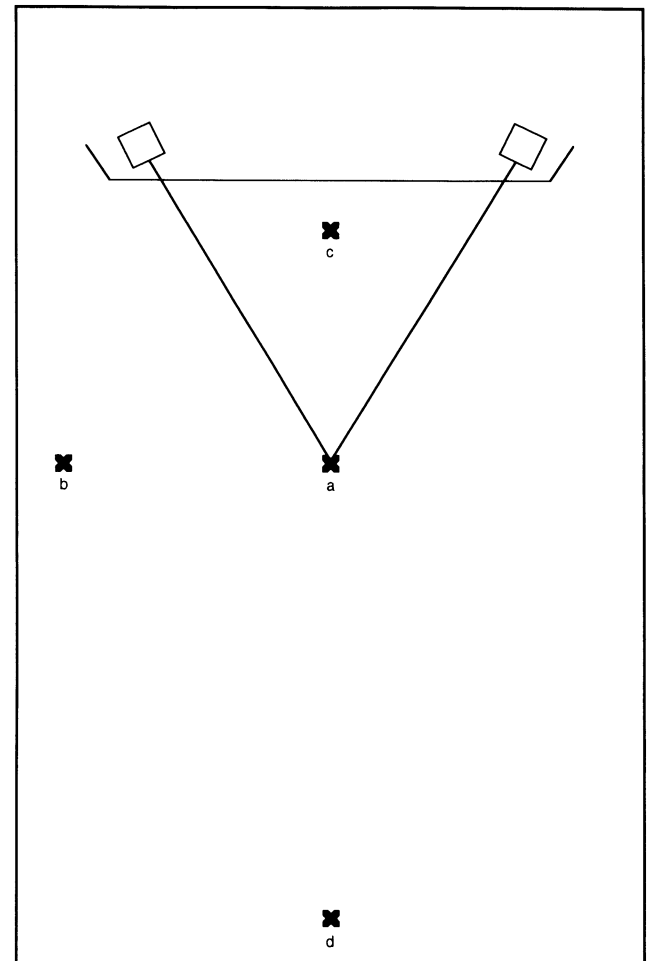Figure 2 shows the beginnings of such a radical solution (note that the line emerging from the centre of

Figure 1

each box indicates the direction in which the speaker is pointing): what in BEAST is called the 'main eight', which I regard as the absolute minimum for the playback of stereo tapes. The original stereo pair from figure 1 has been narrowed to give a real focus to the image as necessary (**main**); this removes the hole in the middle, enhances intimacy and offers the effect of 'soloist' speakers. A **wide** pair have been added so that dramatic lateral movement can be perceived by everyone. In the BEAST system, these four speakers are usually of the same type (ATC) and driven by matching amplifiers (approximately 500 watts each) as this frontal arc represents the orientation for which our ears are most sensitive to timbral imbalance among loudspeakers. They would normally be deployed at, or just above, ear height. Most of the rest of the system consists of speakers of a variety of models (and even manufacturers) with very differing characteristics (predominantly Tannoys – but, even then, with a range of cone sizes, models, vintages and crossover designs – plus Volts, KEFs and Ureis), driven by 500, 250 or 100 watt amplifiers, depending on the speaker itself and its function in the system *in that particular space*. For effects of distance (which
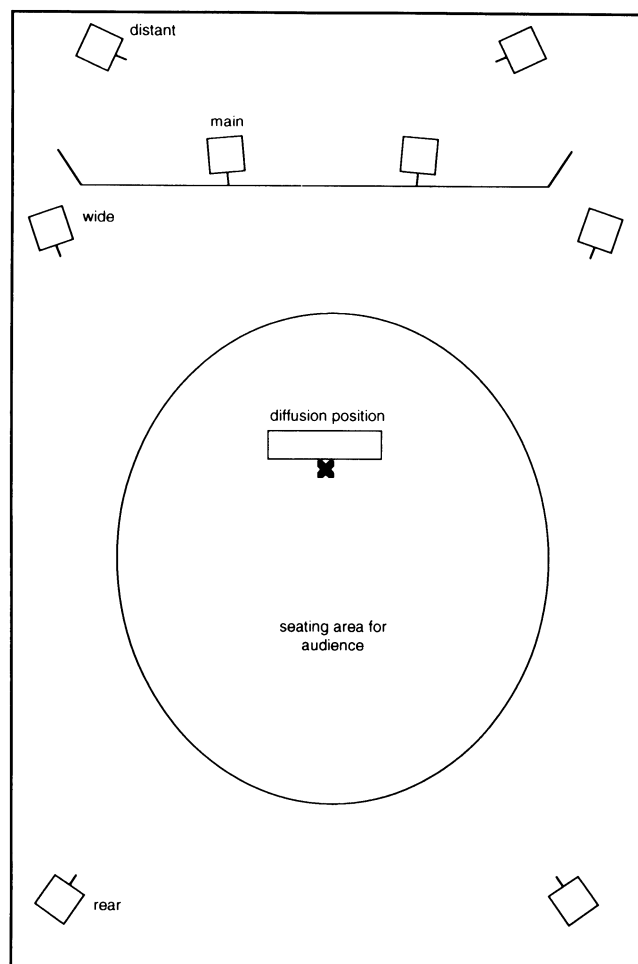
Figure 2

on the original stereo tape are implied by careful balancing of amplitude and reverberation characteristics, and which are very susceptible to being swallowed by (actual) concert hall acoustics), it is useful to be able to move the sound from close to distant *in reality*, following the cue on the tape – hence the **distant** pair. These would normally be angled quite severely across the space (pointing towards each other much more than one would find in any 'normal' stereo speaker placement) to hold the stereo image in a plane *behind* the mains; they are usually placed on scaffolding towers at around two to three metres above ear height. The **rear** pair, also positioned above ear height, helps fill the space, adding a sense of being enveloped in sound; implications of circular motion on the tape can actually be made to circle around the room; and the introduction of sounds behind the listener can still have a startling effect (presumably because our racial memory still responds to aural warnings of potential threats from behind us).

After the main eight, the next most significant additions to a system would be sub-woofers/bass bins (preferably actively crossed-over or filtered, so that the whole output of a large amplifier can be used to

maximum efficiency) and tweeters. Here the ability of the playback system to enlarge and extend the material on the tape applies in the frequency, rather than in the spatial domain, though tweeters such as the Motorola piezo-electric type used in BEAST are sufficiently light to be suspended from the ceiling over the heads of the audience, or at any rate positioned where other speakers are not, so a spatial dimension is involved. In the BEAST system, the four bass bins are typically filtered at 80 Hz, with a roll-off of 18 dB/octave. The tweeters are used in up to ten 'stars' (which resemble upturned umbrella frames with a span of around two metres) of six units each and/or in up to four clusters of three wider dispersion units which can be suspended or floor-mounted on extending poles. The frequency response of these speakers (which do not require a crossover) extends into the upper-mid frequency band, so a TC Electronic parametric equaliser (in which rejection of low and mid frequencies is almost total) is used to ensure that they enhance, rather than interfere with, the overall spatial image.

Beyond this (see figure 3), the number and positioning of loudspeakers is primarily a function of the concert space. Long, thin halls may need **side fills**, to achieve smooth transitions from frontal to rear sound, without the sound suddenly leaping to the back of the hall (these are often best used angled up and/or reflecting off the side walls so that the audience is less aware of the highly directional nature of speakers placed on either side of them, like a giant pair of headphones). Wide halls may need **stage centre** speakers, positioned quite close together, higher than the mains and pointing slightly *out* from the centre, to avoid hole-in-the-middle effects. In some halls, a stereo pair of **front/back** speakers positioned quite high in the stage centre and centrally behind the audience can be useful in overcoming this problem (and create the possibility of cruciform patterns with the wides or side fills). **Punch** speakers, again central and outward-pointing but fairly low for maximum impact, can be useful for *sforzando* reinforcement of strong articulation. If the hall has side galleries or lighting gantries, then height can be used to good effect (in one of our local spaces, the side fills are placed on a side gallery, about two metres above the head of most of the audience, whilst much higher up in the lighting gantries there are **front roof** and **rear roof** speakers – these enable front/rear motion via a *canopy* of sound rather than by moving the sound only 'round the edges' of the hall). In a space with a proscenium stage, height can be used by having at least **proscenium** speakers to add a vertical dimension to the frontal image. Differing heights can also be exploited by angling speakers on the **stage edge** down to the floor. In short halls, it can sometimes be difficult to achieve a real sense of distance, but if the wall
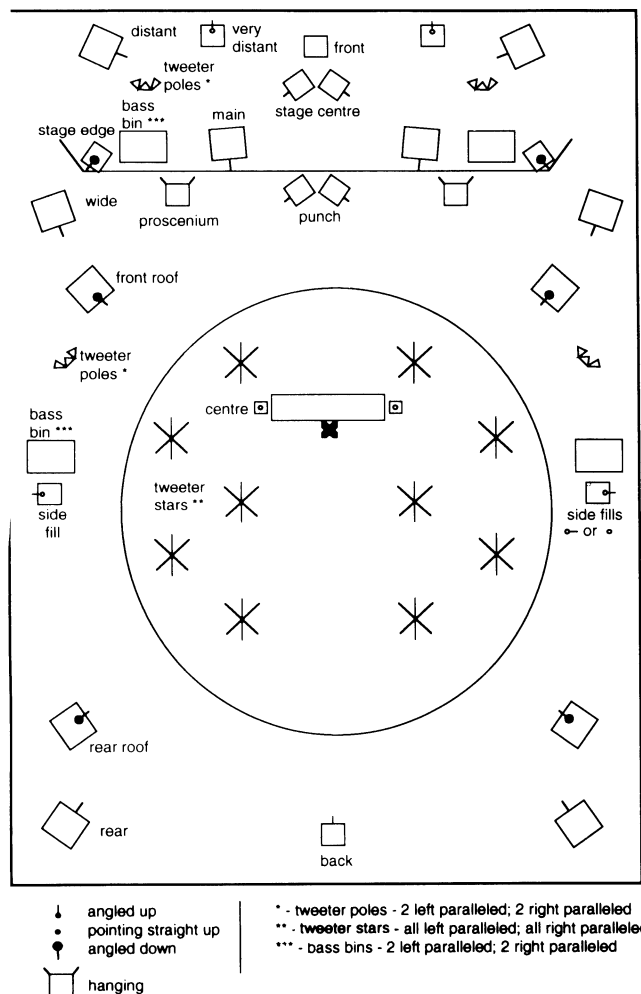
angled up
pointing straight up
angled down
hanging

* - tweeter poles - 2 left paralleled; 2 right paralleled
** - tweeter stars - all left paralleled; all right paralleled
*** - bass bins - 2 left paralleled; 2 right paralleled

Figure 3

at the back of the stage is brick or stone, **very distant** speakers facing *away* from the audience and reflecting off the wall can be effective (the high-frequency attenuation and general reduction in source location mimicking remarkably well the sensation of the sound being further away). Finally, in extremely large halls, speakers placed immediately by the **mixer** can help overcome the sensation that the sound is predominantly at the periphery of the listening space. Of course, not *all* of these speaker locations would always be necessary – it depends entirely on the nature, character and sound of the performance space – but it would be wrong to assume that small halls necessarily require fewer speakers (in BEAST's *rumours . . .* events at the Midlands Arts Centre in Birmingham we diffuse stereo tapes over at least twenty-four separately controllable channels – amplifier plus speaker(s) – in a hundred-seater hall).

5. MIXER CONFIGURATION

The large number of loudspeakers advocated here for diffusion places particular demands on other parts of

the sound system: because every speaker needs to be independently adjustable in level, a separate channel of amplification is needed for each speaker (or group of speakers if they are being run in parallel, as BEAST's multiple tweeters and bass bins are). Even before this stage is the question of independent fader control of every amp/speaker channel. An easy way to derive the multiple outputs needed is to use 'groups' on a standard mixer – the stereo input from the DAT or CD is routed to all available groups and the relative levels achieved by 'playing' the group faders. The drawback with this system is that even 8-group desks normally have 16 or more input channels, of which only 2 are really needed for the stereo input. If the mixer has direct outputs on all channels (lower-cost desks tend not to have this feature), then input channel faders can be used for diffusion, but this necessitates splitting the stereo signal out from the source (via parallel boxes, for example) and running several left/right signal cable pairs into successive pairs of input channels. BEAST has developed an elegant way of achieving what is effectively a 'mixer in reverse' (2 in/many out) by using a switching matrix through which any incoming stereo signal can be routed to any pair of outputs. This desk, custom built by DACS Ltd, offers a total capacity of 12 in/32 out, allowing easy preconfiguration for stereo, 4-channel and 8-channel operation, or for microphone mixes from secondary mixers when needed, without any replugging between pieces. The DACS 3-D offers inserts on every channel for outboard EQ or other effects units as necessary and the main outputs leave the desk via a military grade multiway connector and 32-way balanced multicore cable to the remote amplifier racks, which total 7 kW of power.

The layout of the mixer raises more interesting points. Many diffusion desks are deployed so that the speakers furthest away in front of the audience and diffuser are controlled by the faders on the extreme left of the mixer, the next furthest speakers by the next pair, and so on until the rearmost speakers are reached on the extreme right of the run of faders in use. This is a good configuration for certain kinds of motion (front to back, for example) but is less convenient for more dramatic articulation of material/space. BEAST has evolved a grouping of faders by function in any given performance space: the main eight (which, fortuitously, also happen to fit eight fingers on the faders – so sudden, dramatic gestures on these faders result in the most significant changes in spatial perception by the audience) are always in the centre of the console, with bins and tweeters to the extreme left; beyond this, the layout varies according to the unique design of the system for that space/event. The mixer layout for a typical 24-channel system for *rumours . . .* is shown in the table.

Table

Mixer channels (numbered from left of desk)			
1	2	—	
3	4	—	
5	6	Bass bins	
7	8	Tweeters	
9	10	Stage centre	Stage
11	12	Stage edge	
13	14	Distant	
15	16	Main	Main eight
17	18	Wide	
19	20	Rear	
21	22	Side fill	
23	24	Proscenium	
25	26	Front roof	Canopy
27	28	Rear roof	
29	30	—	
31	32	—	

I have not discussed relative signal levels on all these loudspeakers, how many speakers are used at any given moment in a piece or what kind of spatial motion is appropriate and effective for diffusion – these are *musical* questions, answered by knowing the individual pieces and getting to know the space in rehearsal (informed, of course, also by knowing the system and by being willing to change loudspeaker positions during rehearsal until the best solution is reached – pragmatism again, and economically problematic, as there is never enough time to rehearse in the actual performance space). But it cannot be stressed too strongly that decisions about speaker placement are made with reference to *musical* (perceptual/practical), not technical (conceptual/theoretical) demands.

Insert 2: Organic vs architectonic space

In his article 'Spatial experience in electro-acoustic music', Denis Smalley discusses the relationship between what he calls 'composed space' in a work and the 'listening space' in which the work is performed (Smalley 1991). Conflicts can arise between these two in the resulting 'superimposed space' but one way of dealing with these conflicts is to use multi-loudspeaker diffusion systems to create what Smalley calls 'diffused space'. He further points out that '. . . there are many composers who remain ignorant of superimposed space and the potential of diffused space . . . because they possess a fixed 'image' of their music as conceived and perceived within the composed space of recorded formats'.

There is certainly a widespread belief among many composers that in performance, the aim should be to attempt to reconstruct exactly the spatial image the composer put on the tape. One composer/educator makes a strong plea:

> . . . for phase-aligned fullband systems with enough power to fill larger spaces, which tend to neutralize positional phase-shift and offer a better rendition of the

original compositional intent in the studio. It is certainly not perfect given the conditions of most ea concerts but at least it tries to provide a "neutral" acoustical front to the audience where the music is of prime importance, not the "artistry" of the diffuser.

> . . . when I go to an electroacoustic concert, I want to hear the music in the best conditions possible as it was intended to be heard. I don't go to hear someone express himself on the sliders, when I know perfectly well that whatever is done there (with the possible exception of the composer him/herself) will be at best "inspired" improvisation and at worst "Bobby is loose on the sound system again . . . ." Perhaps there will come a time when sensitive diffusion artistry can be codified, but for the time being, it seems more of a whim than "sensitivity". (Jean Piche, writing to CECDISCUSS[7] on 1 March 1997)

Like Jean Piche, many people would simply deny the validity of BEAST's approach to speaker placement and the use of 'unmatched' cabinets and amplifiers, on the grounds that phase coherence is lost. But phase coherence is no more than an academic conceit to the person in the back row of a large hall, trying in vain to hear a convincing stereo image from a pair of loudspeakers on the stage. Another objection to multi-channel diffusion is that the composer's intentions about space, dynamic, etc., can be overridden by the diffuser and the piece destroyed as a result. Of course, this can be true; but this is no more than saying that bad, unmusical, inappropriate or inept interpretations destroy Bach, Beethoven or Boulez – as with any other musical activity, there is good and bad diffusion. And whatever a composer has put on a tape is potentially at risk in a large space unless positive steps are taken to reinstate what would otherwise be lost. It is surely a myth that all one needs are large, phase coherent loudspeakers placed sufficiently far away for the majority of the audience to be in the sweet spot – the further away the speakers are, the more the acoustic of the performance space will interfere with what is heard. It seems to me that the best approach to performing electroacoustic music in public spaces is not to deny the characteristics of the space in an attempt to recreate the sound as heard in the composer's studio (which is actually impossible) but to use those characteristics as part of the listening experience – anything else is just theoretical.

These issues go back to the earlier discussion of musical structure and what might constitute music in the electroacoustic medium. The simple fact is: much electroacoustic music, particularly that in the musique concrete *and acousmatic tradition is intended to be diffused, has the variability of performance underlying its aesthetic base – but this is not to say that any old fader movements will do! Sound material approached as*

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[7] A discussion list run by the Communaute electroacoustique canadienne/Canadian Electroacoustic Community.

organic matter to be sculpted, shaped, coaxed, caressed into participating in a piece of 'sonic art' generally (and I stress the generalisation) behaves well in diffusion (when properly done, of course), because diffusion is an extension of the compositional approach. When a composer is interested in grain, in the internal evolution of sound events, in spectro-morphology (Smalley 1986), in the textural flux and gestural articulation of time which grows out of a consideration (via 'reduced listening', perhaps?) of the unique sound object, in the event itself rather than the intervals between events, then sculpting sound into a performance space is not a contradiction of the composer's intentions – it is a continuation of them. No, the problems of diffusion arise with musics which spring from a different tradition (where predetermination in one of its many guises is involved), because to be able to predetermine, you have to be able to 'measure', to 'notate' (in some way). Inevitably, it seems, this leads back to structures and musical arguments built on the traditional 'parametric' approach, where 'meaning' in a work is defined by values in pitch, rhythm and dynamic and the measurable distances between those values. If a music, whether on tape or not, sticks so closely to the 'lattice-based' instrumental model (Wishart 1985), then it is not surprising it does not diffuse well – after all, there is something rather disturbing about a low-flying clarinettist (though a recognisably vocal/instrumental sound behaving incongruously in space is, of course, part of the composer's range of expressive means – Justice Olsson's Up *(Olsson 1991) is a good example).*

A substantial amount of music 'on a fixed medium' seems to be there purely for storage of the finished product, for convenience, and is nevertheless still conceptually rooted in the instrumental domain. One need look no further than much music produced with MIDI and Csound for proof. In the first, even non-tempered tuning was an afterthought and the basic unit remains 'the note'; in the second the 'orchestra', which defines the (often constant, 'instrumental') spectral dimensions, is given a 'score' to play. Despite the all-embracing umbrella of the term 'electroacoustic music', MIDI and Csound arguably have more in common with each other and with what I have called a 'traditional' compositional model than does either with musics descended from Schaefferian practice.

There seems, then, to be a fundamental distinction between (much) acousmatic music and (much) 'instrumental' music: in the former, the organic properties of sound objects translate into organic gestures articulating organic structures; the latter tend towards architectonic structures. The former grows, mutates, evolves, permitting a certain fluidity and flexibility in the final aural manifestation of the sound (along the lines of Varese's thinking on the development of crystals), thereby permitting diffusion the possibility of further

expanding the underlying argument. Architectonic form, by contrast, is measured – a projection of dimensions, values, measurements, entirely capable of conceptualisation away from the sound (and the studio) itself, and less amenable to moment-to-moment reshaping in performance. Not surprisingly, architectonic form has searched, historically, for a fixed, repeatable performance capability via multitrack storage and reproduction, and much of the current push to multitrack norms is coming from composers with an 'instrumental' mind-set. Perhaps, therefore, we simply need to say that some music should be diffused and some should not. Where one draws the line between the two may be a matter for debate, but let that debate be musical and not technical!

6. SONIC SCULPTURE

Of course, BEAST is not the only multi-channel diffusion system in the world. Other solutions and approaches have been proposed and developed – the Acousmonium at the GRM was conceived more as an 'orchestra of loudspeakers', positioned in a mainly frontal array on the large stage of the GRM's home auditorium of the Salle Olivier Messiaen, in the Maison de Radio France (a hall almost as wide as it is long and with little space for extensive side or rear speaker placement). Here the analogy of 'family groups' of loudspeakers to the instrumental 'sections' of an orchestra is extended into the physical layout of the loudspeaker ensemble, each 'section' typically being made up of a number of the same make and model of speaker (thereby imbuing a characteristic 'colour' to the sound) and positioned in a block or line. The physical deployment of these groups frequently departs from the equal left and right pairings normally associated with stereo – such as, for example, a diagonal line of four medium-sized JBLs running from mid-stage centre to down-stage right. Much of this approach stems from François Bayle's ideas about '. . . a music of images that is "shot and developed in the studio, and projected in a hall, like a film", and that is presented at a subsequent date' (Dhomont 1995, quoting Bayle 1993).

The term 'sound projection' is itself a contentious issue, even among the advocates of multi-channel systems for the public presentation of (stereo) tapes. Although used by Bayle in an analogy with film, it is also a term used by Varese, who discussed planes of sound being projected and intersecting, causing mutual transmutation. As I have written elsewhere, however, 'We now know, of course, that whatever the source point, sound does not travel in a tightly controllable beam, but diffuses within a given space; for this reason, I prefer to talk of "sound diffusion" rather than "sound projection". . .' (Harrison 1988).

Consequently, a hallmark of many BEAST performances is a tendency to blend loudspeakers in the array rather than to localise sounds in particular boxes, to keep the sound in a constant state of spatial evolution – to sculpt the sound in the space and to sculpt the space with the sound.

7. AUTOMATION AND MULTITRACK

Many people have asked BEAST about the automation of diffusion. On the surface, it seems like a good idea – thirty channels is quite a handful in performance. Apart from the cost implications of developing such a system, however, there are compositional and performance issues involved. Ideally, the automation would be composed *on* the performance system *in* the performance space, to which (as already mentioned) there is never sufficient access. If another performance were to take place in a different space and with a different configuration of the system, then the automated version is hardly any more durable than an individual realtime manual performance. Even at the most fundamental level, performance spaces behave differently in concerts from the way they behave in rehearsals – some kind of intervention to update and correct for the presence of the audience is musically inevitable. The only practicable way to automate is to standardise on a configuration for the system (and it would have to be fairly basic to ensure 'portability'), set it up as the monitoring environment in the studio, compose directly on to it and replicate it in all venues. As I have already stated, this is precisely what I believe is undesirable, because it does not (cannot) take the particular performance space into account.

It is a very short step from propositions of automation and standardised playback conditions to the issue of multitrack formats, now gaining in popularity with the advent of cost-effective digital multitrack systems. It would be Luddite for me to maintain that I am not interested in the possibilities offered by multitrack, though there are some dangers. The problems of 'four-corner quadraphony' are well enough documented not to need repetition here, though the weighting of loudspeakers in the BEAST system towards a frontal array rather than an equal front/rear deployment reflects the empirically proven truth of these issues. The case of *Kontakte*, already discussed in terms of *musique concrete* and *elektronische Musik*, is also relevant here. Although a 4-channel piece, the speakers are not placed in the corners of the space but in a cruciform array, the first tape sounds in the piece coming out of the central upstage speaker. This means that three of the four loudspeakers *plus* the live piano and percussion are in front or to the sides of listeners with only one loudspeaker behind.

But what is even more significant about the spatial dimension of *Kontakte* is that it is *real* – real movement with real phase information in a real environment, recorded via four microphones and captured on tape – this, plus the concentration on frontally oriented sound sources, explains why the circular motion of the work is so convincing. Panned mono signals simply cannot replicate this. As already discussed, mono represents the distance and proximity axis only – and that badly! Lateral movement in multi-mono works polarises in the loudspeaker cabinets and the richness of a three-dimensional 'stage' is rare. Many pieces composed in 4-channel format over the past four decades and many now being composed in 8- or 16-channel digital formats for replay in concert over the equivalent number of loudspeakers actually use(d) mono source material. It seems glaringly obvious to me that the 'space' of such pieces cannot work, for there is little or no phase information on the tape.

As long as composers are prepared to address the complexities involved in working with *stereophonic* images within the multi-track environment (as Robert Normandeau did in, for example, *Tangram* (Normandeau 1994)), all will be well. If, as I suspect, the logistical problems of doing this, even within a program like ProTools, prove too much, we will be reduced to what I call the 'Stonehenge' deployment – an array of eight or sixteen equally spaced, matching loudspeakers at the same height and at equal distances from the central sweet spot. Architectonic structure would have swept all before it. And for all the reasons I have already stated, this would be a backward step.

8. CONCLUSION

Although ostensibly about the performance practice of diffusion, much of this discussion has, necessarily, taken place before an implicit backdrop of musical attitudes. Without an understanding of the motivation and concerns of musics descended from the traditions of *musique concrete*, the need for diffusion makes little sense – as amply demonstrated by Maconie, there was little knowledge, understanding or sympathy outside the French-speaking world for what appeared merely subjective and 'capricious' when compared to the objective 'truth' of achievements in *elektronische Musik*, supported as they were by the inherited traditions of musical 'meaning' embodied in architectonic structure.

For all the claims that the divisions between *musique concrete* and *elektronische Musik* miraculously disappeared in the late 1950s, there remain significant vestiges of the different approaches in the contrasts between what I have called architectonic and organic elements in the music. Architectonic

structure is built on the quantifiable distances *between* musical events (in all parameters), whereas organic structure explores the qualitative evolution, the spectro-morphology of the events themselves. Similarly, architectonic space is built on the quantifiable distances *between* events in the additional parameter of spatial location – this sound is *here* and that sound is *there*; the placement of (often mono) sounds in specific channels (i.e. loudspeakers) offers a clear articulation of this 'space' – whereas organic space explores the qualitative spatial evolution of an already evolving spectro-morphological sound object – it is far more likely to be spatially unstable (i.e. 'on the move').

On this basis, works exhibiting architectonic structure and space are not well suited to diffusion, whilst those displaying organic structure and space certainly are – indeed, *not* to diffuse such material contravenes its very nature and is musically unjustifiable. Fifty years ago, Pierre Schaeffer unleashed a *new way* of musical thinking. *Vive la musique concrete* – and all that flows from it!

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