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Sound diffusion and performance: new methods – new music.

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Abstract

This paper outlines a new electroacoustic composition project. Its aim is to afford greater flexibility and improvisation in performance. Complementary to this is a re-design of the analogue diffusion console to facilitate increased composer control over the entire work at time of presentation.

The project investigates the composition and performance of electroacoustic music using multiple Compact Discs (and later, computers) containing manageable musical units that are assembled in performance and diffused in the concert space by means of a multi-manual console.

The practice and performance of much electroacoustic music has for many years rested upon the diffusion of materials 'fixed' to tape in the composition process. Electroacoustic performance asks that the diffuser make real the spatial motion and structural relationships implied on the stereo tape. This paper considers the practice of sound diffusion and its relationship to composition and reflects upon the moment where a composer commences mixing in the studio and the completed work.

This paper investigates a new middle ground brought about through fracturing the composition and diffusion processes. This approach represents a meeting-point between construction and deconstruction leaving the finished work in a state that requires completion at the time of performance. The close relationship between spectromorphological type and diffusion style is further developed by constructing a live matrix under the diffuser's control in the form of a redesigned 'diffusion console', facilitating changes in performance practice and resembling a *multi-manual organ* in design.

Aesthetic

Lying at the heart of this research is a compositional necessity, the need to approach electroacoustic music on fixed media from another angle. The continuing growth of the Groupe de Recherches Musicales in Paris, and the esteem with which composers such as François Bayle, Francis Dhomont, Jonty Harrison, Bernard Parmegiani and Denis Smalley are held, offers encouragement to those who continue to research/compose with a similar aesthetic. It is their compositional practice that this research wishes to build upon and it is expected that some of these composers will play a part in its development.

The research will focus initially upon the manual control of sound elements in diffusion. The speed at which decisions can be implemented and the dexterity of control required when operating equipment will influence compositional practice, allowing for an unexplored range of diffusion possibilities. The hands will have control over multiple faders, Compact Disc players and (at a later stage) computers. The duration of manageable units of sound will have to be carefully considered within the context of a work.

Initial requirements are based on two assumptions:

1 The fracturing of compositional and diffusion processes can generate positive musical results and offer the possibility of improvisation with materials.

2 We may need to make the problem of diffusion more complex to find new solutions, even to current issues.

Historical perspective

With a longstanding history, it is hard to deny sound diffusion its place in the performance of electroacoustic music. The placement of sound around a performing space is not new. From the 'cori spezzati' (broken choirs) of Willaert and Gabrielli to the 'flying trombones' of Stockhausen's *Gruppen*, composers have delighted in working with space and the performance situation. The need to carve space physically has remained symbolically and musically important throughout most cantoris/decani antiphonal choral music and double chorus works such as Bach's St. Matthew Passion. Multiple loudspeaker installations in performing spaces are but one continuation (and a far stretched one at that).

The foundation of our current diffusion paradigm is based around:

> …an environment one could not create at home, as in Varèse's *Poème Electronique*, Stockhausen's *Gesang der Jünglinge*. And one aspect of an extraordinary environment [is] the spatial distribution of sound. Indeed, ever since Pierre Schaeffer's pupitre d'espace, in 1951, the spatial distribution of sound was thought of as an important if not essential element in the public presentation of tape music. (Chadabe, 1997: 67)

Chadabe counters with the age-old problem, 'who, after all, enjoys sitting in a darkened theater watching inanimate loudspeakers? And why would one go to a concert hall to hear something that could be played on a stereo at home? ' (ibid: 67)

Many composers, and even more audience are still battling with this question. Chadabe identifies the need to make the playing of tapes, 'lively' in concert. But recent history shows a growing tendency to hold firm to the ‘acousmatic’ spirit embodied in much electroacoustic music, which deprives the audience of their sight. The successful ‘Rien a Voir’ concert series in Montréal[1] advertises itself entirely upon the fact that there is ‘nothing to see’. Many other multi-loudspeaker concerts limit lighting to a spotlight over the mixing desk. The status of the sound diffuser is still somewhat confused however.

Jonty Harrison (1999) naturally supposes that diffusion is thoroughly entwined in the composition process but categorically states that diffusion is not ‘the random throwing-around of sound which destroys the composer’s intentions’ (Harrison, 1999)

[1] The Rien a Voir series was created by Reseaux, a production company founded by composers Jean-François Denis, Gilles Gobeil and Robert Normandeau. See http://www.rien.qc.ca/

Spatial articulation in performance: manual process

Denis Smalley (1986) has neatly defined many of the spatial characteristics that concern composers working with electroacoustic materials. He describes five categories that define space: spectral space, time as space, resonance, spatial articulation in composition and the transference of composed spatial articulation into the listening environment. (Smalley 1986: 90)

Talking about this fifth category Smalley writes, 'it is a question of adapting gesture and texture so that multi-level focus is possible for as many listeners as possible' (ibid: 92). He continues, 'In a medium which relies on the observation and discrimination of qualitative differences, where spectral criteria are so much the product of sound quality, the final act becomes the most crucial of all' (ibid: 92). Despite this, little has been written concerning the performance practice of sound diffusion. MacDonald (1995) and Harrison (1999) have commented upon the design of fixed systems of loudspeakers. Two such examples are BEAST (Birmingham ElectroAcoustic Sound Theatre) and the Acousmonium of the Group de Recherches Musicales. Both differ quite dramatically in terms of aesthetic direction.

In 1974, François Bayle created the Acousmonium at the Groupe de Recherches Musicales. The format adopted was an ‘orchestra of loudspeakers’, with all but a few speakers placed on the stage. A formidable sight indeed, presenting ghostly monolithic pillars of sound. The arrangement on the stage was based upon each speaker’s performing characteristic. Whilst the majority of the system was symmetrical, some ‘groups’ penetrated this symmetry as ‘soloists’. This crafty positioning of speakers allied closely with Bayle's own aesthetic of making real in the space, that which is 'encapsulated' on tape but not necessarily surrounding the listener.

BEAST follows a more symmetrical format and attempts to surround the listener much more (depending upon the physical performing space). With both systems, careful attention is paid to the choice of loudspeaker used. Differences in loudspeakers act as fixed filters to diffusion. Where high frequencies tend to suggest high position, BEAST suspends tweeters above the audience. There are many that find a variety of loudspeakers on stage destroys precision, muddies colour, and generally does not represent the composer’s intentions. These practitioners tend to resort to multiple loudspeakers of the same type (normally studio monitors). In many respects this does not allow for creative adaptation to spaces or pieces and assumes that a piece can not be ‘rendered’ in any other way than when conceived in the studio.

Spatial articulation in performance: automated process

Increased timbral separation can be achieved by multichannel tape where, should the composer require, separate sounds can be recorded to separate channels. This kind of information is often difficult to perceive precisely because it breaks the listener's perception of an integrated space. This compositional problem stems from the ill-defined notions of the boundaries between monophony and polyphony that can arise from mixing. Ambsionics model 'sound fields' in an attempt to provide a more integrated 3-D space. Research in this area is well documented by Malham and Mayatt (1995).

Multichannel separation

Multichannel composition (especially 8 channel and n.1 standards) have risen to the forefront of composition research. Over a number of performances, I have noted significant differences in the use of the 8 channel recorder. Ben Thigpen's work, Step Under (1998) presented clearly defined trajectories of sound in definite planes. Jonty Harrison's Streams (1999) utilised 8 channels to present less differentiated elements, but more 'similar but different' illusory material. Paul Koonce's Breath and the Machine (2000) used 8 channels to 'fix' the space. Larry Austin has often used 8 individual channels for multiple polyphony in his work.

With a choice of 2 ‘hard’ formats (Aleisis and Tascam) the multichannel work remains ‘fixed’ to the tape even though sub mixing prior to diffusion can take place. To free the composer/performer from the serial delivery of the tape, increased use is being made of ‘soft’ real-time mixing using pre-composed instruments made in object orientated graphical languages such as *Max/MSP* (Zicarelli) and *pd* (Puckette). It is perhaps reasonable to assume that if a promoter can obtain 8 or more loudspeakers, they can obtain a computer with a drive fast enough to play multiple channels through a multi-channel soundcard.

With the flexibility of the computer in manipulating sound, many researchers have investigated the problem of the human computer interface. More shall be said about this in a later section of this paper.

Given time in the space with a ‘soft’ system one can set up or ‘tweak’ specific motion trajectories. Within the stereo work however, one relies upon individual audio separation and psycho-acoustic phenomena (an understanding of the work, feeling similar motions – or anticipating them along with the diffuser). During rehearsal, approximate trajectories may be mapped to a rough score. Whether the diffuser sticks to these in the heat of performance is another matter. The basis upon which a diffuser will articulate sound within different sections of a work is often concluded during performance. Whilst it would be unfair to state that each time the music moves aggressively from left to right the diffuser moves faders aggressively, it is the perceived lack of form within diffusion that I intend to

investigate through practical work. As far as I can tell, there exists no method of scoring basic diffusion trajectories for simple loudspeaker systems. Take a piece like Pete Stollery's *Shortstuff*. This work demands very careful diffusion and whilst every performer, space and system will require new solutions of diffusion, quite clear trajectories are suggested. Also, 'diffusion redundancy' could emerge. For the opening minutes, the sounds (and the spaces in between them) offer the opportunity to 'fly around the room'. I wonder whether the fader movements here could not be better organised to further structure the work.

Some interesting work conducted by Copeland (2001) merges musical production with sound spatialisation. It is important in these cases to combine theoretical investigation with practice and experimentation. In this way papers such as this become part of an hermenutic solution.

Copeland, Rolfe (2000) and others using the Richmond Sound Design Audiobox with ABControl software are pre-composing spatialisation. Their system seems to offer considerable flexibility. Copeland and Rolfe (2000) point out the obvious difficulty of working with matrix diffusion and the need to automate diffusion to suit the space. They also recognise the need to develop a functional HCI and have adopted the aXiO (Alternative Expressive Input Object) that can be switched from controlling samplers and sequencers to spatial movements.

The prosthetic debate: HCI, Mapping and Artificial Intelligence

How then can we expand upon the diffusion paradigm, embracing the legacy of the past 50 years whilst adopting a new scientific and musical outlook. One composer/engineer who has taken huge strides towards doing just this is Serge de Laubier. In an observation drawn from early work he writes, 'it is more interesting to move a sound around in space if this movement is connected to its spectral evolution'. (de Laubier, 1998). The converse situation is that a sound will suggest a motion precisely because of its spectral evolution.

His (de Laubier's) solutions of realistic spatialisation (simulation of the doppler effect for example), speculative and dramatic placement hold true for the sound diffusion of many works. The distant field is far away, perhaps in the roof. Distant sounds can easily be made to navigate to these areas. High frequencies soar above us (see the BEAST example). Some dramatic gestures work well sweeping from behind our heads to the front of the hall. Having seen his work live, I particularly remember the sonocanne: a hand held speaker array on a pole. De Laubier's early experiments recapitulate the sense of discovery of Russolo and the practical solutions to spatialisation coined by Stockhausen (and so frequently photographed).

De Laubier’s research moved towards the meta-instrument (1998). The control derived from 10 pressure sensitive keys per hand that allow for multiple inputs (attack, pressure, position); thumb keys; hand rotation (with recoil spring - a

feedback mechanism so infrequently incorporated into computer interfacing instruments); arm movements and foot pedals, represents an extensive resource from which to develop mapping algorithms.

The meta-instrument interfaces with the software *Max/MSP* (Zicarelli). Instrument software could be constructed that enables the meta-instrument to control spectral parameters of pre-composed soundfiles and orchestrate their position in space.

New tools like the Lady's Glove, from designer-engineer Bert Bongers and similar tools from composer-researcher Buch Rovan using control-voltage to MIDI via well used interfaces such as the iCube (infusion systems) and the AtoMIC (IRCAM) mean that inexpensive solutions are also being sought to the HCI problem.

Continued research at STEIM has tended to result in one-off, concept based instruments that tend (although as they mostly work in conjunction with one mid-level software language or another) to control the synthesis of the micro level during performance much more than deal with macro level decisions. One can say the same of motion capture. Data sets tend to map to the micro level and often emulate traditional instruments, through mapping pitch and duration.

As we weigh up increased parameter control with complexity of sound, manipulation and the need to improvise and perform, I suggest there is a strong

case for continuing to compose sounds in an environment outside of the real-time performance where one can audition, accept/reject and return. I also believe there is room to fracture the electroacoustic work without destroying this paradigm.

Let it be said the sensorg (Ungvary)[2] represents a considerable period of research, as do 'the hands' (Waisvisz) and the Radio Baton (Matthews) to name three examples. However, these meta-instruments remain very composer/institution specific. It almost seems like the tools still dictate the composition. Electroacoustic music on fixed media manages to eschew this to some extent through the redundancy of its tools.

At SEAMUS y2K (Denton, Texas 2000), Colby Leider presented the Elbo, an instrument for live spatialisation and diffusion of sound in space. The instrument translates gestures into spatial location, point source velocity, pan width (spread), effect parameter, and other diffusion data[3].

It seems clear that our hands are not all that is required for sound diffusion. Whilst computer aided diffusion could be present in all the above examples, it is strictly at the command of the performer. It may well be the case that the

[2] See http://www.speech.kth.se/kacor/sensorg/main.htm
[3] See http://silvertone.princeton.edu/~colby/Instruments.html

computer acts in future as a ‘virtual listener’ and assists with the diffusion. This concept will be referred to in the conclusion of this paper.

A starting point for investigation

This research project relies upon using traditional electroacoustic compositional practice and performance to inform a process of development and modification over two years (beginning May2001). An initial prototype feeds experimental processes, which in turn yield new pathways of composition. A series of refinements will be investigated based upon the need to increase musical and technological functionality. Based around a 48 channel mixing desk with 4 manuals, developments will include couplers, presets, swell controls, ‘flying faders’ and computer interaction. Many of these will be implemented within the second phase of the project. Expert composers will be invited to work with the prototype console in the production of new music and will contribute to the development of the console by submitting ideas for inclusion within the second phase.

Whilst the primary potential market is the electroacoustic composer, it is hoped that resources generated by this project will interest those involved in DJ work and other commercial end users.

Design

The construction of the console and the new methods of composition as imagined are modular and inclusive in design.

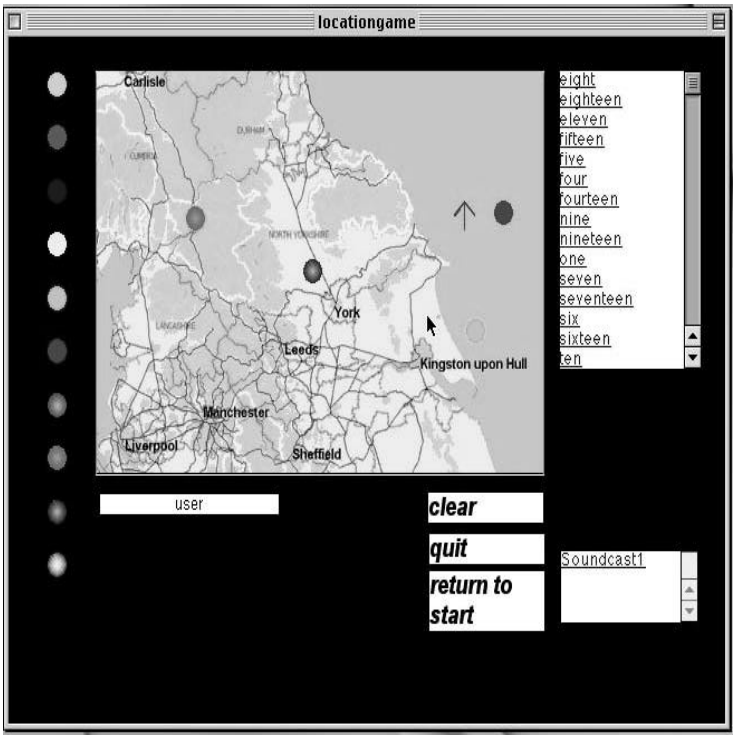
Racks of potentiometers would be staggered one on top of the other with standard inputs (via footpedals) and outputs at the rear or sides of the console. Each rack of potentiometers represents one stereo input. Each potentiometer in one rack should be imagined as being connected to a loudspeaker. Thus A3, B3 and C3 would all mix to loudspeaker 3. This allows for significant development of musical material in the textural dimension (through layering 4 inputs) without over-stretching technical skill in performance. Couplers and other preset stops may in future be placed below one manual, again following the organ analogy. The compact nature of the device is of the utmost importance. Inputs for any standard computer 'breakout box' will be included in the later phase so that a computer can be easily attached.

Conclusion

It is clear that sound diffusion of electroacoustic music plays a vital part in its perception. If performance practice is to be analysed in greater detail it is perhaps necessary to make the problem of diffusion more complex to find out

how best to aid the composer and performer with electronics. This initial research aims to fracture the process of composition and diffusion and hopefully introduce an increased sense of interpretation to the diffusion process.

The final phase of this research project brings on board a computer programmer working within the realm of artificial intelligence and design. As Smalley (1996) has pointed out, sound-context relationships suggest behaviours. Most graphic design programmes allow the attachment of behaviours to objects. This is artificial intelligence at its most basic form. Simple (randomised) artificial motion types were implemented in the location game (Moore and Moore) as part of a simple sound toy.



Whilst the behaviours one would design in a multi-media programme such as Director (Macromind) are vastly different to Smalley's '*dominance/subordination,* and *conflict/coexistence*', (Smalley, 1996: 87) example, it is hoped to construct a 'virtual listener' that will intelligently detect, relate to and diffuse the material it is receiving. The computer would then perform *in conjunction* with the human diffuser. Results from earlier phases of this work will define more concretely some of the possible behaviour characteristics and diffusion patterns available. Indeed, an artificially intelligent diffusion system could benefit from research tried and tested in the games industry. In a similar vein to programs that synthesise sound through physical models it is hoped to search for and implement top-down models of sound diffusion.

This paper has drawn attention to the variety of research taking place in sound diffusion. As a practice in its own right it deserves more attention. The instigation of the first diffusion competition in Brussels last year, pioneered by Annette Vande Gorne sets an international standard. It is hoped this paper and resulting practice-based research will lead to new methods of diffusing and new music.

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