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Spatialising Threads/Hallucinations: Closing the Gap Between Installation and Performance

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*Threads/*Hallucinations is a musical work that combines sound installation and live performance using an eight-speaker array. The work uses spatialisation as a means to control the performance, provide an immersive listening experience and extend musical composition parameters. The work draws on spatial and electronic music composition techniques, sound art installation and site-specific sounds. This paper will outline some key influences on the creation of this work as well as outlining concepts and methodologies for incorporating spatial techniques within the field of electronic music.

Introduction

Threads/Hallucinations (2009) is an electronic music work comprised of five live performance and installation pieces presented within a configuration of eight loudspeakers. The works are diffused through the speaker array by way of real time computer processing. Spatial articulation is employed as a compositional parameter, creating an immersive and rich listening environment. The work was presented on the 2nd of November 2009 at Spectrum Project Space in Northbridge, Perth, Western Australia.

The work is composed specifically for the Spectrum Project Space; this was made a focus from the beginning of composition. Spectrum is a contemporary art space comprised of several adjoining rooms, the largest, central room being approximately 60 square metres and rectangular shaped. Each piece in *Threads/Hallucinations* was composed with site-specific considerations particular to this central space. The arrangement of speakers in the space, the shape of the room, the audience viewing locations and the echoes of the space are key factors in compositional decisions.

The work aims to utilise acoustic qualities particular to the space, altering the performer/audience relationship from a traditional 'proscenium'[i] setting, in order to create an immersive environment for listening. These qualities are examined throughout the pieces in order to challenge the perceived difference between installation and performance pieces.

Project Outcomes

Audience Listening

The strength of *Threads/Hallucinations* lies in the ability to create a unique, spatial listening experience. The work can only take place in this single location, and remains unique on each occasion, due to the spatial arrangement, random variables and unpredictable diffusion of sound. As the work relies on digital processing to alter timbres, layer sounds and manipulate spatial effects, the work relies less on traditional music constructs and more on the immersive quality of spatial sound.

In *Threads/Hallucinations*, spatialisation is used to create an immersive listening environment for the listener. The work draws on Australian sound artist Bruce Mowson's approach regarding immersive works of art, which he describes as "works [that] might be read in relation to empiricism, and by using texture, excessive repetition, and immersion via loudness I have sought to provoke 'observation and experience', rather than references to theoretical constructs"[ii]. Sound has the ability to overpower other senses by occupying a multi dimensional space, in which the audiences are themselves a part of the sound diffusion process through the process of listening to the evolution of sound in space.

Performance and Installation

The act of musical performance promotes a visual dichotomy between audience and performer. As laptop musician and academic Kim Cascone writes; 'musical performance, now distanced from prior rituals of socialization, created a polarized axis of performer and audience. This polarity created a distance or "aura" which empowered the performer with an authenticity, that helped create value in their craft'[iii]. Performances that use theatrical codes borrowed from the theatre arts reinforce music performance as a 'spectacle'. As Cascone proposes, this work attempts to remove the focus from the performer and instead place this focus solely on the sound in space and the ability of sound to create a unique, immersive and rich listening experience.

Music as a performing art relies on the fact that sound is created 'in the moment'[iv]. On the other hand, sound art installation proposes that sound can be installed in an environment enabling it to be 'defined by space rather than time and can be exhibited in the same way as a visual artwork would be'[v]. It allows audience members to dictate the way they experience the work. Works lasting extended periods of time that allow free movement of audience members through the space provide a sense of space and time that is not possible during a typical 'proscenium' performance setting. *Threads/Hallucination* is composed in an attempt to negotiate these two theoretically opposed views of time and create a work that is both installed and performed. To do this, the work has been constructed for a specific environment and utilises the same spatial music techniques throughout each piece of the work. The combination of installation and performance works provides audiences with a spatially aware listening experience, highlighting the spatial techniques and their application to works of different means and sound constructs.

Throughout the work various sound sources are used, including synthesised sounds, sampled sounds and acoustic sound performed live. The laptop performer takes a central position (in relation to the speakers) for the performed works, adjusting parameters according to the compositional framework. The performer changes the spatialisation, sampling and synthesis in real-time. Some sound sources are also controlled live including live clarinet and real-time manipulation of no-input mixer feedback. In the installation works, no performers are present.

Speaker Arrangement and Spatial Densities

The work is composed for eight monitor-type speakers. The speakers are arranged in the space in a manner that provides the clearest distinction between each speaker, avoiding a 'proscenium' area and providing the greatest immersive effect.
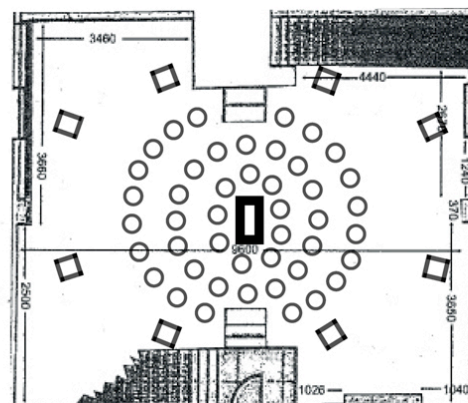

Figure 1. Spectrum Project Space Floor Plan.

The speakers are placed around the outside of the room in a circular pattern facing inwards. Seating for the audience is arranged in rings increasing in size from the centre of the room, facing outwards. This surrounds a single desk in the centre of the space where the laptop performer is situated. Due to the speaker placement and the size of the room, the effect achieved is that of sound emanating from all parts of the room and being propelled towards the centre of the space. The audience may move freely around the space during the performance. This helps to immerse the audience in sound, making them aware of the diffusion of sound, the space and the spatial techniques in the musical composition.

Spatialisation as a Compositional Parameter

The spatialisation in the work can be described and analysed by its combination with, and treatment of, musical elements. The work is analysed by the

contrast, augmentation, diminution or alteration caused by the combination of spatialisation in conjunction with the physical elements of frequency, amplitude and time, which are sub-categorised to musical elements of –

Dynamic (volume)
Pitch (melody, harmony)
Timbre (sound quality, tone)
Texture (density, counterpoint)
Rhythm (tempo, meter)

The arrangement and rates of change of these sub-parameters in conjunction with spatial parameters determine the structural organization. The goal here is to achieve additional layers of musical complexity in the works, build a strong relationship of sound to space and provide a unique listening environment.
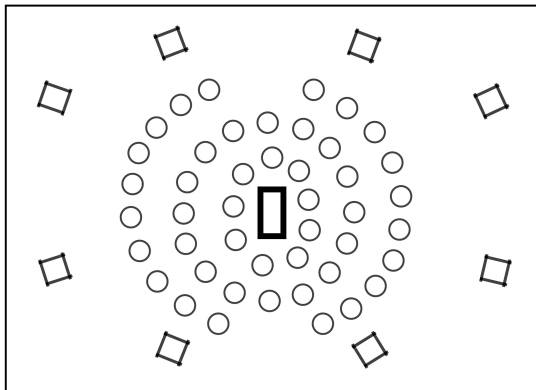

Figure 2. Speaker and Seating Arrangement.

The treatments of different musical parameters are outlined below.

Dynamic (volume): multiple speakers enhancing a single sound give an extreme range of dynamics. Crescendos and decrescendos are achievable by adding or subtracting active speakers for each sound. The movement of volume creates a growing effect for a sound.

Pitch (melody, harmony): sound diffusion can appear to hold tones close together or further apart by separating them in the space. Tones in the same speaker are more likely to appear as originating from the same source and will create a more direct consonant or dissonant harmony.

Timbre (sound quality, tone): the quality of sounds can be merged or separated based on their location in space. Sounds that share similar timbres can be separated by placing them in opposite corners of a space, and then merged by relocating them to the same speaker. Sounds that are moving rapidly have their timbres altered due to the envelopes created, resonance and reverb within the space. These sounds

have more inherent tension and energy to change and/or become stationary.

Texture (density, counterpoint): utilizing multiple speakers to project sound is useful in creating multiple layers of movement in addition to layers of individual sounds. Having sounds become active in multiple speakers also creates more density or body for that sound as it appears to be originating from a larger, or expanded source.

Rhythm (tempo, meter): rhythmic patterns can be accentuated through spatial placement or movement. A held, continuous sound can be given rhythmic qualities by moving throughout a space. This includes a gradually-moving sound that 'drifts' throughout the space; it takes on a time-based tempo even though it would normally be considered a-rhythmic.

Spatialisation Techniques: Digital Audio Manipulation

Threads/Hallucinations uses digital processing to articulate complex spatial arrangements. The computer uses an audio interface that is capable of sending eight outputs, which are routed into the eight speakers. The interface is connected to one microphone and one direct input for the live performances. Any sound that is passed through these into the program is projected among the eight speakers in ways that are determined by the computer program. Simultaneously, any sound the computer is generating, sampling or effecting is also passed out of the speakers.

Programming was completed in Cycling74's Max/MSP/Jitter software, which controls the spatial parameters by implementing compositionally specific processes. Patches have been devised to accommodate for the particular techniques required in the compositions. These patches are pre-programmed with presets that control a range of parameters, including the constraints of aleatoric data that is generated.

'Drifting' Spatialisation

Figure 3 shows the interface of the free8.maxpat subpatcher, one module of octophonic spatialisation. It sends one input source out eight output paths, while reducing the volume for each at an appropriate level to the intended sound projection. This means that if the sound is in the bottom right of the interface, this is closest to the speaker at the back right of the space.
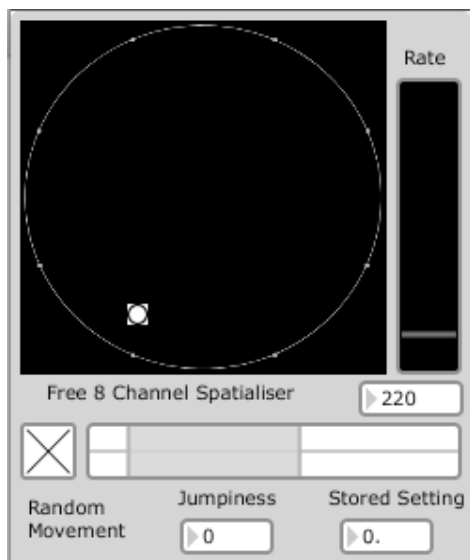
Figure 3. free8.maxpat - octophonic panning module. Based on 8space.maxpat by Tim Place.[vi]

This output path would have the greatest amplitude; the two speakers on either side would have the next highest amplitude, and so on around the array, until the speaker on the opposite side has amplitude of close to zero. Figure 3 shows the sound closest to the rear-left speaker which would have the highest volume, followed by the side-left-rear and the rear-right. The lowest volume would occur in the front-right speaker that would have amplitude of close to 0dB. This method allows panning to occur not just in distinct speakers but also seeming to originate throughout the space, such as in the centre of the room or from a distant corner behind the speakers. This particular module is effective in causing a sound to 'drift' or randomly move around the space at a specified rate. It can be switched on or off, allowing the performer to move the sound to specific locations when random movement is not active.

'Splashing' and Sampled Outputs

Another panning technique is the isolation of sounds to individual speakers, and thereby controlling the rate and positioning of playback. This has been termed 'splashing'. Isolating a unique sound to one particular loudspeaker creates the effect of individual instrumentation, functioning like an instrument in an acoustic ensemble. Techniques such as sampling, delay and granular synthesis produce sounds that can be manipulated to form advanced spatial effects. A delay effect is based on successive repetitions of a sound, each of which can be sent to an individual speaker to create a ripple-like movement.
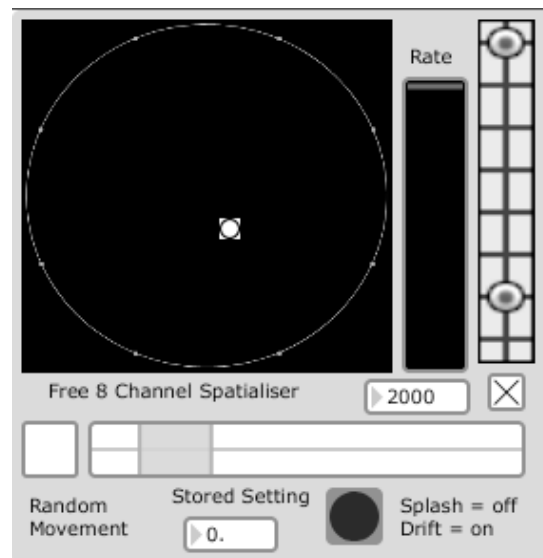

Figure 4. splashdrift_free8.maxpat - panning module with additional settings to 'splash' output. Based on 8space.maxpat[vii]

The delay output module is shown in Figure 5, which shows a ripple output mapping. Granular synthesis generates sounds from miniscule fragments of audio; the playback of each fragment can be played through a different speaker to create an expanded sound or isolated to a single speaker to create a continuous sound. This is demonstrated in Figure 6, which is a table for mapping random numbers to speaker outputs. The spatialisation technique used in this context is referred to as 'splashing' where a sound will dart from one speaker to another, each time diffusing from different points.
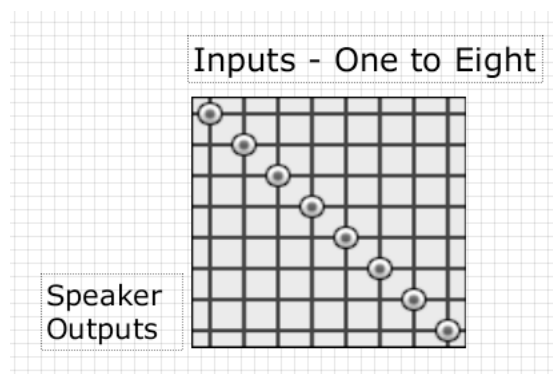

Figure 5. Max/MSP module for output distribution - eight channel delay to eight speaker outputs.
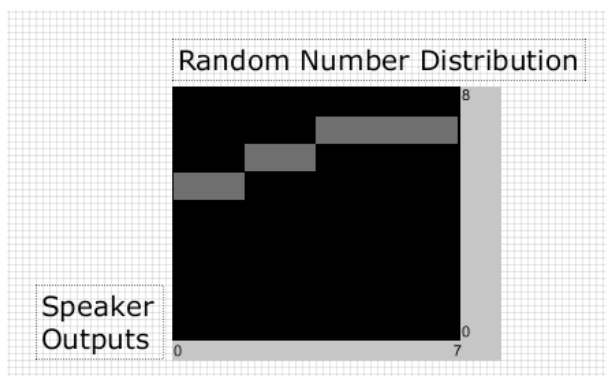
Figure 6. Max/MSP module for output distribution - random distribution table for granular synthesis.

The Pieces of *Threads/Hallucinations*.

Threads/Hallucinations is comprised of five pieces that are to be presented as one continuous work. There are three pieces involving live performers and two pieces that are installed. The order of the pieces is as follows-

1. **Threads** (computer-generated installation, sine tones)

2. **Stretched Limb from Light** (laptop performer, clarinet performer)

3. **Steps of Steps** (laptop performer, no-input mixing board)

4. **Paths Cross in Draped Veins** (laptop performer, pre-recorded sounds)

5. **Hypnogenia** (computer-generated installation, visual information converted to sound)

Threads

The first piece in the program, *Threads* can be installed in the space for an unlimited amount of time leaving the audience free to interact with the way computer-generated sound fills the space. No performer is required. Threads is installed by first selecting a fundamental frequency. Experiments are performed in the space to determine which frequencies will cause distinct phasing patterns between sine tones. The fundamental frequency is chosen for the ability of the overtones to cause significant peaks and troughs in sound amplitude The program then uses 32 sine tone generators that each choose a frequency that is a ratio of the fundamental, these ratios are pre-programmed and include both whole numbers and irregular fractions. Threads enables audience members to experience the sonic space at their own pace. While the computer generates comparatively slowly changing alterations

to the sound, moving through the standing waves creates the auditory perception of fast-moving melodies[viii]. This is caused by the reinforcement or cancellation of standing waves that are being projected through the room. These points occur frequently, moving only a few metres reveals a constantly changing sonic landscape created by the audible tones at each point. The panning utilised in *Threads* involves sounds slowly drifting throughout the eight outputs according to randomly generated numbers, giving the sounds a movement rhythm even though the tones fade in and out over periods of more than 30 seconds. In this piece the speaker array allows for subtle movement of sound, exploring the possibilities of tone combinations in the space. The random generation of different tones, each moving independently is able to generate next to infinite combinations of tones in space. The eight speakers also allow for comparatively greater amplitude levels[ix] than with a lower number of speakers, as well as complex standing tones created by speakers facing opposite each other.

Stretched Limb from Light

The middle section of the program contains pieces that are live performance works, manipulated by a laptop performer in the centre of the space. *Stretched Limb from Light* is an electroacoustic work for clarinet and laptop in which the laptop records clarinet notes played live. The program then uses granular processing to sustain these notes indefinitely and while doing so spatialises them throughout the speaker array. The sound re-production is either assigned to a speaker or is played back in 'grains' of sound (sample playback with durations of less than 200 milliseconds) spread across several speakers. The laptop captures the sound of the clarinet and reproduces them to form harmonies consisting of the notes the clarinet has previously played. The created combinations of tones evolve harmonically through different pitches being added and subtracted, and also spatially through the movement of sounds around the speakers. Here the chords formed from sustaining the clarinet notes are isolated to certain parts of the room, creating the effect of multiple tone centres. The chords are then moved throughout the space and interact with each other. As the piece reaches the climax, the spatialisation is extended; the chords become more dissonant and appear to be created from hundreds of different sources[x].

Steps of Steps

Steps of Steps is a work in which the laptop performer uses a no-input mixing board and laptop to improvise with live eight channel diffusion. The

mixer has its outputs routed back into its inputs in order to create electronic feedback. This creates sounds consisting of clicks, beeps and darting sine tones. The computer program modulates these tones with filters and ring modulation, and layers the sound with sampling, granular synthesis and looping. The performance is structured around a set of densities, timbres and spatial movements. In this piece the diffusion portion of the program works by 'splashing' sound into speakers, drifting the sound among the speaker array in a random pattern and by statically placing sounds in locations of the space. The piece is structured so that it begins with rhythmic clicks in different tempos that are spatialised by the computer into different speakers. The piece also uses rapid 'splashing' of the sound to create separation from each sound and rhythmic spatialisation[xi]. The spatialisation becomes more rapid towards the middle point of the piece; at this point the clicks are replaced with a constant, dense tone. Initially still and holding one position in the space, this tone then increases in layers and density and begins to rapidly 'drift' throughout the space. Finally the constant tones and clicks merge by increasing their rates of 'drifting' and 'splashing' to an extreme level so each are in constant motion and perceived as emanating from the centre of the space[xii].

Paths Cross in Draped Veins

Paths Cross in Draped Veins is an acousmatic composition comprising of pre-recorded found sounds that are triggered, treated with effects and diffused by a laptop performer. The found sounds used are comprised of electronically-generated sounds, recordings of environments or objects and electronically-processed samples. The electronically-generated sounds are stacks of low-frequency sine waves. The environments that have been recorded include a park in which birds and pedestrians can be heard. The recorded objects include a bell tone, a coffee can, rain and running tap water. These sounds were chosen for their rich timbral quality, their recognisable characteristics and the ability to be re-contextualised in a spatial composition. When these sounds are processed and diffused, a multitude of scenarios can be created from combinations of sounds. The diffusion allows the sounds to arrive at the audience from every angle – engulfing them in a dense sound world. This also means multiple scenarios can become apparent, such as the sounds of a park from one side of the room and sounds of dripping water from the opposite side. The electronic processing provides separation from the origins of the sound, replaying sounds in multiple

speakers at any given time and dividing the frequency content of the sounds into different areas of the space. The piece evolves into a moving, energetic display of water sounds, each being filtered and spatialised rapidly. The finely detailed recordings of rain, taps and lakes create a surrealistic expression of movement and strength.

Hypnogenia

The final piece, *Hypnogenia*, is an ongoing audio/visual installation piece. A computer program projects a pre-recorded video while simultaneously converting the image into spatial sound. This work challenges the nature of audio/visual relationships by entangling them into exact alignment. By projecting video in very precise synchronization with audio, additional dimensions of immersion are available to the viewer. This piece is installed at the end of the program for an extended period of time, running in a loop, allowing audience members to fully absorb the connection between video and sound and how they relate to each other and the space.

Each colour is assigned a particular sound quality: red controls the processing of a cello sample, green controls an electronically-generated sample while blue controls a drum kit sample. Each object on the screen is analysed for its size, position and colour intensity. This in turn becomes data for sound processing and is translated to number of particles, spatialisation and volume intensity, respectively. The video uses abstract colour in the form of two-dimensional shapes as triggers for the sound material. The work capitalises on the relationship between colour and sound by initially beginning with a black screen. Lines of one colour are gradually brought in, and as they fill the screen the colour becomes denser. As the colours shift and morph the timbres alter and the density of the sound increases. The patterns of moving lines on the screen creates sound that moves around in the space, forming a synaesthetic relationship. This piece is seemingly quite different from the other pieces, however the compositional process is similar. The sounds that move rapidly or in fast rhythmic combinations correspond to images darting around the screen. Sounds that increase in volume also increase in body[xiii] as a line moves down the side of the screen and the speakers down one side of the room increase their playback volumes. This work is effective in highlighting the spatial arrangement, and displaying clear outcomes of the compositional process to the sound in space.

Figure 7. *Hypnogenia* **(2009). Screen capture, computer-generated image. Dimensions variable.**

Figure 8. *Hypnogenia* **(2009). Screen capture, computer-generated image; black and white rendition. Dimensions variable.**

Reflections and Conclusions

Threads/Hallucinations proved to be a rewarding experience. The resulting sonic arrangements in the space were very pleasing and produced a high quality sound that created musically interesting effects in the space. The space provided for the audience allowed a number of audience members to experience listening positions that were advantageous to hearing the sound produced by all eight speakers.

The work achieved a combination of pieces, each consisting of different performance, improvisation and spatialisation techniques, as well as different sound sources, into the overall composition. The processes applied allowed the work to integrate aspects of live performance, aleatoric computer-controlled sound, electronic instruments and computer processing with a wide range of spatialisation effects. Sound spatialisation was a core compositional parameter.

The overall structure of the work and order of pieces caused some issues regarding the differentiation of performance and installation. Having installation works at the beginning and end of the program revealed the fact that that the audience were expecting performances to begin, and were therefore not as attentive during the installation works, treating them almost as they would 'house music'. Despite this, Threads/Hallucinations was able to create a range of pieces that each separately questioned the space and speaker arrangement, yet overall the program did not fully investigate the relationship between the pieces that comprise the work to a satisfying degree. Other investigations into a more meaningful way of combining installation and performance could link the sonic environment of the installation works with the performance works, in order to create a performance space where installation and performance are experienced as equally-composed musical parameters.

Acknowledgements

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Notes

i Cascone, "Counterfeiting Aura in the Age of Infinite Reproduction" p 5.

ii Mowson, "Being within sound: immanence and listening" p 2.

iii Cascone, "Counterfeiting Aura in the Age of Infinite Reproduction" p 1.

iv Ibid.

v Licht, "Sound Art: Beyond Music, Between Categories" p 16.

vi Place, accessed from http://www.cycling74.com/twiki/bin/view/Share/TimPlace

vii Ibid.

viii This is due to standing waves causing waves to reinforce or cancel one another. Even small movements of the head will pass through several peaks and troughs of standing waves.

ix Higher amplitudes (than with a lower number of speakers, such as the common stereo array) aid the standing wave formation and appear to heighten the density of the sound.

x This is due to the granular playback which produces thousands of samples at a high rate. These are randomly distributed through chosen speakers. This begins with a single speaker but develops to include all eight speakers. This means the sound from each speaker is short and rapid, creating the aural effect of hundreds of sound sources.

xi That is, forming rhythmic patterns and the impression of tempo from the rates at which sounds are 'splashed' or moved around the space.

xii Spatial ambiguity is created from sounds that are moving at too great a speed or in complicated patterns. Ambiguity refers to the inability to determine the source of each sound.

xiii The term 'body' is used in relation to tone. A full-bodied tone contains more low-frequency sound, or appears to originate from a large area.