TIME, SPACE, MEMORY…

A PORTFOLIO OF ACOUSMATIC COMPOSITIONS

by

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ABSTRACT

This portfolio comprises of a collection of acousmatic works which investigate the role of source bonding[1] in music – the tendency of listeners to relate sounds to their real-world sources and the signifying implication of such a link – with a particular focus on how spatial design can contribute towards source-bonding in the music's perception as a holistic spatio-sonic entity. A number of compositional strategies, multichannel formats and spatial audio technologies are investigated, with their merits assessed based on their suitability for shaping the qualities of musical space explored.

The discussion in this commentary will show how these holistic spaces can have similar qualities of perceived 'reality' and 'abstraction' to the individual sounds, and how this is investigated in the musical works. I shall also show how the contrasting environmental qualities of these spaces became a source of of inspiration for structuring the development of my music, and how they might evoke subsequent meaning in their experience based on the listener's understanding of the spatial source bonds.

[1] Smalley (1997), 110.

ACKNOWLEDGEMENTS

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PORTFOLIO: SUMMARY OF MUSICAL WORKS

The portfolio consists of seven fixed multichannel acousmatic compositions and one multichannel installation. These are listed in chronological order below.

Centrifuge

Fixed multichannel composition.

Year of composition: 2011

Format: 8-channel: BEAST-8

Duration: 15:52

Rip

Fixed multichannel composition.

Year of composition: 2011

Format: 8-channel: BEAST-8

Duration: 13:15

Imaginary Landscapes – Through the moors...

Multichannel installation. Composed for presentation over loudspeakers where the audience are free to move around the space inside of the loudspeakers. Ideally I would prefer it if the audience were to remain there for the duration of the installation, however I recognise that this may not always happen.

Year of composition: 2011

Format: 12-channel (see readme on DVD disk 3 for further information)

Duration: 31:50

Resonance

Fixed multichannel composition.

Year of composition: 2012

Format: 8-channel: BEAST-8

Duration: 13:03

False Awakening

Fixed multichannel composition.

Year of composition: 2012

Format: 5.1

Duration: 13:41

Aeolian Forms

Fixed multichannel composition.

Year of composition: 2013

Format: 8-channel: BEAST-8

Duration: 15:57

A moment's reflection

Fixed multichannel composition. Originally presented alongside the painting which inspired the work,[2] however I also consider it suitable for concert performances in which the painting is not present.

Year of composition: 2013

Format: 8-channel: BEAST-8

[2] See DVD disk 1 for an electronic copy of the painting.

Duration: 5:45

Vocem Machinis

Fixed multichannel composition.

Year of composition: 2013

Format: 20-channel (see readme on DVD disk 2 for the speaker layout)

Duration: 8:51

MEDIA CONTENTS

Attached to this commentary are three DVD data disks which contain the original multichannel compositions and supplementary Max/MSP code discussed in the appendices. The DVD contents should be copied to the hard drive of your machine before using them.

Disc 1: Eight-Channel Compositions

Full quality versions of the eight-channel compositions written for the portfolio (24bit, 48kHz). A portfolio player patch is located on the top level to allow easy playback and routing of the audio stream. Please see the PDF documents on the disk for further information on using the patch and routing the audio. The pieces can be accessed by following the link in the player and a PDF document outlines the specification and layout for each of the pieces. Also found on this disk is an electronic copy of Daubiny's *A Seascape*,[3] relevant to *A moment's reflection*.

Contents:

- Centrifuge
- Rip
- Resonance
- Aeolian Forms
- A moments reflection

Disc 2: Compositions for Other Loudspeaker Arrangements

This disk contains the works which were composed for alternative delivery formats. PDF documents outline the specification and speaker layout for each of the pieces. *False Awakening* can

[3] Reproduced with permission from the Barber Institute of Fine Arts.

be copied into the ‘Multi-channel Works’ folder on disk 1, allowing use of the routing and playback facilities offered by the player patch. A separate player is available for *Vocem Machinis*.

Contents:

- False Awakening
- Vocem Machinis

Disc 3: Multi-channel Installation & Max/MSP Patches

This disk contains the installation I composed along with the Max/MSP patches discussed in appendices 3 and 4.

Installations:

- Imaginary Landscapes – Through the moors…

Max/MSP patches:

- BEASTtools
- Personal Max/MSP patches (discussed in appendix 4)

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INTRODUCTION

The purpose of this document is to serve as a guide to my compositional research during the three years of my PhD, examining the musical ideas which interested me and brought about further exploration into electroacoustic art. It is not intended to be a general summary of all possible approaches towards the research topics in the abstract, but rather to illustrate the pathways I took in investigating them through the acousmatic compositions presented in the portfolio. The structure of the commentary follows the same exploratory trajectory which I took in composing these works, showing how new ideas were inspired by the preceding pieces and in working with the compositional resources available to me. By taking this approach I hope not only to illustrate compositionally some of the ways in which I explored the role of recognition in my music, but also how its scope was expanded in order to emphasise the spatial aspects of multichannel[4] acousmatic composition.

RESEARCH PROPOSAL

My initial perspective on the use of source-bonded[5] material in acousmatic composition was how recognisable sounds from the everyday world might be integrated into a continuum which goes from, on the one extreme, complete source abstraction, to the other extreme of being instantly recognisable by the listener. By shaping the listener's perception of movement along this continuum through allusion to – or literal presentation of – real-world sources or scenes, or by masking the origin of a sound by a degree, I proposed that this continuum might be used as a pathway for shaping the listener's experience of compositional development. In my own experience, approaching the source-bonded extreme can cause imagery to be evoked in mind due to a

[4] My use of this word in this instance refers to music which explores a compositional space beyond stereophony, abstracted from any references to particular delivery formats. When dealing with the percept of space or compositional approaches I employ I will adopt a more refined terminology in describing the perceptual aspects of space in acousmatic music.

[5] Smalley (1997), 110.

connection being made between the music and a previous experience, at times transforming the purely acoustic[6] image into a more pan-sensory one. However, in moving between areas of, or combining material from either extreme of the reality-abstraction continuum, the effect can be jarring as one attempts to make sense of these sudden shifts of image. My research therefore seeks to explore this evocation of non-sounding experience by exploring strategies for incorporating recordings in a way that integrates the potential signification of non-sounding information as an integral part of the musical discourse.

As this investigation developed, coupled with further exploration into the use of circumspace[7] and the associated tools and technologies, the role of space in my music became elevated to a more prominent position. As a result, my research began to explore how source bonding might also be explored via space, and its role in the evocation of holistic spatial forms[8] in the listener's imagination. Rather than being interested solely in the behaviour of the individual sounds, I took an approach which investigated the overall quality of space, one which is understood based on any source-bonds in the sounds, their spatiality and quality of landscape, and their combination with other sonic material. Approached from this perspective, I felt that these spaces could have similar qualities of 'reality' and 'abstraction' based on the environmental qualities they evoke and their

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[6] My use of the term 'aural' and 'acoustic' in this document is based on the distinction made by Blesser. He differentiates between these two by describing the acoustic as referring to 'the behaviour of sound waves (vibrations) in solids, liquid, or gases. (…) [Acoustics] (…) uses the language of physics to describe sonic properties which can be measured.' In contrast, 'aural (...) refers exclusively to the human experience of a sonic process; hearing, to the detection of sound; and listening, to active attention or reaction to the meaning, emotions, and symbolism contained within sound.' (Blesser (2007), 4). Consequently, my use of 'aural' refers to the listener's understanding of a sound or space, recognising its ability to evoke ideas beyond that which is explicitly sounding based on the individual's memories and understanding of sound. In contrast my use of the word 'acoustic' refers to the physical and measurable spatial and acoustic properties of a sound or space.

[7] 'Circumspace – space around the listener – extends panoramic space to encompass the listener, with the possibility of approaching or passing over egocentric space [– a perspective of space which is viewed from the point of view of the individual (in this case the listener) –] from all directions. (…). Surround-sound formats, and concert diffusion systems enable the extension of prospective [see p19] space into circumspace' Smalley (2007), 48.

[8] 'Space-form in acousmatic music is an aesthetically created 'environment' which structures transmodal perceptual contingencies through source-bondings and spectromorphological relations. (…) Acousmatic space-form inhabits domains somewhere between space as lived and enacted, and the spaces afforded through spectromorphological contemplation.' (Smalley (2007), 40-41).

perceived order of surrogacy.[9] I also became interested in how giving non source-bonded material a plausible real-world spatiality might help further mediate between the two extremes of the continuum, either by grading the order of surrogacy or else integrating such material into a larger ecologically fused environment. I will discuss how space began to function at a formal level, using the spatial forms to characterise larger sections of music and create narrative structures and meaning – a factor which is investigated in more detail in the later compositions. Space will therefore be shown to not only function on a lower level in terms of the acoustics and trajectories of individual sonic objects, but also as a higher-level metaphor, resulting in works in which spatial organisation is given a formative role in their their conception and experience. I will show how source bonding and evocation in terms of space has the potential to draw upon a rich network of sounding and non-sounding spatial signification, highlighting its basis in everyday experience, and influence upon my own compositional approach.

The listener's experience is key throughout this discussion. Too often, discussions of a spatial nature are related to a specific technology or technologically biased situation, rather than concentrating on space's potential as a shaper of experience. Whilst technical issues will be raised (an inevitability with a genre so reliant on technology), I aim to keep the discussion firmly focused on the listening experience and perception, and how these technologies became part of my compositional toolbox for shaping musical experience.[10]

[9] Smalley (1997), 112.

[10] See chapter 3 and appendixes 2 & 3 for more technical details on the processing techniques I employed.

1. SOURCE BONDING

Smalley defines source bonding as:

> the *natural* tendency to relate sounds to supposed sources and causes, and to relate sounds to each other because they appear to have shared or associated origins.[11]

I find this definition interesting as it suggests to me not only that sounds may be attributed to sources, but interestingly, that there might be grey areas where associations, rather than explicit sources, might be imagined because of the sound's behavioural or spectral characteristics, leading to an association being made to a previous sounding event. This process is personal, subjective but also an unavoidable aspect of hearing sounds, regardless of their presentational mode or context. Numerous listeners can create bonds to similar situations or else create novel imagined bonds never envisaged by the composer. Bonds can be created both by highly connotative sounds as well as by abstract material and 'is an inherent perceptual activity'[12] in a listening situation in which the imagination is free to contemplate a potentially infinite range of possibilities. The sections below explore some of the gradations of source bonding in more detail, beginning to take them into more of a spatial domain and relate them to elements within my own music.

1.1 RECOGNITION

Whilst offering the composer the possibility to explore the effects of referentiality within their artwork, the recognition of a sound's source presents issues relating to the listening strategies used. Firstly, when the listener hears a recognisable sound, they may focus more on the sound's identity or origin rather than its signification within the context of the artwork as a whole. This issue is

[11] Smalley (1997), 110.

[12] Ibid.

unavoidable, as our everyday listening habits are orientated towards assigning source-causes to sounds,[13] and needs to accounted for in order to avoid the music struggling to go beyond the origin of the sounds used. The act of recognition may raise further questions related to the enacted space or context a sound may carry. For example in combining material which does not normally coexist in the real-world, the composer needs to acknowledge that meaning might be created based on this union. Equally a recognisable sound might have strong connections to a particular enacted space, something which might be exploited in working towards creating more holistic spatial forms.[14] The degree of source bonding also has an effect on our perception of the progression of time in a piece of music; in scenes which are heavily real-world referential, we experience a temporal flow similar to that of the everyday world, whereas careful control of the energy of musical events can shape sensations of time varying between speed, stasis, and various states in between. Source bonding therefore needs to be used with care, and in my own approach to using referential sound material in composition, strategies need to be adopted which integrate the internal aspects of music (spectromorphological development etc.) alongside the potential signification of objects or scenes external to these acousmatic elements. By doing so I hope to create music which explores a range of free and imagined possibilities between reality and abstraction, with the potential for transformation and motion between these two extremes.

1.2 ALLUSION

When a real-world connection is implied by abstract or heavily transformed material, it can be said to be alluding to the perceived source, in that it suggests a connection without relying on an explicit bond. Given the lack of clear source references, the connections present are less about what the sound *is* than what it is doing; how is the quality of its morphology creating bonds to events or associations which exist outside of that which is explicitly sounding? Works such as Parmegiani's

[13] Bigand (1993), 146-7.

[14] See chapter 2 for further discussion of this approach.

De natura sonorum, and *Surface Tension*, *Splintering* and *Streams* by Jonty Harrison, demonstrate compositional approaches which, whilst exploring material spectromorphologically, similarly import a degree of real-world origin or behavioural characteristic into the musical experience. The process of signification in these and my own works opens up a network of source-cause connections based upon our knowledge of sounding and non-sounding events. These are stimulated as a result of a deeper ongoing engagement with the material, its context, its morphology over time and any references to previous iterations or formal areas, rather than simply its source. In its hinting at real-world events and behaviours, it highlights the similarity between acousmatic and real-world listening and cognition, as well as how difficult it is to escape the connotative potential of sounds. To describe this network of associations Smalley proposes the idea of 'indicative fields' and 'indicative networks',[15] suggesting a series of perceptual fields which make up his indicative network. These categories are not to be treated as separate entities but rather as overlapping weighted spheres which are in a state of flux, and whose balance is determined by the particular presentation of sonic material. They contribute towards what might be regarded as a metaphorical articulation of perceived source-causes which reinforce various source bonds depending on the degree of surrogacy.[16]

The process of allusion offered me the potential to explore the perceptual grey areas which provide space for sonic impressionism. Rather than trying to create fixed imagery or narratives in the listener, I sought to guide them down perceptual avenues in the hope that they might have a similar aesthetic *engagement* with the music to that which I had as the composer. The connections formed by listeners are inherently fragile, personal and open to disruption: however, through our experiences as composers of and listeners to acousmatic music, we are fully aware of their empirical existence. Rather than seeking to ratify every experiential or phenomenological element

[15] Smalley (1996), 83.

[16] Smalley (1997), 111-12.

of my music I will highlight how these areas of exploration were investigated in the portfolio. Through the shaping of different experiences and creation of connections – both within and exterior to the work – I hope to show how I explored the reality-abstraction continuum by musically re-shaping and recontextualising objects and scenes which are fixed in the real world.

1.3 RIP

Rip takes an approach which explores various levels of surrogacy of sonic allusion, binding the material through their sharing of gestural connections which are investigated via other fields such as space, energy, and our relationship to what we perceive the material to represent. The germ for the piece came from SoundField recordings I made of waves. As the sea was calm that day, the waves were fairly constant; however from time to time there would be a more prominent one which would stand out from the rest. Back in the studio, and particularly when decoded over multiple loudspeakers, these larger waves started to assume the role of formal signifiers, their extra energy giving a sense of 'pushing over the edge' as if bursting through a barrier. The smaller waves also began to acquire a sense of tension in their anticipation of the larger waves. This idea of setting up tension followed by release, articulated by a wave-like energy trajectory, became a compositional metaphor across all levels of the work.

In relation to the issue of investigating the reality-abstraction continuum, *Rip* takes a reversed pathway to some of my other works, starting out from an abstract area which, over time, reveals its links with the real world. In the opening gesture, because most of the extrinsic referential bond to the water is hidden, our ears are drawn to the shaping of energy, frequency and space[17] in time, which has grown out of the original wave recordings and has a characteristically wave-like quality. As more material is added it too follows the same gestural shaping and aligns in time with the more

[17] Space is discussed in more detail in later chapters.

or less persistent original gesture, so that rather than new material appearing as a separate stream on its first entry, it functions more as a way of colouring the underlying wave. In the same way that each iteration of the real waves was slightly different, these abstract waves also differ as their material qualities interact with each other, generating imagined lulls and crests as they overlap.

What I begin to experience is a shared causality of materials based on their gestural qualities and shaping of energy. There is a sense of multiple contrapuntal streams operating at different temporal levels, which coalesce and separate based on their overlapping periodicity. As more material is added the allusory bond to the waves is strengthened, but without resorting to the presentation of explicit causal connections. The wave connection is not revealed concretely until 8:20 when the climactic gesture reveals a real-world seascape; however, even then it is not without coloration by the original processed material. Instead of using the act of revealing the wave source to show a process of reversed theme and development, I overlapped and intertwined the processed material with the environmental recording. Rather than integrating the external referentiality of the environmental recording, or for it to function as a model for mimesis, I wanted to integrate it in a way which highlights the poetic allusion to wave-like sounds which has been at work throughout *Rip*. I feel that the mediation of this quality of movement by the main gestural theme helps avoid a sudden jarring shift of image and gives it a natural quality resulting from the attention being focused on the energy shape and morphology of the sounds. There will inevitably be some importing of imagery of the sea and waves by the listener – this is unavoidable given the use of a sound so connotative. However I try to avoid a sudden shift from one extreme of the reality-abstraction continuum to the other, and the possibility of the listener being pulled out of the imagined musical world and into one which is too fixed due to the strength of the real-world associations. By intertwining the acousmatic elements with the sound's referentiality as perceived

by the listener, I hope to further highlight the real-word origin of the spatial and gestural shapes whilst continuing the movement along the reality-abstraction continuum,.

Like the real waves, there is a gradual sense of accumulation of energy with repeated iterations. One technique used frequently in articulating the entry of new material in *Rip* was to hint at new material using the above mentioned technique of coloration and, by gradually increasing the intensity created by this technique, reach a point whereby the new material acquires sufficient perceived momentum to continue on its own contrapuntal trajectory rather than floating on that of the waves. Examples of this technique can be found at 0:35 and 3:18 where the preceding entries anticipate this liberation of the new material. For me this has correlations with the above mentioned idea of the real waves pushing through a barrier. It is as though there is a magnetism between the new material and the underlying waves which binds the two together; this bond can only be broken when sufficient energy is applied to set them on separate trajectories. This metaphor is scaled up to the formal level and used as a way of articulating movement to new sections. Examples of this can be found at 2:16, 4:18 and 7:41 where, in the same way as the waves, there is an overlapping of contrapuntal streams resulting in a much larger gesture which functions as a climactic signifier. This process reaches its climax at 8:20 where the space opens up and reveals the original wave recordings.

2. SPACE

The issue of spatial experience as a shaper of musical discourse is often skirted over in research because of the lack of verifiable evidence, or else explored from a more scientific viewpoint with regards to the technology available for shaping or synthesising space in music. Spatial experience in music is less frequently explored as an aspect of electroacoustic art, a notable omission given its ability to draw upon and create the perception of novel spatial images for the listener, ranging from specific real-world events to more abstract imagined impressions.

The wealth of anecdotal and research-based evidence[18] relating to spatial awareness supports the theory that humans, with training, have the potential to re-compose spatial imagery using acoustic stimuli.[19] Studies have recorded sighted and visually impaired subjects being able to navigate through spaces using nothing but the spatial acoustics, sometimes able to manoeuvre around busy spaces as though they could see, guided by the mental imagery rendered by the synthesis of acoustic stimuli and their memories and understandings of real-world spatial acoustics. Viewed from a more social perspective, space can bring about emotional responses in a listener in situations where sounds are, for example, consistently behind us, or perceived to be proximate, possibly encroaching on our personal space or 'intimate distance'.[20] From a musical point of view, in my own listening to works by Barrett, Smalley, Young and Harrison, I sensed not only the importance of spatial organisation in their music, but also the ability for this clear organisation to evoke vibrant spatial images in my imagination, which subsequently shaped my sense of the narrative.

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[18] See Blesser (2007), 36-45, for a collection of accounts and studies illustrating this.

[19] By this I do not mean just the ability to perform echolocation or other tasks based on the quality of the reflections coming from an object or surface, but also the more subjective issue of sound being able to evoke spatial images based on their real-world source bonds.

[20] Hall (1990), 116-9.

These types of experiences rely on memories or an understanding of real-world spaces acquired in previous experiences. They may be acquired in a musical experience, though in acousmatic music – which can exploit connections between the sonic material and possible real-world origins – this understanding is grounded in real-world events which are linked back to the original through the similarity of spatial texture or quality of enacted space. Whilst there is some shared similarity in the responses of different listeners, they rely on experiences and an understanding of sound which are, to a degree, personal to each individual. As a result, listeners may respond to musical spatiality differently – for instance, a performance might use a different loudspeaker system, or a fresh experience might result in a new bond with that particular space. Therefore in investigating space from a phenomenological perspective, my discussion is more empirical than evidence-led; I cite experiences shared by myself and other listeners, my own compositional intentions, and established literature which gives weight to these ideas.

2.1 SPATIAL EVOCATION

The ability for space-form in acousmatic music to evoke a recognisable place, perspective or environment in the mind of the listener needs to be discussed differently to recognition or reference to a source. Its experience is less easily defined, both in terms of the acoustic properties which evoke the response and what is actually felt, often requiring reference to personal experience or metaphor to communicate them.[21] Also, acousmatic spaces (i.e. those without visual cues) are often categorised through an ongoing act of contextual comparison and mental organisation of the experienced elements, and the listener's relationship to them, rather than precise identification, and in describing our responses, we may formulate vaguer statements such as; "it is a large space", "that

[21] Compare these two possible observations on acousmatic music; (1) "That sounds like a train", and (2) "It feels like a broad landscape". The second statement responds more to the overall quality of space rather than recognition of a source. In doing so it uses a metaphor which, whilst based on a fairly universal archetype, has a much stronger foundation in the listener and their previous experiences, requiring these to be recruited in order to render the impression. Unlike the first statement, it is much more difficult for us to grasp what might have been heard and subsequently brought about that response.

sound is coming from over there", or "the space feels like...". Similarly, our ecological or social understanding may function in the identification of space, adding personal elements which are not contained explicitly within the sounding information. All of these situations offer a smaller range of spatial configurations, which in terms of their acoustic qualities are perceivably different, than the wide range of spaces and spatial images which may form in the listener's imagination. How then are we able to piece together such a wide range of images or impressions which are deduced from the spatial cues in acousmatic music?

Such a phenomenon relies on the fact that when making sense of everyday events, objects and spaces, we employ not just the primary sensory mode in question, but rather a network of systems, each of which contributes towards the overall percept of space. We apprehend spaces thanks not only to our visual senses but also our acoustic ones, which because of the brain's ability to segregate the acoustic information into streams,[22] analysing the streams' individual morphologies over time whilst simultaneously making sense of their role in the scene as a whole, relates the perceived acoustic patterns to the visual and other sensory information which can be used as mental descriptors for recognition and sense-making in the future.[23] Other sensory responses, gestural qualities and personal emotional responses to the space may also become entwined in its perception and consequently its mental representation. These mental representations are how we are able to perceive objects and scenes which are outside our field of vision, or played to us over loudspeakers, using the mental representation and its associated imagery as a guide for re-constructing these spaces.

As a result, in making sense of acousmatic music – where the stimuli are solely acoustic – there is the potential to evoke, by varying degrees, the non-sounding information associated with an event

[22] Bregman (1990).

[23] Schubert, cited in McAdams and Bigand (1990), 146-7.

outside the musical work. Depending on the order of surrogacy of the sound, visual imagery may be imported from the original experience, creating an imaginary mental space in the listener, one which is shaped by the memories and non-sounding connections stimulated by the sonic cues. Highly connotative sounds or those associated with a particular event or place have the potential to carry their enacted space with them, creating a spatial image which may not be contained entirely within the acoustic information. Conversely, material which is abstract in nature, but which has clear bonds to real-world events or scenes through the similarity of spatial texture, has the potential to resonate the pan-sensory information which is associated with an ecological or anthropological understanding of space existing in our auditory lexicon. Finally, particular energy or gestural shapes can also imply human or proprioceptive[24] qualities which import an element of associated human or social space into the experience. Therefore in discussing spatial evocation we need not only to account for the spatial stimuli – and their purely acoustic bonds to real-world spatiality – but also the intrinsic and extrinsic bonds between the sounding and non-sounding information and the associated imagery these bonds might resonate in the listener's imagination.

In the opening of *False Awakening*, where I attempt to create the impression of being in a large, open forest, it is not just the diffuse quality of the B-format recording[25] which gives the sense of spatial dimension, but also the ecological bond between songs sung by a flock of birds and our understanding that such an event could occur in a wood with birds in the trees. The environmental nature of the bird calls, a quality which I believe resonates with the listener's assumed previous experiences of being in a wood full of birds, combined with the illusory acoustics of the decoded recording, creates the image of an expansive wood in the minds of many of the listeners to whom I have spoken. The power of this effect is profound; in this instance the acoustics of the decoded

[24] Smalley (2007), 41.

[25] See section 3.3 for more discussion on this subject.

recording are not especially immersive because of technical limitations,[26] but the environmental associations which result in the importing of imagery based on the listener's experience is immensely powerful in its ability able to maintain, as Coleridge puts it, a 'willing suspension of disbelief (…) [in the musical image] which constitutes poetic faith'.[27] In bringing into play a sufficiently convincing collection of auditory and referential cues the listener is able to meet the composer part-way and render his or her own pan-sensory image of the acoustic one which is being played.

This example of evoked spatial imagery relies heavily on a fairly universal environmental archetype, and engages with the listener more in terms of its identity rather than exploring the possibility for combinations of more abstract material to evoke spatial imagery. It offers the potential to create sensations of arrival or emergence from more musically abstract zones, enhanced by the transition from a possibly dynamic and unpredictable space, to one which is perceived as being stable and fixed due to its foundation in a known reality.[28] However, a music which explores space purely from this perspective is at risk of being perceived as one-paced in terms of the passing of time,[29] or focussed solely on the identity of spaces due to a lack of deeper investigation into the areas between the musical spaces and the listener's responses and understanding of them. Therefore, in order to create a more dynamic spatial and referential language, my approach was to explore similarly universal spatial concepts, but attempt to hint at and give shape to them using material which was more abstract in nature. The sonic material would often have an order of connection with the spatial archetype in terms of its gesture, spectrum or some other quality, however a link would become clearer due to its function within a holistically perceived space whose

[26] These are discussed further in chapter 3.3.

[27] Coleridge, quoted in Blesser (2007), 160.

[28] See 7:50 in *False Awakening* and 7:30 in *Aeolian Forms* for examples.

[29] See page 5 for an expansion on this idea.

form was inspired by the archetype. Through the careful control of the spatial texture, combined with any source bonds or significant spectromorpholgical behaviours present, I hoped that the representations of space which I was working towards would reveal themselves as the listener scanned and contemplated the various elements contributing towards the holistic impression of space.[30] However, unlike in the example from *False Awakening*, I felt that the more ambiguous source-bonds of abstract sounds would offer me greater artistic freedom in terms of transformation of the spatial configurations, including the possibility to go beyond those with real-world foundations and into imagined ones. Spatiality and the creation of spatial forms would therefore become part of the exploration of the reality-abstraction continuum, allowing an equally varied range of connections to known spaces and quality of associated mental imagery. The order of reality can be varied between the presentation of environmental recordings with convincing spatial acoustics, to areas in which the material is abstract, but which has an overall spatiality imported from a real-world foundation.[31] New spaces can be created by placing sounds in unusual enacted spaces or giving them new spatial behaviours. In doing so the quality of evoked mental imagery and impressions may vary between spaces which are very clear in terms of their configuration, to those which are more abstract and nebulous, depending on the order of surrogacy. Also, by allowing it to go beyond objective referentiality, space becomes a more dynamic, morphological parameter, which is no longer subservient to representation, and explores the aesthetic potential of spatial impressionism and motion. Whilst there is the potential for spatial and referential contradictions in terms of any perceived real-world foundation,[32] the art becomes richer in its potential to explore the

[30] An example of this process is given below with reference to *Aeolian Forms*.

[31] A similar approach is found in *Free Fall* by Jonty Harrison, where the metaphor of falling through air inspires the structuring of spatial trajectories and forms created using highly abstract sonic material.

[32] For example in the movement from the original 'forest' space to the more 'industrial' space at 2.05 in *False Awakening*, the combination of these two spaces contradicts our real-world understanding of these environments, not only as being being geographically separate, but also unlikely to morph from one to the other. However, because the expectation is set up from the start that we are in a musical space, one which already contains material which is unsettling its real-world foundation, we accept this movement as part of a work which explores surreal spatial motion.

poetic freedom of transcending reality, inviting the listener into a deeper dialogue between the music and their understanding, and in the process challenging their conceptions of space.

As an example of how different spatial treatments can effect the quality of spatial evocation, I find it interesting that, despite the spectral similarity of the high frequency sweeps in the opening of *False Awakening* and *Aeolian Forms*, the more energetic spatial movement of the treatment in *Aeolian Forms* results in very different source-bonded mental imagery. For me its role in *False Awakening* is that of a sonic intruder – a foreign object which creeps in and hints that the natural environment is not as it seems on the surface. In its initial statements the lack of significant real-world links causes me to perceive it as separate from the environmental scene, observing it in terms of its spatiomorphological[33] qualities. Even when a link is created to the train recording through the similarity of gestural energy and spatial trajectory, it remains an impressionistic part of the musical landscape. In *Aeolian Forms* I find the material has a more allusory quality and evokes more potent source-bonded imagery and associations than in *False Awakening*. The initial gestures have strong spectral, spatial and behavioural bonds to the wind relationship that I discuss in the programme note, and as a result import a greater degree of non-sounding imagery in my hearing, creating a mental image of gusts flying around me. The link between the gestures, their spatiomorphology and the quality of resonances which are generated across our ear canals in windy situations enhances the spatial allusion further, giving a sense of the wind-like gestures encroaching into the personal, head space of the listener.

Despite these being personal interpretations, they highlight the importance of spatial thinking in my compositional approach. Source-bonded space offers a parallel and reciprocal means for exploring the links between sonic material and the listener's real world, which when considered in terms of the pan-sensory mental imagery it might evoke, allows the composer to hypothesise a wide range of

[33] Smalley (2007), 54.

dynamic spatial percepts which play upon or reorientate our understanding of sound and its mental representations. By approaching space holistically and in terms of its potential as an evoker of mental imagery, spatial aspects which might previously have been brushed over (possibly because they are difficult to define in terms of their purely acoustic properties) can become elevated to a more principal role through their ability to evoke vibrant spatial images in the listener's imagination. Subtle shifts in a sound's spatial behaviour can result in dramatic shifts of imagery and perspective as the spatial bonds interact with different memories or real-world foundations.[34] In moments where there is a lack of explicit referential cues, the mind can no longer engage in automatic recognition and is left to contemplate the signification of this material in more depth.[35] If in such a scenario there are significant spatial references (or if such an expectation is created earlier in the work), I hope that the listener will pick up on these and use them as both a guide for completing the musical space (such as in the example above from *False Awakening* and *Aeolian Forms*) and as a way of tracking the development of the work based on the interaction and movement through the space-forms presented in a work.

2.2 SPATIAL PANORAMA

Following an examination of how spatial evocation influenced my compositional approach, the issue of how these elements are shaped into higher level spatial percepts, or zones, needs to be discussed in order to take us towards space's role in shaping the form of my musical works. In analysing space we not only categorise it in terms of the referentiality of the scene presented, a sound's location in space, or its particular size and distance, but also from the more personal

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[34] This is discussed on more detail on page 21-2.

[35] To demonstrate this I would compare the opening of *Centrifuge* with that of *Aeolian Forms*. In *Centrifuge*, whilst the source of the opening sound is not totally clear, the fact that it is an object rolling around me is very quickly understood. In contrast, the more abstract material used in the opening of *Aeolian Forms* can be less easily characterised in terms of a clear source. Instead, in making sense of this material and forming the associated impressions of the space, I contemplate the sounds, their behaviour, and signification within the resultant space as they interact over a period of time. This process requires that I reflect on the space as a whole, and in doing so recruits more of my cognitive faculties rather than being offered a more easily accessible source-cause.

perspective of sensations of landscape, panorama or environment which result from a particular combination or presentation of material with characteristic spatial or referential bonds. Despite its personal and internal nature, the listener's vantage point is an important perceptual factor in the conception of the forms and narratives present in my works. For example, a scene which is frontal and proximate has very different spatial implications from one which is more open and which surrounds the listener. Sensations of volume are also important and can have significant psychological effects during the perception of space. At this higher level of spatial architecture my investigation focuses more on the the concept of composed spaces – how they might be perceived by the listener – and their place within the overall form of the work. These spatial archetypes vary from presentations of raw environmental recordings, which may impart a degree of spatiality due to their source bonds, to combinations of more abstract material whose overall form is perceived to have a foundation in the real-world. In the latter situation, the imagery is more fragile and subject to degradation or alternative interpretations because of the subjective and personal nature of its cognition. I also found that in my experience as a composer of these spaces that they are the ones which require the most work to craft; the ambiguous nature of these spaces means that they have to be shaped with greater care and attention in order to guide the listener towards a particular impression. Despite this, at this higher organisational level, spatial impressions become much more long-lasting and of greater importance in creating the listener's sense of formal development – the movement through or transformation of perceived spaces and the ability for this motion to create long-range structures based on the connections between them[36] – compared to the more fleeting impressions of the individual sounds.

I felt a shared interest in spatial perspective in other composer's works; for example, Smalley's *Empty Vessels* and *Valley Flow* were inspirational with respect to how qualities of landscape,

[36] For example the dialog between the intimate, gestural spaces and the more open, pitch spaces in *Resonance*, or the transformation of an established spaces originally perceived as real into ones which are much more surreal as in *False Awakening*.

encapsulation and spaciousness might be evoked in the mind of the listener, either via literal references to environmental scenes (as in *Empty Vessels*) or by using careful spatial organisation of transformed material in order to structure more abstract spaces (in the case of *Valley Flow*). In my own works, the spatial panorama, whilst frontally biased, extends the spatial interests of these works into periphonic space, allowing greater flexibility of spatial organisation. In describing my shaping of acousmatic space I frequently refer to a perceptual stage, which recedes into the distance and extends width-wise across the listener's field of vision, on which the majority of the musical activity takes place. Coming out from this and wrapping around the back of the listener's head is an arc of more limited depth, which is treated with care because of the sensitivity of the ears to sounds either side of our head and the restricted ability for localisation behind us. As such my spatial constructs are more prospective[37] and panoramic rather than evenly circumspatial. They recognise and exploit the increased spatial resolution in front of the listener, influenced by my panoramic conception of circumspace, which is enhanced poetically by circumspatial cues, envelopment and other effects (See figure 1).

[37] 'My use of the adjective 'prospective' is derived from the notion of 'prospect', a view of landscape that implies a vantage point from where one looks forwards, scanning and exploring the scene to take in the identity and proportional relations of the shapes observed, and the dimensions, extent and depth of the image.' (Smalley (2007), 49).

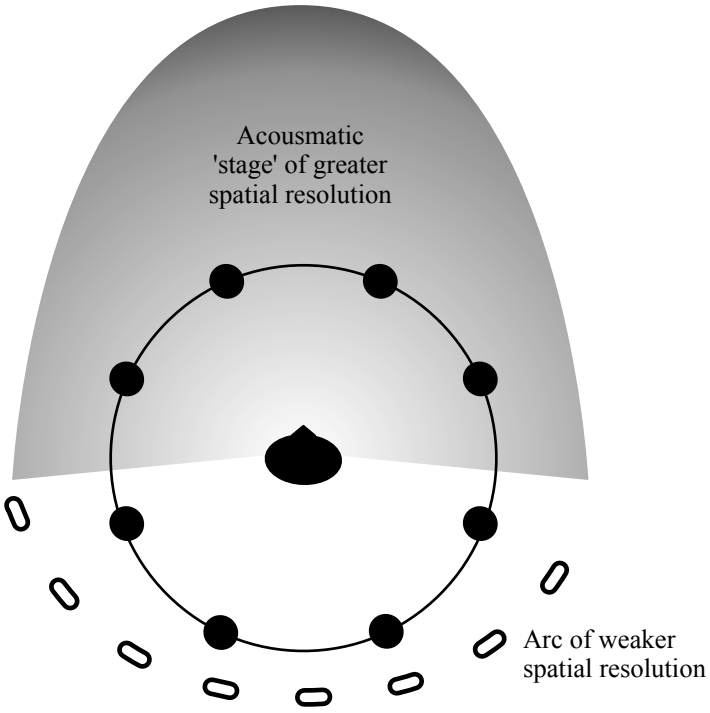

Fig. 1. 'Panoramic' deployment of material in circumspace over a BEAST-8 loudspeaker array.

Some of the clearest examples in my work of the use of prospective space can be found in the opening of *Aeolian Forms*, where the initial wind gestures expand into, and give shape to, a vast panoramic space. My intention is that the focus of the listener is not just on how the sounds are moving in space or their spectromorphology but rather, because of the strength of the spatial treatment, is concerned with how all the factors combine in giving shape to the overall impression of space. The sound, its spatial envelopment, and reverberation all contribute in articulating the breadth and depth of the acousmatic stage, giving shape to the panoramic, semi-visual landscape that I had in mind when composing the work. In *A moment's reflection* the inspiration of the painting on the musical work prompted an equally prospective construction of space, which explores sonically the various qualities of depth and perspective which I discovered in my viewing of Daubigny's seascape. The majority of the opening section explores the depth of the sky and horizon, with wind-like gestures coming out of the distant space. As stated in the programme note, my approach in the work was to open up the frame of the canvas acoustically, stretching the breadth

of the landscape beyond these confines to add an extra layer of poetic interest which was stimulated by my own response to the visual panorama in Daubigny's painting.

Contrasting prospective formations of space are more circumspatial or periphonic[38] spatial constructions. Following my original experiments in multichannel composition I found the concept of circumspace to be problematic. Our ears' bias towards the perception of frontal objects means that not all parts of the space are equally sensitive or have a similar spatial resolution. Placing too much of the material behind the listener can also have the effect of disturbing them or causing confusion because of its conflict with our frontal, audio-visual understanding of real-world spaces. Due to these constraining factors I felt that circumspatial approaches needed to be used with care in order to avoid unsettling the listener and to maintain the plausibility of imagery and sense of acoustic landscape which I was working towards in exploring the reality-abstraction continuum spatially.

Where I found circumspatial treatment to be successful was in attempting to indicate spatial shifts from panorama to proximity by enlarging the size of a sound, or else to contrast prospective spaces with more immersive and periphonically fused spatial percepts. For example in the section at 5:10 in *A moment's reflection*, the water recordings are opened out across the loudspeakers from a frontal and distant position (indicated by the low volume and narrow spatial width), which when combined with the increase in low frequency content creates for me the impression of the sound coming out and opening up from the distant, frontal position and moving me to a position where I am surrounded by it. Contrasting this movement is the section at 2:03 in *Vocem Machinis* where the listener moves from a sonically dense space, acoustically closing them in with the sound of the machinery and the room acoustic, to a section which is much more frontally focussed. What sounds

[38] Both of these terms have been used to describe sound fields which surround the listener with the potential to include height in certain presentational modes (Smalley (2007), 51 & Rumsey (2001), 111).

like a simple movement actually serves to shift the listener's sense of place and space dramatically. In shifting the perspective between open and enclosing spatial situations you are changing the quality of the spatial bonds between the material and the resulting mental imagery, potentially causing dramatic shifts in the perceived acousmatic landscape.

As well as being useful for articulating proximity and enclosure, circumspace is also used in my works to create more diffuse and open sensations of space. Because of their increased amplitude and implied energy, the examples above create more proximate spaces where we appear to be closed in by the sound and the acoustic horizon.[39] In contrast, the landscape can be shaped in the opposite direction, for example in sections such as that from 10:05 in *Resonance*, where the circumspatial treatment combined with the counterpoint of diffuse and nearfield material serves to expand the acoustic horizon and reveal a broader landscape. The contrast with the section which precedes it – bustling, highly energetic and encroaching much more on the listener's personal space – further enhances the sense of opening up the space and gives a feeling of resolution as the intimate circumspatial texture dissipates.[40] Sometimes I combine the two approaches by creating contrapuntal spatial zones, which, with careful balancing of dynamics and spatial orientation, both expand the sense of circumspatial dimension whilst at the same time emphasise the frontal nature of this larger space. For example, in the section discussed above and that at 4:36 in *Rip*, the more delicate material alludes to a smaller prospective space than that in the diffuse field, giving the impression of a more intimate frontal zone whilst the diffuse, circumspatial material simultaneously

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[39] '[The] acoustic horizon [is] the maximum distance between a listener and source of sound where the sonic event can still be heard. Beyond this horizon the sound of a sonic event is too weak relative to the masking power of other sounds to be audible or intelligible' (Blesser (2007), 22). In the examples of enclosure above the most important stream(s) are spatially intimate, with a low dynamic range and high overall volume, creating perceptual occlusion of any other sounds in the scene and closing the listener in spatially. In contrast, in the more open landscapes, the dynamic range is much greater, allowing counterpoint between different spatial streams of varying spatiality which articulate the spatial zones in a scene. By being able to hear these different zones our ears are made aware of objects lying deeper within the space which has the effect of lifting a nearfield acoustic blind and opening up the available depth in a sonic landscape.

[40] This is an early example of the poetic effect of space on the listener. Due to the effect of encroaching on our personal space – a space normally reserved for private discussion and thoughts – we may feel an amount of discomfort due to this perceived invasion of our privacy. I discuss poetic responses to acousmatic space in more detail in chapter 4.

gives shape to the spatial depth, and in the process creates the impression of a great void between these two zones. I attempt to create a similar sense of depth at 7:40 in *Aeolian Forms*, although the low dynamic at 8:00 and the height implied by the aeroplane's real-world bond enhances the breadth of space in my hearing even further.[41] The material and its treatment in both settings was carefully selected not only to articulate a spatial counterpoint with the diffuse field but also to retain the sense of an ecologically coherent landscape. The material in *Rip* shares the energy trajectory used throughout the piece which subtly massages the diffuse, semi-pitched drone. The same can be said for *Aeolian Forms*: the nearfield sound's capricious behaviour has the sense of its being blown in breeze, retaining the wind relationship, whilst the passing airplane gives shape to the space, only here in a more explicitly environmental context.

Space, approached in terms of the landscape-like imagery it might evoke, became a metaphor for approaching narrative constructs and shaping larger forms in my acousmatic works. In all the works from *False Awakening* onwards, the spatial panorama functions as a way of contemplating the development of form, acting as the *idea* behind the work. In *False Awakening* the discourse is centred around the listener's navigation through dream-like realisations of spaces with various references back to real-world origins. In *Aeolian Forms* I was inspired by how wind's sonic interactions can give shape to and become a characteristic of particular spaces, using its energy and resonant qualities to inject motion and articulate the dimensionality of numerous spatial zones with varying immersive properties and poetic implications. Finally *Vocem Machinis'* spatial forms are based entirely on creating a narrative which explores contrasting sensations of scale and immersion, and, as a consequence, movement through different sonic landscapes, all of which were inspired by the pan-sensory spatial aspects of the machinery I recorded. Despite such clear inspiration I would

[41] Despite Aeolian Forms not containing explicit height cues (it is composed for a horizontal array of eight loudspeakers), the strong source bond carried by the plane cause me to import my understanding of its natural habitat – the sky – which, when reinforced using careful diffusion strategies, brings a convincing sense of vertical as well as horizontal depth into my perception of the landscape.

not wish to imply that I wanted to create concrete renderings of the landscapes and narratives that I had in mind. Instead, by creating an engaging sonic landscape I hoped to place the listener at the centre of the experience, causing them to render *their own* panoramas based on their memories and associations.

It is clear from the range of spatial settings discussed here and presented in my music that space is not a definitive concept; space is a fluid percept whose form takes shape in our mind over a period of time and can be sculpted in order to create varying representations. In using space musically I do not attempt to create *this* or *that* space but rather a spatial impression with particular qualities which change over time in order to articulate a sense of development in the musical work. In music, space is no longer tied to the laws of temporality or physics, and as composers we are able to go beyond these laws, taking space into the artistic realm which exists in our imaginations (both composer's and listener's). In my own approach, by imbuing material which is more abstract in nature with a spatiality imported from a real-world setting I seek to make it part of an overall impressionistic space which has a real-world foundation but with the artistic potential that comes with going beyond real-world restraints. In my own composed spaces which exploit dynamic contrasts in location, size and landscape, spatial signification is pushed to the forefront of the perception of the musical work, and when these configurations have their behaviour based in the real-world it is suddenly the spatial elements which are resonating with our memories and pattern recognition faculties, as well as the internal and external bonds discussed earlier. Sensations of landscape are suddenly a primary element by which we characterise the formal development of a work and result in mental imagery which might be less clearly formed without such prominence in the work given to spatial concerns. Space viewed from the perspective of the acoustic landscape is no longer a parameter by which we sculpt the low-level shaping of material but rather a high-level metaphor giving inspiration and shaping the form of an acousmatic work.

2.3 KEEPING IT REAL…

This next section discusses how I seek to move through source-bonded spaces in a way which uses spatial organisation and transformation to mediate between their order of surrogacy, thus seeking to avoid the jarring effects I predicted in the introduction. This approach has been important in the works following *False Awakening*, where I started to consider spatiality in terms of its believability or plausibility with relation to a particular musical or real-world context. In doing so, my works began to combine abstract with perceivably real material in a manner whereby the surrogacy of each is tempered by the other, avoiding disruption of the fragile mental imagery caused by morphological discontinuities or abrupt movements across the reality-abstraction continuum. Rather than perceiving objectively areas which are abstract or real, or else appreciating them based on their precise identification, I hope to create more natural spatial shifts with perceived bonds to real-world space, which are understood in terms of their overall spatiality. Whilst the listener's perceived position in space or quality of landscape will change due to the transformation of material, a change in energy or other connotative factors, the higher-level sensation of being *in* a space remains the same – that is with the same quality of mental imagery evoked by the carefully crafted spatial textures. The development of sonic material, which works hand-in-hand with the movement through associated spatial scenes, in Harrison's *Rock 'n' Roll* was of great interest in highlighting exploratory pathways in which sonic material and space were developed concurrently, and illustrated a quality of spatial organisation which is integral to the development of the music. For example, as the opening 'rock' attack is developed in terms of its gestural and material qualities, it is simultaneously expanded from the close stereo speakers out onto the surrounding array. This spatial expansion not only has a natural quality due to its correspondence with the development of the other sonic characteristics, but also serves to set up the expectation that meaning can be found in the spatial organisation present in the work. In my compositional research, spatial organisation became one of the primary ways in which I could temper more remotely surrogate material with a

perceived sense of plausibility, or else challenge a sound's surrogacy by placing it in a new spatial context. As well as adding to the network of relationships, I feel that this approach allows me to temper the level of abstraction along different parallel pathways, whilst simultaneously offering greater subtlety in the articulation of and movement through impressionist spaces.

During the composition of *False Awakening*, as a result of wanting to create an effortless transition into the dream-like composed spaces, I was keen to ensure that all the elements in the work, from explicit real-world references to extreme transformations, had a sense of plausibility – a sense that they should be there and fit into the composed landscape. In order to try and achieve this unity, my approach to spatial treatment was, regardless of how abstract, to give the material a believable spatiality which grew out of any implied behaviour or bond. In doing so I hoped to maintain a link with reality, which would allow me to interweave real and abstract material more seamlessly, creating the unsettling encroachment of the artefacts and coloration from the abstract, dream-like state onto scenes previously perceived as real. For example, the high frequency sweeping material in the opening section, when considered outside of the context of the work does not sit with the raw environmental recording. However by giving them a believable and natural spatiality based on the implied cues in the sound I accepted the two streams as congruous within the context of the composed space. These streams are gelled further with the arrival of the train at 2:06. The distant call – whose spatial depth is in harmony with that of the sweeps – combined with the similarity of gesture, energy and spatial trajectory between the train and the high sweeps allows it to almost seamlessly become part of the musical landscape. Also pertinent is how at this point in the work, the space – both the objects within it and its dimensions – are altered significantly. Whereas before, the space had been a vast one – implied by the spatial bonds in the environmental recording and the low noise floor – the space suddenly becomes more proximate as objects arrive in it. The sources become larger, pull in the acoustic horizon and lift the noise floor, reducing the dynamic range and

further closing off the aural arena. As with the combination of material, I feel that this process of spatial transformation has a seamless and natural quality to it because of the careful combination of material with particular referential bonds and overall sense of space. The transformation is not natural in the sense of existing in the real-world but rather through a harmony of space, gesture, energy and source bonding, for me it feels artistically natural – it feels as though it should happen that way.

One other way in which material was made perceptually more real and transparent in its spatial imagery was by using the SoundField microphone to capture environmental scenes. Using this I was able to capture the full spherical spatial image present in an environment, which could be decoded over a loudspeaker array back in the studio, and integrated into my compositions with a similar circumspatial quality. As a spatial resource it offers composers the ability to capture spatial images not previously obtainable through stereophonic microphone techniques and integrate their spatiality into the compositional narrative. The combination of referentiality with the presence of believable circumspatial events and cues which one might experience in such a space, can create an extremely convincing and seductive spatial impression, inducing powerful mental imagery in the listener.[42]

Ambisonic environmental recordings are used in *Through the moors…*, *Rip*, *Resonance*, *False Awakening* and *A moment's reflection*, and in all of them they provide an important spatial as well as referential role. In *Rip* and *A moment's reflection* the textural play of lapping and the swell of the larger waves across the frontal arc of loudspeakers inspires many of the spatial gestures and textures in those works. In *Resonance*, recordings in which the microphone was placed inside the body of a conga, capturing a resonant, semi-pitched soundfield not heard from the exterior, inspired the link to the constellation-like pitched material, and ultimately to the lamenting bells at the end. Finally in

[42] See chapter 3.4 for more technical descriptions on my use of SoundField recordings in my compositions.

Through the moors… and *False Awakening* the unique spatial character of the natural environments, their qualities of spatial depth and the connotative qualities of the images they evoked was what partly guided the structuring of these works and inspired me to make the recordings in the first instance.

Space is thus shown not only to function at a lower level in the transformation of material but also at a higher level in the shaping of formal sections, providing a source of inspiration and narrative trajectory over the entire musical work. Whole pieces become characterised for exploring particular spatial constructs, not simply in terms of the parameters of space but more importantly in terms of the potential mental imagery resonated by the musical landscapes and how these various spatial percepts intertwine. Sound takes place in space and our experience is intrinsically linked with its enacted space. I employ sound's potential to evoke imagery, memories and connections of these enacted spaces as a by-product of the activity of musical engagement. It is this associated imagery and its potential stimulation by music with a particular spatial texture that has become the starting point for my personal compositional narratives and which is explored in my creation of musical space.

In experiencing a musical work which uses space in such a primal manner, the listener's external concepts of space as a fixed dimension, supported by the foundations of nature and architecture, are challenged as they are taken through new sensations of landscape and spatiality whilst remaining seated in the concert hall. By embracing the potential for spatiality to shape our experience, we are offered new and novel pan-sensory connections and perspectives between material and and the everyday world, rendering vivid new images in the mind of the listener. In doing so space transcends its real-world existence and becomes appreciated as an art in its own right – 'the art of

spatiality'[43] – allowing the music to go beyond a representation of reality and into the imaginative realm of poetic representation.

[43] Blesser (2007), 159.

3. SHAPING SPACE

With a project which deals with spatial transformations, the issue of how I achieve these percepts is clearly going to be of importance. Until recently very little commercial software was available for multichannel sound transformation[44] and as a result, I found I needed to invest a significant amount of time in researching software tools and spatio-transformational techniques within the context of compositional development. What follows is not intended as a software critique, but rather to illustrate some of the transformational avenues I have explored in investigating space, and their realisation in my acousmatic compositions.[45]

3.1 SPATIALISATION

My personal approach to spatialisation includes not only the spatialisation of single points or stereo sources but also bodies of sound with a particular size and spatial morphology. I make this distinction because sounds in the real world are not always point sources; sounding bodies exist on a scale ranging from small points up to large walls of sound of epic proportion (compare the spatial experience of hearing a small creature to being in front of a huge machine). The perceived size of objects also changes as they move through space in relation to the listener; when the source is further away it is perceived as coming from a more definite direction, whereas when it is nearer, the increase in volume, low frequency content and apparent source width (ASW)[46] cause it to take up

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[44] Some of the most elegant commercial software solutions with support for up to eight channels is available from the company Flux (http://www.fluxhome.com). With an interest in audio and film mastering, multichannel functionality has been integrated in their software from the start rather than being an add-on. As well as their standard range of dynamics processors and EQs they recently collaborated with IRCAM, taking IRCAM's Spat room emulation and SuperVP Trax spectral processing algorithms (http://forumnet.ircam.fr/products-list/) – which were previously only available in the command line or as objects for use in Max/MSP – and packaged them into a range of VST plugins offering multichannel panning, reverb, HRTF downmixing and other spectral transformations. Version three of the GRM Tools Classic (http://www.inagrm.com/grm_tools_classic) also allows multichannel processing with some of the tools when they are run in standalone mode.

[45] For a more technical discussion of the transformational techniques and Max/MSP development see appendixes 2, 3 and 4.

[46] Apparent source width is the perceived space occupied by a sounding object, observed from a sonic point of view (Rumsey (2001), 36). The effect is closely related to the prominence of early reflections or 'image blur' (ibid., 37), the time of which alters the perceived width. For more information see Rumsey (2001), 36-7.

much more of the acoustic space. In experiencing very large objects in proximity the listener may also find that they localise different parts of the same object which are spatially separate, further increasing the sense of scale. Therefore my personal approach to spatialisation explores not only azimuth and elevation, but also distance and size as shapers of spatial experience. It explores the wealth of spatial imagery that we can perceive, rather than simply the movement of sounds around the listener.

One approach I use throughout the portfolio is to upmix or decorrelate[47] material over eight channels and then spatialise these channels in an arc,[48] the radius of which can be controlled in realtime,[49] ranging from narrow to fully encompassing the listener. What results (depending on the decorrelation technique used) is the sensation of a larger body of sound, which with careful use of decorrelation has a coherence as a whole. When the width of the body is manipulated in coordination with the distance and azimuth relative to the listener, an impression of enlargement and contraction is created, which when used in combination with distance-based filtering, and possibly the Doppler effect, can accentuate sensations of movement through space, creating an effect similar to the vanishing point in visual art (see figure 2). When more aggressive decorrelation settings are used, causing the eight channels no longer to be perceived as fused, we may hear something more akin to a collection of discrete points. However, the ability to control the spatial impression of such a sound is still immensely powerful, offering the potential to shape the listener's perspective to and sense of immersion in such a sound dynamically, creating dramatic changes in the spatial landscape.

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[47] See appendix 2 for a distinction between these two techniques and more details on the methods used.

[48] Fewer points may be used depending on the level of immersion or source width that I wish to create with the sound. In using this technique for creating narrower images, I have found that using all eight points can result in comb filtering due to proximity-based phase cancellation. Therefore in these instances I would generally decorrelate over fewer channels before spatialising them. Conversely, in composing *Vocem Machinis*, I sometime spatialised material over sixteen channels in order to add height to the body of sound. This then allowed me to expand the size of the sound vertically as well as horizontally when the material was subsequently spatialised.

[49] See appendix 4 for more information on the tools used in this process.

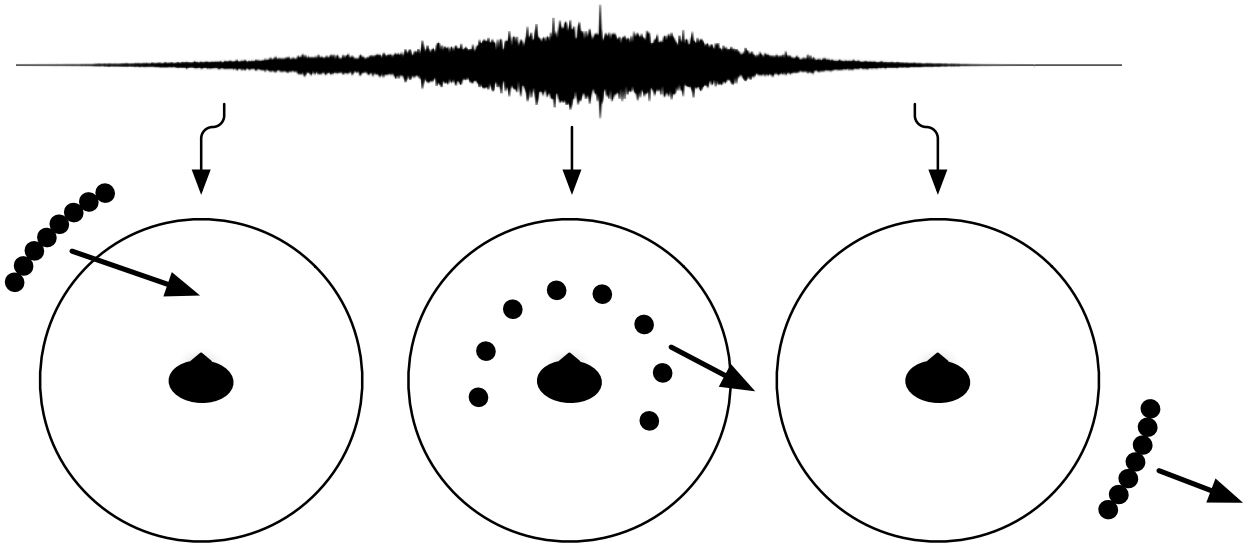

Fig. 2. Three stages of spatial movement and growth based on distance to the listener.

Clear examples of this use of spatial bodies can be heard in *A moment's reflection* where from 1:30 until 2:17 there are two large sweeps which come out from and retract back into the distal panoramic space. The increase in source width of these elements, coupled with other proximity-based cues, dramatically enhances the sense of their coming towards the listener from a distant, diffuse space and, as it grows, spatially separates it from the rest of the material in that section. I feel that the effect would not have been so dramatic had the phrase been composed using a spatialised stereo stem of a fixed size. In this instance the spatial expansion has the further implication of causing the first significant alteration of the quality of space in the piece, transforming what was very much a prospective landscape into something much more intimate and circumspatial. Further examples of this type of shift in musical space and the listener's perspective can be found in *Aeolian Forms*, for example at 5:00, where the high frequency iterative material opens out from being a frontal part of the panorama until, at 5:17 where it moves quickly around the listeners, closing them in and creating an enveloping spatial texture.

The individual channels making up this arc do not need to be fused as a single stream. Textures in which the individual channels are not congruous can sometimes benefit from narrowing and expansion in order to change the quality of the perceived space or to create spatiomorphological

growth. *Aeolian Forms* has many examples of this; the wind-like material in the first thirty seconds of the piece opens and closes spatially, mimicking the sense of spectral growth and ebbing, creating a strong bond between space and gesture. Throughout the piece, these types of behaviours are used as a way of creating distance-dependant changes to the apparent source width as the wind-like bodies move towards and away from the listener.

As well as a variable arc, pseudo-random swarm behaviours are used at times when I wish the spatial impression to be more energetic and less fused between the channels. A simple vector-based motion algorithm is used which swarms towards a point (with control over the attraction to the point, viscosity of the medium through which the points are travelling, and randomness), creating varying swarm-like behaviours which orbit about a central point. What normally results is a type of controlled scattering in space which works well with fragmented textures. I often use this technique with more energetic and 'scatty' material, using an envelope follower to control the attraction of the swarm in a way which creates a fusing of the points depending on the amplitude of the sound (for example pulling the channels to a focal point when there is a louder attack or impulse in the material - see figure 3). This technique is used to control the spatial behaviour of much of the textural material in *Resonance*, particularly the more phrase-like textures from the beginning until 2:53, articulating the gestural phraseology in the spatial domain.

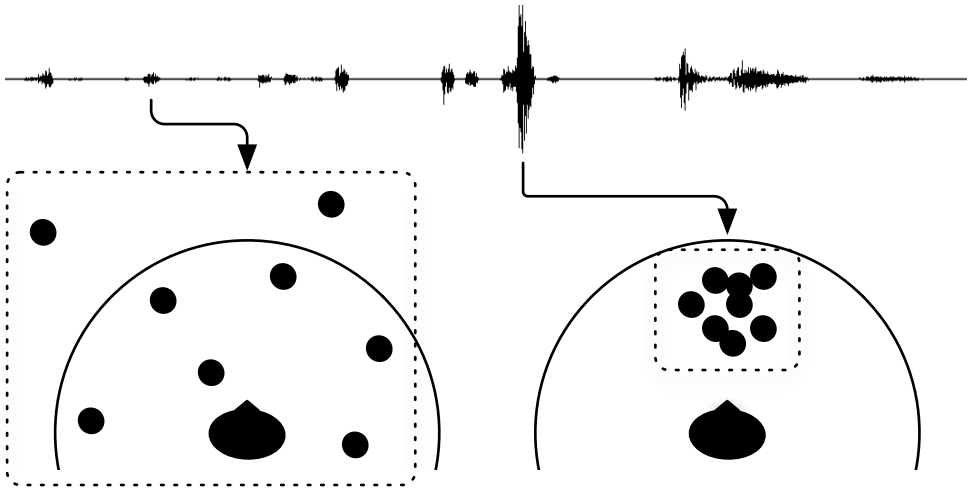

Fig. 3. Amplitude-based control of swarming points.

3.2 AMBISONICS

In this discussion on ambisonics I will discuss both its applications in microphone recording technology as well as a spatialisation tool.[50] In my own research I have found that whilst it does offer interesting possibilities,[51] its disadvantages negate its potential as a sole technique for spatialisation. In reality, third-order ambisonic spatialisation begins to approach VBAP

[50] I discuss the artistic potential of ambisonic microphone recordings in section 2.3.

[51] In composing *Vocem Machinis* I was intrigued by the ability to store the piece in an ambisonic format which would allow me to decode it over different speaker arrays in the future. This is an approach now used by Natasha Barrett in her works composed for 2D and 3D loudspeaker arrays, allowing them to be decoded based on the available loudspeaker configuration. However, the technical resources required to reproduce the composer's encoded spaces exceeds that which was available in the BEASTdome system. In Barrett's recent works, up to 7th order encoding in 3D was used (Barrett, 2012) (requiring a minimum of 64 loudspeaker), whereas only 3rd order was available to me (the maximum available using 20 loudspeakers) Also, in my own tests, whilst this technique worked quite well in a small and dry studio, when the same tests were conducted in the larger, more reverberant performance space, the image became much more blurred and delocalised, as well as having issues related to coloration of certain frequencies (possibly due to variations in the acoustics around the different arrays or approximation of the speaker locations in the decoding software). I therefore adopted the approach of hard-spatialisation using mostly VBAP techniques and will adapt the spatialised stems for different delivery formats if needed in the future.

techniques,[52] though because the localisation cues in VBAP are stronger,[53] I have adopted a mixed approach in the pieces following *Rip*. In line with my toolbox concept of transformational tools, I make use of different technologies based on their spatial qualities and appropriateness for the task at hand (I expand this discussion in section 3.3).

Using a SoundField microphone to record material in B-format allows recorded scenes to be decoded over a 2D or 3D loudspeaker array,[54] creating immersive circumspatial musical images containing both environmental recordings and transformed material. The slightly blurred and non-localised quality of the decoded recordings also accentuates the depth and expansive nature of freefield spaces, giving the image a transparency very difficult to achieve via upmixing or

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[52] With the addition of higher ambisonic orders, more virtual microphones (or directional channels) are present to capture the spatial information in the soundfield (a third order 2D ambisonic signal uses eight directional channels rather than three in first order). Consequently each channel can have a tighter polar pattern, allowing the decoder to work as an amplitude solution for more of the frequency range rather than using differences in phase.

[53] One of the issues relating to ambisonic panning techniques is that certain frequencies will be localised using phase cancelation, a process which requires sound of a particular phase and amplitude to come from multiple loudspeakers, and assumes that the listener is sitting in a small sweet spot in the centre of the loudspeaker array in order to create an accurate image. For listeners in the sweet spot, this may not cause issues: however for those closer to the edge of the listening area, their proximity to loudspeakers which contain non-amplitude-based panning information may cause confusing localisation cues. Take for example a listener sitting very close to a loudspeaker which is producing localisation information using phase in order to generate localisation cues at a different point. Because the sound from the proximate loudspeaker arrives before that of the actual source location, the listener may localise the source to the nearest loudspeaker, or else perceive separate or blurred sources depending on their position and the quality of spatialisation. In-phases decoders attempt to address this issue by correcting phase errors between the different speakers in the soundfield, however even when using 'maximum energy' correction (see Monro (2000) for a technical explanation) with 3rd order decoding, I found the quality of the sound to be unsatisfactory in comparison to the VBAP decoding experiments (discussed in footnote 45). In contrast, VBAP generates a virtual source between or at loudspeakers, using as few speakers as possible in order to create clear localisation from a single point (Pulkki (1997), 461). In doing so the sound comes from as narrow a point as possible, thus minimising the potential for localisation confusion generated by phase information and creating as sharp an image as is possible with the given loudspeaker configuration.

[54] Despite its simplicity the solution is not perfect. As there are only three directional capsules which are in reality not coincident, there are a high number of variables which the decoding algorithm has to account for, particularly in relation to sounds off-axis to the individual microphone capsules or when decoding over irregular arrays (see Wiggins (2008) for more information). In general SoundField microphones do not work as well for capturing nearfield information with a high spatial resolution, often having a slightly blurred image. Where the SoundField microphone works very well is as a tool for capturing mid-field and diffuse scenes, which have more of a freefield-like spatial quality, with fewer early reflections and narrower source widths, aiding source localisation.

decorrelation techniques.[55] As with spatialisation techniques, I am not suggesting that only ambisonic microphones should be used, but rather I am pointing out the potential of its use in relation to my compositional strategies.

No discussion of ambisonics is complete without mentioning the decoder used. For most of my multichannel pieces Harpex[56] was used in the DAW to decode the recordings. Harpex, as well as performing high-quality decoding,[57] offers the potential to perform reorientation and reshaping of the soundfield with all the benefits of working in an automated, non-destructive DAW environment. This possibility allowed me to create dramatic spatial shifts such as the emergence of the church bells at 11:46 in *Resonance* and a similar gradual emergence to a frontal position, and then to immersion, of the water from 3:27 until the end in *A moment's reflection*.

3.3 MULTICHANNEL FORMATS

With so many institutions and researchers adopting slight variations in loudspeaker configurations, or the restrictions imposed by established commercial multichannel delivery formats, the issue of which configuration to use and why is a complex one. As a way of trying to get over the hurdles put in my way by certain formats, I have adopted the diffusion systems/delivery formats and their

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[55] Providing that there are more loudspeakers in the array than there are channels in the encoded ambisonic format, the decoder attempts to make the sound energy equal, regardless of whether the source is positioned on or between the loudspeakers. It attempts to avoid the issue of sounds being localised at the loudspeaker and less localised between them (as can happen with amplitude-based techniques) by creating an equal quality of localisation across the array (making the energy for sources at the loudspeakers match that when they are between them). Some listeners comment about the loudspeakers 'disappearing' (Wiggins (2008)) in playback. I would argue against this as this is only true if you are in the sweet spot (roughly the size of a human head at the first order) – if you are sitting off centre and close to a loudspeaker then you do hear it. A fairer statement is that because of the localisation blur, B-format recordings have a diffuse quality which leans towards articulating larger spaces.

[56] http://harpex.net

[57] Harpex (High Angular Resolution Planewave EXpansion) uses a hybrid decoding process, combining the physical correctness of linear decoding and the spatial sharpness of parametric techniques. Linear decoding techniques preserve the mathematical accuracy of the ambisonic signal, generating a physically correct reconstruction at the sweet spot, whilst parametric techniques analyse the directional channels of the incoming signal in order to calculate the most likely point of origin of the analysis bins, and steer them towards this point. Both systems have issues; linear decoding, whilst having a natural, immersive quality, can suffer from a lack of localisation, whilst parametric decoders can be confused by situations where the analysis window detects strong localisation cues from different points. The Harpex technique attempts to exploit the benefits of both systems and allows balance between the diffuse and localised parts of the decoded signal (see Berge & Barrett (2010) for further technical information and reports on the technique).

idiosyncrasies into my compositional toolbox as a way of mediating between my poetic aims and the sounding result achievable over the available loudspeaker configuration.[58]

BEAST-8

The BEAST-8 format has been adopted for the majority of my multichannel works, as it is a relatively standardised format in the electroacoustic music studios at The University of Birmingham, and one of the foundations on which the larger BEAST diffusion systems are constructed. It offers good resolution through the azimuth plane because of the numerous and equally spaced loudspeakers, and can be downmixed to stereo surprisingly well. Two common criticisms of composers' use of this format relate to a combined issue of the on-axis relationship of the 'side' loudspeakers where the ears are most sensitive,[59] and the lack of a centre loudspeaker, which at times can result in an overly wide and side-dominated image. My panoramic approach to circumspace (discussed in chapter 2.2) attempts to overcome these issues and maintain a good frontal image whilst exploiting the spatial resolution available with this delivery format.

5.1

False Awakening is an example of a situation in which the criteria for performance in some ways dictated the approach to composition. It was originally composed for performance in the Deep Space auditorium at the Ars Electronica Centre, Linz, which contains a 5.1 array. Being a new

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[58] Factors external to the composition may make this decision even more difficult by adding technical constraints which affect one's choices. Issues such as "What loudspeaker configuration is used by the performance system?", "What resources are available in the studios?" or "I was hoping to do a 5.1 DVD-A release of this piece" may well affect one's choice of multichannel delivery format or potentially put technical hurdles between the composer and the desired artistic result.

[59] A number of composers have commented that, depending on the type of material or spatialisation strategy used, the 'side' loudspeakers can appear to jump out of the array. This may be due to a number of factors; this loudspeaker pair is almost on axis with our ear canals in a zone where we are extremely sensitive to the arrival of sounds. At the same time we are less able to resolve the phantom images between these and the 'wide' loudspeakers when facing forwards due to our compromised localisation ability, possibly causing the 'sides' to be perceived as separate with certain qualities of motion. Another possibility which relates specifically to some concert diffusion situations, is that the typical BEAST system has much more depth at the front than it does at the side (see Harrison (1999)). Therefore when the 'side' speakers are deployed they may be comparatively closer than the majority of the frontal loudspeakers which were being used, with the possibility of causing them to be perceived as non-contiguous with the rest of the surrounding image depending on the relative distances and volumes at work.

delivery format, I felt it would be an interesting research exercise to compose a piece for 5.1 as a way of exploring the potential of this loudspeaker configuration for shaping my acousmatic spaces.

In my initial experiments of attempting to create similar spatial configurations and trajectories that I compose over a BEAST-8 array, a number of issues began to emerge relating to 5.1's potential for articulating circumspace. Firstly, the large gaps between the front and rear loudspeaker groups were generally too large to create a circumspatial continuum, resulting in perceived holes in the image. When material was panned around the listener it would appear to jump between the front and rear speakers because the algorithm is unable to resolve the image accurately over such a large gap (see figure 4). The resolution across the rear was also poor although was less perceptually obvious because of our compromised rear localisation. When trying to create contiguous circumspatial textures, I also felt that the array began to separate into front and rear zones because of the lack of speakers to fill in the spatial gaps. The results varied from spaces which were spectrally contiguous but spatially separate, to causing the image to be drawn to the rear because of the surround loudspeakers' on-axis position with our ears. Both of these issues posed serious problems as to how I might go about creating a unified circumspace and sensations of complete immersion.[60]

[60] Ordinarily this is not an issue for film/cinema audio as the frontal nature of the mode of presentation has resulted in an approach whereby most of the music or sound effects are presented on the front loudspeakers, with the surround channels reserved for immersion 'effects' or spatial cues which support what is taking place on screen. Many cinemas also use multiple surround speakers with the information on those channels decorrelated in order the broaden the image across a larger space or articulate greater sensations of depth. With formats such as Dolby Atmos (http://www.dolby.com/gb/en/professional/technology/cinema/dolby-atmos.html) beginning to increase in popularity it will be interesting to see whether film audio content creators will embrace a more periphonic approach to sound design and recording and whether this will lead to more periphonic delivery formats.

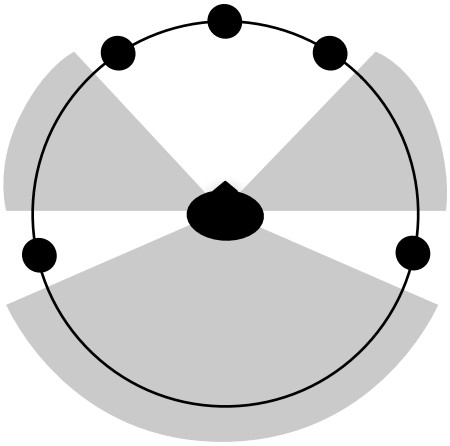

Fig. 4. Zones of poor circumspatial resolution in a 5.0/5.1 array.

Despite these issues, 5.1 has some interesting qualities; it is frontally biased with very good accuracy and sense of an acousmatic stage, whilst the presence of a central loudspeaker helps avoid holes in the frontal image. It is also a standardised delivery format with fixed technical specifications to ensure compatibility when distributing works for performance and playback. 5.1 systems can also found in many living rooms[61] offering further potential for the distribution of electroacoustic music.

Therefore a slightly different perspective was needed in my compositional approach in order for me to realise my ideas, but which was spatially adapted to make use of and overcome the idiosyncrasies of the 5.1 array. By embracing the peculiarities of the format, as well as the properties of certain spatial audio technologies, I was able to create percepts of circumspace which satisfied my poetic aims. The approach I took was to split the space into three zones – not discrete zones but ones which form part of a continuum – which together would allow me to create similar percepts of space to those which I create for a BEAST-8 array. The first of these was a diffuse layer composed of decoded B-format environmental recordings. Because of the diffuse nature of this material,

[61] This said, I would hardly call many people's arrangement of loudspeakers standardised. Because these systems are purchased primarily for watching films, their positioning is often subservient to the arrangement of the living room in order to avoid compromising its social function as well as the social ceremony which home film watching often is. Perhaps if the audiophile community, with their emphasis on imagery and the quality of reproduction, were to embrace multichannel audio more then we might see these home systems moving from the living room and into the listening room – a much more personal, introspective space in which a single user can selfishly arrange the room for the purpose of enhancing the acoustic experience.

combined with the referential cues which hinted towards large spaces, it helped to fill out the space behind and between the loudspeakers, gluing the front and rear arrays together and creating a natural enveloping space.[62] Spatially this layer was quite static in order that it might became an anchor of reality – a creator of imagery which places the listener in a very real environment, onto which the other layers are hooked. This material is present from the opening and in varying degrees throughout the whole work in order to help glue the image together and provide a bonded sense of space with particular referential or spatial characteristics.

The second layer represented the midfield of space, comprising spatialised material with some room simulation[63] in order to blend it with the diffuse layer and add depth in places. It uses a mixture of spatialised stereo material and larger bodies which move through space around the listener. Transformationally this layer moves on from the diffuse material and teases aspects out from the real environments, which it starts to develop as musical sound objects.

The final layer is more intimate nearfield material, mostly hard panned to particular loudspeakers in order to localise it clearly. It comprises a mixture of short iterative sounds, which are easy to localise, or decoded mid-side recordings upmixed using a custom matrix.[64] This layer has a very different spatial quality from the other two, sounding much more like a layer on top of the more contiguous mid- and diffuse fields because of the lack of spatial smoothing. Ultimately I was less

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[62] In listening sessions conducted with three other experienced listeners and composers, all three observed how this material gave very little sense of there being just five full-frequency loudspeakers, creating very compelling images of larger spaces which confirmed to me just how effective this layer would be at gluing the image together.

[63] Generated using IRCAM's Spat externals for Max/MSP.

[64] This simple matrix operation placed the mid on the centre loudspeaker, and then the in- and out-of-phase side on the left and right loudspeakers respectively. In order to generate surround content the left and right channels were duplicated to the rear, being high-pass filtered and high shelf filtered by between -6 and -9dB @ 10kHz. The signal was also processed using impulse response reverberation with the dry and direct parts of the sound removed in order to decorrelate them even more from the front. The mixture of the three parts of the stem (left/right, centre, and surround) could then be balanced in realtime to shape the level of width and immersion. Whilst this effect this did not create a natural sense of space – in the sense of it containing similarly realistic acoustics as one finds in B-format recordings – when combined with the other spatial layers, it created artistically convincing circumspatial images with a strong frontal presence (for example in the slowly working machine from 2:51).

concerned about making this material part of the whole soundfield, but more about using it as an element which encroached upon the two other, more 'natural' layers, creating surreal juxtapositions of imagery which upset the spatial narrative (see figure 5).

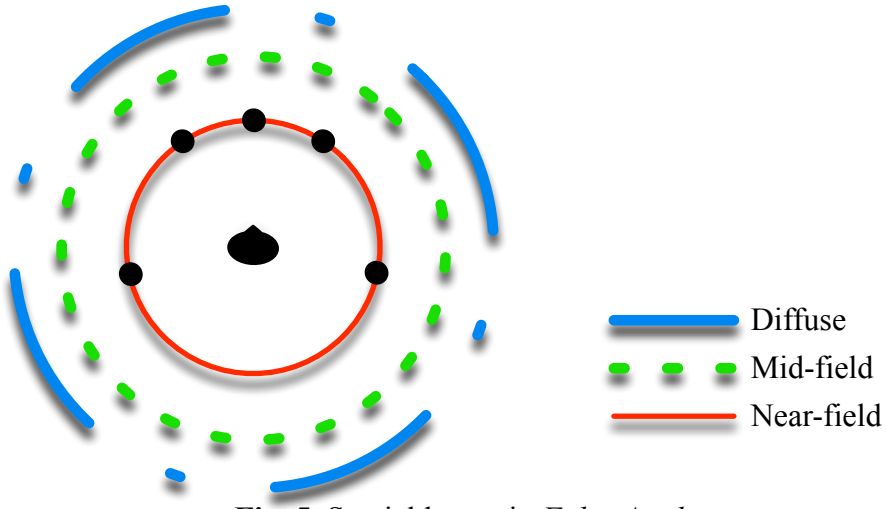

Fig. 5. Spatial layers in *False Awakening*.

This semi-stratified approach to spatial composition was essential in inspiring my shaping of space and its narrative in *False Awakening*, something which I feel helped ensure its success as a musical work. It creates excellent spatial depth given the number of available loudspeakers, a tangible sensation of circumspace, and thanks to the unique spatial quality and musical role of each layer, clear spatial counterpoint. Most of the layers are present most of the time, and by shifting the balance of the three I attempted to create shifts in spatial dimension, perspective and perceived surrogacy. In terms of the narrative of the piece, the spatial discourse begins in the diffuse field and gradually works into the nearfield, articulating the movement from reality to surreality. In my own and others' experience of this work, the transparency and immersive quality of the B-format layer, combined with its distinctly referential role, serves to draw the listener into the dream-like world that I was trying to create. From this point I was able to shape the process of recontextualization and surreal imagery that results from the gradual transformation of material and space, and reveal the dream-like nature of the scenes. Because of its success, this zoned conception of multichannel space was adopted to some degree in all my works following *False Awakening* as a way of beginning to

structure and create works which explore the potential of space as an enhancer of form, structure and narrative. This is not to say that its architecture remained the same in every piece, but rather that formal or structural zones were given a clear spatiality which was bound to our understanding of that formal area and its position within the piece as a whole, in order to give space a higher-level formative role in my construction of acousmatic spaces.

In this chapter I have described some of the most important processes which I investigated in composition and now employ extensively in shaping the listener's experience of musical space. As much as possible, I have tried to keep my handling of space focused on the issue of creating percepts – rather than fixed volumes or trajectories – informed by an awareness of the available technologies and their potential to allow me to achieve these percepts. There is not one single process or technological resource that I feel is the most important or contributes most towards my sculpting of space: rather, together they all form my compositional toolbox, offering me a network of resources which is bonded to its potential as a shaper of experience.

4. THE POETRY OF SPACE

In this final chapter, I wish to investigate some of the poetic interests with which I engaged in creating the works in the portfolio. Music is more than the sum of its parts; it has the power to convey emotive signification which exists outside of the abstracted acoustic information, but which is understood by the listener to contain 'meaning' within and bound to the aural experience. But how has something so uniquely non-sounding become part of my understanding or creation of musical space? I will discuss how this became of greater interest in the latter works in the portfolio, and how my own poetic relationships to the material or a particular experience contributed towards the creation of poetic narratives.

4.1 MEMORY & EMOTION

The issue of emotional resonance in music has long been of interest to aestheticians and critical theorists. However, the exploitation of recognition, allusion and indication in respect of real-world events in my music shifts the focus of this discussion from one which is is focused on traditional forms of emotive signification, to one which is required to investigate the listener's *own* relationship to the events depicted and the reality they evoke. My focus on the spatial dimension adds further complication, as the spatial lexicon that we are discussing is as fleeting in its ability to be perceived as the emotions themselves. Despite these factors, in my own discussions with listeners and those conducted by other researchers in the field, poetic signification can be carried by acousmatic works and is worthy of further investigation.

The issue of emotion in acousmatic experiences embraces spheres beyond source bonding and the indicative fields discussed by Smalley.[65] Whilst these are important in the earlier stages of translating the acoustic information into a meaningful event, the subsequent poetic responses rely

[65] Smalley (1996), 82-93.

more on cultural and social understanding, as well as our own memories and experiences, which are prompted by musical references. Another important issue is that the composer is not the sole shaper of meaning in these events; the act of meaning-creation is a two-way reciprocal agreement between the poetic signifiers created by the composer in the musical work and the listener's understanding of their signification. As such, any discussion of emotion needs to be aware that both sides contribute to the aesthetic response. Regardless of whether it explores more traditional poetic signifiers or ones directly related to spatial evocation, signification relies on previous experiences, memories and understanding of sound, and directly exploits these in the process of emotional response. In my compositional approaches to the issue of emotion, I decided to explore just a few concepts at any one time, which I felt could be understood by a wide-range of listeners (see below for examples of these). I also tried to avoid forcing the listener to have emotional connections or to have too fixed a realisation of the music. I felt that in order for such powerful personal responses to occur, the listener needed to be allowed to realise them themselves, placing them at the centre of the experience, and that any attempt to force a realisation might serve only distance them from or complicate the idea with which I was working.

A result of this approach is that cognitive or cultural differences between listeners have the potential to bring about different responses (or no response at all). Despite this, I feel that some of the representational pathways explored in my music do have some commonality amongst listeners. For example my uses of environmental depiction in works such as *Rip* (8:22) and the opening of *False Awakening* play on environmental percepts, which, because of their clear foundation in real-world experience, I feel have the potential to be evoked by their sonic referentiality and spatiality, prompting similar ideas of 'a wood' or 'the sea' in a range of listeners. Similarly, I feel that the way in which I allow the abstract material to encroach on these environmental scenes can create a similar type of unsettling sensation (albeit resulting from different imagery across individuals). I am

not attempting to create exact images or responses in these situations, but through a consideration of the way in which a number of listeners might make sense of my music I hope that they might have similar types of responses that I had as the composer.

One example of emotional evocation in my music is the use of nostalgia. Many of the distinctly environmental or recognisable recordings used in my music have something of a nostalgic quality in that they view the environment or object on which I focus through the musical equivalent of rose-tinted spectacles. My perspective on this is to depict something more akin to a caricature of the original, or an impression which focuses our attention on a particular feature of it which has a meaningful relationship to me as the composer, and which I hope to convey to the listener. This approach bears a resemblance to some of the work carried out by Murray R. Schafer, in his research on the changes in environmental acoustics that have occurred as a result of the industrialisation of society.[66] My nostalgic approach attempts to reverse the issue of 'lo-fi soundscapes'[67] within the context of acousmatic works and re-visit poetically some of the spaces being lost to the persistent noise of modern life. For example in *False Awakening* the opening three minutes of the piece show a gradual increase in extraneous noise in the soundfield as objects which are foreign to it are introduced into the opening forest-like scene. Similarly, in *Through the moors…*, I depict a number of landscapes which are personal to me in a journey through my native Yorkshire. I highlight how their acoustic and spatial fingerprint changes throughout the journey, and in some, show locations which are particularly evocative of spacious countryside, or scenes which hark back to historic eras with a personal romantic coloration.

Another example of emotive resonance relates to lamentation, a much more personal feeling which reaches deep into the individual. Rather than wishing to create feelings of sorrow or loss I combine

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[66] Schafer (1994), 3.

[67] Ibid., 43.

scenes, objects or sound-types with which listeners (who after all, are not so very different to me) might have personal associations, giving them the time to pause and reflect, to investigate the meanings and their relationship to them in more depth. For example, the tolling bells which appear from 11:45 onwards in *Resonance* convey to me feelings such as emptiness and sorrow, because of the ceremonial connections of a single ringing bell combined with the huge contrast in orchestration, which in this section is much sparser and more open than the denser setting at 9:18. A similar situation is used in the closing section of *Vocem Machinis* where the slowly evolving chords are evocative of a surging string section which plays an evolving pitch-cluster taken from the metallic screeching which articulates the transition into this section.

In the above examples I seek to colour the original environmental scenes by using the emotive signifiers to hint at something which exists beyond the explicit referentiality or sonic exploration, and in doing so take the narrative beyond that which is purely sounding. I aim not to be prescriptive, but rather to use emotive signification to resonate to a greater degree the listener's own memories and poetic associations. In doing so, I am inviting another layer of the listener's own understanding to be added to that which was already evoked in the processes of recognition or allusion. Connecting these to the poetic signifiers has the potential to cause shifts to new listening modes, adding fresh poignancy or colour to the mental imagery than that which would have occurred otherwise, and cause its meaning to the listener, and the musical context, to be contemplated in greater depth.

4.2 IMMENSITY

As my musical narratives began to orientate themselves around conceptions of space which were more abstract and subtle in their referentiality, I wondered whether these spatial constructs, and their interrelationships, might have the potential to evoke an emotional depth which exists beyond

the dimensionality of the acousmatic spaces. Barrett's *Utility of Space* was an early source of inspiration, in which I felt the evocation of the poetic by the composer's depiction of spatial dimensionality and sensations of enclosure and landscape. Works such as Dhomont's *Pareil à un voyageur perdu*, and Young's *Time, Motion and Memory* were also influential, their vast, surreal spaces reaching inwards and inducing sensations such as loneliness and emptiness as my mind wandered through the open spaces. One of the first pieces in which I composed with this spatial perspective in mind was *False Awakening*; however, as this piece explores more surreal, dream-like conceptions of space, I shall reserve an in-depth discussion for the next chapter. For examples of my poetic understanding of spatial immensity I begin with *Aeolian Forms*, a piece in which sensations of spatial volume are integral to the narrative of the work. As well as the perception of dimensionality, in composing this work, and placing such a strong focus on the resulting spatial textures, I began to sense an element of emotional signification being resonated as a result of my socio-cultural understanding of space.

Blesser hypothesises such an occurrence in *Spaces Speak*, saying that:

> 'in addition to providing acoustic cues that can be interpreted as objects and surfaces, aural architecture can influence our moods and associations. (…) We may experience a living room as cold or warm independent of its actual temperature, or a train station as lonely and forbidding independent of its actual appearance. The acoustics (…) of an elevator can produce the feeling of encapsulation and, in the extreme, claustrophobia. The acoustics of an open area can produce feelings of either freedom or insecurity'.[68]

[68] Blesser (2007), 2.

He goes on to talk about how spatial dimensionality, whilst a property of space, is experienced in terms of its social context[69] rather than being something which is measured. Also,

> 'in contrast [to vision], *hearing* decodes size as the global metric of volume because sound permeates air as a fluid, flowing around objects [which might obscure our vision] and into crevices. We cannot see volume but we can hear it. (...). For hearing, volume or area remains primary, and boundaries are secondary'.[70]

There can be no doubt that visual perception participates in our understanding of space, both for early dimension cues as well as assigning meaning based on the space's contents. However, sensations of immensity and immersion have a unique power to colour these spaces by adding their own meaning which is separate from the visual elements.

But what are the qualities of space which might evoke an emotional response? Such a question is a difficult one to answer concretely; unlike sensation – which can be investigated by observing the chemical reactions of our sense organs – the ontology of perception involves the more personal, unverifiable aspect of personal experience and culture,[71] which varies between individuals, and whose influence may differ in multiple listenings. Bachelard's analysis of the poetic signification of space in text begins in the home and its comforting affective nature.[72] In such a space we are at ease with the spatial configuration and there is little potential of threat. It is also deeply personal; we do not like unwanted visitors coming into our private space or for visitors to degrade or rearrange it. Musically such a space might manifest itself as a configuration which is mostly frontal (without threatening objects behind us), perceived as a living-room size, and possibly containing material or

[69] Blesser, 21.

[70] Ibid. (my emphasis).

[71] Ibid., 12.

[72] Bachelard (1964), 3.

depicting scenes which are referential or source bonded in order to offer the listener a greater degree of familiarity. More personally it may evoke a sense of beauty, either in the music's connection to a real-world event or configuration, or else because of its majesty or grandeur (in the case of larger sounds or enacted spaces). Once these affective connections are established, changes to the spatial configuration or its degree of surrogacy may have subsequent implications towards its perception. For example if a sound in the scene were suddenly to become much more proximate or circumspatial we may feel a degree of discomfort because of its movement from a safe social or public distance to something which is perceived to be in our personal space,[73] with the associated possibility of it being able to touch us or experience our most intimate moments. The transition at 5:11 in *Aeolian Forms*, where the previously midfield gestures begin to fuse and open up to become more circumspatial and enclosing, is an example of a moment in which I tried to create such a spatial response. The effect is enhanced by the energetic nature of the material, adding a further dynamic quality and making it much more difficult to track, thus enhancing its potentially threatening nature. I attempt to create similar sensations of threat or unrest in *Vocem Mechanis*, in moments such as 6:46, where the more open, diffuse space is transformed by a sonic object which appears much closer, more energetic, and spatially reaches over the listener, as if to impose its grand dimensionality and volatility onto their personal space.

In contrast, more open spatial settings can evoke feelings of relaxation or floating, or alternatively unsettle the listener, depending on the context within the musical work. For example, the contemplative section which starts at 10:06 in *Resonance* is composed of more tranquil material with a much more diffuse quality than that of the previous section, giving the sense of a large, open space with a seemingly infinite acoustic horizon, and which resonates to the pitched clusters. The slow evolving quality of the pitches in the cluster also serve to slow down my perception of time,

[73] Hall (1990), 121-5.

adding a further contemplative quality to the music, which causes me to become immersed in the space and its signification in more depth. This spatial impression and its stark contrast to the previous section creates in me a feeling of being free from the physics of the real world whilst suspended in solitude in a space of immense horizon – it is 'immensity with no other setting than itself'.[74] Contrasting this, the setting at 7:18 in *Aeolian Forms* has a more desolate quality to it, potentially because of the empty, void-like spatial quality combined with the edgy spatial behaviour of the high sounds which are blown around. The very open quality of the space causes me to import further signification from my environmental understanding of barren spaces and the loneliness which I associate with them. In doing so it adds an extra dimension to my perception of the space through the arousal of emotional associations.

4.3 THE DREAM SPACE

Depicting a space with the listener observing its dimensionality and their own aesthetic responses to it was not the only means by which I wished to place the listener at the centre of the spatial experience. A parallel approach was to create a response whereby the musical space transcends its existence as something which is simply presented to the listener, and be realised in the listener's imagination as *their own* space. Such a situation has the potential to create a greater degree of connection between the listener and the music, by allowing the cognitive time and space for them to relate their own experienced spaces and responses to them, forming an individual mental space in the process, based on the aural cues and musical discourse. I feel that rather than attempting to depict spatial dimensions or references in an overly objective manner, an approach which was more dream-like and surreal in its referential qualities would offer opportunities for the listener to explore their own imaginative response to the music, and in doing so evoke the rich network of personal responses and emotions that come with such a meaningful interaction.

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[74] Bachelard (1964), 195.

In order to create this oneiric depth, an approach is required which, rather than being overly depictive and figurative in its portrayal of space, merely suggests ideas or orientates the listener towards an impression of a space with particular characteristics, and allows them to fill in the gaps left in the depiction, forming a mental image based on their personal understanding. In many ways, the more simple the signifiers with which we are working, the more it engages the imagination by presenting an idea or combination of ideas with sufficient oneiric space so that the imagination is engaged in investigating and completing the mental image. In this experience the image or realisation of the space transcends the cues which evoke the response; what starts off as a resonance or reminder of a previous experience soon takes hold of us, and as our imagination contemplates it, becomes our own new experience inspired by the resonance of the past.[75]

As well as a less depictive approach, time is required in order for the image to take root in us. By this I mean not only time in terms of duration, but more subjectively, our perception of musical time – the progression and unfolding of events which shape the progression of the work's narrative and sense of forward movement. In moments where the quality of space is changing rapidly, or if it is very busy and made up of very gestural material, we may only have the time to engage with the changing sounds in terms of their immediate properties or how they are changing, rather than allowing them to shape the personal realisation of the space in the manner described above. However, in moments where the musical space unfolds more gradually, or where it establishes itself for a longer duration, we as listeners are given more time to contemplate and realise the acousmatic space in its fullness as our focus shifts from the properties of the individual sonic elements to their meaning within the holistically sculpted space in which they belong. With even greater time there is the possibility for further reflection on what the spatial impressions mean to us, both in relation to our understanding of them along with their significance within the context of the artwork. To both

[75] Bachelard (1964), xxiii.

of these points we can add the unique qualities of acousmatic space, which, where we are no longer bound by the norms of the physical world, has the potential to bend the laws of time and space. In my configurations of dream space I am engaged in a 'play of fantasy',[76] where the real is coloured by the surreal in order to bring about new realisations that occur when the imagination is set loose in the unharnessed world of imaginative free-play.

This dream-like conception of acousmatic space was first explored in *False Awakening,* whose narrative is completely conceived around the movement through and transformation of perceptually real and surreal spaces. In the presentation of the environmental scenes in *False Awakening* I am not overly objective in my depiction or suggestion of space. I was keen to avoid sensations whereby the listener felt they were viewing the space as though painted on an aural canvas; rather than depicting *my* space I wished the listener to become absorbed in the music and realise *their* space, a situation which I hoped to create by orientating them towards more universal spatial archetypes rather than trying to depict them literally. Due to the more impressionistic nature of the spatial depiction, the listener is engaged with the music in a manner in which their imagination wanders freely along the cognitive pathways resonated by the musical signifiers, with more sudden realisations brought about by the jarring spatial juxtapositions (such as at 2:48 where a new spatial layer is added on top of the diffuse field). Our imagination is unhindered by objectivity and certainty, both in terms of representation and the passing of time, conditions I feel are essential in allowing these dream-like spaces to form.

Many of the pieces following *False Awakening* use similarly restrained depictions of space in order to absorb the listener into a dream-like interaction with the musical discourse. The openings of the latter works tend to take shape over a longer period of time, often using material which gives hints of the spatial discourse which is being investigated, whilst being sufficiently impressionistic in

[76] Bergson, quoted in Bachelard, xxxiv.

order to allow the mind to wander amongst the ideas which are raised. Another example occurs in the second half of *A moment's reflection*, where the focus is on the more capricious qualities of the water. Rather than just presenting material which modelled or mimicked these types of behaviours, I continued the character-like concept of representation, using material which I felt had a sense of this playfulness, whilst a parallel stream explored the signification of feelings and emotion via the minor sixth in the pedal. In such a situation the experience of music becomes as much about what the music means to us as listeners, as what the sound *is* or what it is doing. By having the time to extend our imagination outwards into the dream space, we are simultaneously given the cognitive time and space to reach inwards and contemplate our personal understanding of the music *and* its space in more depth.[77] Equally, when it is no longer bound to the laws of representation, the music is able to transcend objectivity or literal representation and evoke highly subjective ideas based on the listener's personal responses to the spatial configurations. The interweaving of the real and the poetic gives a new dynamic and colour to what we previously understood as real.[78]

In this chapter I attempted to show how engaging with the potential to evoke the poetic or emotional in the act of spatial perception has shaped my approach to the latter compositions in the portfolio, as well as how source-bonded space can release poetic meaning. When acousmatic space is observed from this phenomenological perspective it is no longer a container of a particular dimension, but rather something which is lived in through the musical experience. It transcends its existence as a volume of a particular size, which is expressed via an abstract scale of measurement, and becomes something which we appreciate in relation to our own body, the real-world and our personal experiences. The listener becomes an integral part of the cognitive process; without the individual listener's understanding of the spatial signifiers, the process of signification would not

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[77] See Bachelard (1964), chapter 8 for further debate on the dialog between immensity and intimacy in poetic representation.

[78] Bachelard, xxxv.

occur. Space also has the potential to have a more lasting impression through this process, with greater poetic poignancy resulting from the resonance of personal experiences. This is not to say that *all* spatial configurations in my music should or do have greater significance, or that I wish to move towards a spatio-poetic code, but rather that, instead of treating 'space' as an aspect of source recognition or – worse – merely a measurement of location or trajectory, employing non-sounding spatial signification[79] as an element of my compositional thinking has offered new possibilities for reflecting on a musical discourse. The fact that this enters into the realm of the personal, possibly making it much harder to discuss, need not be a problem; as Bachelard points out: 'the [poetic image] needs *you* to give it *your* superabundant images, nurtured in your intimate space, in "this space which has its being in you"'.[80]

[79] In this chapter I extend the ability for the listener to construct a signifying link to an idea which is not contained within the explicitly acoustic information, beyond the creation of spatial forms and imagery. Here I include the possibility for these spatial configurations to bring about more personal poetic responses based on the listener's socio-cultural or poetic understanding of them, or due to a personal connection with a similar space that has been experienced in the past. In both of these cases the information is not contained explicitly within the sounding material, but is the result of the listener contemplating the space and investing it with meaning based on these signifying links or source bonds.

[80] Bachelard, 200 (my emphasis).

CONCLUSION

I have presented in this commentary my personal investigation and expansion of the concept of source bonding in acousmatic music, investigating a number of manifestations in my own compositions. The focus has been on how space – when viewed in terms of its phenomenological effects – rather than source recognition, has had a principal role in the conception and creation of musical spaces which are perceived via their bonds to the real world. During this process, the investigation has been less about the quality of localisation or movement and more about what space means to the listener. As a result of this shift in focus, I no longer simply perceive a continuum between reality and abstraction, but instead, more subjective movement through spaces which evoke particular landscape-like images in my imagination. These spatial archetypes have an order of perceived surrogacy, depending on their source bonds, and their transformation is what begins to shape my sensation of the musical narrative. Space, when viewed from this perspective, is no longer simply a container for sound or a discrete parameter in the compositional process, but instead explores the parallel between spatial experience in acousmatic and real-world contexts, taking note of the similarities and their potential for shaping meaning though spatial transformation.

My relationship with space and narrative has changed during the course of my PhD, from one where the composer is the primary sculptor of time and space, presenting an acousmatic image or narrative in the work, to one which embraces the reciprocal arrangement between composer and listener in the act of perception. Such a shift moves from the stimulation of that which is external to the listener to an approach which hopes to resonate that which is personal and internal, offering scope for personal interpretation and re-configuration of musical spaces. In changing my understanding from external source bonding to personal source-bonded spaces, I feel that there is the potential to engage the listener in a discourse which explores the signification of *their* mental

imagery, rather than being occupied with a more surface-level, taxonomical exploration of the transformation of individual sounds.[81]

Whilst I am proud of all the works in the portfolio, the ones which I feel illustrate my spatial exploration most clearly are those from *False Awakening* onwards. At any time in these works our position in the narrative can be characterised as a spatial zone in which the listener is immersed. This zone is not solely that which I attempted to create by crafting acousmatic space, but rather a mental image which I hope forms in the listener's mind because of the focus on source-bonded space. The resultant spatial textures are what create my pan-sensory experiences of space, landscape and perspective, and in the process create heightened mental imagery with the listener at the centre of the musical experience.

From this perspective the quality of the spatial architecture, and its ability to shape sensations of place, perspective and time, becomes elevated above the role of source recognition, spectromorphological development and gesture. Traces of gesture, agency and other indicative fields do exist, but their presence in a more holistically sculpted space means that their role is in shaping the overall identity (and identification) of these spatial gestalts, rather than being perceived as discrete parameters in the compositional discourse. The taxonomy of indicative fields begins to disappear as space becomes a more coherent whole, experienced in terms of the resultant mental imagery and spatiomorphology. Consequently, the listener is engaged in a more remote listening mode, contemplating the musical space in a more subjective manner which is released from the shackles of objectivity. The imagination is free to wander through more poetic realisations of the spaces presented, which exist beyond those of the real world, and with a more elastic sense of time, space and motion. In such an act the focus is brought back to the listeners themselves and *their*

[81] This said, spatial thinking is not something which can just 'happen' – it needs to be learned in the same way as any new lexicon. However, doing so rewards the acousmatic composer with a rich new array of resources for shaping the listener's musical experience.

musical experiences; they bring their own memories, understandings and emotions to the cognitive table, now liberated from their previous real-world bonds in an act of imaginative free-play, set in motion by the act of acousmatic engagement.

APPENDICES

APPENDIX 1: PROGRAMME & PERFORMANCE NOTES

Centrifuge

First performed: BEAST presents... *Espaces* (MAC, Birmingham, 5th March 2011)

The image that immediately comes to mind is that of spinning. However whilst rotation around the listener is a movement frequently used, the primary concern in *Centrifuge* is of creating a depth of space – the contrast between very close objects against the larger, more spacious acoustic environments. This depth of spatial organisation played an essential role in the compositional process: solo material with very clear movements through space is gradually developed into larger, much denser environments which appear to fill the hall with sound. Certain sounds play an explorational role in the music, moving through the spatial depths and briefly coming into focus only to disappear again.

The source material for *Centrifuge* is made up entirely of sounds which are 'in motion', either speeding up, slowing down or moving through space. As such this gives rise to music which is constantly growing or shrinking with the changes of momentum in the recordings, and an overall sense of growth and increase in energy throughout the piece.

Centrifuge continues my interest in the creation of contrasting and changing acoustic spaces. The multichannel medium assists in this exploration by allowing the simultaneous projection of different spaces, movements, and trajectories, each with a characteristic spatial fingerprint, over different parts of the hall, bringing together contrasting spatial elements into a single musical stream.

Rip

First performed: BEAST presents... *Waves* (CBSO Centre, Birmingham, 19th November 2011)

The sound types and structuring of *Rip* are influenced by the gestural shaping and energy of tearing and cutting motions. The piece is built around this fundamental wave-like gesture, whose energy is applied over differing temporal spans to create a changing landscape set in motion by these gestures. Here these sweeping motions and textures interact, forming swirling currents and tides, which ebb and flow and build to moments of strong physical gesture. Sensations of spatial perspective are also important in *Rip*. The listener has a changing view of the landscape throughout the piece, at times looking out over broad vistas, and at other points being enveloped and pulled along by fast-flowing currents, carrying us into new sound worlds.

Imaginary Landscapes – Through the moors…[82]

First performed: 'SOUNDkitchen's cinema for the ears', Supersonic Festival 2011 (Custard Factory, Birmingham, 22nd October 2011)

Through the moors… tracks a journey from my home in York out to the coast of North-East England. The inspiration for the piece came after standing on a river bank in York and being amazed by the complexity of the sonic landscape and the sense of panorama I felt as the various sounds – trains, boats, people, etc. – interacted. This installation extends some of my recent compositional investigations – multi-channel spatialisation, the use of field recordings and experimentation with varying sensations of reality in the material used – over a longer time-span, and with a greater focus on the acoustic environment created.

Resonance

First performed: BEAST @ RedSonic Festival (RedSonic Gallery, London, 16th April 2013)

[82] The title '*Imaginary Landscapes'* is a personal one and not a reference to the work by Cage of the same name.

During a recent recording session I experimented with a collection of skinned percussion instruments, exploring their potential for larger gestures, as well as more subtle, textural material played delicately on the skins. This proved to be sonically interesting, but what surprised me most was the resonant material available via some unusual miking of the larger congas, which showed the instruments in a different light and which began to move away from the other explicitly drum-like sounds.

Back in the studio I began to explore this contrast further, on the one hand focusing more on the 'skin' sounds – the texture and grain of the skin of the drum – rather than the percussive 'drum' sounds, pulling the listener into a closer examination of the surface of the drum, whilst on the other exploring the resonant interior sound-world of the instrument. As the piece develops, 'real-world' sounds are pulled into the music, further exaggerating the environmental qualities of the interior of the drum, moving the listener away from a purely acousmatic examination of the instrument, and into a new landscape, where images, memories and emotions are evoked in the listener, set in motion by the impulses from outside.

False Awakening

First performed: Sonic Intermedia: BEAST (Ars Electronica Centre, Linz, 30th October 2012)

As the listener descends into sleep, they become more lucid as the environment around them comes into focus. Periodically our descent is broken by a jolt back into a seeming reality, only to find that where we have actually arrived is another dream – a false awakening into a distorted reality, with an unsettling undercurrent which takes us deeper into the subconscious...

False Awakening is in many ways a trip down memory lane, exploring sounds and environments which conjure up fond memories of childhood experiences. Recent trips to parts of North Yorkshire

have renewed my appreciation for the natural beauty of these places, whilst also filling me with a sense of apprehension that, with the ever increasing rate of inflation and need for space, their beauty will not remain untouched for long. Much of the sound material revolves around recordings made in the North Yorkshire Moors and those made at a steel yard in Thirsk, and the listener is pulled between these two sound-worlds in a disturbing reverie, where vast, untouched landscapes are encroached upon by the sounds of modern life.

Aeolian Forms

First performed: BEAST: Vanishing Point (CBSO Centre, Birmingham, 25th May 2013)

The wind is an ephemeral force; we know it not as a 'thing' in its own right but rather through its effects on the world around us – the movement of branches and leaves, the changing of the weather and as an exciter of resonances. It gives shape to otherwise acoustically transparent landscapes through its interaction with inanimate objects or the colouring of sounding bodies. So often we hear the wind as much as sense it physically – the colour and intensity of the sound indicating energy and proximity – causing its resonances to become part of the acoustic fingerprint of a space.

Aeolian Forms conveys the idea of a virtual landscape whose spatial architecture is in constant flux, shaped by the changing energy of the wind. The impressionistic voyage seeks to portray not only the vastness of open spaces but also feelings of intimacy, enclosure and emptiness as the winds evolve and acquire new significance.

A moment's reflection

First performed: SonicVisions (Barber Institute of Fine Arts, Birmingham, 13th September - 10th November 2013)

Composed for the *Sonic Visions* installation exhibited at the Barber Institute of Fine Arts between September and November 2013, this work was composed in response to Charles-François Daubigny's (1817 – 1878) *A Seascape* (Brittany, possibly 1867). The installation was presented without programme notes; however, the following is a script of a recorded interview discussing the inspiration behind the work and its relation to the painting.

> The first thing that caught my eye with this work was not so much related to the subject being a seascape – the presence of water, waves, etc. – but rather the quality of texture depth and light in the sky which is towards the top-left of the work. For me it was this sky rather than the explicitly sea quality which was the defining element in the work and, for me, creates the mood and depth in Daubigny's depiction of his seascape. Daubigny's language also interested me in that, rather than depicting a scene in an overly objective manner, he chooses to depict it in a way which gives a feel or character of it – something almost poetic and emotional which exists beyond what the objects actually are. As a result, in my viewing I felt an impression not only of the power and the violence of the sea, but also things such as darkness, emptiness, and a certain sense of fragility towards the artist who exists in the midst of the tempest. In many ways I felt that by depicting something so vast and without borders in a way which encourages imaginative wanderings in the viewer, the vastness portrayed manifested itself as something quite personal and internal in the listener. I would compare it to standing on a mountain by oneself; you are in the midst of immensity but, by the same measure, acutely aware of your own solitude in the midst of that immensity, and I think that it is for this reason that I felt a certain level of darkness and solitude in my own viewing of the painting. As such my response would not be to depict overly objectively the seascape which is shown in the painting but rather to depict my own aesthetic response to it. The narrative of the work would follow the same exploratory trajectory and guide the listener down a path whereby the listener

might have similar sensations or realisations of the work as I did. Also, just as in my viewing of the painting, where the sky and its gestural quality were the elements which drew me into the work, the start of the work is marked by turbulent, wind-like gestures which give a sense of a large space which is also highly dynamic. It is not until the second half of the work where the space begins to open up more, and the attention shifts to the delicate water material, that it becomes representative of the introspective immensity that I felt whilst viewing the painting.

Finally, in using the multichannel speaker arrangement, I tried to open up the canvas, stretching it beyond the confines of the frame of the painting, both in terms of width and depth of image, and place the listener in a slightly alternative, impressionist world which both my own and Daubigny's artistic language inhabits.

Vocem Machinis

First performed: BEASTdome (Bramall Music Building, Birmingham, 8th November 2013)

The machinery lumbered, speaking to me in breathy, almost human tones... Its chorus of voices span the range from the slow, heavy engines which give power to the environment, to the ratchets and other smaller mechanisms whose teeth chatter as they carry out their tasks, surrounding me in a cupola of sound as I wander through spaces shaped by their activity.

Vocem Machinis is a reverie inspired by the sense of scale, power and, at times, living qualities observed in the sounds of industrial revolution machinery. In using the BEASTdome loudspeaker array I was able to explore the contrasts in scale that I observed in both the machinery and the spaces in which they were active, and which inspired the spatial exploration in the work. I am extremely grateful to the staff at the Blist Hills Museum in Ironbridge, particularly Richard Aldred, who allowed me free rein around their fantastic collection of period steam machinery.

APPENDIX 2: SPATIO-TRANSFORMATIONAL TECHNIQUES

Upmixing & Decorrelation

The techniques of upmixing and decorrelation are different but complementary to spatialisation. Upmixing involves enlarging the image over more channels than were contained within the original material, in a way which preserves the relative spatial distribution found in the (often stereo) input rather than repositioning a source (or sources) in space.[83] In most cases this does not achieve a realistic spatial impression – the upmixing algorithm hypothesises acoustic cues for each of the loudspeakers[84] – although depending on the combination of algorithm, input and settings, there is the possibility of creating more immersive circumspatial translations of the original stereo image. Decorrelation processes generate multiple versions of the input audio which appear different, whilst seeming to come from the same source. Unlike upmixing, decorrelation does not alter its channel-by-channel behaviour based on a delivery format, and may not use spatial information contained in the input to control the distribution of the sound. It is often used as a way of de-localising audio or expanding its width using processes different from those of upmixing tools, and does not conform to particular delivery formats.

Matrix-based Upmixers

[83] This is not to say that what is generated is not subsequently spatialised – section 3.2 discuses an approach in which I do just that.

[84] Most commercial upmixers are designed for converting stereo to 5.0 or 5.1, using a matrix which deduces surround information based on the differences between the left and right channels, often applying filtering and decorrelation effects in order to make the surround channels more diffuse, whilst keeping the more central part of the stereophonic image on the front three speakers.

Given that it was composed for 5.1, upmixing plugins[85] were used to generate surround material from existing stereo stems in *False Awakening*. A lot of the material which I took from *Steel Curtain* had a stereophonic image which I simply wanted to be expanded over the 5.1 array, and so these tools allowed me quickly to enhance its immersive quality, whilst preserving the frontal imagery which originally drew me to the sound (for examples see the attacks at 2:47, 4:24 and 9:38 and the high machine which enters at 2:49). When these stereo attacks were originally panned in 5.1 space, I perceived their image as that of a spatialised stereophonic image, rather than the immersive one which I was looking for. I felt that in order to achieve the jolt or shudder-like gesture, an effect of 'being inside' the attack was needed – something which had a greater sense of physicality and which encroached more into the listener's personal space than a frontally orientated attack. For this upmixing was ideal; it spread the gesture over the five loudspeakers allowing me to increase the prominence of the surround channels and sense of immersion of the image, whilst retaining a frontal dominance and impact of the original. Because many matrix-based upmixers use mid-side sum and difference techniques in order to extract stereo width information, they are often excellent at preserving a central focus whilst at the same time expanding the width of the stereo information. For attack gestures this is ideal as, depending on its image, it gives the effect of diffusing the wider stereo decay whilst focusing the impulse of the attack on the centre loudspeaker, thus differentiating between these two parts spatially. This characteristic is also effective over delivery formats which do not have a centre speaker, such as a BEAST-8 array. For example, the low attacks which enter at 10:15 in *Aeolian Forms* are upmixed to 5.0. However, rather than positioning the five channels in their standard positions I spatialised them in a frontal arc over the BEAST-8 array, with the centre channel retaining its position in the middle (see figure 6). This has the effect of significantly widening and enlarging the apparent source width of the sound, especially in the decay phase,

[85] The two that I used most and which I found to be the most flexible and give the best quality results were the Waves UM226 (http://www.waves.com/plugins/um225-um226) and Iosono Anymix (http://www.iosono-sound.com/vstrtas-plug-ins/).

whilst preserving the frontal articulation of the impulse which excites the resonance. This technique is used with the other attacks in this section.

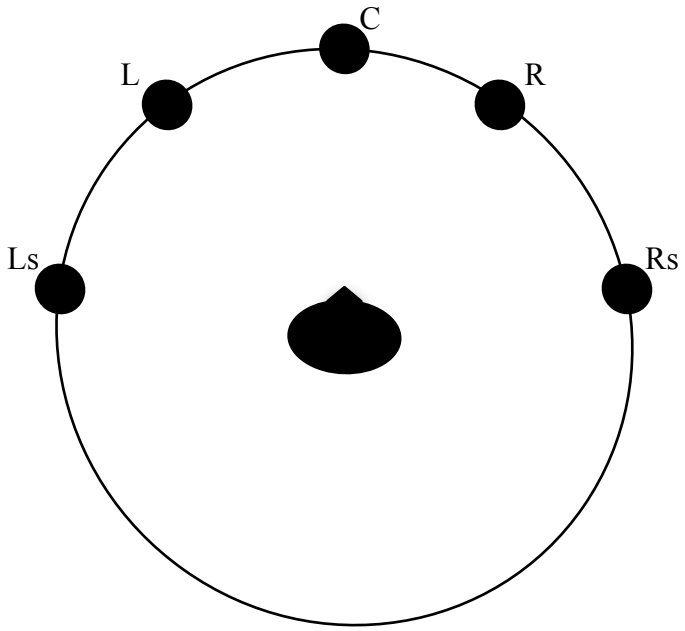

Fig. 6. Representation of a possible deployment of an upmixed 5.0 stem in circumspace.

Temporal Decorrelation

Using this technique, material is distributed over *n* channels[86] and differentiated by inter-channel temporal differences. Effects such as delays and granulation achieve this well and, depending on the time differences set by the user, the resulting effect can vary from anything between spatial chorusing and comb filtering (close to spectral decorrelation) to rhythmic iterations. I frequently use granular delays with shorter grain and delay times (30-150ms) in order to intensify or accentuate semi-rhythmic or textural material. This can be heard in the high sounds which enters at 10:26 in *Resonance*, where the effect serves to expand its energetic and erratic nature into the spatial domain. The same technique is used in *Aeolian Forms* to create some of the circumspatial yet spatially decorrelated textures. Examples can be heard at 5:10 and 12:39 in the high-frequency and highly energetic material. In both pieces not only does the process of decorrelation serve to diffuse

[86] In using the term *n*-channel I avoid tying a process to a particular delivery format, particularly when what is generated is often subsequently spatialised to control further the shaping and distribution of sound in space. In different scenarios I will upmix material over differing numbers of channels, depending on the intended effect.

the material over multiple loudspeakers, but from a musical perspective the technique mimics the behaviour, energy and causality of the material in the spatial domain, creating a natural expansion of the material from its stereo origin.

Spectral Decorrelation

With spectral decorrelation, the inter-channel separation is achieved in the frequency rather than time domain, using differences in frequency content or phase to differentiate the material in each channel. Its spatial quality generally differs from temporal techniques in being more diffuse and more difficult to localise. One such technique splits the sound into 'bands' which can then be placed at various positions in the space. Using this process it is possible to create interesting qualities of spatial motion, particularly with material whose spectromorphology is not stable, causing the movement through the spectrum to articulate spatial movement.[87] This was done in the opening of *A moment's reflection* as a way of spatialising the low warped water material up until 2:30, where the lower part of the spectrum was smeared across the front four speakers of the BEAST-8 array, whilst the higher frequencies making up the more spectrally dynamic water elements were spatialised in order to create more energetic movements across the frontal space.

Spatial Volume

The issue of how to generate convincing multichannel cues as to the magnitude of an enacted space (as opposed to the size of the source which is discussed in section 2.1) has been precarious until

[87] I used Peiman Khosravi's *Circumspect* software for this which splits the spectrum into bands using the FFT and allows the user to place the various parts of the spectrum across the eight channels. It usefully includes control over the spreading of the frequency bins in space, allowing you to transform the quality of the space in real-time. This technique needs to be used carefully; extreme settings can result in parts of the spectrum being overly localised to particular loudspeakers causing separation of the spectrum. However, a subtle treatment based on the morphology of the sound serves to accentuate the energy through the coupling of space and spectrum.

recently because of the lack of easy-to-use reverberation or room-emulation tools.[88] Before such software was available in my transformational toolbox, rather than using reverberation, I often implied volume or borderless images by mimicking the perceptual effect of reverb, creating diffuse soundfields which smeared material in space and/or time in order to give a sense of it filling the space (see 7:55 in *Centrifuge* for an example of this). Ganging four stereo reverbs together is also used in *Centrifuge* as a way of adding reverberation to certain sounds (see 7:11 for an example). However, the effect is once again that of a large space and should be used sparingly in order to avoid it becoming tiring.

In *Aeolian Forms*, given that so much of the piece is based around the idea of wind articulating spatial volume, it is not surprising that a great deal of experimentation was done in investigating how this might be achieved. In the opening section, as well as using the previously discussed technique of source widening, reverb[89] is faded in and out proportional to the effect of distance from the listener I wished to create.[90] What I wanted to achieve throughout this section was the sense of wind-like gestures coming out from the panoramic space, to a point whereby they create their own intimate space, and then recede away into the prospective space, giving a dynamic sense of spatial depth and scale of movement as the reverberation gives shape to the frontal stage (the

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[88] Software such as IRCAM's Spat library of objects for Max/MSP (http://forumnet.ircam.fr/en/product/spat/) was one of the first to offer not only controllable true multichannel reverberation, but also a solution which coupled spatialisation with reverberation (or room) effects, allowing you to place a sound (or sounds) at a particular position in space and obtain the correct perceptual balance of reverberation, spread and other spatial cues based on the location and room settings chosen. Other software such as Altiverb (http://www.audioease.com/Pages/Altiverb/) offer multichannel impulse-response reverberation as a VST plugin, although these do not have the same interaction of source-location parameters and sounding result which make the Spat software so powerful.

[89] Generated using Flux's IRCAM Verb plugin in eight-channel mode.

[90] This can also be done using the Spat objects in Max/MSP or using the plugin by Flux, however both of these methods had problems when integrated with my way of working. The first option, that of using the Max/MSP objects requires that the resulting audio is recorded to a new sound file, fixing the reverberation characteristics and making it at best difficult to change the reverb at the mixing or post-production stage. Using the Flux Spat plugin would have allowed this however each eight channel stem that was being spatialised would have required me to automate at least sixteen parameters, which over the course of a full composition would have been extremely complex and time consuming, as well as removing the real-time interaction that my Max/MSP spatialisation patch has (see appendix three for more details on this). Therefore the approach of spatialising material dry in real-time using the Max/MSP objects and applying room characteristics via an auxiliary send seemed to offer me the most flexibility and impinge the least upon my workflow.

fade-out and re-entry starting at 0:20 illustrates this). Using this technique, I perceive the wind material moving between being a proximate sound in its own right, to becoming part of the larger space as the reverb became more prominent, causing the sound and the response of the distal space to become fused. As well as creating sensations of panoramic depth, circumspatial depth and immersion was also explored in *Aeolian Forms*. I have already commented on the creation of intimate circumspaces, but here I was interested in contrasting these with sensations of immersion in larger, resonant spaces such as those created by the low frequency attacks at 9:56 and 12:03. The quality of sound is important here as, because of the link with proximity cues, very low frequencies have a psychoacoustic effect of creating immersion.[91] and the hollow quality of the sound adds further acoustic cues of a resonating body. However, in its spatial treatment, I used a multichannel reverb with the low frequency behaviour set so that it is excited more than the highs. What I perceive is a sensation of the entry of the low attacks exciting the space, further enhancing its size, sense of immersion, and frontal spatial depth, as well as functioning as a contrast to the intimate, circumspatial material in this section.

[91] Rumsey (2001), 36.

APPENDIX 3: BEASTTOOLS

Rationale and History of the Project

As the studios at Birmingham began to develop into multi-channel facilities, allowing composers to explore beyond the scope of stereophony, the need for tools for transforming stereo sound files into multichannel ones, also began to grow – particularly as at that point in time very little commercial software existed which supported the 'BEAST-8' format being adopted by the studios. The route taken by many composers at Birmingham was to write their own software tools for sound transformation, often in Max/MSP, many of which tried to give the material a certain 'believability' in multichannel space by using certain intrinsic qualities or properties of the sound to control the spatialisation behaviour. As the number and variety of tools being used by composers grew, and more composers came to the department, each with their own compositional interests and programming skills, Erik Oña proposed the idea of concatenating these discrete tools together into a single package which would allow sound-sample playback, manipulation, recording and flexible routing through a number of different transformational tools. It is from this point that *BEASTtools* began to grow.

As Erik was a skilled Max/MSP programmer, the decision was taken to use this program as the environment in which to build *BEASTtools*. It is worth noting that whilst, at first glance *BEASTtools* may not appear to offer anything particularly novel or beyond the scope of existing software tools in terms of transformational potential, the beauty of the package is the ability quickly to generate and record multichannel material from within one environment, with a range of tools which offer many of the processes that we as composers used prolifically for stereo composition, only now available in multichannel format. Also worth mentioning is that fact that virtually everyone involved in the development of *BEASTtools* is a composer, and so the issue of ‘‘composer

ergonomics' – the little details designed to avoid frustration on the part of the user'[92] – featured highly in our development, ensuring that the software could be used by composers regardless of their knowledge of programming or Max/MSP, as well as bringing about novel touches not available in other software environments. Following on from this, recent developments have focused on unified GUIs, clarity of tool layout, and external control.

The Core

Central to *BEASTtools* is the *Core*, a centralised patch for managing top level elements of *BEASTtools* – the DSP settings of Max/MSP and the Core Audio engine, output volume and routing, loading tools into the current session and mapping external controllers to tool parameters.

Routing

BEASTtools' flexibility lies in both the unlimited instances (i.e. limited by only the machine's processing power) of patches which can be opened, but also the ability to route the output from any one tool to the input of another. *BEASTtools* in many ways resembles the modular synthesiser approach, where modules can be routed in an infinite number of ways. This offers incredible flexibility for the composer, who if they suddenly decide that a particular patch needs to be inserted, can do so without needing to re-compile, switch to another environment or do anything else which might distract their focus from the compositional task at hand. The new tool is simply opened from the *Core* and inserted into the audio chain via the drop-down menus.

Tools

I will not give an in-depth description of every tool here but will talk in brief about those which I have added or worked on significantly in the *BEASTtools* development.

[92] Harrison (2013).

- **Circul8**: A 2D pseudo-VBAP panner which positions a 2-8 channel arc in eight channel space with controls over the spread and centre point of the arc. Also built in are high-shelf filters, volume roll-off controls and the Doppler Effect to add distance and movement cues.
- **Envfol**: An eight-channel envelope follower which applies the amplitude envelope of one input to the sound of another. Control is available over the shape of the curve, amount of amplitude attenuation and temporal resolution of the envelope.
- **Granul8**: A granular synthesiser capable of granulating a stereo soundfile and distributing the grains over eight channels. Based on a patch by Richard Dudas,[93] the engine and parameter controls have been significantly revised and added to. A sister patch called **Brassage** is also available, performing the same process as *Granul8* only now taking grains from two soundfiles and splicing them together to form a composite grain stream of the two sounds.

GUI Refinements

One concern I had when I first began working on *BEASTtools* was just how different the layout of some of the tools were (no doubt an inherent result of taking patches from different composers, each with their own particular workflow). I was keen not only to try to unify the visual workflow and layout of the tools (a difficult task given the esoteric nature of many of them), but to also give them a more 'professional' look – one which would hopefully make them look less like Max/MSP patches and which might invite the novice user to experiment rather then be frightened by a cold, uninviting native GUI scheme. Coming up with a clean and clear colour palette, along with compartmentalising the parameters into relevant groups, helped improve the clarity of the tools and made it much easier to navigate through the available parameters. Custom switches, buttons and

[93] Dudas, R. *Granularized*. Cycling 74. 2003.

potentiometers were also created using the ‘pictctrl’ object, which allows the creation of new skins using picture files.

Workspace Recall and Preset Morphing

As users’ *BEASTtools* sessions became more complex, it became evident that a way of recalling the tools used in a session, as well as the settings of the parameters for each tool, was needed in order to allow re-takes of processed material to be done later on in the compositional process, or the storing of meta-tools – preset combinations of tools with particular parameter settings which are used for specific tasks. The first solution was the creation of the *Workspaces* sub-patch, which uses the new ‘Dict’ objects in version 6 of Max/MSP, to store the tools and samples which are in use in a session in a single text file which can be loaded again at a later date. The second issue, that of recalling parameter presets, was added to the *Workspaces* sub-patch, allowing not only the storing and recall of parameter presets within a single file, but also interpolation between two presets over a stated time. (Because of time constraints and changes to the low-level functionality in recent updates of Max/MSP, this feature has not been totally integrated into the BEASTtools environment; at this stage it can be considered a ‘final proof’).

APPENDIX 4: MAX/MSP PROGRAMMING

As well as being part of the development of the *BEASTtools* environment, a significant amount of time was spent developing transformational tools for personal use in Max/MSP. As the majority of my multichannel works use the BEAST-8 format – a format not yet embraced by many commercial software developers – most of these tools were built with the aim of generating or spatialising material over eight (or possibly more) channels via some means. They were generally developed on an 'as needed' basis whereby I was faced with a compositional issue for which the tools available at that time were unsuitable or inadequate for creating the musical result I had in mind. Their development was also quite sporadic, resembling something more akin to rapid prototyping as new ideas came to me which would be subsequently added to the patch. As a result, the patches that I developed are primarily designed for personal use, and may contain programmer's idiosyncrasies which came about as a result of their developmental process. They are not provided to illustrate coding efficiency (although some have been optimised over the three years of my study) or proficiency of DSP, but rather to evidence the importance of developing my own transformational tools for specifically musical purposes. I will outline my approach to programming as well as investigating some of the tools in more depth.

PHILOSOPHY

User Interaction

In designing patches (either for myself or the public) the issue of how the user may interact with my creation is of high importance. "Do I want to set the low level parameters carefully or manipulate more perceptual characteristics?", "What level of control is needed over the parameters?"; these are important questions that should be asked when starting to design a new patch as they will have implications as to the types of interaction, and as a consequence, the sonic results, that are available. Some of my earlier creations were more concerned with replicating plugins or software that existed

for stereo use which were expanded via some musically meaningful method to eight channel, but consequently retained the discrete parameter-based interaction of the original. In contrast, many of my later creations, particularly those with which I was interested in creating longer textures with a larger-scale sense of development and morphology, had a quality of interaction in which I dealt with high-level perceptual characteristics which allowed me to make more dramatic changes in real-time. Many of these types of patches had a number of parameters linked in a way which was musically interesting, replicating the type of linking which occurs during performance using acoustic instruments[94] (as in *Texture Delay*). A similar solution used the 'pattr' collection of objects to create a number of presets with particular characteristics, which I could then morph between to shape the behaviour of the patch (as in *Envfol*).

The next issue related to interaction is how I go about controlling the parameters in the patch. Thankfully the mouse has long been replaced as a musical controller, with companies offering a wide range of fader, knob and keyboard controllers based on the MIDI protocol. HIDs such as game controllers also provide interesting alternatives which move away from the traditional knob-fader paradigm. For my own control purposes, I have settled on the Lemur app for the iPad.[95] This is based on the firmware of the original Lemur control surface[96] but has been adapted for the touchscreen interface of the iPad, integrating some of its extra functionality such as tilt detection and accelerometers. It retains the diverse range of objects, physical modelling and scripting possibilities of the original device, but now uses cheaper and more portable hardware. It communicates to Max/MSP (other other compliant software) over a local network using the OSC protocol, which offers a number of benefits over MIDI and HID devices in terms of a higher resolution, fixed minimum and maximum values, and a simple tag-based controller naming

[94] Paine (2009), 215 contains further discussion on this topic in relation to music software design.

[95] http://liine.net/en/products/lemur/

[96] http://www.jazzmutant.com/lemur_overview.php

structure. It is also highly customisable, allowing me to create my own way of interacting with each Max/MSP patch rather than it being dictated by the physical objects on a hardware control surface. Figure 7 shows a typical iPad screen, in this case for controlling the spatialisation for a swarm granulation algorithm (see further discussion below).

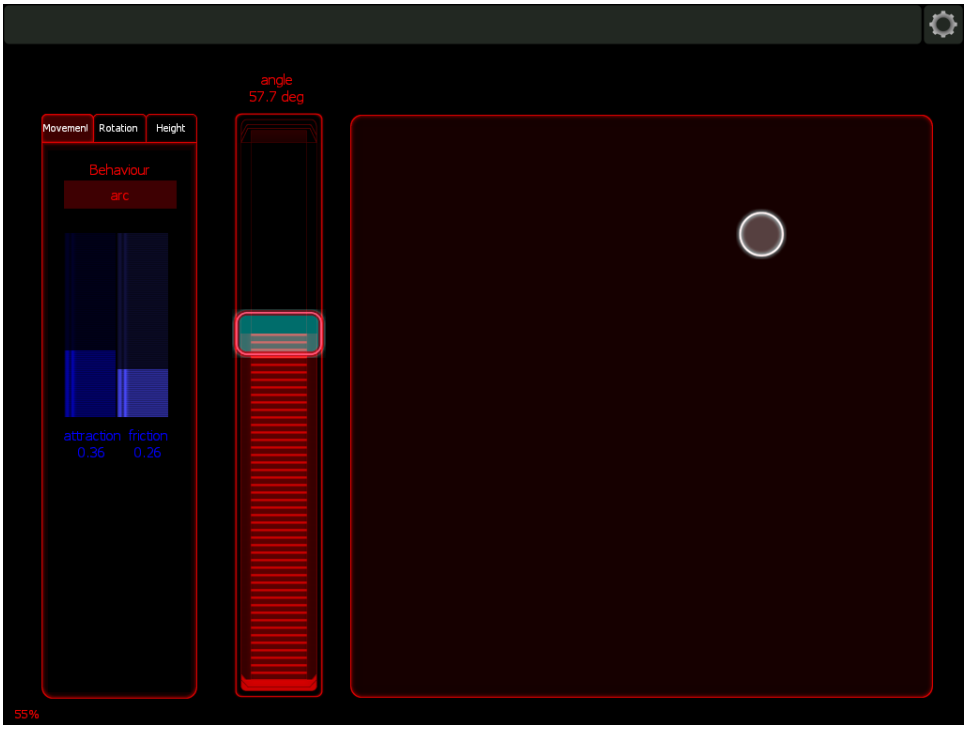

Fig. 7. Spatialisation interface for Lemur. The XY grid controls the x/y orientation of the centre point of the arc or swarm whilst the larger fader controls the width of the arc or attraction of the swarm particles.

Randomisation

In order to prevent the sonic output from my patches becoming too predictable or static, the approach of adding random functions to certain parameters was adopted to give a sense of natural variation. The randomisation would often be added to some of the lower level parameters in order to give them a slight sense of movement or natural instability whilst I manipulate the higher-level controls. Depending on the settings applied, this sense of motion would give the sonic result a slight sense of inner energy – an organic, living quality which mimics the pseudo-random nature of so many behaviours in our day-to-day life.

As with noise, there are varying degrees and colours of randomisation which can effect the sounding results. The subject of amount of randomisation is fairly clear but the issue of colour deserves some further investigation. A lot of random behaviour built into software applications is of the non-weighted type (for example the 'random' object in Max/MSP), which whilst useful and computationally inexpensive, tends to have a quality which sits at odds against the more statistical, weighted random behaviours in the everyday world. A conversation with Visa Kuoppala[97] made me aware of the Lehmer random number generator (LRNG) which is a simple recursive algorithm[98] which can be given a particular statistical behaviour depending on the three variables chosen. These behaviours can range from anything between non-weighted randomness to iterative patterns, although the settings which interested me most were those that had a weighted randomness or that had a shape to their behaviour, giving the sense that they were attracted to a particular part of the range. The various colours of weighted behaviour could be used to enhance the sonic properties of the material which I was generating or transforming, enhancing sensations of grain or articulating micro-gestures, depending on the behaviour and the LRNG settings.

Re-usability Of Code

Many of the processes I employ are not exclusive to a particular patch, but rather are slight adaptations of a technique for a particular purpose (random number generators being an example of this). As a result, rather than having to re-code processes shared across multiple tools, I tend to employ abstractions where possible that can have their behaviour, channel routing and other initial states modified through the use of variables at the patcher level. The 'poly~' object has been especially useful in this regard as it will not only generate multiple instances of an abstraction which run on the audio engine, but also allows simple instance-by-instance management using the 'thispoly' object. This has been essential in optimising audio processing code running in eight

[97] In a correspondence around April 2012.

[98] The formula for the equation is $X_{(t+1)} = (X_{(t)} * a + b) \bmod m$.

channels by creating one voice per channel and spreading its processing across the multiple CPU cores available on modern Apple machines.

SPATIALISATION PATCHES

Below is a brief outline of some the principle patches I designed and used to generate or spatialise material over multiple channels. All of these patches are designed as specific tools for a larger toolbox, and as such most operate in the *BEASTtools* environment to take advantage of the multichannel bussing, sample player and recorder contained within the suite.

- **Shuffle**: As the name suggests this is an eight channel reproduction of GRM's Shuffling plugin.[99] It replicates the process of shuffling an incoming audio stream via a delay line which feeds a granulation patch. Each grain can be given a different delay time and be spatialised within the eight channel space, shuffling the grains in space as well as time. The poly~ object allows the creation of many more parallel grain streams than the GRM version to create more smearing of the incoming sound, and the dry version can be placed in any of the loudspeakers.
- **Pitchy**: Pitchy was originally developed for use in *Steel Curtain* as a stereo tool but has subsequently been expanded as a way of decorrelating material over eight channels by frequency and phase. At the input stage of Pitchy there is a parametric EQ per channel using the 'cascade' object to highlight certain pitches or spectral zones in the material. Each channel is then processed by the FFT with a large window size in order to give it good frequency resolution, after which magnitude squaring of the polar coordinates increases the amplitude of the louder bins and reduces that of the quieter ones, thereby enhancing prominent pitches. Spectral smoothing and averaging can then be performed

[99] http://www.inagrm.com/shuffling.

in order to smooth out frequency changes, and the phase values randomised in order to decorrelate the channels. Further decorrelation can be performed using the randomiser on the EQ which attenuates the amplitude of each band with a different value applied for each channel, creating spectral motion around the ring of eight loudspeakers.

- **Texture Gen**: A simple granular texture generator which was designed for use in *False Awakening* to generate semi-rhythmic textures comprising attack-like grains. The grain trigger uses a LRNG where you control the maximum random periodicity, which triggers grains with parameter values based on random ranges set at the top level.
- **Texture Delay**: This is a more sophisticated version of the above and performs a similar process to *Shuffle* but only triggers grains when the incoming audio passes above a threshold. Its grain envelope is optimised to accentuate shaper attacks, or textural material comprising smaller impulses, having by default a short attack and longer decay phase.
- **Poker**[100]: A sixteen channel high shelf filter[101] set at 10kHz which exploits the attenuation of high frequencies caused by distance, applying gain or reduction randomly per channel, and resulting in channels being perceptually 'poked' out of the array of loudspeakers. The nature of this effect requires that there is a significant amount of high frequency content in the sound being processed in order for it to work and was used extensively in *Vocem Machinis*.
- **Massager**[102]: Similar to the above patch but applies a random volume attenuation per channel over sixteen channels.

AmbiSpat

[100] Located in '20ch Tools'.

[101] A high shelf filter applies a constant gain to all frequencies above the cutoff point.

[102] Located in '20ch Tools'.

This patch became my main resource for real-time spatialisation used in all my works from *Rip* onwards. It originally started off as a simple patch which combined the ambisonic Max/MSP externals produced by the ICST[103] in Zurich into a single patch with simple high shelf filtering and Doppler effect. More interesting for me was the fact that it offered real-time control, via the Wacom drawing tablet,[104] of the spatial position or trajectory of a sound in eight-channel space, rather than having to automate this or else rely on the less predictable behaviour of Rot8 in *BEASTtools*. This movement into real-time control combined with a degree of precision, allowed me to use the tool more like an instrument, learning its intricacies and 'playing' it in a way which translated the implied or potential spatial movement and energy latent within a sound in a natural and believable way. Very soon, as my ideas began to grow, an impulse-response reverb was added, using four ganged instances of Altiverb, with the mix between the wet and dry signals balanced according to the distance from the listener to add distance-based reverberation effects. The ability to spatialise eight incoming signals in an arc or swarm was also added to give further potential for shaping space in *Rip* and *Resonance* and initiating my idea of spatialising bodies of sound as discussed in 3.1. In its current manifestation it allows either third-order ambisonic or VBAP spatialisation, with eight-channel room emulation performed post-spatialisation using IRCAM's 'ircamverb~', with the dry and room balance controlled using 'spat.oper', which generates low level parameters such as these from higher-level perceptual behaviours. The spatial behaviour of the direct and room parts of the sound can be shaped further by adding EQ using 'spat.hishelf~.control'. In terms of actually spatialising sound, the eight incoming channels can be placed in an arc of user definable width or swarm, the velocity of which can be either controlled by the user or else by the built in amplitude follower. External control can now be input using any OSC device which conforms to the tags given in the help document: my own solution used an x/y pad to control the centre position of the arc or

[103] Institute for Computer Music and Sound Technology (http://www.icst.net).

[104] http://www.wacom.com.

swarm in space, with a separate slider controlling the width of the arc or velocity of the swarm (see figure 7).

GLOSSARY OF TERMS

BEAST

Birmingham ElectroAcoustic Sound Theatre[105]. A transportable and custom-configurable system for the diffusion of acousmatic, audio-visual and mixed electroacoustic music, and installations based at the University of Birmingham. Also often used as an umbrella term for composers studying or researching electroacoustic and/or mixed composition at the University of Birmingham Music Department.

BEAST-8[106]

The multi-channel speaker arrangement adopted by BEAST and the Electroacoustic Music Studios at the University of Birmingham for the composition and diffusion of electroacoustic music. Consists of eight equally spaced loudspeakers arranged in four left-right pairs (Front, Wide, Side and Rear), with the listener(s) positioned in the centre of the ring (Not to be confused with the 'BEAST Main Eight' configuration developed by Jonty Harrison, comprising Distant, Main, Wide and Rear pairs[107]).

B-Format

A first-order ambisonic[108] technique for encoding spatial audio information present in a soundfield which can then theoretically be decoded over any loudspeaker arrangement (stereo, multichannel or 3D) in post-production to reproduce the recorded environment. Consists of one omni-directional

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[105] http://www.birmingham.ac.uk/facilities/BEAST/index.aspx

[106] Also referred to as a 'French eight' but no official name exists for this loudspeaker arrangement. For more information on the BEAST-8 configuration and its history consult Harrison (1999), 'Diffusion: theories and practices, with particular reference to the BEAST system', http://cec.sonus.ca/econtact/Diffusion/Beast.htm.

[107] Harrison (1999), 124.

[108] See Rumsey 2001 for more details on ambisonic theory and its applications.

signal (W) to determine overall sound pressure and three bidirectional channels carrying the front/ rear (X), left/right (Y) and up/down (Z) spatial information.

HID

Human Interface Device (e.g. mouse or joystick).

HRTF

Head Related Transfer Function. A model of the spatial filtering caused by the ears, head and rest of the body as sound moves around a person.

Mid-Side

A stereophonic microphone technique for encoding a stereophonic image. Typically uses a cardioid (mid) and figure-of-eight (side) microphone arranged to be as coincident as physically possible. Allows the adjustment of the stereo image width in post-production.

OSC

Open Sound Control. A network-based protocol for messaging between computers, developed at CNMAT[109], for sharing data between electronic musical instruments. It offers much higher resolution, bandwidth and scope for expansion than MIDI.

SoundField Microphone

A range of microphone systems manufactured by SoundField Ltd.[110] for capturing the full spherical soundfield of a scene or object in B-Format.

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[109] Center for New Music and Audio Technologies (http://cnmat.berkeley.edu).

[110] See http://www.soundfield.com for more information on the company and their products.

VBAP

Vector Base Amplitude Panning. Amplitude-based panning technique for spatialising sound over 2- and 3-dimensional loudspeaker configurations.[111]

[111] Further information can be found in Pulkki (1997).

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