PORTFOLIO OF ORIGINAL ELECTROACOUSTIC COMPOSITIONS

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SCHOOL OF ARTS, LANGUAGES AND CULTURES

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Total duration: 81:57

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	Iteration/Banger (live electronics 8-channel version)	8-channel	6:41
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	Iteration_Banger_Patch 2	Max patch (.maxpat file)	n/a
	Technical setup read me file	pdf	n/a
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Abstract

This commentary accompanies the portfolio of electroacoustic works realised at the NOVARS Research Centre, and intends to provide insight into methodologies for acousmatic composition as researched at the University of Manchester between 2013 and 2016. Six compositions are presented in order of realisation, as follows: *Frictions/Storms, Rise, Glitches/Trajectories, Transmissions/Intercepts, Reductions/Expanses,* and *Iteration/Banger*. An analysis of each work in relation to research-specific topics is provided, adopting Denis Smalley's concepts of *spectromorphology* and *space-form* as appropriate syntax in the elaboration of compositional methodologies and overall outcomes.

The research focuses primarily on the appropriation of transformed and synthesised sound materials in acousmatic spatial composition. Resulting works are intended for presentation in concert via the practice of live sound diffusion performance. The portfolio documents an arc of development working in fixed media formats incorporating live electronics processes into the realisation of multi-channel compositions, to finally arrive at a methodological merging of fixed media studio composition and live electronics performance practices.

Additional supplementary materials in support of the portfolio and commentary are provided including Max coding patches, video tutorials, technical information and related audio materials.

Declaration

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Technical Information (surround works)

Multi-channel audio and stereo reductions of each portfolio work are provided in 24-bit 48kHz interleaved wav, aif or aiff file formats. Channel assignments to loudspeaker placements are displayed in the diagrams below:

8-channel setup

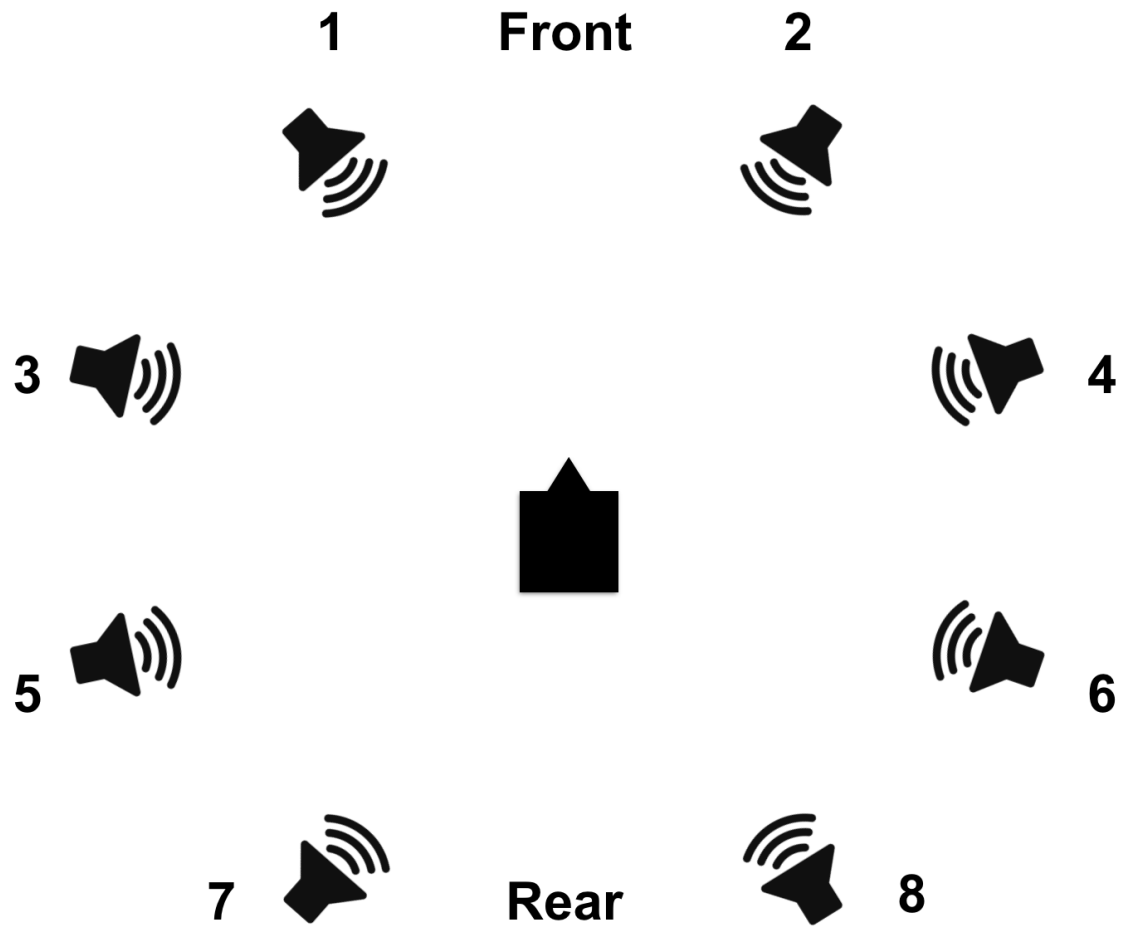

Diagram 1: 8-channel loudspeaker setup.

8-channel portfolio works:

Frictions/Storms

Glitches/Trajectories

Reductions/Expanses

Iteration/Banger

5-channel setup

Note: *Transmissions/Intercepts* may be presented in standardised 5-channel (as in Dolby Digital 5.1) surround configurations, but was composed in the configuration shown below: channel 2 is a front centre speaker output and channels 1, 3, 4 and 5 create a quadrophonic surround setup i.e., loudspeakers 4 and 5 are intended to mirror the positions of loudspeakers 1 and 2. As opposed to being *left surround* and *right surround* positioned, they are *rear* positioned.

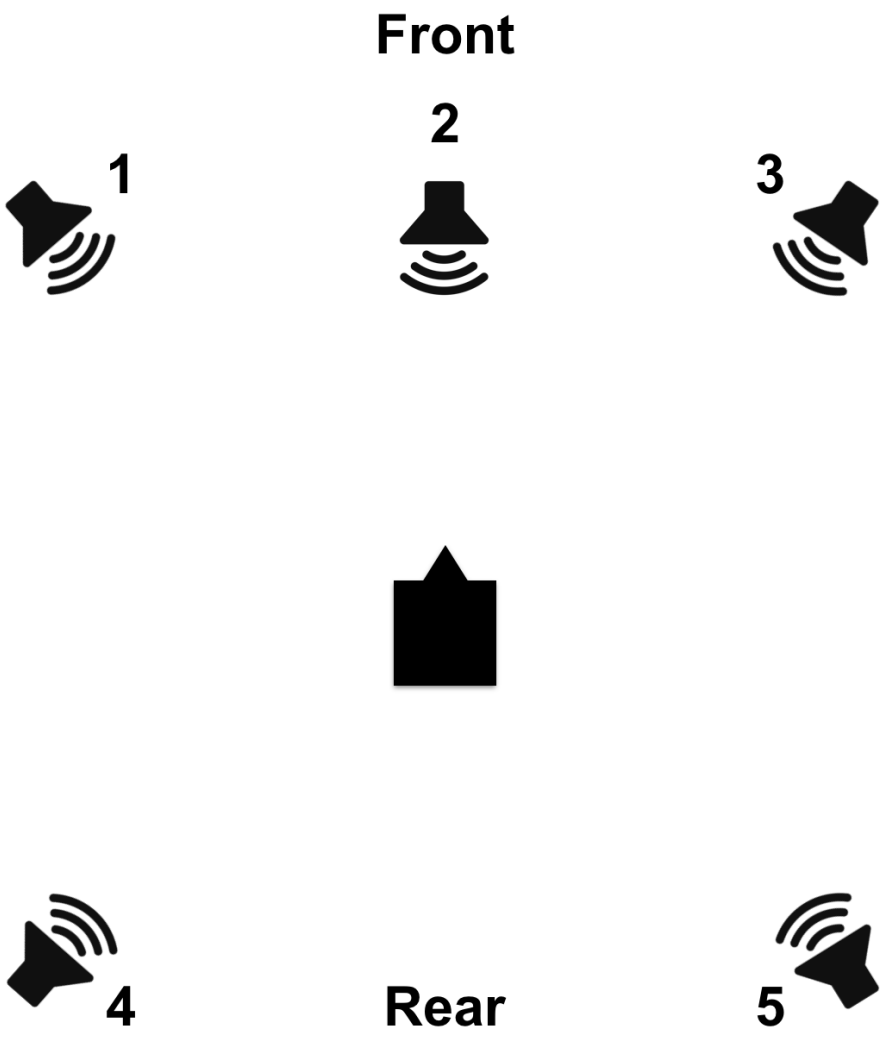

Diagram 2: 5-channel loudspeaker setup for *Transmissions/Intercepts.*

5-channel portfolio works:

Transmissions/Intercepts

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Additionally I thank all the NOVARS postgraduate students I have been fortunate enough to work alongside during my time at the University of Manchester.

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This work is dedicated to my parents Janice Mary and Charles Dennis Saul, and my grandmother Brenda Deakin. For your endless support and love, I thank you.

‘The results are profoundly monotonous. Furthermore, all these noises are identifiable. As soon as you hear them, they suggest glass, a bell, wood, a gong, iron … I’m giving up on music.’

Pierre Schaeffer, 15 April 1948

‘Always record! Always record!’

Jack Black, 28 November 1997

INTRODUCTION

This portfolio and supporting commentary document a four-year journey of development as an electroacoustic composer, and are intended to highlight several core aspects of research through composition. Many of the key concepts can be identified across the body of work, and each chapter considers one or more research topics in relation to a specific composition. The writings of Denis Smalley have been highly influential on my work, specifically the analytical concepts of spectromorphology[1] and space-form.[2] Both are applied throughout the commentary as appropriate syntax in delineating compositional methodologies, musical structures and overall outcomes. Through practice-based research focused on fixed media or acousmatic composition (intended for playback and/or performance through multiple loudspeaker configurations),[3] my work addresses the following questions:

- How can the electroacoustic composer create musical coherence when employing predominantly abstract sound materials in non-linear musical structures?[4]
- How can relationships between studio-based composition and live electronics performance practices be merged to develop composed musical outcomes?
- How might aleatoric processes be successfully incorporated into composition and sound generation techniques?

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[1] 'The two parts of the term refer to the interaction between sound spectra (*spectro*-) and the ways they change and are shaped through time (-*morphology*).' Denis Smalley, 'Spectromorphology: explaining sound-shapes', *Organised Sound*, 1997, **2**(2), Cambridge University Press, 107 - 26, 107.

[2] 'An approach to musical form, and its analysis, which privileges space as the primary articulator. Time acts in the service of space.' Denis Smalley, 'Space-form and the acousmatic image', *Organised Sound*, 2007, **12**(1), Cambridge University Press, 35 - 58, 56.

[3] 'According to the definition in *Larousse*, the Acousmatics were initiates in the Pythagorean brotherhood, who were required to listen, in silence, to lectures delivered from behind a curtain so that the lecturer could not be seen. The adjective 'acousmatic' thus refers to the apprehension of a sound without relation to its source.' Trevor Wishart, 'Sound Symbols and Landscapes', in *The Language of Electroacoustic Music*, 1986, Macmillan Press Ltd., 41 - 60, 41.

[4] 'A sound could be labelled abstract simply through the inability of the listener to ascribe to it any real or imagined provenance. Many electroacoustic musicians conceive of a continuum between the 'abstract' and 'referential' which may function as a micro- or macro- structuring principle, or determine the overall narrativity of the music. The pairing of terms abstract/referential is also referred to as intrinsic/extrinsic (by the composer and theorist Denis Smalley, for example).' Ears ElectroAcoustic Resource Site. [online] Available at <http://ears.pierrecouprie.fr/spip.php?article198>, accessed 24 July 2016.

- What approaches might be adopted in order to extend and embellish composed multi-channel fixed media works through concert presentation, in relation to contemporary sound diffusion methods?[5]
- How might tonality be successfully employed alongside abstract sound materials in acousmatic works?
- What potential might the creation of multiple performable variations of composed works hold for the composer/performer?

The commentary is structured as follows: Chapter 1, *Frictions/Storms,* focuses on source bonding and gestural surrogacy as related to recorded materials and sound transformations. Chapter 2, *Rise*, focuses on the role of structural functions in an acousmatic composition, giving additional consideration to musical expectation and space in the stereo image. Chapter 3, *Glitches/Trajectories,* examines behavioural relationships between sound types and outlines methods for studio spatialisation techniques, aleatoric development of materials, and the transference of semi-improvised live electronics performance techniques into composed fixed media. Chapter 4, *Transmissions/Intercepts,* investigates coherence in long-form composition and through detailed musical analysis considers the application of remote (and synthesised) sound materials within a concept-based musical framework. Chapter 5, *Reductions/Expanses,* investigates the transference of a fixed media composition into multi-channel live performance environments, explicating methodologies for spatial reinterpretation as achievable through sound diffusion performance. Chapter 6, *Iteration/Banger,* explores an alternate approach to the development of materials, incorporating aleatoric algorithmic procedures in the generation and organisation of sounds, resulting in a composed work that is performable through both fixed media and live electronics formats. Additional consideration is given to stylistic hybridity within the work. Finally Chapter 7 provides conclusions to my research and proposes a compositional methodology as reached through the convergence of research areas outlined above.

[5] Sound diffusion refers to the performance practice of redistributing sound spatially via playback of a fixed media audio file through multiple loudspeakers, usually presented in a concert hall environment. Discrete channels of audio (such as channels 1 and 2, or left and right, in the case of a stereo piece) may be assigned to multiple loudspeakers, and amplitude levels of loudspeakers are then manually adjusted by way of a mixer or purpose-built control interface, allowing the potential for immersive or dramatic, spatial listening experiences.

Through processes applied in the production of the portfolio, and through the post-compositional analyses and conclusions provided, I seek to strengthen the composer–listener relationship via meaningful musical discourse and further the ongoing development of electroacoustic music and its presentation.

CHAPTER 1. *FRICTIONS/STORMS*: SOURCE BONDING AND GESTURAL SURROGACY AS COMPOSITIONAL AIDS

> 'One approach to electroacoustic composition is to use source-causes which are intended to be recognised. They are used precisely because we can recognise them, associate with them and because they have a reality. Heard sources have a dual identity, an intrinsic existence (within the context of the musical work), and an extrinsic existence (in real-world experience outside the work). In entering the musical work they carry with them their identities and activities from the world outside. They automatically have two contexts and are therefore *transcontextual*.'[6]

1.1 Compositional methodology

Frictions/Storms (12:17) is illustrative of my approach to acousmatic composition during the early period of my PhD research, being a bottom-up constructed,[7] multi-channel work themed on the exploration of one or more recognisable sound objects.[8] Featured source materials are linked through friction, as integral to the cause behind sound generation. The work is concerned with Smalley's concepts of source bonding[9] and gestural surrogacy;[10] as sounds are subjected to transformation their identities become masked, and through increasing remoteness imagined sources and causes may be inferred.[11] Transformed materials may suggest (electronic) storm-like shifting weather patterns (hence the work's title), and evoke images of trains passing through distant landscapes. Works inspiring this approach to source materials include David Berezan's *Cyclo*

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[6] Denis Smalley, 'Defining transformations', *Interface*, 1993, **22**(4), 279 - 300, 281.

[7] '[…] many composers make bottom-up works, that is, works based on materials they have assembled which they subsequently manipulate and place in sequences to form structures.' Leigh Landy, *Understanding the Art of Sound Organisation*, 2007, MIT Press, 34.

[8] Previous compositions produced during my MusM degree at the University of Manchester include *Blow* (2012), a stereo fixed media work made exclusively from saxophone recordings, and *Jaws* (2012), an 8-channel fixed media work themed on recordings made of my pet cat.

[9] Source bonding: '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.' Smalley, 'Spectromorphology', 110.

[10] 'The process of increasing remoteness I refer to as *gestural surrogacy.*' Ibid., 112.

[11] 'We should not think of the gesture process only in the one direction of cause–source–spectromorphology, but also in reverse – spectromorphology–source– cause. When we hear spectromorphologies we detect the humanity behind them by deducing gestural activity, referring back through gesture to proprioceptive and psychological experience in general.' Ibid., 111.

(2003), Adrian Moore's *Study in Ink* (1997) and Manuella Blackburn's *Switched on* (2011), where sounds derived from identifiable sources are reshaped to take on new and fantastical forms.

1.2 Source materials: spectromorphological archetypes and variants

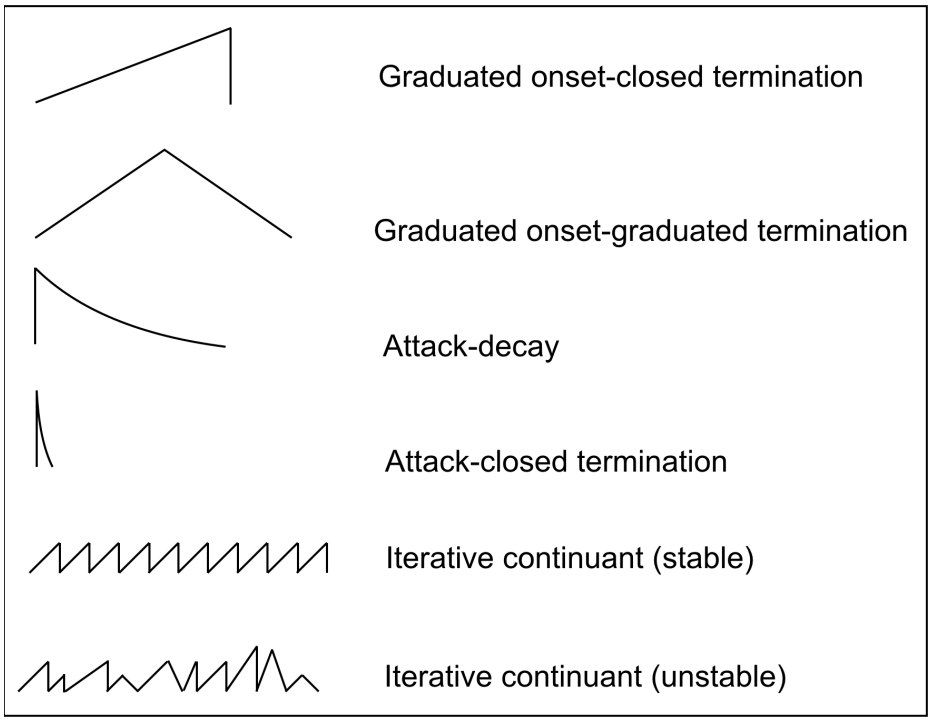

Figure 1: Morphological models.[12]

Recordings were derived from gestural play with three groupings of sound sources: tiles (clay roofing tiles and ceramic bathroom tiles) dragged across one another and struck, various sizes of saws and hacksaws (sawing wooden planks), and bowed violin strings. Additional recordings were made of large plastic bin lids being slammed shut. Through auditioning of gesture captures, relationships and contrasts between spectromorphologies were identified in order to consider their potential for application in a musical context.[13]

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[12] See Denis Smalley, 'Spectro-morphology and Structuring Processes', in *The Language of Electroacoustic Music*, 1986, Macmillan Press Ltd., 61 - 93, at 68 - 73.

[13] 'In the acousmatic studio, the fixity of sounds on the medium allows us to stop and repeat sound, inviting probing analysis of any sound object and in turn investigating the nature of our responses to and relationships with sound.' John Young, 'Sound morphology and the articulation of structure in electroacoustic music', *Organised Sound*, 2004, **9**(1), Cambridge University Press, 7 - 14, 7.

Source material/sound type	Agential activity	Spectromorphology
Tiles (clay and ceramic)		
(Noise-based)	Scraped together	Graduated onset-closed termination (gesture)
	Scraped together in rapid succession	Stable/unstable iterative continuant (texture)
(Internal resonance)	Struck together	Resonant attack-decay (gesture)
Saws on wood		
(Noise-based featuring rising/ falling pitch content)	Iterative sawing motion	Stable/unstable iterative continuant (gestural or textural)
	Single forward sawing motion	Graduated onset-graduated termination (gesture)
		Graduated onset-closed termination (gesture)
Bowed violin		
(Pitch-based)	Iterative bowing motion	Stable iterative continuant (texture)
Bin lids		
(Noise-based)	Slammed shut	Attack-closed termination (gesture)

Table 1: Source materials and related spectromorphologies developed for *Frictions/Storms*.

Table 1 identifies a selection of spectromorphologies rendered from gestural play with source materials.[14] Figure 1 provides a visual representation of these spectromorphologies. Scraping tiles together produced a variety of noise-based gestural spectromorphologies, and striking tiles revealed inherent internal resonances. Sawing on wood resulted in timbrally discrete noise gestures with internal rising/falling pitch content (as audible through a single forward or backward sawing motion: from stasis, to sawing motion, speeding up, slowing down and terminating back to stasis). Bowing a violin produced a variety of archetypal sound-shapes and variants, contrasting the noise-based qualities of tiles and saw sounds due to the instrument producing pitch-based spectromorphologies. Furthermore, iterative gestural interaction with materials produced textural continuants. Motions of dragging, rubbing and bowing all

[14] The terms *graduated onset-closed termination*, *iterative continuant*, and *attack-decay*, refer to Smalley's terminology relating to gesture units and spectromorphological expectation. See Smalley, 'Spectromorphology', 112 - 113.

resulted in varied degrees of tension/release gestural energy, acceleration/deceleration behaviour, and/or textural iteration, forming behavioural links between spectromorphologies.

1.3 Transformation, gestural surrogacy and inferred sources

In their untreated states the recordings of tiles and saws may be classified as first-order surrogates.[15] The violin recordings fit within the second-order surrogate classification.[16] Through transformation a variety of new spectromorphologies were produced, classifiable as third-order[17] and/or remote surrogates.[18] Third-order transformations open the work (0:00 - 2:13); short gestures of tiles dragged across one another were subjected to spectral processing (FFT analysis and resynthesis allowing for interpolation between frequency components over time, smearing the sonic detailing inherent in the untreated sound), resulting in extended durations of noise-based textural continuants. The layering of several variations of this transformation created a noise-based 8-channel texture, that may suggest sandstorm-like weather patterns as a possible source and cause.

Another example is audible at 6:12 - 6:57 where several saw recordings have been re-pitched, slowed down, filtered and layered; here short pulse-like iterations (saw teeth dragging on wood) become slower iterative continuants, lower in pitch and too long in duration to suggest sawing motions, masking the original source and cause. These new textural noise-based continuants may evoke images of trains on railway tracks or more industrial sources and causes.

Elsewhere transformation removes all trace of source-cause associations, and remote surrogacy is achieved; an audible example of this is between 7:37 - 8:00, where unstable, noise-based and behaviourally active granulations suggest

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[15] '*First-order surrogacy* projects the primal level into sound, and is concerned with sonic object use in work and play prior to any 'instrumentalisation' or incorporation into a musical activity or structure.' Ibid., 112.

[16] '*Second-order surrogacy* is traditional instrumental gesture, a stage removed from the first order, where recognisable performance skill has been used to develop an extensive registral articulatory play.' Ibid.

[17] '*Third-order surrogacy* is where a gesture is inferred or imagined in the music. The nature of the spectromorphology makes us unsure about the reality of either the source or the cause, or both.' Ibid.

[18] '*Remote surrogacy* is concerned with gestural vestiges.' Ibid.

neither implied nor ascertainable sources or causes. Spectromorphological relations and contrasts between the untreated and transformed materials provided the basis for compositional exploration.[19]

1.4 The function of space

Spatialisation of materials in 8-channels augments the potential for alternate sources and causes to be suggested. The immersive distribution of third-order surrogates – treated with filters (reducing high frequency content) and amplitude envelopes – allows for the illusion of proximate and distal[20] sound events occurring in circumspace.[21] The 8-channel image may produce an immersive and transformed storm-like surrounding weather pattern experience for the listener (example at 7:54 - 8:32).

1.5 Structural analysis

The work is formed of three sections, each focusing on one of the three primary sound sources:

Section 1 (0:00 - 4:56): clay and ceramic tiles

Section 1 establishes an increasingly remote soundworld predominantly defined by third-order surrogates while briefly introducing sound materials (violins and saws) to be further developed in Sections 2 and 3.

The work opens with a slowly evolving noise-based graduated continuant texture, punctuated by gentle attack-decay gestures (resonant tile strikes audible at 1:27 -

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[19] '[…] in the time domain one might use granular methods to synthesise new timbres with spectral signatures that are not perceptually related to the original sound structures. Those are processes which generate new sound signals. On the other hand, the process of repeated audition itself enables us to listen 'into' the sound ever more acutely, which can alter the perception of the sound's musical potential during the compositional process, as listening contexts evolve through generation of new materials and the process of testing of these against each other.' Young, 'Sound morphology', 10.

[20] 'I use the term 'proximate' to designate space nearest to the listener, and 'distal' for space furthest from the listener. The relationship between proximate and distal space creates depth of image.' Smalley, 'Space-form', 36.

[21] ''Circumspace', which incorporates the Latin preposition for 'around' or 'about' as a prefix, seems appropriate to represent the aesthetic notion of relations of position, movement and scale in this, the most comprehensive type of perspectival space.' Ibid., 51.

1:44). Amplitude modulation applied to the noise continuants produces reciprocal internal texture motion,[22] and varying the frequency of oscillations suggests accelerating/decelerating notions of time (1:47 - 1:57).[23] Granular transformations of tile strikes are introduced (1:59) leading to the first major contrast of materials at 2:13, where all sounds terminate to reveal layered, pitch-based violin loops.[24] A dominating gesture concludes the violins at 2:33, where a brief section of subtle tile transformations (re-pitched and reversed) retains clear spectromorphological relationships with first-order tile sounds. The introduction of increasingly third-order transformation types (2:59) leads into a behaviourally active section of noise-based granulations (from 3:10). At 3:32 resonant granulations extracted from tile strikes are briefly introduced, creating a contrast of stable iterative pitched material. At 3:48 remote noise gestures briefly force out all other sound materials, leading at 4:00 to the climax of the section – the return/establishment of granular, resonant and stable pitched iterations, gradually terminating while crossfaded with a new granular texture (transformations of saw sounds), hinting at materials to be established in Section 2 and concluding with a closed termination to silence (an untreated, closing door).

Section 2 (4:56 - 8:42): saws and hacksaws

Section 2 explores contrasting timbres and behaviours to those featured in Section 1 and functions to develop the work's temporal pacing and spectral content. Tension initially builds via two opening crescendos, progressing to a slower, sparse train-like sequence. As activity and spectral density gradually increases, materials become progressively remote, leading to a dense return passage of saw transformations, in turn leading to spectral clearing.

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[22] 'In *reciprocal motion*, movement in one direction is balanced by a return movement. Oscillation and undulation, which are contour variations, could apply to internal, textural motions, as well as being descriptions of external contour.' Smalley, 'Spectromorphology', 116.

[23] Amplitude modulation was achieved using the *Auto Pan* Ableton Live plug-in. For more information visit Ableton. [online] Available at <https://www.ableton.com/en/>, accessed 27 July 2016.

[24] Granular transformations featured were created using the *BEASTtools Granul8* module, part of the *BEASTtools* modular multi-channel transformation environment (for Max). [online] Available at <http://www.birmingham.ac.uk/facilities/ea-studios/research/beasttools.aspx>, accessed 5 July 2016.

Section 2 opens with two successive crescendo variations created from transformations of saws on wood (4:57 - 5:26 and 5:28 - 6:05). Stable granulations (applied to lower-pitched saw material) emerge and maintain a pulse. These are layered with unstable continuant granulations (randomised grain lengths of hacksaw recordings, higher in pitch). Low-pass filtering is applied to some of the noise-based hacksaw material, gradually revealing higher spectral content in combination with applied amplitude envelopes, resulting in increasing spectral density. Considering both crescendos as individual spectromorphological events, the overall result is two texture-carried variations evocative of hurricane-like weather patterns.[25] A final low-pitched saw gesture (5:58) processed with reverb creates a graduated termination transitioning into the next stage of development.

Several layers of saw recordings are introduced (slowed/pitched down and filtered) resulting in material evocative of trains passing in both proximate and distal space. From 6:25 a new violin sequence emerges and departs. From 6:56 filtered and re-pitched variations of a repeating saw transformation sequence lead into a gesture suggestive of a wave crashing against rocks (7:15 - 7:21). The saw sequence is then given prominence through less filtering and proximate spatial positioning, complimented by emerging and underlying filtered noise continuants. All materials suddenly terminate at 7:36 revealing new remote surrogate granulations. From 7:49 - 8:38 the saw transformation sequence returns alongside dominant granular noise continuants; this passage may evoke source-causes of (electrical/ transformed) storm-like weather patterns through a gradually increasing spectral density and activity. High-pass filtering applied to background noise materials (example at 8:08 - 8:16) produces a sense of ascension/termination, as sounds fade out clearing the spectral image to reveal violin material, opening Section 3.

Section 3 (08:42 - 12:17): violins and bin gestures

Section 3 functions as a gradual crescendo, contrasting the previous sections by establishing pitched violin materials as dominant, following brief appearances in the preceding sections.

[25] 'Where one or the other dominates in a work or part of a work, we can refer to the context as *gesture-carried* or *texture-carried*.' Smalley, 'Spectromorphology', 114.

Section 3 comprises pitch-based violin transformations created primarily from repetitions of two discrete edits (re-pitched and spatialised in circumspace). The most prominent of these two loop-based edits is briefly introduced in Section 2. These are layered with a third granular violin edit (creating a stable pitched drone, audible from 8:42), and a fourth, lower-pitched transformation (a graduated onset-graduated termination, audible example at 9:19 - 9:24). Through applied amplitude envelopes, a slow crescendo of amassed violin loops is spatialised, emerging from distal space in the front loudspeaker pair of the 8-channel image (from 8:42), eventually defining proximate circumspace. Dynamic content is enhanced through the introduction of gestural bin lid transformations (processed with multiple delays through amplitude envelopes) resulting in iterative drum roll-like graduated onset-closed termination gestures. The reintroduction of train-like saw transformations as featured in Section 2 provides further structural coherence (audible from 9:48). Bin lid iterations eventually increase in speed to propel the pacing of events forward to the final climax, where spectral density peaks and a repetitive pitch-based spectromorphology (evocative of a railroad crossing bell, audible from 10:56 - 11:14) arrives and departs, functioning as an agent to clear spectral density. The work concludes with a brief spectrally sparse section (11:20 - 12:17) focusing on variations of bin transformations combined with a filtered drone that emerges (at 11:17) and gradually terminates.

Conclusion

Frictions/Storms explores the potential of transcontextual sound materials in composition; through electroacoustic processes (sound transformation), sound objects of a relatively mundane first-order nature are reshaped, and via concepts of source bonding and gestural surrogacy, reveal the potential for fantastical abstractions of themselves, able to evoke unreal and imagined extrinsic associations.

CHAPTER 2. *RISE*: STRUCTURAL FUNCTIONS, EXPECTATION AND SPACE IN THE STEREO IMAGE

> 'Our acquired knowledge of the contexts of spectral change provides an almost 'natural' reference-base not only for developing the wider, more imaginative spectromorphological repertory into the third-order surrogacy of electroacoustic music, but for decoding patterns of expectation in musical form. We predict or try to predict the expected tendencies of spectral change. Electroacoustic music, even when deprived of known instrumental spectromorphologies and tonal harmonic language, still relies on culturally acquired expectation patterns.'[26]

2.1 Overview

Rise (12:10) marks a departure from my work concerned with notions of masking and revealing recognisable sources, and highlights a growing interest in working with predominantly abstract sound materials. As such, source bonding in *Rise* is almost exclusively achieved via aurally perceptual relationships between spectromorphologies. The title refers to the work's exploration of rising and falling movement in spectral space,[27] and was in part influenced by Bernard Parmegiani's *Géologie Sonore* (1975) and Denis Smalley's *Pentes* (1974) – both works focusing primarily on abstract and/or synthesised sound materials and featuring explorations of spectral space through glissando.

2.2 Transformation of source recordings

Source materials featured include recordings of gestural play with tea-towels (mainly noise-based, attack-closed termination gestures), the closing of a sliding wardrobe door (a graduated onset-closed termination), and the strike of a resonant bowl-shaped sink (an attack-decay). All three sound types are featured in their untransformed states, however it can be strongly argued that actual source-causes are not possible to ascertain in the context of the composition; source-causes are neither alluded to in the work's title, nor via any emphasis on extrinsic

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[26] Ibid., 113.

[27] 'Put crudely, spectral space is concerned with space and spaciousness in the vertical dimension – up, down, height, depth, along with infill and clearing.' Smalley, 'Space-form', 45.

identities. Recordings produced for *Rise* were minimal, being no more than two or three captures of each sound type. From a palette of approximately ten short edits, multiple related third-order and remote surrogate spectromorphologies were developed (both gestures and textures). Sections 1 to 3 of *Rise* each focus on transformations derived from one of the sources:

Section 1 (0:00 - 2:48) was created primarily from transformations of a single recording of a sliding wardrobe door closing, treated with two instances of the *GRM Delays* plug-in, using multiple rapid delays (under 500ms).[28] The overlapping of delay lines produced stable pitch (similar in effect to comb filtering, audible examples from 0:00). Further application of freeze tools to these gestures resulted in a texture drone (introduced at 0:59) that is source bonded to the gestures through both pitch and internal iterative content (an audible variation of the delay processed gestures).[29]

Section 2 (2:49 - 4:32) focuses on transformations produced from a selection of recordings of tea-towels. Source materials were time-stretched using Ableton Live's *Warp* tool. One particular algorithm (the *Beats* warp mode) staggers the warping process to result in granular iteration (repetition of micro-segments of audio); this allowed the creation of varied spectromorphologically-linked gestures. Both these and the wardrobe door gestures in Section 1 were further processed with distortion and filtering to create spectrally dense variations (audible wardrobe door variations at 0:46 - 0:51 and tea-towel variations combined with wardrobe door transformations from 3:45 - 4:00).

Section 3 (4:33 - 7:23) focuses on pitched attack-decay sink strikes. Pitch-shifted variations of a single untreated strike were layered and aligned to create tonally rich gestural events (example at 5:06). Further transformations were created by applying delay lines to a reversed sink strike resulting in decelerating iterations (audible at 4:34 - 4:56).

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[28] *GRM Delays* is part of the *GRM Tools Classic* bundle. [online] Available at <http://www.inagrm.com/delays>, accessed 27 July 2016.

[29] Freeze tools used included *GRM Freeze* (Classic bundle); Jean-Francois Charles' *Live spectral processing patches*. [online] Available at <https://cycling74.com/toolbox/live-spectral-processing-patches-for-expo-74-nyc-2011/#.V719SLUllE4>, accessed 24 August 2016.

Rise features several other sound types that were developed through extensive transformation processes, and the resulting remote spectromorphologies have no direct associations to recurring sound materials (an example being the sequence of remote iterative noise variations moving from right to left in the stereo image at 7:07 - 7:22). Further examples include high-pitched drone continuants featured in Section 2 (audible at 3:30 - 3:57) and the dense glissando texture dominating Section 5 (audible from 10:00).

2.3 Space-forms in *Rise*

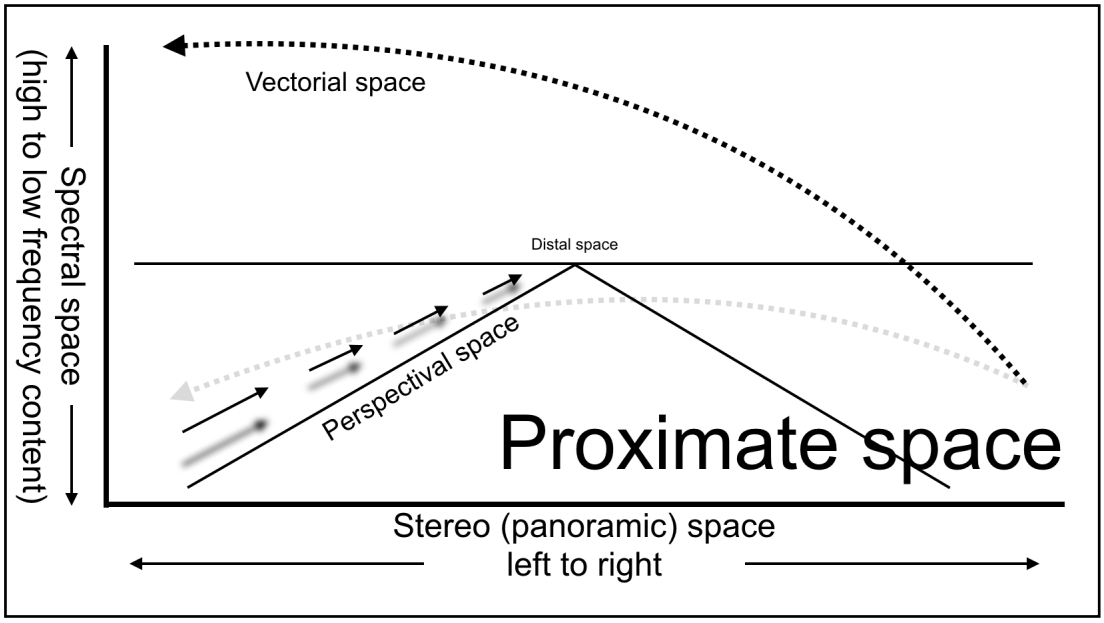

Figure 2: Space-forms in the stereo image.

Space-forms explored within the work were informed by the choice of spatial format: perspectival space,[30] panoramic space[31] and spectral space were appropriate for developing composed space[32] in stereo. Combined filtering and amplitude envelope editing of sounds may imply distal and proximate spatial positions; proximate sound events are achieved by placing materials in prominent positions in the mix, whereas distal events appear quieter, with reduced high

[30] 'I define the 'perspectival space' of the acousmatic image as the relations of position, movement and scale among spectromorphologies, viewed from the listener's vantage point.' Smalley, 'Space-form', 48.

[31] Panoramic space: 'The breadth of prospective space extending to the limits of the listener's peripheral view.' Ibid., 55.

[32] Composed space: '[…] the space as composed on to recorded media.' Smalley, 'Spectromorphology', 122.

frequency content, as if perceived from a distal vantage point (an example of perspectival layering of sounds is audible at 5:15 - 5:28). Furthermore, movement in panoramic space (panning and/or processing with doppler effect plug-ins), may result in vectorial space (example gesture at 7:41 - 7:42).[33] Vectorial space and spectral space may be combined though panning and band-pass filtering, creating the illusion of gravitational trajectories of sound ascending or descending from left to right or vice versa (an example gesture at 3:24 - 3:27 appears to move from the top left of the stereo image across to the bottom right). Through subtle amplitude envelope processing and additional attenuation of high frequency content, it becomes possible to create vectorial spatial trajectories occurring within the combined frames of panoramic, spectral and perspectival space (an example gestural passage audible at 5:41 - 5:48).

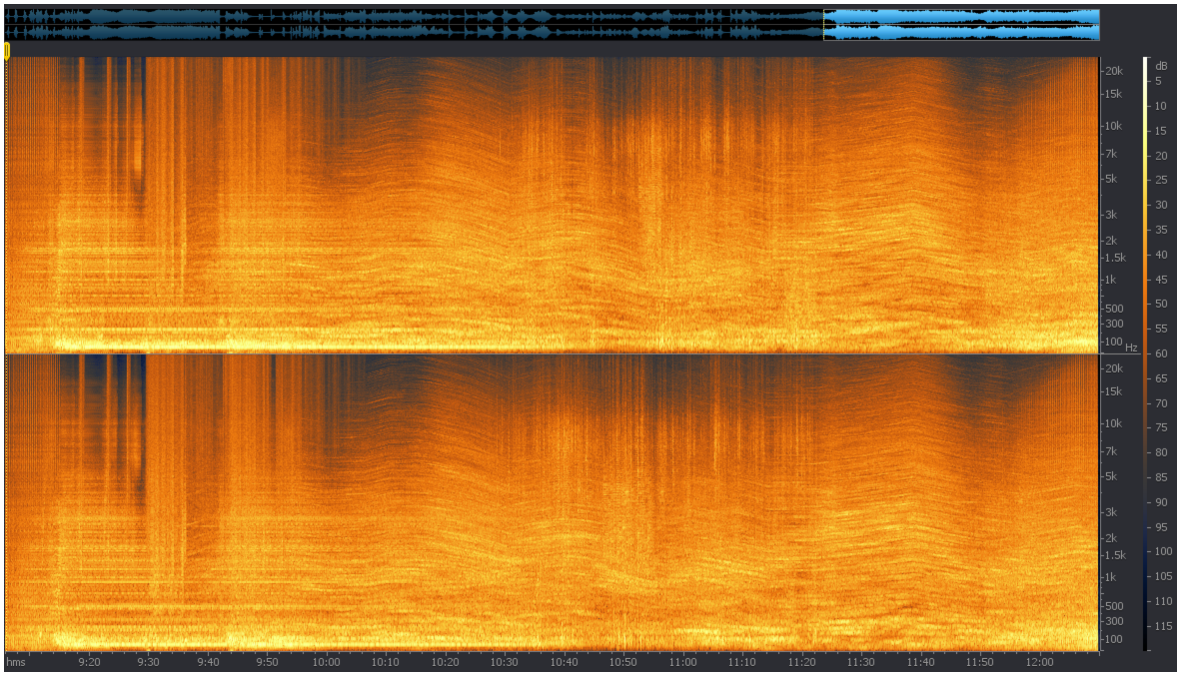

Figure 3: Sonogram displaying spectral rise/fall glissando material in *Rise*, Section 5.

Spectral space is explored via sound materials occupying (or transitioning between) discrete spectral ranges: for example, at 0:58 - 2:11 where a dominant textural continuant drone – defining a grounded root position – is complimented by high-pitched continuant materials, seeming to occupying a higher/canopy

[33] Vectorial space: 'The space traversed by the trajectory of a sound, whether beyond or around the listener, or crossing through egocentric space.' Smalley, 'Space-form', 56.

position.[34] Spectral density via an amassing of sounds, or processing with distortion, may also imply proximate space, as materials appear to block out other sound events or fill spectral regions. Equally, reduced spectral content and activity results in spectral clearing (for example, the transition from the spectral density of Section 2's conclusion, into Section 3 at 4:33). Glissando material (Section 5 from 10:00), emphasises gravitational notions of spectral space, through rising/falling motion (see Figure 3).

2.4 Spectromorphological expectation

> 'The ideas of onset (how something starts), continuant (how it continues) and termination (how it ends) can be expanded into a list of terms, some of them technical, some more metaphorical, which can be used to interpret the function-significance of an event or context. These functions can be applied at both higher and lower levels of musical structure, referring, for example, to a note, an object, a gesture, a texture, or a type of motion or growth process, depending on our focus of attention.'[35]

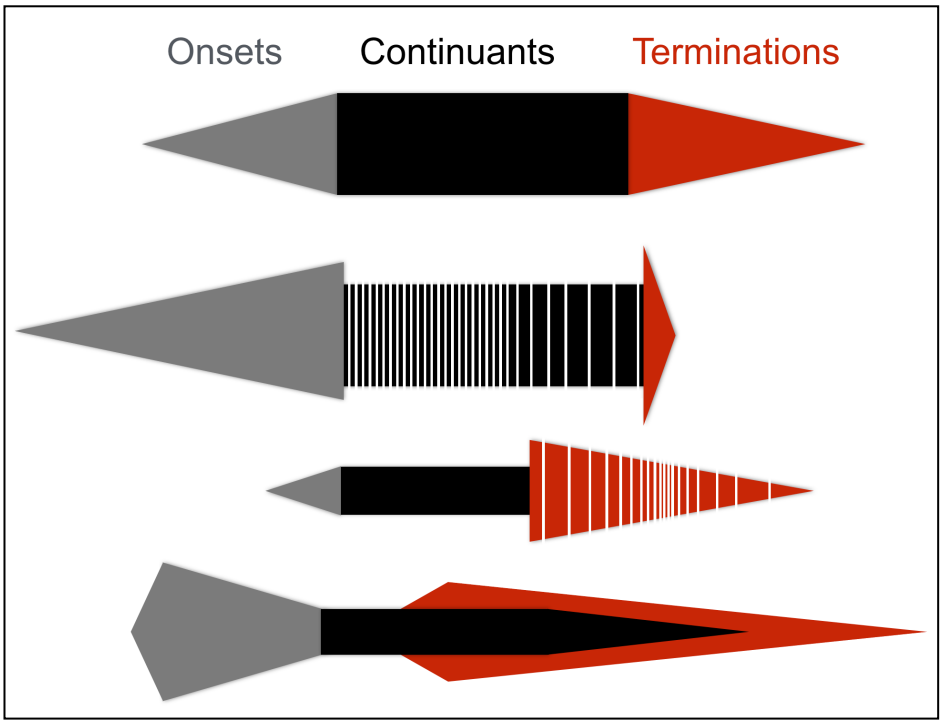

Figure 4: Gesture units/spectromorphological variants.

[34] 'Canopies and roots can be regarded as boundary markers which may have functions. For example, textures can be hung from canopies and use them as goals or departure points, while we already know that the drone can act as a root-reference.' Smalley, 'Spectromorphology', 121.

[35] Ibid., 115.

Rise explores musical expectation through structure and development; gesture and texture types are established, reprised and reestablished throughout the work, forming source bonded links between materials and musical sections, creating familiarity for the listener as the work unfolds. Lower-level spectromorphological expectation is addressed through variations on constructed sound units,[36] and morphological stringing of events.[37] Examples of sound unit variations are audible in Section 3 (from 5:15 - 6:06); a sequence of gestures comprising several component parts occur and the components are assigned structural functions (onset, continuant and termination roles). Each returning function features reshaped materials, resulting in successive variations on an established sound unit structure. Example variations may include extended duration of the onset, tonally re-pitched resonant components, or reshaping to result in a sound unit of compressed duration. Figure 4 provides four visual analogies of possible sound units/spectromorphological variations.

[36] Manuella Blackburn identifies sound units: 'I view sound unit construction within my work as a fundamental compositional strategy built entirely on the premise that every sound event has a start, a middle and an end. Construction possibilities are vast and particularly well suited for dealing with shorter sounds that yield gestural shapes through this combination process.' Manuella Blackburn, 'The Visual Sound-Shapes of Spectromorphology: an illustrative guide to composition', *Organised Sound*, 2011, **16**(1), Cambridge University Press, 5 - 13, 6.

[37] '[…] morphologies are not just isolated objects. They may be linked or merged in strings to create hybrids.' Smalley, 'Spectro-morphology and Structuring Processes', 71.

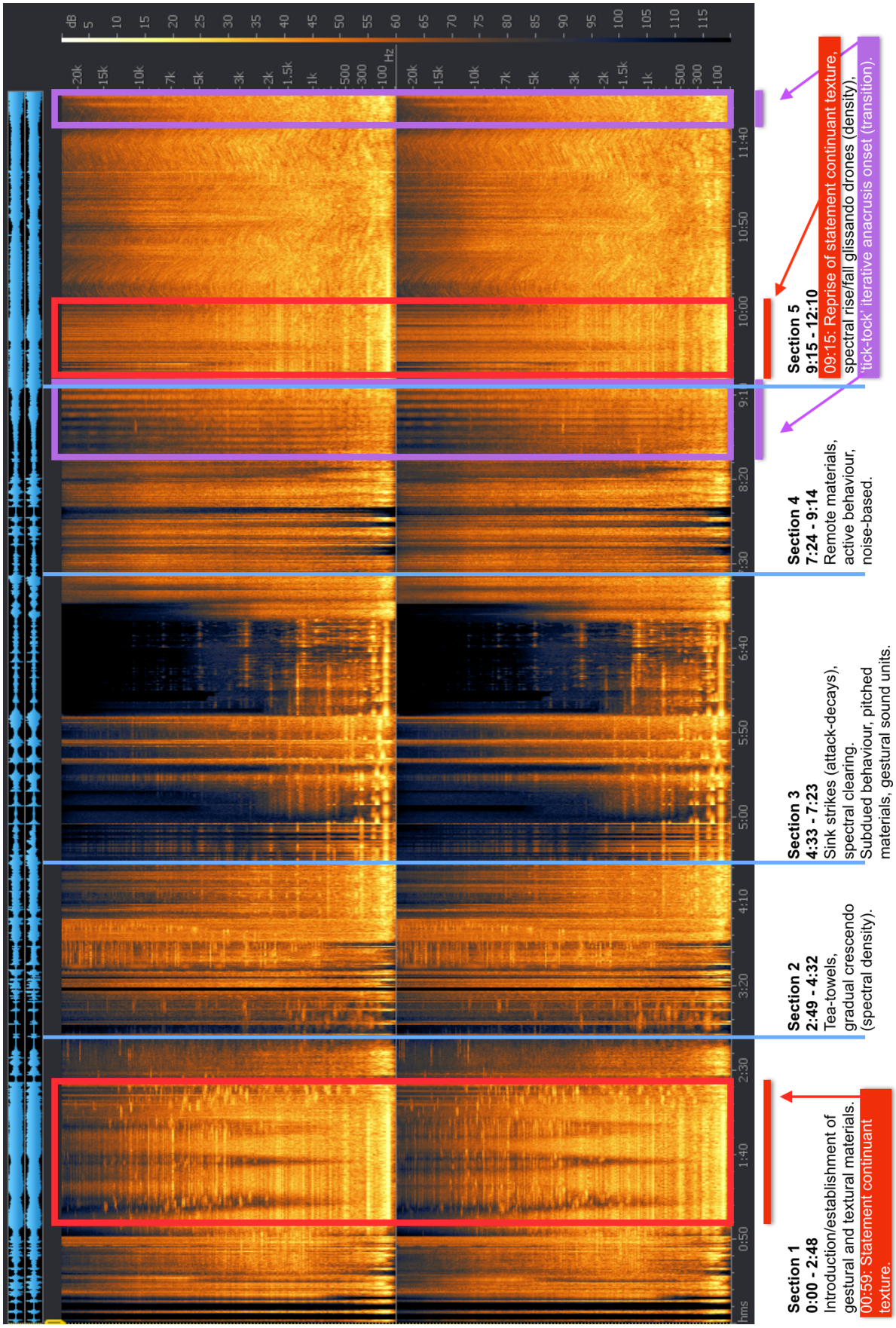

Figure 5: *Rise* sonogram and waveform representation to timeline.

2.5 Structure and function attribution

Rise is structured as follows (see Figure 5):

Section 1 (0:00 - 2:48): Introduces gestural materials that play a recurring role throughout the work, and establishes a *statement* texture continuant[38] that also functions as a *disappearance* termination.[39] (See Figure 5, Section 1, highlighted in red.)

Section 2 (2:49 - 4:32): A gradual noise-based crescendo passage develops from sparse beginnings to achieve dense spectral occupancy, climaxing to reveal pitched sink-strike iterative transformations.

Section 3 (4:33 - 7:23): A spectrally sparse and tonal passage centred around a sequence of gesture units (created from component materials) results in morphological stringing. Sounds emerge from distal space to converge with prominent tonal attack-decay gestures in proximate space, then retreat into distal space. Tonal cadence provides suspension and resolve.

Section 4 (7:24 - 9:14): Establishes remote materials briefly featured in Section 1. Sounds are organised to imply one event causes the onset or termination of another (causality) through dominant and subordinate behaviour types (7:45 - 8:21).[40] Eventually, stable iterative noise-based 'tick-tock' pulses are introduced (from 8:32), functioning as an *anacrusis* onset leading into Section 5. (See Figure 5, Section 4, highlighted in purple.)

Section 5 (9:15 - 12:10): Reestablishes the statement continuant and variations on associated gestural materials from Section 1 (see Figure 5, Section 5, highlighted in red). The functional role of the statement continuant develops into a

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[38] *Statement*, *disappearance, prolongation* and *anacrusis* are taken from Smalley's table of function descriptors. See Smalley, 'Spectromorphology', 115.

[39] '*Function attribution may be double or ambiguous*. A context may have different, simultaneous functions. This is particularly so when events are overlapped or motion is continuous. For example, a contour which seems to resolve a motion could also form part of the anacrusis to a following peak – in this case the termination function is also an onset function on the same level.' Ibid.

[40] '*Causality*, where one event seems to cause the onset of a successor, or alter a concurrent event in some way, is an important feature of acousmatic behaviour.' Ibid., 118.

disappearance termination, and via morphological stringing, merges with the onset of a new dense *prolongation* continuant texture, featuring internal glissando (rising/falling) motion through spectral space.[41] Eventually the anacrusis onset of 'tick-tock' pulses are reintroduced, growing in presence to occupy proximate space. The implication of this material (as a previous anacrusis function) is to suggest this to be a passage preceding further musical development. Expectation is then denied, as the work is concluded with a surprise closed termination of all sound events. (See Figure 5, Section 5, highlighted in purple.)

2.6 Alternate 10-channel stem version[42]

While the stereo version of *Rise* is the definitive version, an alternate 10-channel version was also produced in order to explore further possibilities for live diffusion of the work on large-scale multiple loudspeaker performance systems (see *Appendix_C/Audio/Rise_10_Channel_Version/Rise_10_Channel.aiff*). Here two channels contain the gestural materials and higher spectral content, and the additional eight channels contain isolated textural continuant materials (four stereo pairs of variations developed from the original stereo continuant passages from Sections 1 and 5 of the work). The intention was to explore spatialisation of gestural content independent of the more grounded textural material (fixing the textural materials onto a ring of eight loudspeakers surrounding the audience). This allows, for example, an extended exploration of spectral space in the concert hall by placing higher-pitch materials in roof loudspeakers. Alternately it may allow for a more defined exploration of vectorial spatial movement to occur without expanding/contracting or repositioning a fixed circumspatial texture-setting.[43] After

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[41] 'Merged correspondences may also occur through the cross-fading of termination and onset, or more rapidly as a consequence of a reversed onset-termination.' Smalley, 'Spectro-morphology and Structuring Processes', 71.

[42] 'Stems constitute the submixes or – more generally speaking – discretely controllable elements which mastering engineers use to create their final mixes. In a similar fashion, one can compose in stems, separating out elements that need to be treated discretely in a final spatialisation, which in itself may vary to a small or great extent from one performance to another.' Scott Wilson and Jonty Harrison, 'Rethinking the BEAST: Recent developments in multichannel composition at Birmingham ElectroAcoustic Sound Theatre', *Organised Sound*, 2010, **15**(3), Cambridge University Press, 239 - 250, 245.

[43] 'This is an example of *texture-setting* – texture provides a basic framework within which individual gestures act.' Smalley, 'Spectromorphology', 114.

diffusing both versions on the MANTIS[44] large-scale loudspeaker system, I concluded that the stereo version yielded a more convincing spatiality in performance; in separating gestural and textural content, the act of diffusion considerably altered the balance of materials (in relation to one another), resulting in a performance where spatial development was somewhat lost at the expense of seeking a balance closer to that rendered onto stereo fixed media.[45]

Conclusion

Rise is given coherence through three main processes: use of contrasting gesture-carried/texture-carried and noise-centric/pitch-centric passages, the establishing (and later reintroduction) of a statement continuant passage, and finally, the forging of relationships between sound types through use of gesture units, spectromorphological variation and considerations of musical expectation. The assigning of structural functions aid musical development in order that abstract sound materials may maintain source bonded relations, aurally guiding the listener through the work's development, before intentionally misleading the listener via a final, unexpected closed termination.

[44] MANTIS (Manchester Theatre In Sound), features a 48-loudspeaker sound diffusion performance system, initially designed by Professor David Berezan, currently maintained by staff and postgraduate students at the Novars Research Centre, University of Manchester.

[45] Moore highlights related issues: 'Increased timbral separation can be achieved by multichannel tape where, should the composer require, separate sounds can be recorded to separate channels. This kind of information is often difficult to perceive precisely because it breaks the listener's perception of an integrated space. This compositional problem stems from the ill-defined notions of the boundaries between monophony and polyphony that can arise from mixing.' Adrian Moore, 'Sound diffusion and performance: new methods – new music.' Proceedings of the *Music Without Walls? Music Without Instruments?* conference, De Montfort University, June 21 - 23, 2001. [online article] Available at <http://www.dmu.ac.uk/documents/technology-documents/research/mtirc/nowalls/mww-moorea.pdf>, accessed 28 July 2016.

CHAPTER 3. *GLITCHES/TRAJECTORIES*: BEHAVIOUR, MOTION AND GROWTH PROCESSES, AND METHODOLOGIES FOR 8-CHANNEL SOUND SPATIALISATION

> 'The metaphor of behaviour is used to elaborate relationships among the varied spectromorphologies acting within a musical context. I believe that listeners can intuitively diagnose behavioural relationships (or a lack of them) in electroacoustic music contexts and that this diagnosis affects the listener's interpretation of and reactions to the music. In this respect, behaviour is archetypal.'[46]

3.1 Overview

Glitches/Trajectories (11:29) is, as the title suggests, themed on both sound representative of defective audio (glitches) and the exploration of vectorial space (trajectories) in the 8-channel format. The work is partly inspired by Bernard Parmegiani's *Capture éphémère* (1967), where imitative and reactionary sound behaviours are developed through interactions between third-order and remote surrogates;[47] in *Glitches/Trajectories*, behavioural relationships between sounds, and motion and growth processes direct the work's structural development.[48] Developed glitch materials were inspired by a live recording of modular analogue synthesist Keith Fullerton Whitman, entitled *Occlusion (Rue De Bitche)*, (2012). The performance features metallic-sounding attack-closed termination gestures (possibly generated using FM synthesis), resulting in fragmented glitch-like variations of spectromorphologies. *Glitches/Trajectories*, however, employs no use of analogue synthesis; third-order and remote surrogates featured were predominantly derived from transformed recorded materials.[49]

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[46] Smalley, 'Spectromorphology', 117.

[47] It is safe to assume that the synthesised sounds featured in *Capture éphémère* would be unknown sources and causes for many listeners, particularly at the time of the work's realisation in 1967.

[48] 'Motion and growth have directional tendencies which lead us to expect possible outcomes, and they are helpful guides in attributing structural functions.' Smalley, 'Spectromorphology', 116.

[49] The work features some subtractive synthesis. At this time I would not have associated sounds in either *Capture éphémère*, or *Occlusion (Rue De Bitche)* specifically with analogue synthesis techniques. The transformation of recorded sound materials was of primary interest in developing my own sound-shaping techniques during this period.

3.2 Blurred sources/blurring the gesture–texture continuum

Sound materials featured in *Glitches/Trajectories* were developed through extensive transformation and re-rendering of previously rendered transformations – third-order surrogate sounds that had been intentionally labelled without reference to sources and causes. With the exception of synthesised sounds included in the work, it is impossible (for me as the composer) to determine specific sources and causes from which featured materials were derived.

A series of continuant spectromorphologies with varied dynamic contours and timbres were rendered in stereo. Some featured internal spectral development – harmonic up/down shifts of pitch, similar to that achievable when controlling guitar feedback (by holding a string to create resonance, producing a stable feedback pitch and adjusting the angle of the guitar to the amplifier to find positions that produce alternate feedback pitches – audible example at 5:48 - 6:12). Others were spectrally dense drones (layered examples at 9:00 - 9:30). Some featured gritty-sounding and unstable noise with less spectral occupancy (thinner frequency ranges – an edited/fragmented passage transformed from these continuant types and layered with additional materials is audible at 0:09 - 0:15). From the creation of these sequences two processes were identified in order to fragment and further shape the materials prior to musical incorporation, as illustrated below.

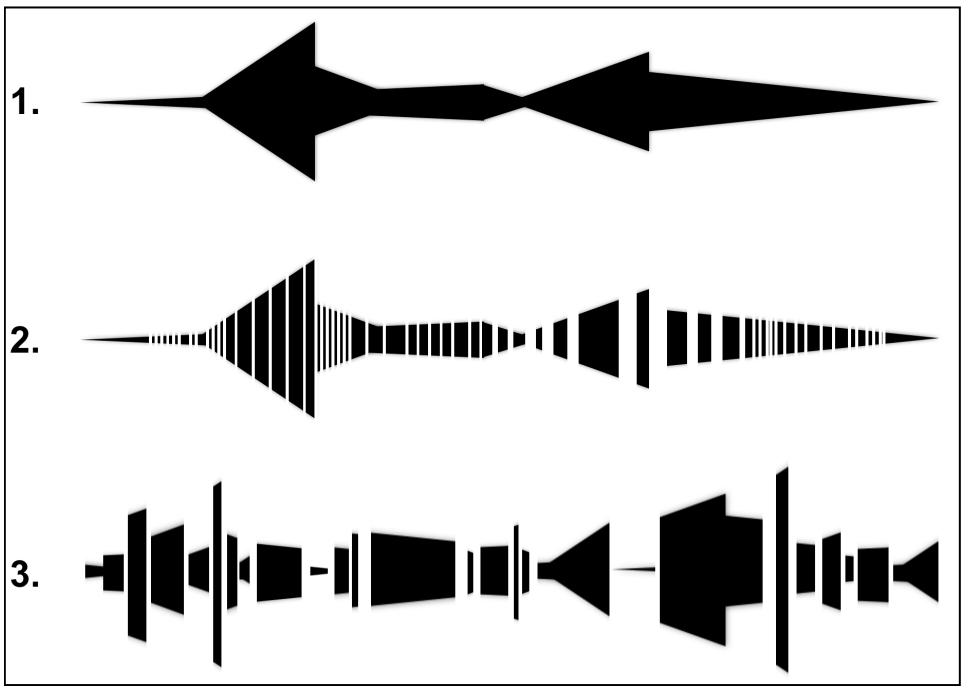

Figure 6: Three visual analogies of audio processing.

Figure 6, Shape 1 is analogous to one of the aforementioned sequences; a continuant spectromorphology featuring dynamic contouring (through, for example, amplitude envelope processing and/or timbral morphing). Shape 2 visualises the application of amplitude modulation to the Shape 1 sequence, resulting in a new continuant spectromorphology with relatively stable fragmentations. Material of this nature proves highly suitable for deployment in vectorial space; internal reciprocal motion as illustrated in Shape 2 produces a sense of pulse (derived from regular amplitude modulations) and helps the listener to perceive vectorial motion through its grain-like iterations moving through a vectorial spatial setting. Additionally, temporal expansion and compression can be suggested (also visualised in Shape 2) through applied acceleration/deceleration of amplitude oscillations (hence its *relative* stability, audible example at 5:48 - 6:12). Shape 3 visualises a possible spectromorphological outcome derived from the second key transformation process used in developing materials; a transformation of the Shape 1 sequence as achieved through simple subversion of MaxMSP playback tools.[50] Randomly dragging a playback timeline marker back and forth when play mode is engaged results in a sequence of unstable and fragmented glitch material similar to the playback of a faulty compact disc (random jumps between points along a timeline, audible example layered with additional materials at 10:20 - 10:30).[51]

As musical materials came into focus, the lines between gesture and texture became increasingly blurred. The fragmentation of continuants into iterative continuants may reduce the gesture–texture continuum; continuant spectromorphologies such as those visualised in Shape 2 may be perceived as a sequence of aurally source bonded, attack-closed terminations, assuming gestural roles (the lower the frequency rate of amplitude oscillations, the more gesture may be implied). Equally, Shape 3 fragmentations may be considered gestural or – through multiple layering – adopt the role of unstable texture. Amassing variations

[50] MaxMSP is a visual coding language, originally developed by Miller Puckette, maintained by software company Cycling ’74. [online] Available at <https://cycling74.com>, accessed 29 June 2016.

[51] This form of processing regularly required additional treatment to remove undesirable clicks created by the randomised playback of continuous audio. A few clicks, however, were intentionally incorporated into the final piece, where sequences of materials featuring prominent clicks were found to be of spectromorphological interest (as glitch material), and not deemed to be problematic with regards to the technical execution of the work.

of these materials allowed further gesture–texture blurring through the creation of multidirectional motions featuring vectorial movement.[52]

3.3 Live electronics development

During the developmental stages of sound-shaping for *Glitches/Trajectories* I found myself regularly performing semi-structured/semi-improvised live electronics events using Ableton Live and MIDI controllers to manipulate and transform both live-inputted and rendered audio. Spontaneous montaging/layering of sounds, and real-time transformation in performance environments informed my fixed media compositional methodology from this point.[53]

Parameters of transformation tools including filters, waveshapers, amplitude attenuators, delays and reverbs were assigned MIDI control. Some physical controls were assigned multiple audio plug-in parameters to attenuate (within set minimum/maximum ranges). For example, a single MIDI controller dial attenuated amplitude level, low-pass filtering, and reverb decay time applied to a single channel of audio, allowing a single dial turn to suggest sound movement from proximate to distal spatial positions. As the amplitude decreases higher frequency content is subtracted, and reverb is added. Conversely, as amplitude increases, full resolution of frequency content is restored and reverb is reduced, resulting in a dryer sound, suggesting closer proximity.

Attenuation of the frequency rate of (stereo) amplitude modulation was another process assigned MIDI control. This allowed manipulations expressive of accelerating/decelerating texture motion (as visualised in Figure 6, Shape 2), and at lower frequency rates resulted in audible separation of the stereo signal into two spectromorphologically-linked mono sources working in tandem (sequentially switching between outputs, first the left channel and then the right channel).

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[52] '*Bi/multidirectional motions* create expectations, and most have a sense of directed motion. They can be regarded as having both gestural and textural tendencies, and could be large structures in themselves.' Smalley, 'Spectromorphology', 116.

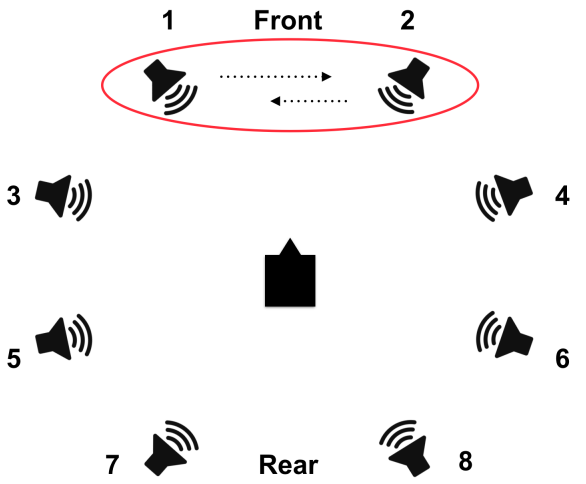
[53] Performances were semi-structured in the sense that some combinations of materials to be explored (and approximate structural points at which to introduce materials) had been decided in advance. I also predetermined certain transformation processes that would be explored in relation to specific sound materials.

Live Set 1 is a capture of a live performance from this period (see USB-drive, *Appendix_C/Audio/Live_Electronics_Sets/Live_Set_1.wav*). The performance opens with an improvised passage of materials that would later form part of Section 2 of *Glitches/Trajectories* (*Live Set 1* at 0:00 - 1:47. See *3.5 Behaviour and motion and growth processes* for a structural analysis of the composition). Materials present from 9:57 were later developed for the transition section of *Glitches/Trajectories*. From 10:42 low frequency drone materials emerge, similar to those developed for Section 2 of *Glitches/Trajectories*. 11:42 - 12:44 features a sequence of glitch-like live transformations – this material was further developed for inclusion in Section 2 of *Glitches/Trajectories*. From 12:45 to the conclusion of the performance, structural development (an extended crescendo) is also similar to that of Section 2 in the final fixed media composition.

Improvised live performance requires the performer to persist with, and respond to, spontaneous musical developments as they occur in real-time – events that may be dismissed as fruitless and sooner abandoned if arrived at in the studio. This proposes the possibility of improvised and aleatoric outcomes that differ from those developed in non-performance environments. In performance I found my listening drawn to the immediacy of musical interactions as they unfolded through a combination of spontaneous (and semi-planned) structural shifts, and aleatoric triggering/processing of audio. Behavioural relationships between sound materials, potential growth processes and structural possibilities identified through performance were further explored in the studio and remapped to 8-channels, seeking to achieve dramatic vectorial spatial development in circumspace.

3.4 Vectorial space in the 8-channel image

Figure 7 illustrates possible left to right vectorial movement in proximate (stereo) panoramic space.[54] In seeking a more immersive deployment of vectorial space, several stereo to multi-channel remapping techniques were employed.



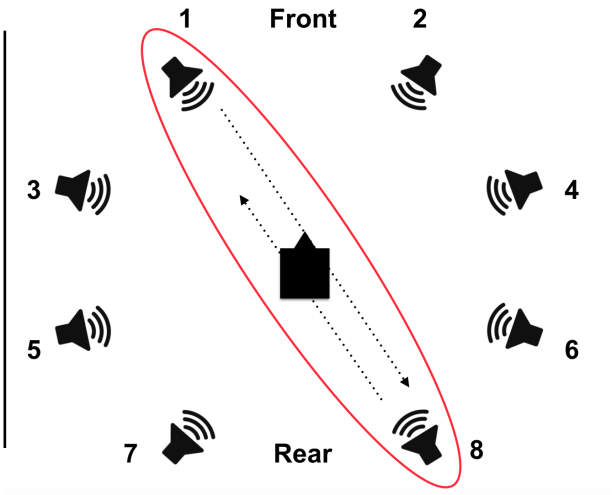
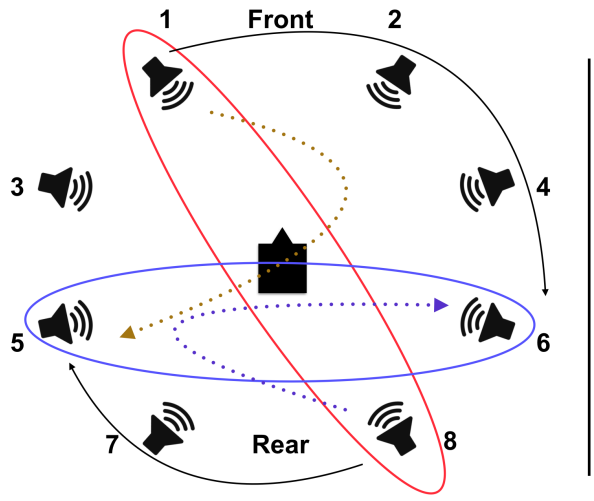
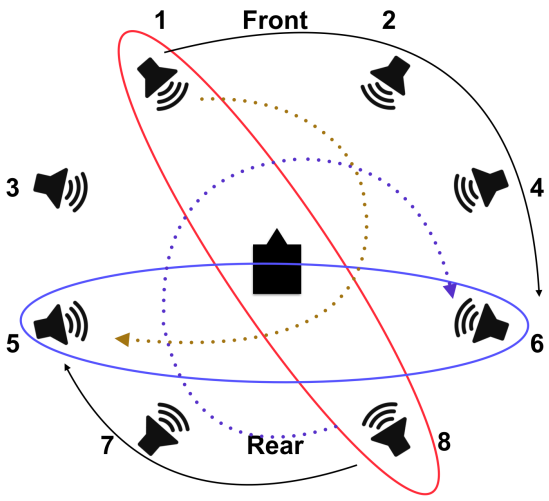


Figure 7 (above left): Proximate panoramic vectorial movement.
Figure 8 (above right): Vectorial space passing through egocentric space.





Figures 9 & 10: Vectorial motions.

[54] As discussed in Chapter 2.3, perspectival space and spectral space provide an enhanced framework for vectorial spatial development to occur within the stereo image. However, the following examples presume the initial stereo vectorial movements to be occurring in proximate panoramic space.

Figure 8 illustrates a possible reassignment, where the initial separation of 45° between channels (from a centrally located listening position) is widened to 180°. Loudspeaker 1 retains the left channel output and loudspeaker 8 is assigned the right channel output. Vectorial movements originally in proximate panoramic space are now positioned in circumspace and encroach on egocentric space.[55]

If clockwise and counterclockwise rotational motion is added, vectorial movement is no longer in a straight line and passes through egocentric space, defining trajectories within circumspace (within the 8-channel image); Figures 9 and 10 show two possible distributions (indicated by the dotted arrows), initially separated by 180° (as in Figure 8, highlighted in red), rotating clockwise as left to right channel vectorial movement occurs. As rotation progresses, the 180° separation is gradually reduced to 135° separation by the arrival point (outlined in blue) at loudspeakers 5 (right channel, initially positioned in loudspeaker 8) and 6 (left channel, initially in loudspeaker 1). Variations of vectorial motions as shown in Figures 9 and 10 are determined by both the speed of left to right vectorial movement as rendered in the original stereo file, and the speed of the clockwise/ counterclockwise rotation.

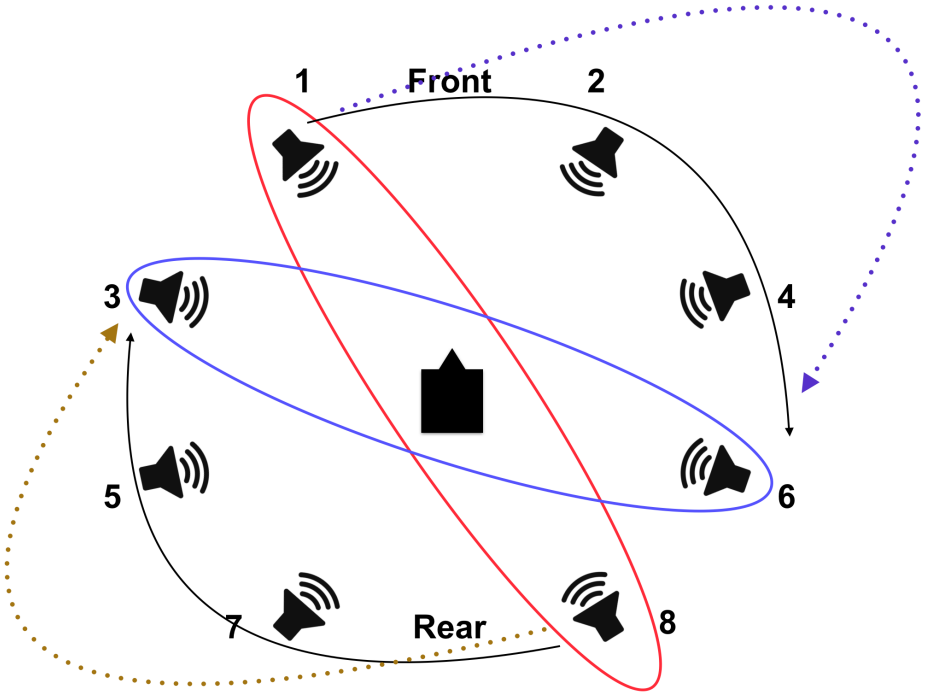


Figure 11: Perspectival trajectories in circumspace.

[55] Egocentric space: 'The personal space (within arm's reach) surrounding the listener.' Smalley, 'Space-form', 55.

Figure 11 shows two possible trajectories of perspectival movement. Here left to right materials function independently (as two discrete mono spectromorphologies in tandem, separated by low frequency amplitude modulation applied to the stereo file). Clockwise rotation is combined with reduction of amplitude and high-frequency content (achieving the illusion of circumspatial motions withdrawing into distal space, beyond the ring of loudspeakers, indicated by the dotted arrows). Vectorial movement concludes with both channels returning to a proximate circumspatial position through a return to full amplitude and full spectral resolution. Both spectromorphologies have shifted 135° clockwise while maintaining 180° separation.[56]

3.5 Behaviour, and motion and growth processes

Glitches/Trajectories is structurally in two halves with a brief transition section segmenting the two. The following analysis identifies behavioural activity featured in the work as related to structural development.

Section 1 (0:00 - 3:27)

The piece opens by introducing low-level noise activity; two identical, brief unstable continuants are introduced terminating to silence, separated by 180° panning in the 8-channel image, establishing fragmented distorted noise moving through proximate circumspace. Activity starts again with the introduction of multiple unstable noise-based continuant spectromorphologies, establishing a discontinuous multidirectional texture motion;[57] vectorial movement passing through egocentric space is also first introduced here at 0:07 - 0:08. Spectromorphological coherence is achieved through use of related terminations; a closed termination (comprising two low-pitched thuds) is used at the first silence (0.01) and again leading into the second silence (0:16).

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[56] Spatialisation tools applied in developing these transformations include *Orbit 2D* (for Max). [online] Available at <http://www.peterbatchelor.com/software>, accessed 29 July 2016, and *BEASTtools* modular multi-channel transformation environment.

[57] 'Texture motion may vary in internal consistency. *Continuous motion* is sustained while *discontinuous motion* may be more or less fragmented.' Smalley, 'Spectromorphology', 117.

From 0:21 variations on these established spectromorphologies return, introducing further fragmented noise continuants and prominent noise gestures featuring reciprocal oscillating internal motion (0:26 - 0:28). Between 0:36 - 0:41 these gesture types highlight examples of descending non-rooted motion.[58] Materials briefly dissipate (0:42 - 0:45) maintaining low-level activity, to then return to full prominence (0:46 - 1:02), establishing a distorted, continuous and erratic texture motion terminating to silence.[59] Overall, the first minute of the piece functions to introduce a distorted noise-based erratic soundworld where activity is punctuated by moments of silence, creating anticipation for the work's next phase.

From 1:04 a new set of noise-based spectromorphologies (functioning as equal parts gesture and texture) are introduced, mimicking the arrival/departure behaviours of the previous sound materials; a series of four multi-channel sound units (comprising component parts), each lead to a passage of silence. The departure of the first sound unit is graduated (1:06 - 1:07), and the following three variations use closed terminations (1:12, 1:15 and 1:20-1:21), followed by an extended silence. Mimicking behaviours present in the first minute of the piece, silence is followed by a continuous erratic texture motion of materials (1:26 onwards), where complex noise spectromorphologies are punctuated with three graduated onset-closed terminations, located in the upper spectral regions (1:42 - 1:45, 1:46 - 1:50 and 1:53 - 1:56). The third of these – another descending motion – arrives at a grounded root position in spectral space, establishing the next stage of activity.[60]

1:56 - 3:23 is a passage of flocking, continuous and granular texture motion in circumspace.[61] Materials appear spectrally grounded owing to the inclusion of lower frequency content, in comparison to the descending spectral motions of the

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[58] 'Thus analogies with flight, drift and floating can be common. Motion towards a root could be implied in a spectral descent towards termination, but a root may not be achieved if the motion fades 'in the air'.' Ibid.

[59] 'Both continuity and discontinuity can move in a more or less periodic–aperiodic/erratic manner, with internal fluctuations in tempi. Continuous/discontinuous texture motion may need to be considered as a totality, or may follow grouping patterns if contours, fluctuations or discontinuities are subject to repetitions, cycles or pauses which imply higher-level groupings.' Ibid.

[60] '*Motion rootedness*. Some are more likely to be 'earthbound' (push, drag) while others are not rooted to a solid plane.' Ibid., 116 - 117.

[61] '*Flocking* describes the loose but collective motion of micro- or small object elements whose activity and changes in density need to be considered as a whole, as if moving in a flock.' Ibid., 117.

immediate preceding material. Gestural closed terminations (example at 2:17), imply causality by terminating activity of surrounding materials, leading to spectral clearing and revealing higher spectral content. Repeated use of closed terminations creates spectromorphological associations (source bonding) and musical expectation (example passage between 2:17 - 2:32). Variations on materials featured in the first minute of the work are reintroduced (2:27 - 2:42: unstable, fragmented noise continuants and internally oscillating gestures), leading to an increase in upper-region spectral density (from 2:41). Additional new materials are embedded in the texture density, including noise granulations and unstable pitched gestures, highlighting movement in spectral space (2:43 - 3:23). The passage concludes with a gradual dissipation of materials, crossfaded with a brief passage of new, unstable pitched material featuring amplitude oscillation (3:20 - 3:30), leading into the transition section.

In conclusion, Section 1 combines loose motion coordination behaviours, with pressured motion passages through flocking behaviours, the amassing of spectral density, and use of causal terminations leading to spectral clearing and/or further emergence of sound materials.[62]

Transition section (3:27 - 4:27)

This brief segue focuses on new sound materials exclusive to this section; sounds featured are noise-based continuants with random internal (stepped) pitch content, comparable to sample and hold processing. Behavioural connections to passages featured in Section 1 are established; materials are introduced gradually leading to a closed termination and to silence (3:27 - 3:38). Continuous flocking texture motion with internal iteration is then established (3:39 - 4:05). From 3:58 unstable pitched oscillations – as introduced/crossfaded with the end of Section 1 – re-emerge, this time with the addition of a low-pitched stable drone, functioning as an *emergence* onset/*disappearance* termination. At 4:05 this material causes the termination of other sound behaviours, leading to a moment of spectral clearing. Trajectorial materials move through circumspace and egocentric space, and suggest more perspectival motions than the previous behaviourally active

[62] 'The vertical dimension is concerned with *motion coordination* (concurrence or simultaneity), while the horizontal dimension is concerned with *motion passage* (passing between successive contexts).' Ibid., 118.

passages. Proximate to distal spatial movement occurs (from 4:08 onwards) and iterations accelerate and decelerate, as several streams of continuants overlap in perspectival circumspace, hinting towards divergence and convergence patterns of motion and growth to be developed in Section 2. A second spectrally-rooted drone (again, an emergence onset/disappearance termination, at 4:10 - 4:28), arrives, peaks (4:21), and decays almost to silence as Section 2 begins.

Section 2 sound types and behaviours

Section 2 features three primary sound types, all of which retain their spectromorphological identities throughout its development. It is appropriate to identify each before considering their interactions:

Oscillations: Pitched continuants with internal iteration (amplitude oscillation). Iterations are stable with accelerating/decelerating tendencies, designed to emphasise reciprocal texture motion. Pitch is unstable and has tendencies towards harmonic-like spectral shifts (similar to guitar feedback), occupying the upper spectral regions. These sounds function as both gestural (discrete sequential events arriving and departing in perspectival space) and textural (continuant in nature and once amassed, producing circumspatial texture). Oscillation sounds define vectorial space within circumspace, perspectival space and egocentric space. Audible example: 4:32 - 4:55.

Glitches: Unstable glitch noise materials comparable to remote transformations being played back through a faulty compact disc player. These materials also evade specific gesture or texture classification due to their fragmented and unstable continuant nature. They mainly occupy a presence in proximate circumspace, occasionally retreating into distal regions. Audible at: 5:37 - 5:41.

Drones: Low-pitched drones. These occupy spectrally grounded root positions and gradually arrive and depart to fill/clear lower spectral regions. Drones range from shorter (graduated onset-graduated termination) spectromorphologies (example: 6:42 - 6:46) to longer graduated continuants,[63] with some featuring turbulent and

[63] 'The onset starts gradually as if faded in, and the note terminates gradually as if faded out. In between, the note is sustained for a time.' Ibid., 113.

iterative internal texture motion (unpredictable shifts of internal oscillations, example at 9:23 - 9:34). Due to their strong spectral occupancy, drones are the most dominant of the three spectromorphologies featured.

Drones are behaviourally coexistent alongside the oscillations and both sound types function together to develop spectral space (adding and subtracting spectral density). Glitch materials function as argumentative, working against the loose motion coordination established by the oscillations and drones.

Section 2 (4:28 - 11:28)

A dense and digitally-overloaded noise gesture announces the arrival of Section 2, decaying to reveal oscillations and establishing sparse activity; acceleration and deceleration behaviours aid the propulsion of sound behaviours in space. As materials retreat into distal circumspace the first glitch materials are revealed at 5:01 in proximate circumspace. 5:12 - 5:38 employs an increasing dominance of layered oscillations working in loose motion coordination. Glitches gradually return and create a pressured motion passage at 5:38, immediately terminating the oscillations.

From 5:41 the oscillations return to then recede into distal space. Oscillations gradually increase in proximate presence and activity, arriving and departing in perspectival circumspace and passing through egocentric space while maintaining loose motion coordination. At approximately 6:14 drone materials begin to emerge and from here to 7:12 spectral density and activity is developed. The passage peaks at 7:08 and activity begins to subside – oscillations decelerate and spectral density clears. 7:12 - 8:18 is a subtle extension of the preceding passage, focusing on established behaviour patterns applied to variations of oscillation and drone spectromorphologies. Motion is again achieved through the amassing/clearing of spectral density and via dominant arrival/departures of drone materials.

From 8:18 layers of low drones are gradually introduced, featuring turbulent internal oscillating behaviour. Between 8:48 - 9:01 we hear the reintroduction of graduated onset-closed terminations, descending from upper spectral space to lower positions, propelling motion and growth forward (as established in Section 1,

examples at 1:46 - 1:50). As in Section 1 where these precede a structural development, here they function as onsets towards the spectrally dense and behaviourally active climax of the work.

Multidirectional growth is achieved via a convergence[64] of materials through exogeny.[65] A dense drone-led passage is established where drones amass, resulting in turbulent texture motion and agglomeration, featuring internal oscillations (embedded within drone material).[66] At 9:41 drone materials begin to retreat into distal space, resulting in spectral clearing, revealing at 10:06 glitch materials in proximate circumspace. A passage of behaviourally agitated and unstable oscillations and glitches follows, exploiting vectorial movement in circumspace and passing through egocentric space as the two sound types appear to battle for dominance. In this final passage the spectromorphological relationship between the oscillation and glitch materials becomes audibly clearer; through inclusion of glitches of longer durations the listener may identify that glitches are, in part, developed fragmentations/transformations of oscillation sound types. The two sound types featured (oscillations and glitches) begin to merge, losing discrete qualities and resulting in a sequence of unstable glitch oscillation spectromorphologies where all sound events appear to battle for dominance. From 11:10 intensity of activity is marginally reduced, and the work concludes with a final passage of fragmented audio leading to a closed termination, with remnants of reverb decay falling to silence.

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[64] '*Divergence* and *convergence* are strongly directional and could be gestures or texture growths, or a simultaneous linear descent/ascent.' Ibid., 116.

[65] '*Exogeny* (growth by adding to the exterior) could be allied to dilation and agglomeration, while *endogeny* (growing from inside) implies some kind of frame which becomes filled, or texture which becomes thickened.' Ibid.

[66] '*Agglomeration* (accumulating into a mass) and *dissipation* (dispersing or disintegrating) are textural processes.' Ibid.

Conclusion

Glitches/Trajectories employs behaviourally imitative, interactive and reactive sound types within a structure that unfolds through spectromorphological mimicking of preceding passages, leading eventually to the development of an extended passage of convergent and divergent motion and growth. The identification and shaping of suitable materials, the assigning of behavioural roles to those materials and their deployment within space, as outlined, allows for a dramatic multi-channel musical experience to be achieved.

CHAPTER 4. *TRANSMISSIONS/INTERCEPTS*: STRUCTURAL COHERENCE IN LONG-FORM AND METHODOLOGY FOR CONCEPTUAL WORK

> 'Here we reach *remote surrogacy.* But the links with gesture need not be entirely lost. The gesture-field operates in the psychological domain, and in remote surrogacy the indicative link can be forged through the energy-motion trajectory alone, without reference to real or surmised physical gesture or an identifiable source. The listener is thus called upon to exercise and enjoy maximum gestural imagination.'[67]

4.1 Concept

Transmissions/Intercepts (24:32) is a large-scale 5-channel work themed on the mysterious undisclosed soundworld of government shortwave radio broadcasts known as *number stations*.[68] These broadcasts may be intercepted by anyone in possession of a shortwave radio and generally take the form of a brief tune-in tone or melody, followed by several minutes of Morse code, or a voice relaying a sequence of numbers, concluded with a signifying 'end' or 'out' message.

There is an eerie lifeless quality to the broadcasts; the voice relays are clearly technologically and/or mechanically automated, and it is in the merging of utterance space,[69] mechanised space[70] and mediatic space[71] that a basis for sonic exploration is found. The piece therefore focuses on the source bonded qualities

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[67] Denis Smalley 'The Listening Imagination: Listening in the Electroacoustic Era', *Contemporary Music Review*, 1996, **13**(2), Routledge, 77 - 107, 85.

[68] 'Number stations are shortwave transmissions from foreign intelligence agencies to spies in the field of foreign countries.', Priyom.org, 2010. [online] Available at <http://priyom.org/number-stations>, accessed 21 March 2016.

[69] A type of enacted space: '*utterance spaces*, which are articulated by vocal sound,' Smalley, 'Space-form', 38.

[70] 'Although all these are human creations, and although they may sometimes be triggered or controlled by human agency, they can emit sound independently of us, thereby, in part at least, producing their own space. We can call these *mechanised spaces*, and they can be nested in broader enacted spaces.' Ibid., 39.

[71] 'This is *mediatic space*, which comprises an amalgam of spaces associated with communications and mass media, as represented in sound by radio and the telephone, and sonic aspects of film and television.' Ibid.

of the voice in conjunction with remote and synthesised sound materials, in attempts to produce a work rich in electroacoustic musical language.[72]

The theme for *Transmissions/Intercepts* stems from the discovery several years ago of *The Conet Project* (1997), a 4xCD collection of number station recordings.[73] Additionally Andrew Lewis' audio-visual work *Lexicon* (2012) was of particular inspiration, specifically Lewis' strikingly transparent handling of voice transformations.

4.2 Extrinsic associations/intrinsic spectromorphologies

The shortwave radio soundworld suggested a variety of spectromorphologies that provided a basis for the development of sound materials.[74] The notion of constant streams of broadcast sound suggested textural continuant materials. Radio frequencies and tuning suggested pitched content (both relative and intervallic).[75] Radio interference suggested noise, spectral reduction, spectral density and low-fidelity distorted sound. Morse code suggested gestural iteration, stable pitch and internal texture detailing (the amassing of Morse code iterations to create texture). Additionally the variety of sound transformations achievable through exploration of the radio spectrum – when tuning between random frequencies – seemed to allow for all manner of generated (synthesised or transformed recorded sound) third-order surrogate and remote surrogate sound materials to be considered for

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[72] This analysis focuses primarily on the electroacoustic sound detailing within the work (over a detailed transcription of the work's tonal content). Tonality within the piece was developed aurally, and its development over time does not follow a set metre. It can be argued that transcription is of less value than, for example, a discussion of spectral development, or of sound organisation and behaviours featured in the work.

[73] Irdial Discs have made *The Conet Project* complete 4xCD recordings available as a free download from Archive.org. [online] Available at <https://archive.org/details/ird059>, accessed 25 July 2016.

[74] 'Music is a cultural construct, and an *extrinsic* foundation in culture is necessary so that the intrinsic can have meaning. The intrinsic and extrinsic are interactive.' Smalley, 'Spectromorphology', 110.

[75] 'In *intervallic pitch* we can hear pitch-intervals, and therefore their relationship to cultural, tonal usage will become important. In *relative pitch* contexts we hear with much less precision the distance between pitches and can no longer hear exact pitches or intervals in spectral space.' Ibid., 119.

inclusion. Notions of masking and revealing the voice were also suggested (as occurs when broadcasts are intercepted with little regard for accurate tuning-in).[76]

4.3 Utterance and voice transformation

The voice, as the recorded and automated relayer of number sequences, was explored in both natural and transformed states, ranging from recordings edited and sequenced with minimum treatment (suggesting a listening experience occurring outside of broadcast space within a real-world setting), to heavily transformed repetitions of number sequences (iteration resulting in mechanised utterance space). Different languages provided a further avenue of metaphorical exploration (global broadcast space). Opting to recreate the number station soundworld in the studio, I turned to NOVARS postgraduate students to provide me with voice recordings in varied languages.[77]

Primarily the voice was considered as a source bonded sound object for musical exploration; the words spoken (the phonetic alphabet), and numbers relayed in different languages, have no inherent meaning beyond that of sounding words, or words associated with broadcast. As number station broadcasts make no sense to anyone other than (presumably) the broadcasting agent and the intended recipient, it seemed appropriate to focus on musical coherence as opposed to deeper levels of conceptual investigation, or other processes that may inform the electroacoustic composer when exploring a conceptual theme.[78] It is then, through montage (repetition) and sound transformation, that the voice becomes a signifier for combined mediatic and mechanised space.

From the variety of voice transformation processes explored, granulation proved effective in highlighting internal timbral properties of words spoken (phonemes), and allowed for the exploitation of internal pitch content. The application of a

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[76] 'The human voice, however, can be recognized even when its specific spectral characteristics have been utterly changed and it is projected through a noisy or independently articulated channel; it is also notoriously difficult to imitate electronically.' Wishart, 'Sound Symbols and Landscapes', 50.

[77] With grateful thanks, *Transmissions/Intercepts* features the voices of NOVARS postgraduate students Haruka Hirayama, Constantin Popp, Rosalia Soria Luz, Ignacio Pecino, and composer Daniel Barreiro.

[78] Referring here to processes such as data collection/analysis and sonification.

(reverse sawtooth ramp) control signal to modulate the grain size, while also adjusting the playback position of the file being transformed, resulted in a granular time-stretch effect incorporating a high to low glissando pitch sweep (a result of rapid playback of layered grains gradually increasing in grain length and slowing down – for example, 15:08).

4.4 Tonality, glissando and structural functions

In contrast to the predominantly noise-based soundworld of shortwave radio, the decision was made to develop tonal and pitch-centric material; stable intervallic pitch provides a degree of aural grounding and accessibility for the listener (Landy's 'something to hold onto' factor).[79] Additionally, the extraction of pitches inherent in the spoken voice (through granular transformations), further suggested the development of synthesised pitch content to support and enrich the vocal material (through tonal layering). The application of glissando to different sound materials formed behavioural relationships between voice materials (heard in the previous example at 15:08), low frequency material (a sine wave, example at 10:25) and continuant synthesised drone materials (at 4:21, later reintroduced at 19:20). The latter glissando drone continuants provide a structural function within a motion and growth process; glissando introduced towards the end of Part 1 (at 4:21) creates a divergence of tonality, shifting to relative pitch from the stability of the preceding intervallic pitch material. This disruption in spectral space signifies the onset of a musical transition, leading to a climactic gesture (at 4:40), from which spectral density dissipates, concluding the introductory musical passage. A variation on this growth process occurs later (at 19:20) where the reintroduction of relative pitch glissando material leads into a return explosive gesture, once more allowing density to dissipate and leading the listener in anticipation of climax and release, transitioning from Part 3 to Part 4 of the work (see *4.7 Structural analysis*).

[79] 'There are works of sound-based music that concentrate on a single parameter of sound to a large extent, whether it be loudness (the extremely quiet and the extremely loud come to mind), spatial projection of sounds or more traditional aspects including pitch (e.g., tuning, but anything that is focused on audible pitch relationships is relevant), and/or rhythm.' Landy, *Art of Sound Organisation*, 29.

4.5 Aleatoric development

Following initial generation and editing of sound materials, identification of coherent musical combinations were derived from improvisations (spontaneous montaging and sound transformation with real-time processing) within a live electronics (laptop computer) performance environment. An Ableton Live session was set up, with edited audio clips of generated sounds placed in discrete channels containing a variety of real-time signal processing effects chains (including, for example, filters, waveshapers and reverb plug-ins). Parameters to be modified were assigned a physical control via MIDI. Through the spontaneity of semi-improvised aleatoric exploration (and the later auditioning of these sound events as captured through a stereo recording of the performance), successful sound combinations and potential structural ideas were identified. The live recording (see USB-drive, *Appendix_C/Audio/Live_Electronics_Sets/Live_Set_2.wav*) provides insight into the process of semi-improvised performance with fixed materials feeding directly into the compositional process; the performance follows a similar development to Part 1 of *Transmissions/Intercepts* (*Live Set 2*, 0:00 - 2:54) in amassing spectral density with noise-based materials (here noticeably including drone materials from Section 2 of *Glitches/Trajectories*). The performance then transitions into an early variation on *Transmissions/Intercepts'* tonal material (*Live Set 2*, 2:54 - 5:27). A timbral variation on this tonal material occurs further into the performance (*Live Set 2*, 9:45 - 12:41, materials later incorporated into Part 3 of *Transmissions/Intercepts*), following near identical structure to Part 3 of the final composition, leading (*Live Set 2*, at 12:41) into an antecedent shorter version of Part 4 of *Transmissions/Intercepts*, concluding the live performance.

4.6 Typology of sounds

Transmissions/Intercepts features four primary classifications of sound types: utterance, pitch-centric, noise-based and environmental sounds. These groupings, however, contain several sub-classifications of spectromorphologies, some of which link to other primary classifications (iterative granular voices for example, fit within utterance as primary classification, but are also pitch-centric). Additionally, within each subcategory, the identified transformations and behaviours are non-

exclusive (for example, spoken iterative utterance is present in the work as both untreated and filtered variations). Table 2 presents a typology of the most common sounds types, each with an audible example (time reference), and an indication of where the sound types feature in the work.

Primary Grouping	Sub-categories of behaviour/ transformed state	Audible at:	Prominent in:
Utterance	Spoken, untreated	21:00	Parts 2 and 4
	Spoken, iterative (repetition of number sequences)	8:26	Parts 2, 3 and 4
	Iterative, granular (phonemes, stable pitch)	9:45	Part 2
	Time-stretched/time-compressed, (glissando pitch)	15:08	Part 3
	Filtered (spectrally reduced)	8:26	Parts 1, 2 and 3
Pitch-centric	Morse code (iterative, stable pitch)	9:23	Parts 1 and 2
	Synthesised graduated continuants, (intervallic pitch)	16:25	Parts 1, 2, 3 and 4
	Synthesised graduated continuants, (glissando relative pitch)	19:22	(End of) Parts 1 and 3
Noise-centric	Radio interference: (untreated and granulated versions)	2:48	Part 1 and (end of) Part 3
	Synthesised trajectorial iterative gestures	2:00	Parts 1, 2 and 3
	Synthesised oscillating trajectorial continuants	6:05	(End of) Part 1
	Synthesised, abstract gestures (stable, both relative and intervallic pitch, some iterative)	6:19 / 9:43	(End of) Part 1, Part 3
	Abstract gestural noise, unstable, trajectorial	13:37	Part 3
	Abstract textural noise (granular)	12:46	(End of) Part 2
	Continuant noise (two types: transformed noise/unstable electrical hum)	14:01/ 22:51	Parts 3 (transformed noise) and 4 (electrical hum)
Environmental	Continuant textural outdoor ambience (includes birdsong, footsteps and footsteps on leaves)	20:28	Part 4

Table 2: Typology of sounds in *Transmissions/Intercepts*

Of the four sound groupings identified, Table 2 highlights utterance, pitch-centric and noise-centric materials to be present throughout the work, where environmental sounds feature in Part 4 only. Noise-centric materials are both gestural and textural, and feature more diverse spectromorphologies than the three other groupings. Pitch-centric materials featured are predominantly continuant in nature. Iteration and granulation are also notable as common processes applied across utterance, pitch-centric and noise-centric materials.

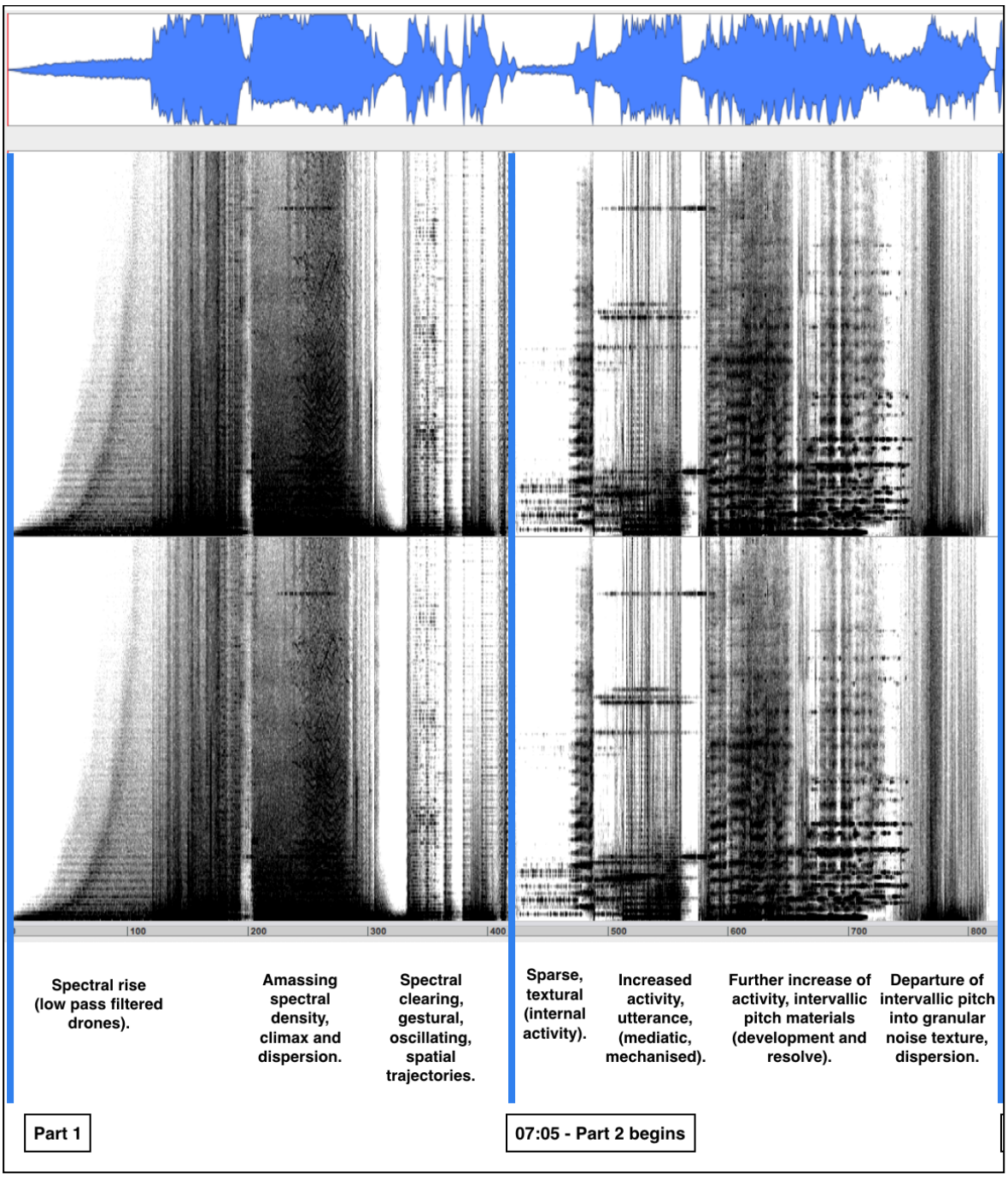

Figure 12: *Transmissions/Intercepts* sonogram (Parts 1 and 2).

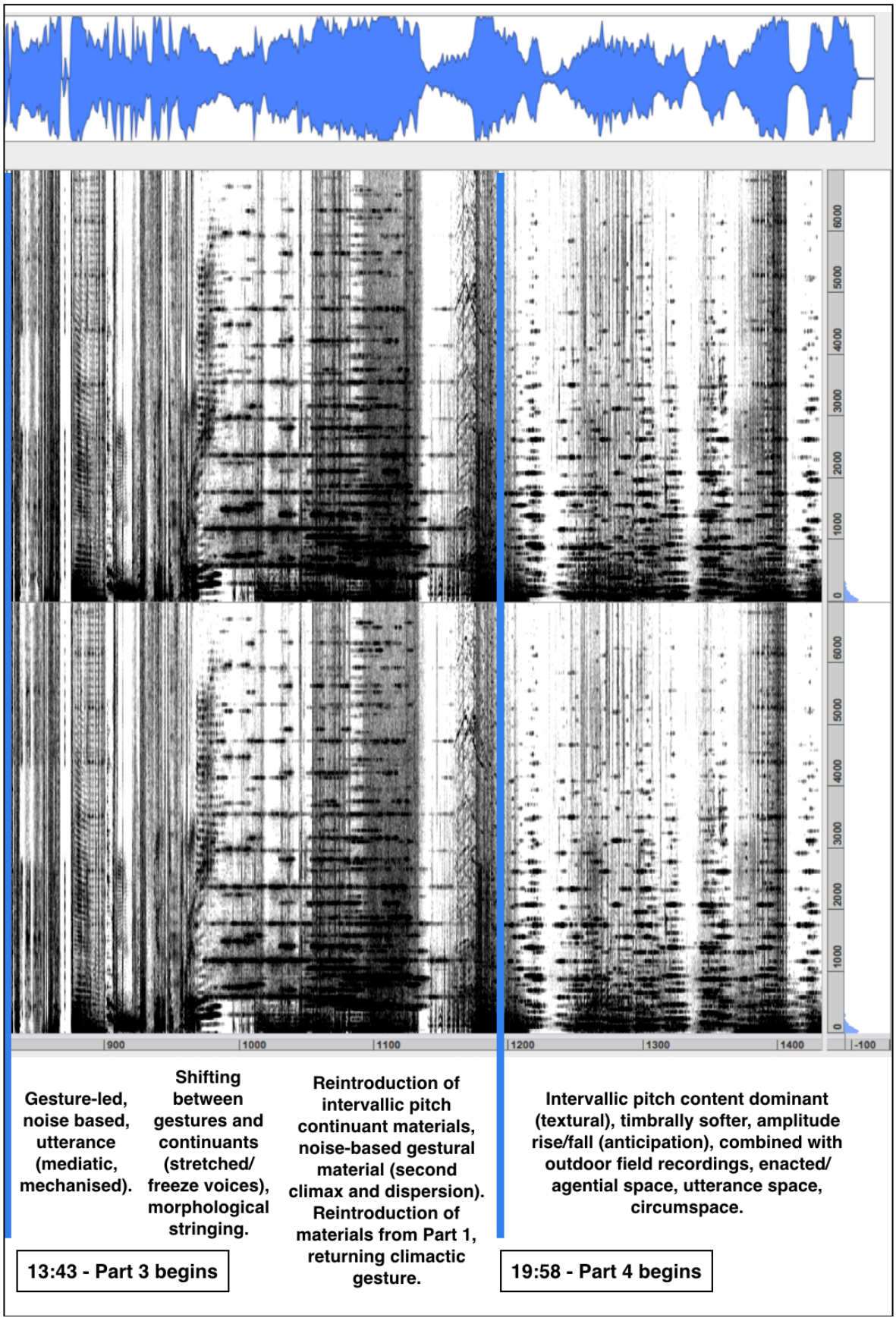

Figure 13: *Transmissions/Intercepts* sonogram (Parts 3 and 4).

4.7 Structural analysis (spectromorphology and space-form)

Transmissions/Intercepts takes the form of four movements. The following is a brief overview and detailed analysis of each movement (see Figures 12 and 13 for an overview of the work's development: a sonogram analysis and waveform representation of the complete work, with brief comments).

Part 1 overview (0:00 - 7:07)

An exposition laying the tonal groundwork and introducing noise-based gestural materials featured in later movements; an emergent and increasingly dense graduated continuant, texture-carried section intended to evoke claustrophobia as metaphor for the multitude of frequencies continually streaming broadcast sound.

Part 1 analysis: emergence/establishment

Part 1 of *Transmission/Intercepts* is underpinned by two graduated continuant drones (rendered as stereo pairs: one to the front left and right loudspeaker pair, the other to the rear left and right loudspeakers).[80] Both are centred around the pitch of D (D0 and D1 in both pairs) and both subjected to subtle frequency modulation and low-pass filtering, gradually revealing upper spectral content and increasing the harshness of the (predominantly) sawtooth wave-like timbre, filling spectral space. The continuants provide a root for spectral content, and establish a root for intervallic pitch content yet to come. The resulting circumspatial sound image creates a state of gradual emergence and expanse through coexistence and motion rootedness.[81]

This texture-setting is disrupted at 2:00 by the introduction of iterative and spatially trajectorial gestures (synthesised sound materials treated with delay to create an echoing effect), moving through the 5-channel image and defining circumspace.

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[80] For consistency with my composed spatial intentions, I use the term *rear* loudspeakers as opposed to *surround* loudspeakers. Please refer to page 12 for the intended loudspeaker positions i.e. a quadrophonic setup with a front centre loudspeaker.

[81] 'Many spectromorphologies are inherently non-rooted because there is no bass anchor (fundamental note) to secure the texture.' Smalley, 'Spectromorphology', 117.

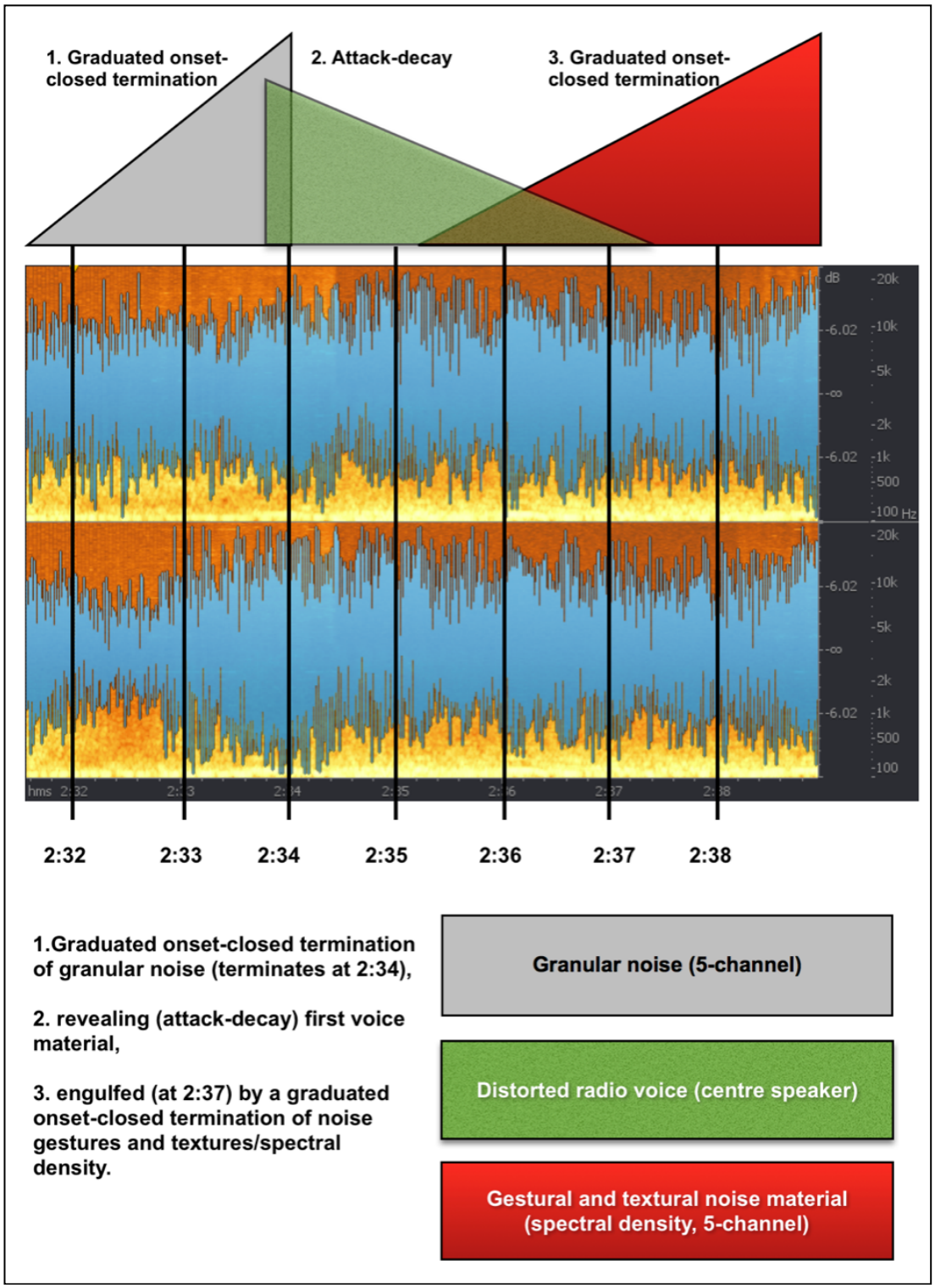

Figure 14: Morphological stringing of sound materials in *Transmissions/Intercepts* Part 1.

As further variations of noise-based gestural content are introduced, the overall spatial image becomes increasingly spectrally dense. Noise materials are organised to imply that one sound event triggers another through convergence and divergence within motion and growth. An example of this can be heard at 2:32 - 2:37 (see Figure 14), where remote granulated textural noise and granulated

radio broadcast noise are combined to produce a graduated onset-closed termination gesture. The immediacy of the termination reveals the first vocal material (an attack-decay of heavily distorted radio utterance, positioned in the centre loudspeaker only), immediately fading out while being engulfed in a spectrally dense, graduated onset-closed termination of noise material.

Iterative noise materials are introduced creating front to rear spatial movement in proximate circumspace (from 2:18, with accelerating/decelerating speed of iterations, suggesting expansion/contraction of time, and the winding-up/winding-down of mechanised activity). Additional active noise materials move around the 5-channel image (2:21 - 2:26). Individual grains of noise are randomly assigned to different channels adding further detail to the noise texture (example at 2:38 - 2:40). The interaction of sound behaviours and increased density create a sense of pressured motion passage, audible at 2:51 - 3:34; the accumulation of noise materials forces other sound materials out (at 2:56), the continuant root D drones are high-pass filtered to remove low frequency content. The drones gradually disappear to reveal the emergence of Morse code material in the centre loudspeaker and a voice repeating ‘atenção’ (‘attention’, Portuguese), located in the front left and right loudspeakers. Eventually the D drone texture is reintroduced at 3:22, filtered in to reestablish low-end pitched content, seemingly forcing out all other sound materials at 3:30.

From this point the 5-channel sound image becomes increasingly spectrally dense, amassing continuant drones and noise materials previously introduced, combined with an increasingly prominent Morse code relay and heavily distorted broadcast utterance, maintaining a tannoy-like centre loudspeaker position. The packed nature of the spectral density fills proximate circumspace. Several high-pitched drones are gradually introduced, their frequencies modulated (initially centred around the root, minor third and fifth notes – a D minor triad), creating note-based intervallic to relative pitch variation, resulting in instability and tension, adding a further layer of density to the upper spectral regions. Two explosive gestures at 4:40 and 5:05 mark the climax of the introduction and trigger the dissipation of sound materials, leaving the D continuant drones to gradually terminate.

Part 1 concludes with a sparse noise-based section (5:23 - 7:07), focusing on abstract (synthesised) iterative and oscillating sound trajectories occurring in perspectival circumspace. Contrasting the density of the preceding soundworld, this passage reintroduces materials previously established (such as the low frequency iterative gestures from 2:00), presenting them alongside new, synthesised arrival-departure continuant sounds. The reduced spectral density is intended to draw the listener's focus towards individual sound behaviours as they emerge and disappear in circumspace. A final arrival-departure continuant at 6:52 gradually terminates to reveal the textural onset of Part 2.

Part 2 overview (7:05 - 13:43)

A texture-led movement reimagining the number station soundworld through electroacoustic musical language. The spoken voice relaying number sequences is presented in varied states of transformation, while retaining its causal identity (human utterance).[82] Tonality in the voice and synthesised materials create moments of tension and resolve, finally leading into a graduated termination texture of granular noise to conclude.

Part 2 analysis: reimagining the number station soundworld

Voice transformations are spatialised to produce an immersive texture-carried opening passage, focusing on internal texture activity and intended to create a sense of stasis. This is interrupted (at 7:47) by the graduated onset of a granulated voice continuant texture. Pitch content inherent in the spoken word (‘niner’, female voice) is emphasised (through granulation), producing pitch stability then exploited for musical effect (at 7:47 - 8:08, B2 and C3). A synthesised gesture combined with a male voice (‘niner’ at 8:08) triggers an increase in texture activity; pitch content embedded within this new textural material is derived from Morse code recordings and transformations. The male voice emerges again, positioned in the centre loudspeaker and intended to suggest a consistent, fixed (broadcast) spatial position within the 5-channel image. The reduction of frequency content and additional bit reduction applied to the voice recording is intended to emulate

[82] ‘Once we can grasp the relationship between the sounding body and the cause of the sound we feel we have captured a certain understanding: intuitive knowledge of the human physical gesture involved is inextricably bound up with our knowledge of music as an *activity*.’ Ibid., 109.

mediatic space. Further, the repetition of a number sequence (‘Zero, one, two, two, niner’), evokes combined mechanised space and utterance space. Additional musical development occurs at 8:32 where a transitional remote gesture triggers new synthesised sound materials, including a low-pitched drone texture (B0), providing a root for the tonal content inherent in both the voice granulations and the Morse code transformations. A second number sequence (‘Zero, one, five, four, niner’), is repeated, spatialised in circumspace and transformed to further develop the notion of combined mechanised, utterance and mediatic space.[83] The centre loudspeaker number relay becomes increasingly blurred through filtering and applied reverb as the voice recedes into distal space. At 9:20, a 5-channel abstract noise gesture appears to drive out most of the current sound activity, leaving remnants of the texture-carried activity introduced at 8:08, while the low B0 drone fades away; spectral space clears to reveal an emergent Morse code relay positioned in the centre loudspeaker, recalling the Morse code revealed in Part 1 (at 3:15).

The next development occurs (at 9:35) where synthesised gestural sounds (positioned in the rear left and right loudspeakers) trigger a further texture-carried section (9:42), reintroducing iterations of phonemes (extracted from the female voice ‘niner’) moving through circumspace as the centrally fixed Morse code relay maintains stability. The focus here is primarily on tonal relations between pitched content inherent in the voice (also re-pitched through transposition) and tonal synthesised gestural material, establishing at 9:43 a G major second inversion (D0, G0, D1, G1 in synthesised sound materials and B2 in granular vocal). Emulating behaviours further strengthen the relationships across sound types; granular voice transformations change pitch with glissando – this rising/falling glissando is mirrored in the lower spectral range with sine wave tones, suggesting vertical (spectral) spatial movement. Table 3 details tonal development from 9:43 to its resolve on a C minor major (10:41) and then to C minor (10:46). Figure 15 highlights the points on the timeline where tonality changes (vertical blue lines *a* to *g* as referenced in Table 3) and also highlights spectral development as visualised by sonogram analysis.

[83] Combined utterance, mechanised and mediatic space is achieved through the sound material (the recorded voice), its behaviour (repetition), and its broadcast-like timbral qualities (achieved through transformation).

Figure 15 reference	Time from:	Synthesised tonality/bowed glass transformations:	Voice granulations:
a)	**9:43**	G major tonality, D0, G0, D1, G1 (synthesised reverse attack-decay gestures).	B2.
b)	**9:53**	Repeat gesture.	Shifts to C3 (at 9:59).
c)	**10:02**	Repeat gesture.	Maintains C3.
d)	**10:12**	Re-pitched gesture (G#1, E ♭ 2).	Maintains C3 with additional introduction of D3, moving to E ♭ 3 at 10:15. At 10:19 C3 is pitched down to B2.
e)	**10:20**	Transposed gesture (G1, D2).	Maintains B2 and E ♭ 3. At 10:26 E ♭ 3 is pitched down to D3 then back up to E ♭ 3, as B3 is pitched back up to C3.
f)	**10:31**	Re-pitched gesture (G#1, E ♭ 2).	Maintains E ♭ 3 and C3. At 10:35 emergence and disappearance of *'row, row, row'*, vocal at G2 pitch.
g)	**10:41**	Gradual introduction of bowed glass transformations (G3, E ♭ 4).	Maintains E ♭ 3 while C3 is pitched back down to B3, then gradually back up to C3 by 10:46 (resolving to C minor).

Table 3: Figure 15 pitch references.

At 10:48 a noise-based granular texture emerges (previously introduced at 9:20 as a short gesture), alongside a graduated termination of the granular vocals. New third-order surrogate pitched continuants (bowed glass drones) are introduced to vary timbre. As spectral content begins to clear (low frequency content exits at 11:54), we hear two transformed variations on the utterance 'zero', time-stretched and treated with delay (referencing the number sequence earlier in the section). The emergence of two untreated voices (one male, one female) – recalling in turn the number sequence 'zero, one, five, fo-wer, niner', followed by 'zero' (male), 'zero' (female), 'zero' (female) – gradually retreat into distal space; the untreated voices are intended to imply a degree of real-world sound after journeying through the reimagined broadcast soundworld.

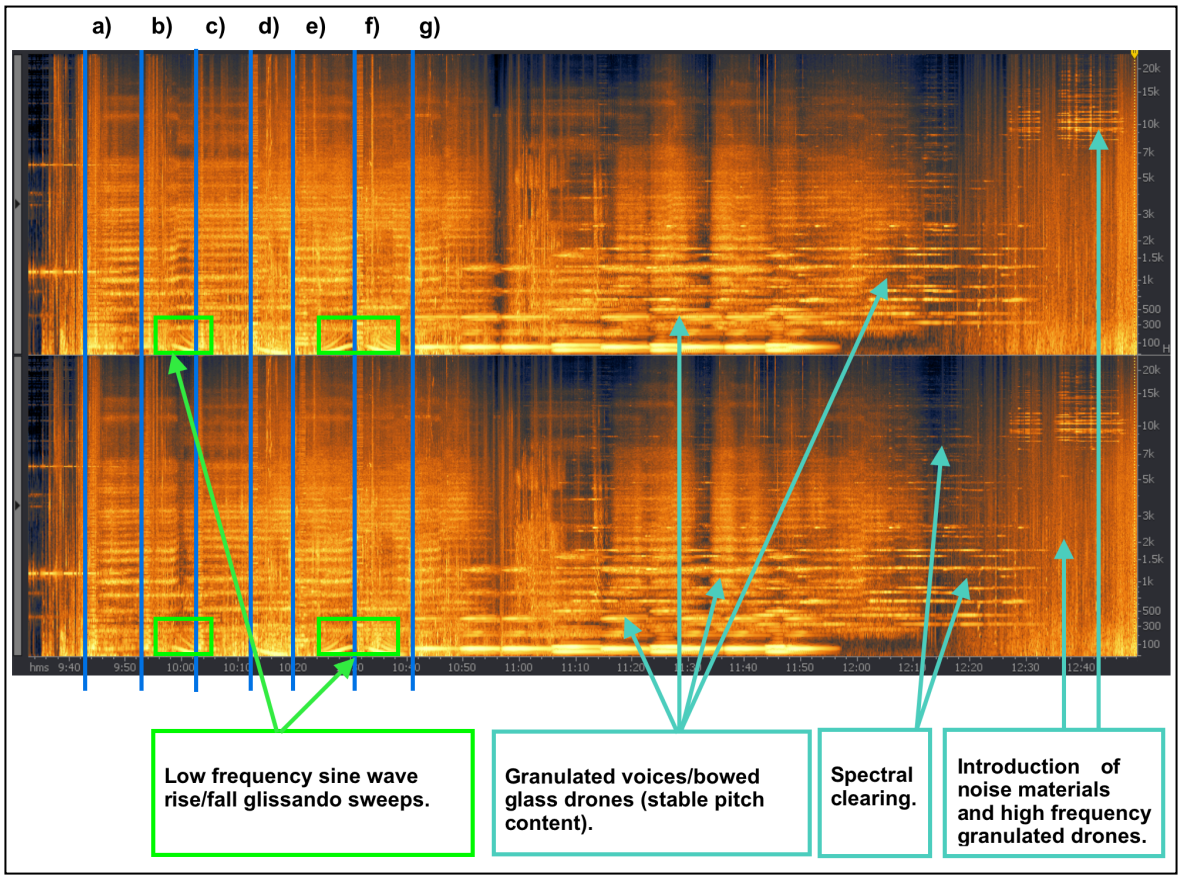

Figure 15: Spectral development in *Transmissions/Intercepts* Part 2 (09:35 - 12:50).

At 12:27 high-pitched granular continuants enter as the bowed glass drones exit. The noise texture grows more dominant and active, rising at 12:46 to engulf the circumspatial image, driving out all other materials. This texture motion gradually fragments into audible variations of the same granular-based coexistent behaviour,[84] as variations on established sound materials (gestures introduced in Part 1 at 2:00) are reintroduced (13:01 - 13:13). These gestures depart and the section concludes at 13:40 with a graduated termination of the noise texture.

[84] 'The *continuity–discontinuity continuum* runs from sustained motion at one extreme to iterative motion at the other. If iterative repetitions become too widely spaced then separate objects will be heard. This tendency is possible with some of the multidirectional growth processes if the internal texture becomes sparser during fragmentation in the growth process.' Smalley, 'Spectromorphology', 117.

Part 3 overview (13:43 - 20:14)

A dramatic gesture-led noise-based passage intended to mimic notions of radio tuning and interference. The first voice relay has been extracted from an actual number station broadcast. As the section develops, noise material and extensive voice transformations lead into a radical shift towards streaming tonality, evoking an imagined euphoric broadcast space.

Part 3 analysis: (first half, 13:43 - 16:08) contrast and morphological stringing

Intended as a contrast to the preceding sections, Part 3 initially sets out to explore both (the illusion of) time manipulation (example at 15:02 - 15:30; rapid shifts between gestural events that propel time forwards, and sustained granular time-stretched voice transformations intended to suggest suspended time), and the organisation of materials resulting in morphological stringing and timbral metamorphosis.[85]

A brief period of silence is harshly interrupted by a timbrally-abrasive (centre-loudspeaker positioned) edited recording of an actual number station broadcast. Moments of silence are contrasted with short unstable bursts of noise in between the number relays. The noise materials make fast unpredictable movements within 5-channels, contrasting with the stability of the voice material and number sequences explored in Part 2.

In a development at 13:58, two transformed white noise continuants (triggered by the immediate termination of previous noise material) pan left to right (positioned in the front left and right, and rear left and right, loudspeakers respectively). The voice begins to multiply and is distributed outwards from the centre loudspeaker to the 5-channel image. The unstable noise materials maintain, and then increase, presence until (at 14:27) the word ‘niner’ immediately terminates all activity, falling

[85] ‘Sound transformations may be defined as a timbral metamorphosis (i.e., from point 'A' seemingly naturally to point 'B') within one single sound event or sonorous gesture. In the latter case this can either take place within a sound continuum or by way of a discrete sound's repetition being transformed into that of a second [, third, etc.] sound, again as 'naturally' as possible.’ Leigh Landy, ‘Sound Transformations in Electroacoustic Music’, 2001. [online article] Available at <http://www.composersdesktop.com/landyeam.html>, accessed 3 April 2016.

to silence. ‘Niner’ repeats in isolation a second time at 14:30, followed by a further, extended silence. Pitch is reintroduced with the arrival of a third transformed ‘niner’ (preceded by a short noise gesture); granular layers of utterance are re-pitched to form a G minor tonality, and layered with a low sine wave tone; both then begin a graduated descending glissando.

From 15:00 a combination of time-stretch transformations of spoken numbers and various noise-based remote materials are organised to infer causality from one sound event to the next. Voice transformations here suggest a speeding up and slowing down of time, with ascending and descending glissandi becoming suggestive of powering up/down-type behaviour (mechanised utterance). Further utterances (both stretched and time-compressed – examples of which are audible at 15:20, 15:36 and 15:48) decay or terminate to reveal (or appear to morph into) a variety of behaviourally active noise-based remote sound materials. Synchronicity and morphological stringing of events work in conjunction with spectral rise and fall inherent in the voice granulations, until the final (freeze transformation) ‘tr-ee’ (at 16:08) is layered with an ascending glissando granular voice. This ascension merges with the reintroduction of stable pitch content, marking the onset of Part 3’s climax.

Part 3 analysis: (second half, 16:08 - 20:14) spectral space and pitch space

16:08 features an emergence of a D4 pitched graduated continuant. From here Part 3 becomes texture-carried through the use of layered intervallic pitched continuant sound materials (created from a single synthesised tone, re-pitched, stretched and layered multiple times). Use of sustain and intervallic pitch are combined with an increasing density of graduated onset-closed termination noise-based gestures and utterance (a metaphor for radio interference), creating an interplay between stable and unstable content and gradually amassing spectral density in circumspace. While it was not a conscious compositional choice, on reflection, the inclusion of numbers throughout this section seems to imply some form of countdown to an approaching event or development, further building anticipation. The function of spectral space within the texture-setting is a key part

of the development (specifically tonal pitch space);[86] tension is built through the introduction, removal and reintroduction of higher and lower frequency content, as tonality and gestural noise amass (see Figure 16). Examples of this can be heard between 17:46 to 19:00, where low frequency content is subtracted and reintroduced.

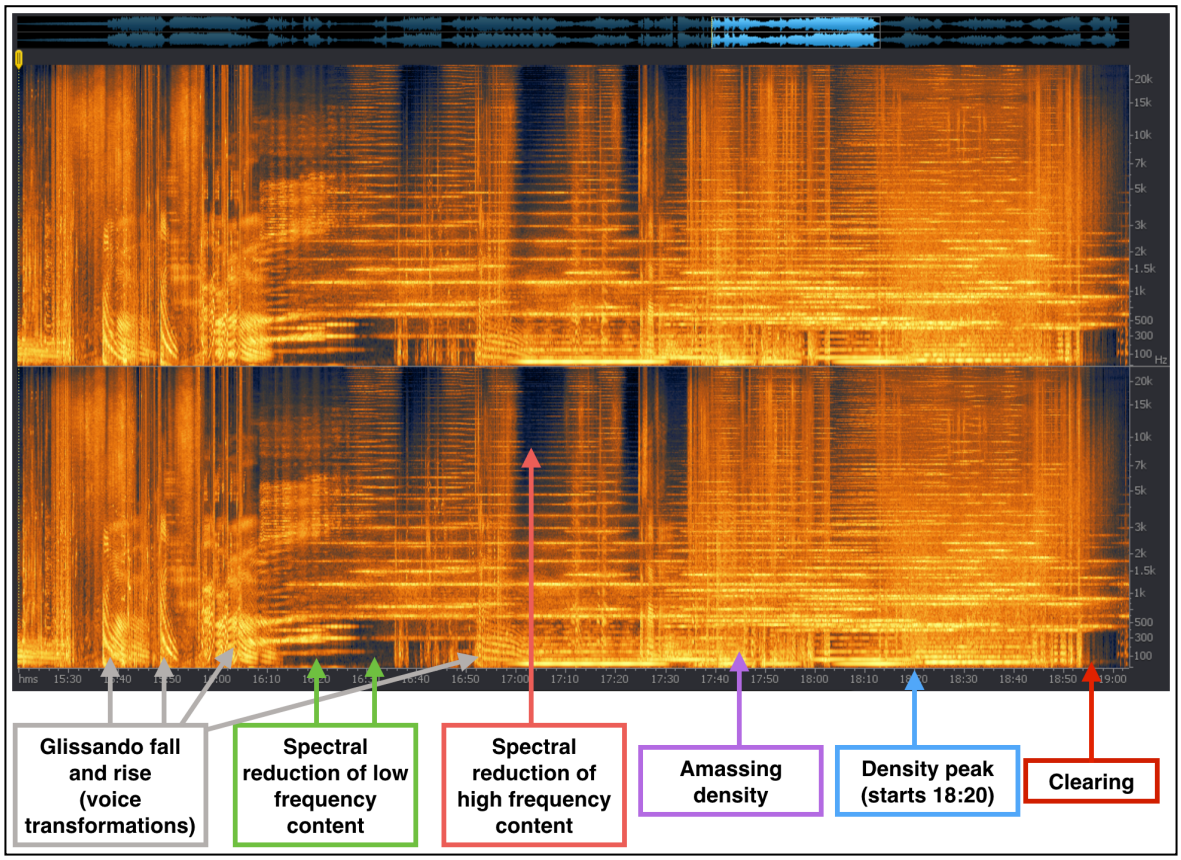

Figure 16: Spectral development in *Transmissions/Intercepts* Part 3 (15:20 - 19:10).

Tonality (organised around a tonic of D) shifts from major third to suspended fourth (16:26 to 17:00), then back to the root note. D minor tonality is next introduced and gradually developed before finally making a dramatic shift to G minor at the section's climax (18:20). The arrival of this climax is onset by the graduated introduction (via the opening of a high-pass filter) of a G1 tone, transformed to contain audible distortion; the combination of tonality and noise result in a dominant continuant, intended to evoke an imagined high energy broadcast stream. Sustained (and increased) activity in the upper spectral regions further add to the dense and tonally rich spectral image.

[86] Tonal pitch space: 'The subdivision of spectral space into incremental steps that are deployed in intervallic combinations – a sub-category of spectral space.' Smalley, 'Space-form', 56.

The section concludes as spectral space clears (through gradual high-pass filtering of content), to reveal once more the initial D4 tone, as a voice is heard reading through the phonetic alphabet. Voice transformations are introduced and layered, intending to suggest connections between natural (untreated voice), mechanised (granulated) and mediatic (filtered/frequency shifted) forms of utterance. Sound behaviours and interactions present in Part 1's climax are then emulated; the reintroduction of relative pitch (glissando) continuants mark the transitional segue into a final explosive gesture (at 19:36), from which noise materials gradually dissipate, leading into the work's final movement.

Part 4 overview (19:58 - 24:32)

A timbrally softer extended variation on Part 3's tonal content, introducing field recordings. Tonal materials are combined with untransformed voices and source bonded outdoor sounds. The listener is taken out of the imagined broadcast soundworld and repositioned within an imagined real-world environment (the space in which the broadcasts are received), producing enacted space.[87] Tonality and timbre in this section are expressive of melancholy as something the listener may associate with reflection (as the work's concluding movement), and as a musical contrast to the predominantly lively preceding movements.

Part 4 analysis: from an abstract aural discourse, towards the abstracted and mimetic

Referring to Emmerson's language grid,[88] the majority of *Transmissions/Intercepts'* preceding sound materials are abstract in nature. Spectromorphologies included throughout the work were developed and selected for musical effect (intrinsic qualities), yet may be found to suggest extrinsic associations related to the work's theme (as previously discussed, see *4.2 Extrinsic associations/intrinsic*

[87] 'Spaces produced by human activity I refer to as *enacted spaces*, and they can be divided into two primary types – *utterance spaces*, which are articulated by vocal sound, and *agential spaces*, where space is produced by human movement and (inter)action with objects, surfaces, substances, and built structures; we can also include human intervention in the landscape.' Ibid., 38.

[88] Emmerson is concerned with '[…] the possible relation of the sounds to associated or evoked images in the mind of the listener.' Simon Emmerson, 'The Relation of Language to Materials', in *The Language of Electroacoustic Music*, 1986, Macmillan Press Ltd., 17 - 39, 17.

spectromorphologies). Abstract content, therefore, intends to produce a combined aural and mimetic musical discourse.[89]

The emergence of outdoor/field recorded materials result in a spatiomorphological development,[90] shifting the listening experience towards the mimetic via this new abstracted material.[91] Source bonded sounds include birdsong, general outdoor ambience and physical movement (footsteps and footsteps on leaves), producing enacted space and agential space, and contrasting the work's prior focus on mediatic and mechanised space-forms while providing additional aural grounding for the listener.[92] The transportation of the listener between spatial settings, and the combining of abstract and abstracted materials, creates an interplay between the real (source bonded nature) and the (preceding) imaginary spaces.

From 20:00 multiple variations of a short synthesised tone (a timbrally softer tone to that used in Part 3's climax, containing less high frequency content) are re-pitched, stretched and layered according to aural preference, resulting in tonal streaming texture motion *expressive of* melancholy.[93] This variation reprise is intended to mirror the tonality of Part 3 while contrasting the preceding spectral density and climax. A sense of musical rise and fall is achieved through the spectromorphologies themselves (graduated onset-graduated terminations), applied amplitude envelopes and moments of near silence where tonal materials all but disappear. Several untransformed voices relaying numbers emerge and are

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[89] See Emmerson, '*4. Combination of aural and mimetic discourse: Abstract syntax*.' in 'The Relation of Language', 30 - 31.

[90] 'I use the term *spatiomorphology* to highlight this special concentration on exploring spatial properties and spatial change, such that they constitute a different, even separate category of sonic experience. In this case spectromorphology becomes the medium through which space can be explored and experienced. Space, heard through spectromorphology, becomes a new type of 'source' bonding.' Smalley, 'Spectromorphology', 122.

[91] See Emmerson, '*5. Combination of aural and mimetic discourse: Combination of abstract and abstracted syntax*', in 'The Relation of Language', 31 - 33.

[92] 'The recorded 'scene' provides a low-level reference – a window on a real event which has a documentary connection with lived experience that in a sense cannot be reduced, although it can be influenced by, for example, details of recording focus determining the rhythm of presentation and perspectives on how we are being offered the scene. So then if a more abstracted sound world is developed around this using electroacoustic transformation tools, we have in the real-world sound event a groundwork for meaning.' Young, 'Sound morphology', 9.

[93] 'For we describe music emotively even when it is perfectly clear that the music is not (and cannot be) expressing the emotions we ascribe to it, or when we have no way of knowing whether it expresses those emotions because we have no way of knowing what emotive state the composer was in when he wrote it.' Peter Kivy, *The Corded Shell: Reflections on Musical Expression*, 1980, Princeton University Press, 14.

spatialised to create continuous texture motion in circumspace; mediatic space is no longer present.

At 22:28 transformed voice material (spectromorphologically linked to the first voice texture in Part 2) emerges low in the mix. At 22:50 remote noise material is superimposed on the environmental space (electrical buzz and hum referencing electrical activity), combined with untransformed vocal texture – one voice repeating the word ‘fin’ (‘end’, Spanish) layered and spatialised in circumspace. There is a subtle climax (22:50 – 23:27) that concludes with a closed termination. A final swell of material is led by the (graduated) introduction of a pulsing bass tone (in D), building tension one final time before its sudden closed termination, leaving the remaining tonal content to gradually terminate and concluding the piece.

Conclusion

Transmissions/Intercepts achieves musical coherence in long-form composition through several applied methodologies including the assimilation and sonic interpretation of conceptually-linked space-forms, the merging of tonally-based textural material with noise-based gestural content and the exploration of reciprocity between the abstract (aural discourse) and the abstracted (mimetic discourse) via concepts of source bonding and spatiomorphology.

CHAPTER 5. *REDUCTIONS/EXPANSES*: SPATIAL TRANSCENDENCE AND STRATEGIES FOR SOUND DIFFUSION PERFORMANCE

> When a composer is interested in grain, in the internal evolution of sound events, in spectro-morphology (Smalley 1986), in the textural flux and gestural articulation of time which grows out of a consideration (via 'reduced listening', perhaps?) of the unique sound object, in the event itself rather than the intervals between events, then sculpting sound into a performance space is not a contradiction of the composer's intentions – it is a continuation of them.[94]

5.1 Overview

Reductions/Expanses (13:39) explores (the illusion of) spatial transcendence,[95] and notions of temporal prolongation and suspension through (primarily) third-order surrogate sounds.[96] The title refers to the result of spectrally reduced materials (at very low amplitudes), creating a horizontal perspectival expanse, able to suggest a listening experience originating from the edges of distal circumspace. Composed space may then suggest events occurring beyond the boundaries of a superimposed space.[97] Temporal extension and suspension is achieved through slowly evolving continuant spectromorphologies, and an extended passage of centric (pericentral) texture motion. As a predominantly texture-led work, notions of emergence and disappearance play functional roles within musical structuring and transition. As all my electroacoustic works are intended to be experienced live,

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[94] Jonty Harrison, 'Sound, space, sculpture: some thoughts on the 'what', 'how' and 'why' of sound diffusion', *Organised Sound*, 1998, **3**(2), Cambridge University Press, 117 - 127, 125.

[95] 'Containment and transcendence are experiential qualities associated with the image, and can be regarded as a companion concept to enclosure/ouverture.' Smalley, 'Space-form', 53.

[96] Spatial transcendence is often considered in reference to (environmental) soundscapes. Smalley writes: 'A circumspatial or purely prospective image that suggests 'environmental' dimensions, through whatever combination of spectral, source-bonded and perspectival means, is liable psychologically to transcend the boundaries of the listening space. This is because, firstly, we know that environment is more expansive than any concert hall or domestic setting, secondly, because the suggestion of the openness of environmental space tends to eradicate consciousness of boundary walls, and thirdly because transmodal perception transports our imagination into environmental settings.' Ibid.

[97] 'The (indoors) listening space encloses and may either confine or expand the composed space. This ultimate space where the listener perceives is therefore a *superimposed space,* a nesting of the composed spaces within a listening space.' Denis Smalley, 'Spatial experience in electro-acoustic music', in *L'Espace du Son II. Special Edition of Lien: revue d'esthetique musicale*, 1991, Ohain: Editions Musique et Recherches, 123 - 126, 123.

analysis of two approaches to performing the piece provide appropriate examples of my personal methodology towards sound diffusion, seeking to avoid an absolute recreation of composed space and favouring instead the exploration of alternate assignments of channel stems to loudspeaker groupings in attempts to exploit superimposed space for musical effect.[98]

5.2 Source materials and transformation

Studio recordings were made of metallic sound sources including sheet metal, iron rods, cymbals and resonant U-shaped iron ground hooks. Materials were captured using both conventional microphones and contact microphones in order to extract internal resonances from the sound objects.[99] Sounds were transformed to obscure the original source-causes while retaining some original spectromorphological elements; combined granulation and reverb processes for example, were applied to extend the resonances of gestural attack-decays into sustained continuants. I sought to merge the resonant internal spatial properties of these objects with tonal materials developed from source recordings of (attack-decay) acoustic guitar notes and chords. Granulation of guitar chords extended the gestural source recordings into third-order continuants, producing material that may or may not suggest an acoustic guitar as a possible source.[100] Additionally, through transformation and organisation of component materials I sought to achieve a sense of distal spatial detailing through texture with blurred (spectrally reduced) image definition featuring internal spectral activity, and complexity in gesture unit construction.[101]

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[98] 'There is certainly a widespread belief among many composers that in performance, the aim should be to attempt to reconstruct exactly the spatial image the composer put on the tape.' Harrison, 'Sound, space, sculpture', 124.

[99] '*Internal space* occurs when a spectromorphology itself seems to enclose a space. Resonances internal to objects (hollow wooden resonance, metallic resonance, stringed instrument pizzicato resonance, etc.) can give the impression that their vibrations are enclosed by some kind of solid material. Internal space is therefore source bonded in that one needs this sense of an actual or imagined sounding body.' Smalley, 'Spectromorphology', 122.

[100] As with *Glitches/Trajectories* and *Transmissions/Intercepts*, recorded source materials and transformations – here specifically metallic sound sources and granular processing – were initially explored via semi-improvised live electronics performance, prompting further studio exploration and development.

[101] 'We should note that a distant image could be blurred or clear, as could a close image.' Smalley, 'Spectromorphology', 124.

5.3 Structure and development

Structurally in two halves, *Reductions/Expanses* first establishes a shifting soundworld moving between passages of spectral density and activity in more proximate spatial positions – where gesture and texture play relatively equal roles (0:00 - 1:27) – to texture-led spectral reduction and temporal stasis (1:27 - 3:17) occurring in distal space (intending to achieve a sense of spatial transcendence). Texture detailing is explored through transformations of materials resulting in spectrally reduced continuants featuring internal spectral development and motion (example audible at 1:56 - 2:08). Constructed gesture units emerge from distal space to dominate as they pass through egocentric space, departing once more into distal space, punctuating the less active texture motions and assisting forward temporal motion (2:38 - 3:10). From 3:10 a spectral rising motion emerges from the preceding gesture unit, leading into a highly active passage of spectral density featuring movement in proximate circumspace and through egocentric space. Spectromorphologies in this passage (introduced previously at 0:23 and 0:54 and reintroduced at 3:47, 4:03 and 4:24) provide an example of gesture resulting in a form of contiguous spatial texture;[102] the gestures imply a high velocity movement through vectorial space leaving a trail of spectromorphological remnants behind.[103] Tonality begins to emerge at 4:37 as density clears, leading into a second passage of spectral reduction and temporal stasis. As spatially transcendent, tonal continuants appear to recede further into distal space, temporal stasis is harshly interrupted by a domineering attack-decay gesture in proximate space comprising transformations of (struck) iron rods, layered, re-pitched and spatialised (at 6:23). This gesture reintroduces tonal textural materials (granular guitar transformations) leading – via a second iron rod strike gesture – into the second half of the work at 7:05.

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[102] '*Spatial texture* is concerned with how the spatial perspective is revealed through time. This is a question of *contiguity*. Space is contiguous when revealed, for example, in continuous motion through space (such as in a left–right gestural sweep), or when a spectromorphology occupies a spread setting (without spatial gaps).' Ibid.

[103] 'A trajectory is not necessarily a concentrated point-source. As the head or bulk of a gesture moves through space it can leave residues behind. Trajectories can therefore leave trails, can be smeared across space or be spread in a more egalitarian way through space. It may be that the establishing of a residue is part of a transformation of a gesture into a spread setting – the spread setting is introduced by a trajectory.' Ibid.

The second half focuses on a combination of centric motion and growth, spectral amassing and clearing, and the illusion of temporal prolongation.[104] This is achieved via several processes, including the creation and gradual layering of multiple granular continuant spectral resonances (internal spatial qualities captured from recordings of metallic sound objects) with tonal granular guitar transformations; spatial deployment results in textural pericentral motion.[105] Guitar recordings have in part been (aurally) selected to mirror component spectral and tonal content found within the metal resonances, allowing the possibility of timbral metamorphosis to play a compositional role (metal resonances and guitar granulations – as discrete spectromorphologies – may appear to morph between one another). Exogenous growth allows the texture motion to gradually amass and clear, while never achieving a state of full (packed) spectral occupancy.[106] Spectromorphological recycling of materials enhances notions of temporal extension and suspension within the growth process (from approximately 8:00 - 9:17).[107] A final rise and fall of gestural and textural activity arrives and gradually terminates (10:08 - 10:42), leading to a sparse passage of tonally-based granular pericentral texture motion. Activity and density subtly grows with the reintroduction of established noise-based spectromorphologies (from 11:55) before transitioning into a less active set of continuant drones, gradually terminating to conclude the piece.

5.4 Embracing superimposed space: considerations for sound diffusion performance

My works are intended to be experienced through live performance – diffused in performance spaces – using available loudspeaker configurations to further

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[104] 'Generally in music, *centric motion* is expressed by spectromorphological recycling, giving an impression of motion related to a central point. This can be achieved through spectromorphological variation alone, but is frequently aided by spatial motion.' Ibid., 116.

[105] 'Centric motions can also be associated with growth. For example, I can think of rotating motions which gather textural materials to them as they expand spectrally – a combination of rotation and exogenous or endogenous growth. The *spin*, *spiral* and *vortex* are rotational variations. *Centrifugal* (flung out) and *pericentral* (merely moving around a centre) are also a related group.' Ibid.

[106] 'Thus a packed or compressed spectral space is compacted so that is suffocates and blots out other spectromorphologies.' Ibid., 121.

[107] 'Continuing recycling, like other forms of repetition, can give an impression of structural stasis, but centric motions can also be strongly directional – vortical and spiral motions have this possibility, for example.' Ibid., 116.

enhance their composed spatial qualities, and where possible, seeking satisfactory reinterpretations of composed space. My methodology for sound diffusion performance is a combined semi-improvised/semi-planned strategy wherein several structural *arrival points* in the composition are identified. These are then assigned a particular distribution of channel stems to loudspeakers, providing a framework for improvised diffusion to be undertaken with confidence during performance. It is often the case that time to rehearse on loudspeaker concert systems is extremely limited; in my experience, composers generally tend to be assigned a soundcheck allocation that is anywhere between one and two and a half times the duration of the work they intend to perform. With such limited access to a given performance system the improvisational aspects of diffusion performance require (for me personally) an acceptance and an embracing of superimposed space.[108]

Superimposed space in performance space is primarily defined by two factors: the acoustic properties of the space itself and the configuration (groupings) of loudspeakers and their positions within the performance space.[109] My involvement in the design and implementation of the University of Manchester's MANTIS 48-loudspeaker sound diffusion system (working alongside Professor David Berezan and NOVARS PhD student Constantin Popp) provided a richly rewarding experience of experimentation with loudspeaker positions and groupings; alternate layouts were often explored alongside more standardised speaker placements.[110]

Loudspeaker groupings

Figure 17 is a top-down plan of the MANTIS 48-loudspeaker diffusion system, highlighting four specific groupings employed for the concert premiere of

[108] Despite limited rehearsal times I often find by the end of a soundcheck that I am confident in my intentions for the diffusion of the work. I do not create diffusion scores, instead preferring to make performance decisions based on aural response. I have however, found it beneficial to make brief notes during sound check to refer to if necessary during performance; these notes always include initial diffusion desk level settings for the start of the performance, and generally refer to specific loudspeaker groupings that should be emphasised at the *arrival points* identified.

[109] Superimposed space often changes considerably once the audience is seated within the performance space. The audience often absorb an undeterminable amount of sound reflections, thus altering the acoustic properties of the space. The audience therefore becomes an additional contributor to superimposed space.

[110] The MANTIS (Manchester Theatre In Sound) system always has fixed configurations to accommodate playback of stereo, quadrophonic, 5-channel and 8-channel works, providing a standardised spatial framework for diffusion performance.

Reductions/Expanses.[111] A *Main 8* ring of Genelec 8050 loudspeakers surrounding the audience is highlighted in red.[112] A *Distant 8* ring of Genelec 8040 loudspeakers are highlighted in blue. The Distant 8 are at floor height, angled approximately 45° (backwards) from an upright position, directed away from the concert hall's central spot.[113] Highlighted in green is a *Stage 8* grouping, a quasi-ring of loudspeakers (mixed models and sizes). Figure 18 shows the on-stage positions of the Stage 8, the loudspeaker directions, and my personal channel assignments.[114] By assigning all 8-channels to this formation, the entire spatial image may be positioned in front of the audience: channels 1 and 2 outputting from a *stage high* pair (on stands at the rear), channels 3 and 4 outputting from *stage wide* loudspeakers, channels 5 and 6 assigned to loudspeakers centrally placed, facing inwards towards one another, creating a *stage fill* effect, and finally channels 7 and 8 outputting at the front of the stage, lower in position relative to loudspeakers 3 to 6, in close proximity to each another, creating a mono-type output and functioning as a *stage solo* pair.

Highlighted in orange (Figure 17) is an *Inner 4* ring, positioned around the performer, within the audience seating area; channel stems are grouped in pairs to output from each loudspeaker as shown, drawing the 8-channel image into a more intimate position nesting within egocentric space. Directional positions of

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[111] *Reductions/Expanses* was premiered at the *MANTIS Festival*, University of Manchester, UK, 17 October 2015.

[112] Note the MANTIS *Main 8* is based on four stereo pairings of loudspeakers surrounding the audience from front to rear in a ring formation (positioned as shown in Figure 17) and differs in configuration from Harrison's original notion of a *Main 8*, as employed in the design of the University of Birmingham's BEAST system (this being a main stage pair, a wide pair, a distant pair – at the rear of the stage – and a rear pair behind the audience). See Jonty Harrison, 'Diffusion: Theories and Practices, with Particular Reference to the BEAST System', *eContact 2.4* on the website of the Canadian Electroacoustic Community/ Communauté electroacoustique canadienne, 2000. [online article] Available at <http://econtact.ca/2_4/Beast.htm>, accessed 28 August 2016.

[113] 'In short halls, it can sometimes be difficult to achieve a real sense of distance, but if the wall at the back of the stage is brick or stone, very distant speakers facing away from the audience and reflecting off the wall can be effective (the high-frequency attenuation and general reduction in source location mimicking remarkably well the sensation of the sound being further away).' Harrison, 'Sound, space, sculpture', 122 - 123.

[114] On-stage loudspeaker positions and directions were decided in conjunction with Professor Berezan and Constantin Popp. Composers performing multi-channel works however, generally only assign front-oriented composed channels to these loudspeakers. Considering an 8-channel work where stems are assigned to the Main 8 as shown on page 11, channels 1 to 4 would be assigned to stage loudspeakers, whereas channels 5 to 8 would not be assigned to any on-stage loudspeakers; instead they would be assigned to loudspeakers positioned at the sides and rear of the concert hall, maintaining a surround position to the centrally-located audience. The assigning of all 8 channels to a frontal, on-stage position (and directional choices applied to the Inner 4 desk loudspeakers), were personal preferences of mine.

loudspeakers mimic a carousel-like configuration, and (as with the Stage 8) result in a diffused space considerably different to that of the composed space. Figure 19 is an in-studio recreation of this configuration to further clarify.

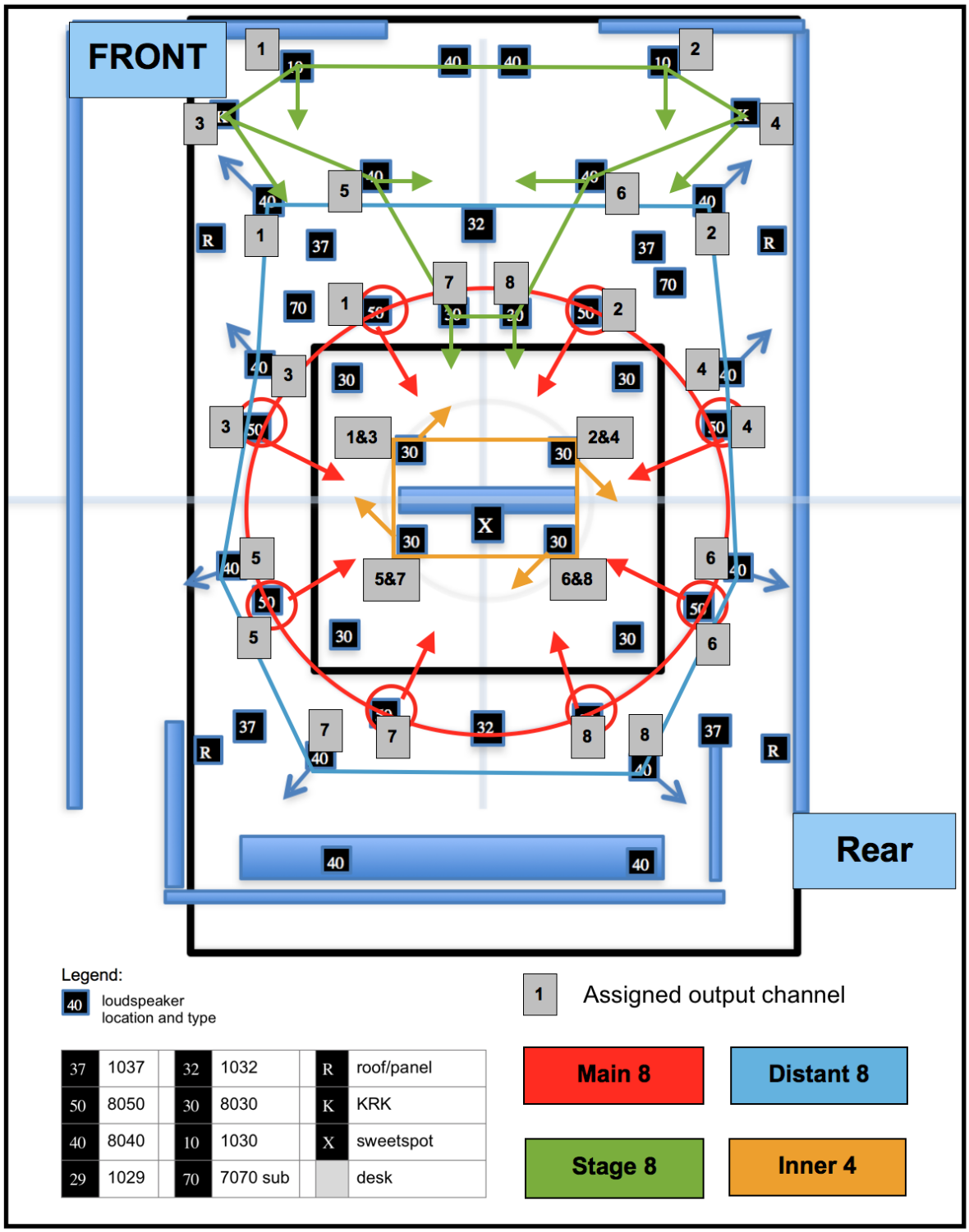

Figure 17: MANTIS 48-channel performance system and four possible 8-channel groupings.[115]

[115] This diagram was developed from an initial template created by Professor David Berezan, as a standard template used in visualising loudspeaker layouts for any given MANTIS concert system, as would fit in the John Thaw Theatre (located in the University of Manchester's Martin Harris Centre for Music and Drama, Bridgeford Street, Manchester M13 9PL).

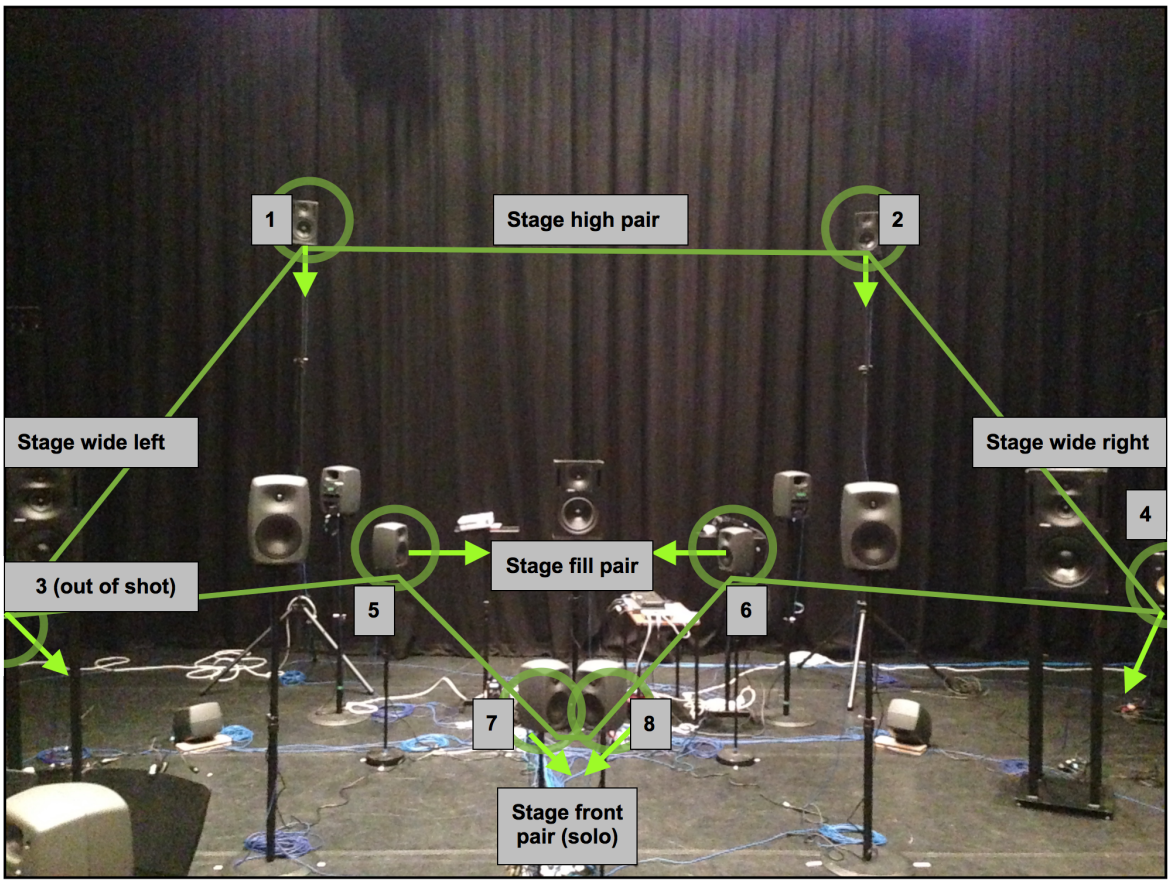

Figure 18: Stage 8 quasi-ring (on-stage positions and directions).

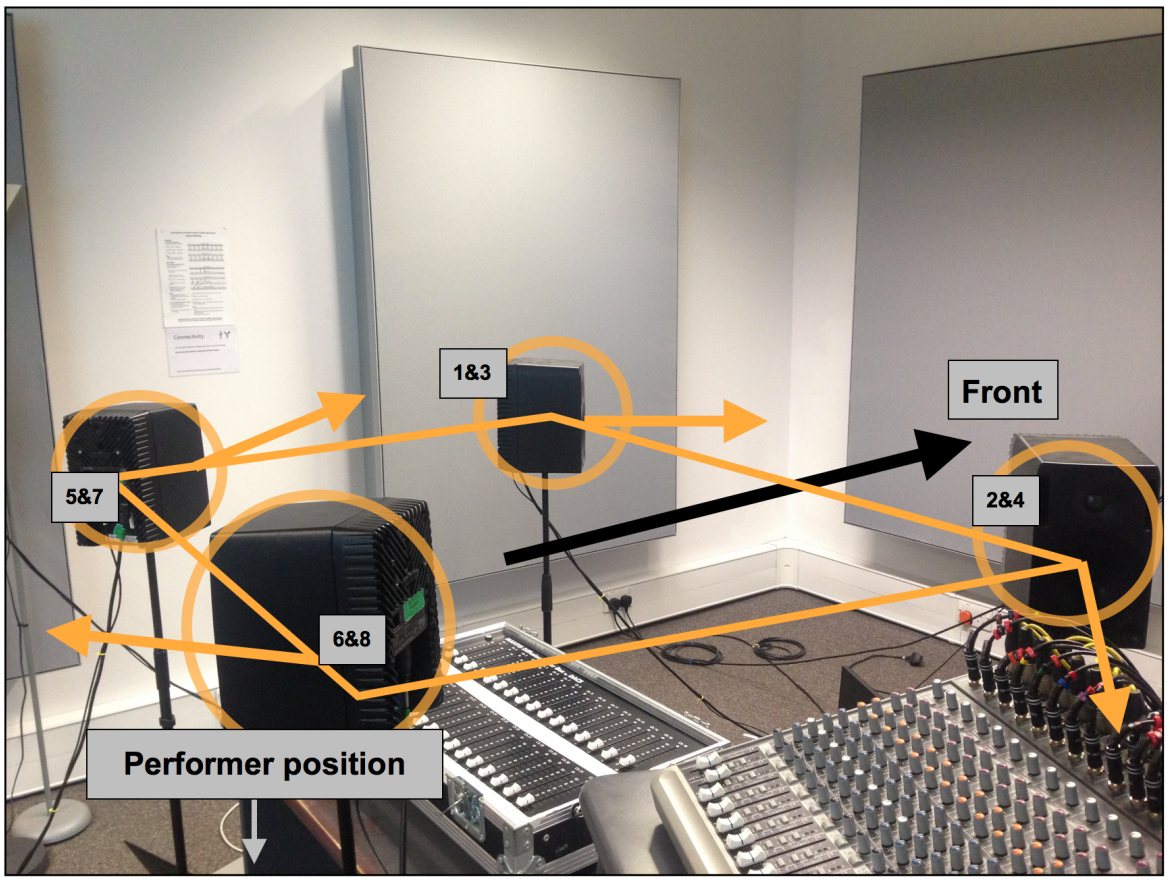

Figure 19: Inner 4 (8-channels to 4 loudspeakers and directions).

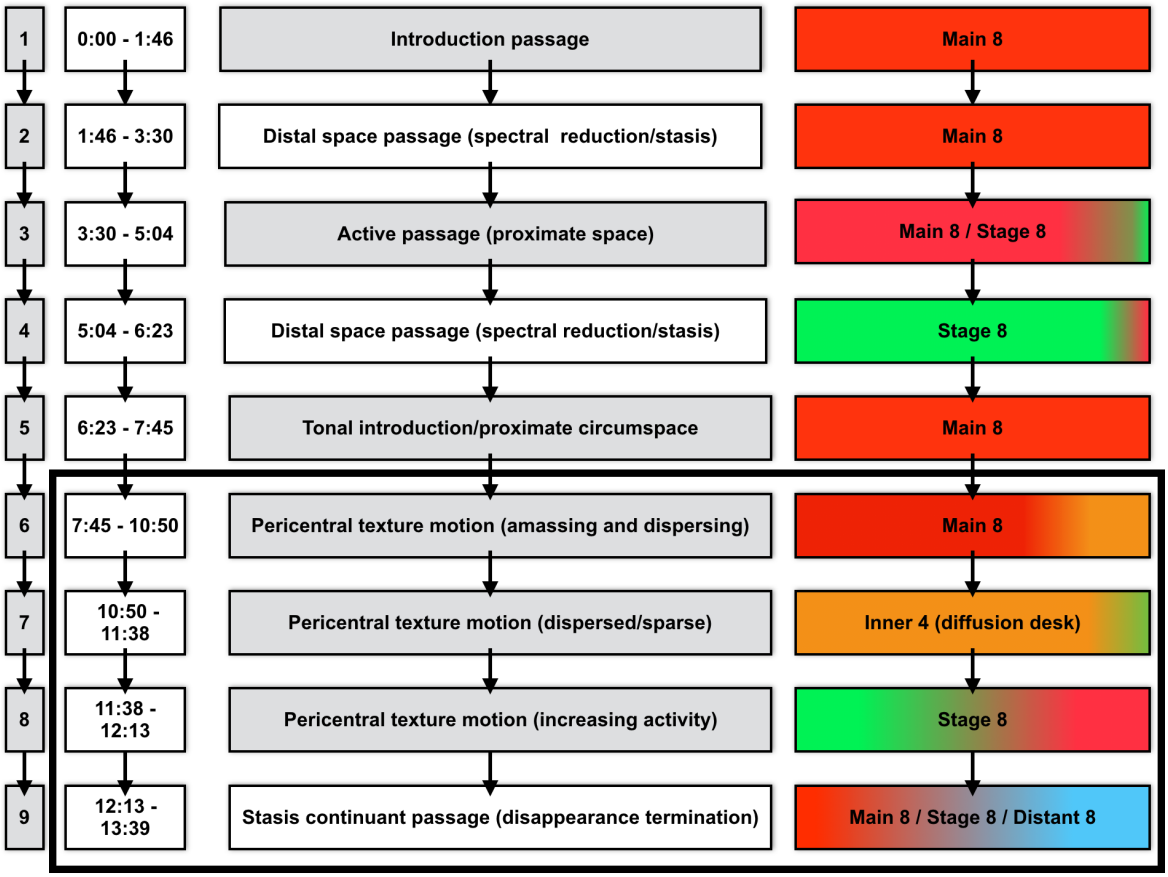

Figure 20: *Reductions/Expanses* structural overview/MANTIS loudspeaker group assignments.

5.5 Diffusion strategy 1 (large-scale concert system)

Figure 20 provides a concise overview of *Reductions/Expanses'* structure, identified as nine passages; right hand boxes detail the primary choices of spatial distribution in relation to groupings discussed above (for clarity, colour coding of right hand boxes in Figure 20 relates to colour coding applied to loudspeaker groupings in Figure 17). The nine passages highlight examples of structural arrival points identified during rehearsal. While these may be subject to change during performance (hence the semi-improvised aspects), the final four passages (6 to 9) and their loudspeaker groupings were identified as core to the successful embracing of superimposed space.

Throughout performance, prominence is given to the Main 8 group. Each of these loudspeakers is allocated an individual fader on the diffusion desk for controlling output volumes; during performance I would alter these to emphasise/extend dynamic highs and lows, also making subtle but randomised attenuation

movements during more active passages such as Passage 3 (active passage in proximate space, Figure 20).[116] Passages 2, 4 and 9 (see Figure 20, white descriptor boxes) are focused on distal spatial activity and temporal stasis; here volume attenuation in diffusion performance emphasises distal activity in composed space, seeking a sense of spatial transcendence within the performance space. Moving from Passage 3 into Passage 4 I gradually shift the entire 8-channel image to the Stage 8; here morphing from a circumspatial output to a panoramic position located exclusively in front of the audience, featuring perspectival depth and height variation (see Figure 18). The Main 8 are reintroduced in time for the abrupt gesture at the start of Passage 5 (at 6:23) to surround the audience once more, following the stasis-like graduated termination passage.

Passages 6 to 9 (outlined in black, Figure 20) employ a planned sequence of spatiomorphological developments. From the circumspatial amassing of pericentral textural movements (Passage 6), as texture becomes more sparse, transition occurs to the Inner 4 group (Passage 7), creating a sparse intimacy of spatial distribution nesting within egocentric space. As spectral occupancy and activity rises once more (Passage 8) the sound is redistributed to the Stage 8, creating a panoramic perspectival image. A gradual transition back to the Main 8 is undertaken, leading into the concluding stasis continuants (Passage 9). A final transition is gradually made from the Main 8 to the Distant 8 seeking spatial transcendence once more as the performance concludes.

Where spectromorphological recycling of materials and sustained pericentral texture motion through these final passages produces a degree of subtlety in the composed 8-channel structural development, the diffusion outlined above results in augmented structural development via spatiomorphology. Reinterpretation of the composed space-forms via a large-scale loudspeaker performance system is therefore used to produce a more immersive and expansive spatial listening experience.

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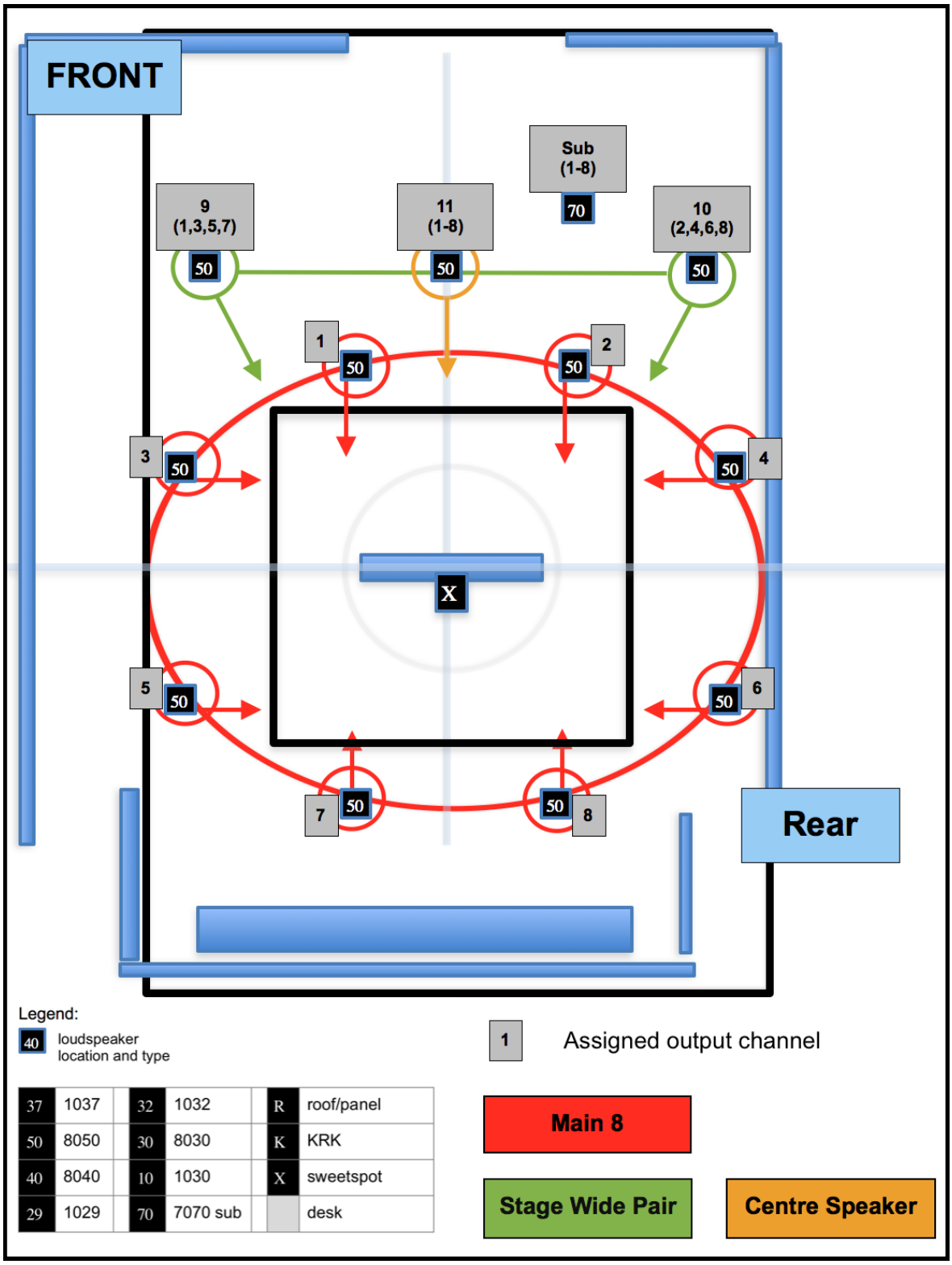
[116] ‘In performance I would, at the very least, advocate enhancing these dynamic strata – making the loud material louder and the quiet material quieter–and thus stretching out the dynamic range to be something nearer what the ear expects in a concert situation.’ Harrison, ‘Sound, space, sculpture’, 121.



37	1037	32	1032	R	roof/panel
50	8050	30	8030	K	KRK
40	8040	10	1030	X	sweetspot
29	1029	70	7070 sub		desk

Figure 21: *Reductions/Expanse*s channel assignments for a small-scale 12 x loudspeaker diffusion system.

5.6 Diffusion strategy 2 (small-scale concert system)

A performance of *Reductions/Expanses* at the *International Festival for Innovations in Music Production and Composition 2016 (iFIMPaC)*, provides evidence of an alternate diffusion strategy, designed to exploit a small-scale system.[117] Figure 21 presents an approximation of the available performance system and channel assignments. The limitations of a system based on a single *Main 8* ring of loudspeakers, an additional stereo *Stage Wide* pair and a *Stage Centre* loudspeaker (alongside a sub loudspeaker) presented an opportunity to explore an alternate spatial distribution. In order to achieve this I opted, at short notice (just prior to sound check), to create an 11-stem version of the piece.

Stems 1 to 8 remained identical to the fixed media version submitted in the portfolio. Stems 9 and 10 were a stereo mix-down of the 8-channel version (previously created), assigned to the Stage Wide stereo pair. Separation of left and right side composed space in the 8-channel image was retained in the stereo mix; the Stage Wide, left loudspeaker handled channels 1, 3, 5, and 7 and Stage Wide, right loudspeaker handled 2, 4, 6 and 8. Stem 11 was a mono mix of the stereo mix-down (therefore combining all eight composed channels into a single channel stem). This stem was assigned to the Stage Centre loudspeaker.

Referring to the structural breakdown outlined in Figure 20, Passages 1 to 6 maintained a circumspatial position, distributed through the Main 8 loudspeaker ring, with appropriate fader variation intended to enhance dynamic range and composed space. Transition into Passage 7 was achieved through the introduction of the Stage Centre loudspeaker mono mix, and the graduated departure of the 8-channel image to reduce this sparse passage down to a single position in panoramic space. As activity increases (leading into Passage 8), a transition is gradually made from the Stage Centre loudspeaker output to the Stage Wide stereo pair, broadening the panoramic spatial image. Finally the gradual reintroduction of the Main 8 ring coupled with the gradual fade-out of the Stage Wide pair allowed Passages 8 and 9 to reestablish circumspace, relying on composed space to convey a final receding motion into distal space, concluding the performance. See USB drive *Appendix_C/Audio/Reductions_Expanses_11_*

[117] Leeds College of Music, UK, 11 March 2016.

Channel_Diffusion_Excerpt/Reductions_Expanses_11_Channel_Excerpt.aiff (and the accompanying readme.pdf file for channel/loudspeaker assignments), for an 11-channel studio rendered example/excerpt of the diffusion strategy outlined from Passage 6 to Passage 9.

Conclusion

Reductions/Expanses combines predominantly texture-led passages with perspectival space-forms (proximate to distal/spatial transcendence), pericentral motion with amassing/dispersing growth processes, and temporal prolongation/ suspension contrasted with passages of increased activity propelling time forwards. The nature of the piece allows for radical spatial reassignments to be explored in live performance environments. Through the embracing of superimposed space as determined by given concert halls and performance systems, the methods outlined for the transference of fixed media into performance spaces highlight the potential for unique reinterpretations of fixed media works to be achieved; here composed space may be further augmented in the performance space, via diffused space.

CHAPTER 6. *ITERATION/BANGER*: COMBINING ALGORITHMIC, GENERATIVE AND ALEATORY PROCEDURES FOR MULTIPLE PERFORMABLE OUTCOMES

> 'First, the computer offers powerful possibilities for constructing a new sound world (far exceeding those by traditional instruments or analogue electronic means) and for controlling with the greatest care and precision the minutiae, the atomic structure, of sounds themselves. Second, the computer suggests new ways to think about musical structure because of the unprecedented facility for unifying macro- and micro levels of a composition. The machine gives the composer the capability of applying analytical and theoretical concepts expressed as compositional algorithms or programs, prompted by the necessity of organizing the new sound world that has become available. Thirdly, by establishing an interaction between the composer and technology, the computer stimulates thought about the compositional process itself and suggests a new relationship between creator and material with the computer functioning as a more or less active intermediary.'[118]

6.1 Overview

Concluding the portfolio, *Iteration/Banger* (7:51) is an 8-channel fixed media, gesture-led work exploring an alternate soundworld to the preceding compositions, and hinting at likely future directions to be explored in my work. The work is electroacoustic in that it is a composed multi-channel piece realised through technological means with an emphasis on spatial exploration. Stylistically, however, it lends itself to areas of contemporary electronic music affiliated with rave and techno music cultures, specifically the genre termed *post-rave*. As such, the work makes use of synthesised sound materials, some remote in spectromorphological nature, others adopting the roles of second-order surrogates associated with musical gesture (synthesised kick drums and electronic percussive sounds).[119]

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[118] Tod Machover, 'Thoughts on computer music composition', *Composers and the Computer*, 1985, William Kauffman, Inc., 89 - 111, 90.

[119] 'Much music which uses simulation of instrumental sounds can also be regarded as second order since, although the instrument may not be real, it is perceived as the equivalent of the real. Commercial synthesizer usage is of this type when we recognise both the gesture involved and the instrumental source simulated.' Smalley, 'Spectromorphology', 112.

Simon Reynolds writes:

> ‘By 1996 a new zone of music making had emerged out of the ruins of “electronic listening music”; a sort of post-rave omni-genre wherein techno’s purity was “contaminated” by an influx of ideas from jungle, trip-hop and other scenes. Not particularly danceable, yet too restlessly rhythmic and texturally startling to be ambient chill-out, this music might be dubbed art-techno, since the only appropriate listener response is a sort of fascinated contemplation. Imagine a museum dedicated not to the past, but to the future, where you can marvel at the bizarre audio sculptures.’[120]

Inspiration for the piece was drawn primarily from contemporary electronic artists whose use of rhythm stems from chance procedures and generative computer processes, resulting in unpredictable rhythmic and spectromorphological developments; Autechre’s later works, including the *Confield* (2001) and *Exai* (2013) albums, explore the terrain of generative computer music through development of Max coding patches. One album of particular influence during this period was Mark Fell and Gábor Lázár’s collaborative release *The Neurobiology Of Moral Decision Making* (2015) – a set of rhythmically complex pieces produced with a minimal palette of sounds (a kick drum, a synthesised hand clap and what appears to be FM synthesis with minimal additional processing).

Iteration/Banger is performable as either diffused from fixed media, or alternately as a live electronics performance. The 8-channel fixed version is the definitive version, however Appendix C includes (along with a stereo reduction of the 8-channel fixed media version), recordings of two alternate real-time performed versions (see USB drive *Appendix_C/Audio/Iteration_Banger_Live_Electronics_Versions*). One is stereo for a single laptop and MIDI controller, the other is an 8-channel version for two networked laptops and MIDI controller.[121]

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[120] Simon Reynolds, *Generation Ecstasy: into the world of techno and rave culture*, 1998, Little, Brown and Company, 359.

[121] To clarify, this work is not intended as a piece for other composers to perform or reinterpret through performance.

6.2 Development in Max and Live/signal path overview

Iteration/Banger resulted from experiments combining Max programming and Ableton Live. The creation of a computer instrument capable of producing rapid, synchronised and unpredictable rhythmic output with timbral variation became the starting point for developing a fixed media multi-channel composition focused on rhythm. As the Max patch became increasingly complex in both coding and potential musical output I opted to separate its elements into two patches, each handling different processes. Using classifications of compositional algorithms as identified by Rowe, the performance system for *Iteration/Banger* incorporates *transformative*,[122] *generative*[123] and *sequenced*[124] components, and adopts an *instrument* paradigm.[125] The signal path for the generation of 8-channel audio can be split into three discrete stages. Stages 1 and 2 are handled on a MacBook Pro and Stage 3 occurs on a second MacBook Pro – both MacBooks are connected via Ethernet:

- Stage 1: Real-time sound shaping (generative) and sequential/chance triggering of pre-rendered audio (sequenced), occurring on MacBook 1 via Max Patch 1.
- Stage 2: Real-time processing (transformative) of audio output from Patch 1, occurring on MacBook 1 via Ableton Live.
- Stage 3: Real-time spatialisation (transformative) of the stereo output from Live to 8-channels, occurring on MacBook 2 via Max Patch 2.

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[122] 'Transformative methods take some existing musical material and apply transformations to it to produce variants. According to the technique, these variants may or may not be recognizably related to the original. For transformative algorithms, the source material is complete musical input. This material need not be stored, however—often such transformations are applied to live input as it arrives.' Robert Rowe, *Interactive Music Systems: Machine Listening and Composing*, 1993, MIT Press, 7.

[123] 'For generative algorithms, on the other hand, what source material there is will be elementary or fragmentary—for example, stored scales of duration sets. Generative methods use sets of rules to produce complete musical output from the stored fundamental material, taking pitch structures from basic scalar patterns according to random distributions, for instance, or applying serial procedures to sets of allowed duration values.' Ibid.

[124] 'Sequenced techniques use prerecorded music fragments in response to some real-time input. Some aspects of these fragments may be varied in performance, such as the tempo of playback, dynamic shape, slight rhythmic variations, etc.' Ibid.

[125] 'Instrument paradigm systems are concerned with constructing an extended musical instrument: performance gestures from a human player are analyzed by the computer and guide an elaborated output exceeding normal instrumental response. Imagining such a system being played by a single performer, the musical result would be thought of as a solo.' Ibid., 8.

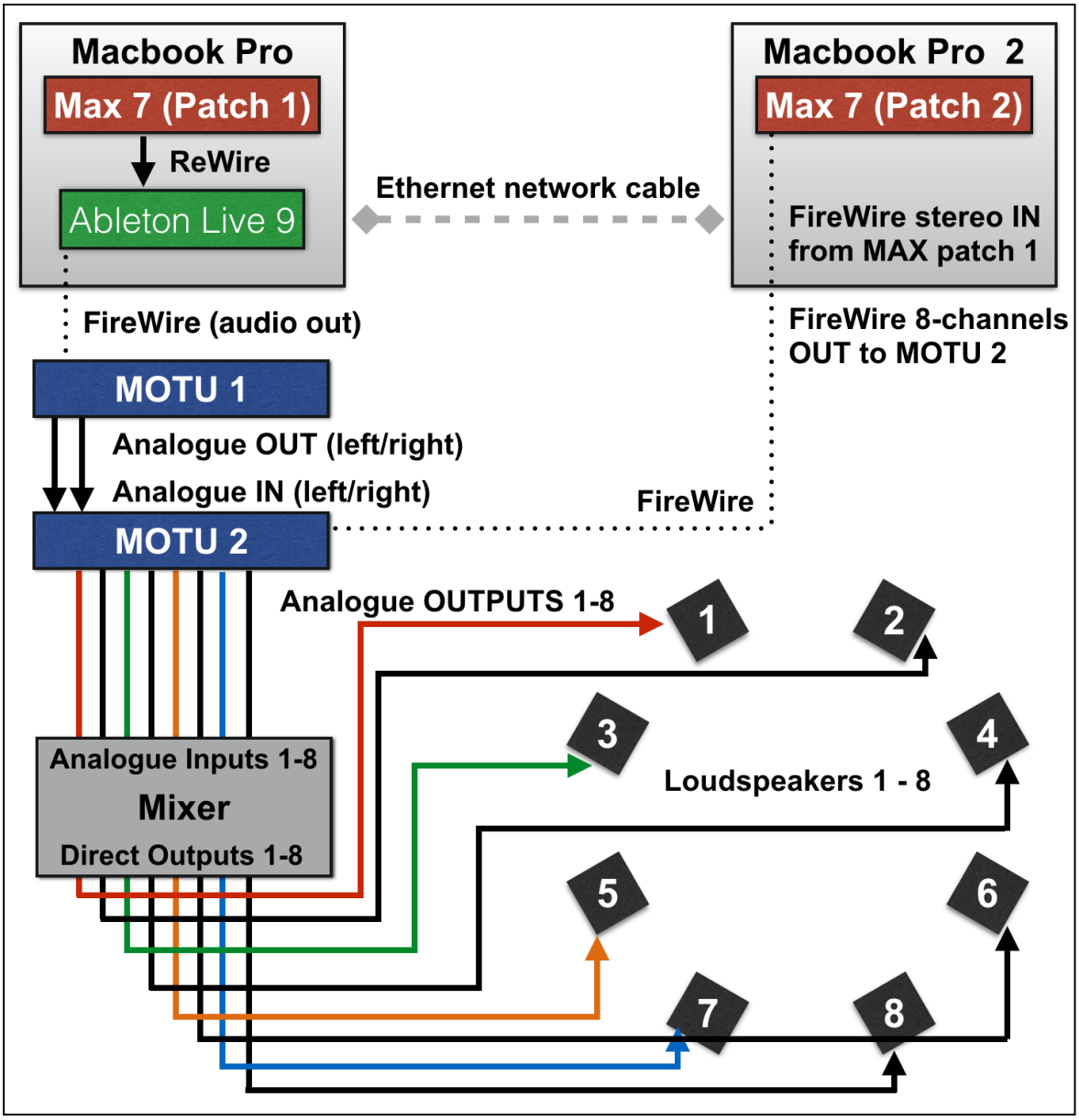

Figure 22: *Iteration/Banger* software and hardware setup/signal path.

Figure 22 is an overview of the signal path and hardware setup used in the creation of the 8-channel fixed media version. Max Patch 1 manipulates a primary sine wave in real-time, several synthesised (pre-rendered) kick drums, a pre-rendered (snare-like) gestural noise burst and some simple FM synthesis (see *Appendix_C/Software/Iteration_Banger_Patch_1.maxpat*). The audio output of Patch 1 is sent out grouped as four discrete stereo pairs (eight channels), via the ReWire software protocol into Ableton Live 9. In Live, the four stereo channels are processed further with a variety of audio plug-ins, using multiple stereo channels. For example, three stereo channels in Live may be receiving the stereo signal from outputs 1 and 2 from Max Patch 1, each applying different processing to that

stereo signal, then summed to the master output channel of Live, resulting in further timbral shaping in stereo. Some plug-in parameters are modulated in real-time using Max for Live LFOs.[126] These channels are then summed to a stereo master output and sent to an audio interface (Figure 22, MOTU 1). The analogue stereo output (L/R) of MOTU 1 is sent to the analogue in of MOTU interface 2. This stereo signal is received via FireWire out from MOTU 2, by a second MacBook Pro (running Max Patch 2). Max Patch 2 (see *Appendix_C/Software/Iteration_Banger_Patch_2.maxpat*) redistributes the stereo signal to an 8-channel audio output, and sends it back via FireWire to MOTU 2. The eight analogue audio outputs from MOTU 2 are finally sent to a mixer and from there direct to eight loudspeakers. The Ethernet connection between MacBooks 1 and 2 allow *udpsend* and *udpreceive* Max objects to pass data (in this case, *bang* or trigger messages) from Patch 1 to Patch 2, allowing performed changes in the output state of Patch 1 to affect spatial distribution settings in Patch 2, enhancing control when improvising in real-time with the performance system.

See Appendix B for further detail on both Max patches and the Ableton Live setup. Appendix C (USB drive), features:

- both Max patches used in the creation of the piece (all sub-patchers feature written explanations of signal shaping, audio triggering, spatialisation, etc., as related to that part of the patch),
- audio samples for Patch 1 (place these in the Max file search path),
- an example Ableton Live session (using only native plug-ins to Live version 9), to emulate Stage 2 of the signal path,[127]
- two audio/video walk-through guides demonstrating the functionality of the Max patches,
- stereo and 8-channel recordings of live-electronics performances of the piece.

[126] For more information see <https://www.ableton.com/en/live/max-for-live/>, accessed 21 July 2016.

[127] It was not possible to include the original (Stage 2) Ableton Live session, as it uses third party plug-ins including software by Waves and iZotope.

6.3 Genre hybridity and stylistic similitude

Musical hybridity is of less personal concern to my compositional interests than seeking to create musically coherent fixed media multi-channel outcomes. However, in the interest of analysis it is of value to consider some of the inherent stylistic traits in *Iteration/Banger* that derive from rave and techno music genres. The most obvious of these is rhythm itself; while rave and techno styles generally focus less on rhythmic complexity in favour of stability (for example, 4/4 time at a fixed tempo), *Iteration/Banger* focuses on rhythm as a primary compositional element and explores complexity within – for the most part – stable metre.

Sound materials incorporated are directly related to rave and techno; synthesised kick drums and simple repetitive tonality are closely related to rave music's instrumentation and use of repetitive synthesised one chord stabs. In *Iteration/ Banger* tonality is created by the application of a tuned comb filter effect to an input signal of a rapid high to low sine wave sweep; the high to low sine wave sweep shapes the timbre (the sweep being fast enough to result in a percussive sound rather than audible descending glissando), whereas the tuned comb filter resonates intervallic pitches based on the Dorian mode, from a set fundamental base frequency. Constraint of sound material is also common to (minimal) techno and rave; *Iteration/Banger* employs a minimum of core materials. Certain processing techniques applied in the composition are also derivative of rave and techno, in particular the use of side-chain compression to force the prominence of kick drums and/or to result in compacted, spectrally dense textures (example at 3:55 - 4:10). Furthermore the application of long-decay reverb and the low-pass filtering of continuant materials is commonplace in techno music production.

Iteration/Banger's musical form is comparable to techno and rave form; repetition occurs on both micro (rapid gestural iteration) and macro levels (returning/ developed variations of established musical sections, related to popular music form). High energy gestural passages in the work are contrasted with brief passages of less active textural material, followed by returning gestural and rhythmic passages; this also mirrors aspects of techno music form, where contrasting textural (ambient) passages often lead to the reestablishment of the

work's primary (rhythmic) passages (for example, reintroducing a regulated kick drum and repeating motif or phrase).

6.4 Development/extraction of materials and organisation

Experiments with Patch 1 and the Ableton Live session via live electronics performances (as the code was still in development), led to a refinement of the system's potential responses – for example, varying and setting input value ranges being fed to parts of the patch controlling the timbral shaping of the sine wave output. Modifications were added to control sound behaviours, tempo and transformative settings. Through continued refinement of both patches and the Live session's performance functionality (allowing hands-on control over defined pre-set states of aleatoric timbral and rhythmic output), and through the later rendering of several studio improvisations in 8-channels, discrete and contrasting musical passages were generated. Once identified, the most musically potent recorded passages were extracted, edited and sequenced to define the overall structural framework of the fixed media version.

Additional materials were then developed – some created using the Max patches, others created with alternate tools and plug-ins – to add further contrast to materials featured and to enhance spectromorphological detailing. The 8-channel audio output of the signal path (Figure 22) primarily produces sound activity located in proximate circumspace (from generated materials in Max Patch 1 and Live sent to Patch 2 then distributed to 8-channels). As such, additional space-forms were incorporated through the development of remote materials that may be considered equal parts gesture and texture (continuants with internal spectromorphological development treated with doppler effect), producing vectorial movements in stereo. Stereo renders were then reassigned to 8-channels via a matrix~ object in Patch 2 (random redistribution of the stereo signal to any two of eight channels), resulting in vectorial spatial motions, passing through egocentric space within circumspace (examples between 0:33 - 0:53).

As the core audio output of Patch 1 is short rapid variations of gestural material, I sought to create complimentary continuant textures; high-pitched drones were developed by passing continuous white noise through one of the tuned comb filter

settings (intervallic pitch), then applying a high-pass filter to reject lower frequency content. Later the continuants were processed through a low-pass filter to gradually reduce them to silence (audible example at 5:00 - 5:52).

Varied spectromorphologies are linked through shared transformation processes; tonality provided by intervallic pitch comb filter processing, for example, forms bonds between the pitched gestural content and pitched continuant drone materials (both sound types feature the same inherent intervallic pitches). The synchronicity of gestural events (sine wave output, kicks, noise burst and FM synthesised gestures) forges behavioural links between sound types.

6.5 Structure

Figure 23 provides a structural overview of the piece. Section 1 was predominantly generated without using the Max patches and seeks to create emerging active behaviour and spectral density through continuant materials positioned in the mix to suggest a layering of sounds located in different perspectival spatial locations. This texture-setting is disrupted by attack-decay gestures (1:07), introducing the dominant gestural content to come, causing a shift towards a spectrally-cleared circumspatial image. Section 2 establishes the primary soundworld of the piece: rapid iterative variations, density, synchronised gestural events and random spatial assignments. Events occur in proximate circumspace suggesting spatial containment, surrounding the listener. Transitions between musical sections fragment the iterative, metred nature of the material; temporal pacing switches between forward-propelled (gestural) sections and less active (textural) transitional passages, creating a pause of gestural activity. Section 3 reestablishes the soundworld introduced in Section 2 with more complexity through inclusion of additional gestural materials, leading into the next transition passage of spectrally dense continuants (from 3:26, regularly interrupted by side-chain compression triggered by a muted kick drum), gradually receding into distal circumspace. A dominant gesture at 4:11 introduces a variation on Sections 2 and 3, featuring transposed tonality and fragmentation of metre, where synchronised events accelerate and decelerate, suggesting expanding and contracting notions of time. Section 5 provides further contrast, as sparse activity and temporal stasis is

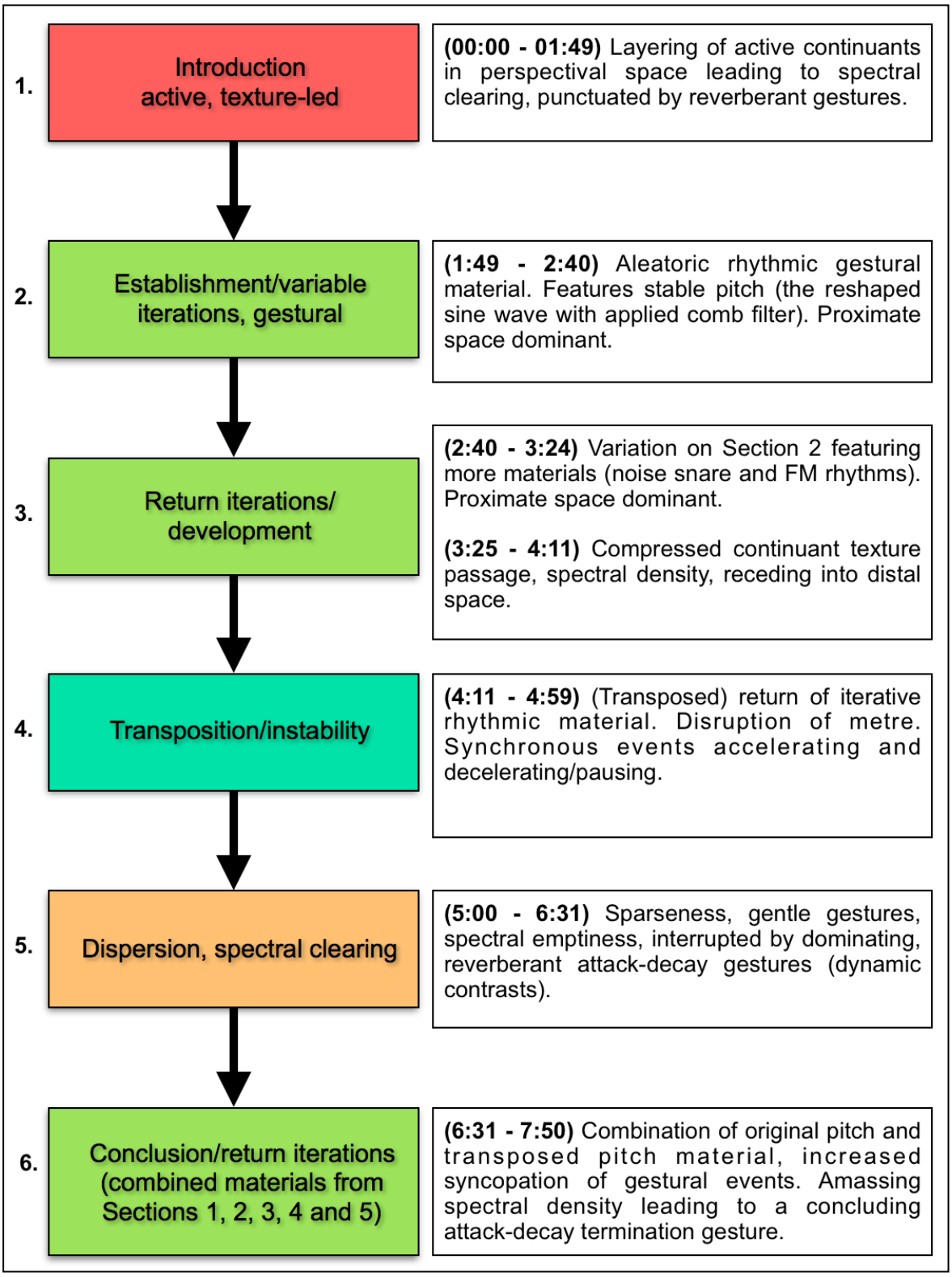

Figure 23: *Iteration/Banger* structural overview.

established, only to be interrupted by unpredictable, prominent attack-decay gestures with long reverb tails, located in proximate circumspace, exploiting minimum to maximum dynamic ranges between materials. Finally, Section 6 combines variations on materials from all 5 preceding passages; iterations here

create more syncopated rhythmic outcomes (synchronised gestures follow metre, but may be triggered independent of one another). In its final moments the work grows increasingly spectrally dense leading (through a textural, rising glissando motion), to a final attack-decay termination gesture, concluding the piece.

6.6 Multiple performable outcomes/additional performance functionality

As outlined, this research resulted in multiple performable versions of *Iteration/ Banger*.[128] The fixed media 8-channel version features more materials, greater detailing in featured spectromorphologies and more varied spatial development, than the live electronics versions. The live versions feature a variation in the work's structure; both live versions begin and conclude with variations on Section 5 of the fixed media work, as a way to start and conclude performances with a degree of subtlety, substituting Section 1 sound materials.[129] The stereo live version in particular is intended for performance possibilities in less controlled spaces, such as club environments.[130]

Functionality in Patch 2 has been designed with capability to incorporate additional fixed media materials into a real-time live electronics performance; up to two 8-channel fixed media files may be randomly redistributed spatially (randomly reassigning/crossfading channel stems with the possibility to adjust crossfade times). Patch 2 also contains an additional *sfplay~* object allowing for playback of a fixed stereo file that may be randomly reassigned to outputs in the 8-channel image, featuring time-stretching and pitch-shifting functionality. Depending on the stability of the performance setup, the aforementioned tools (all of which played

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[128] The 8-channel fixed media version is intended for performance via small or large-scale loudspeaker sound diffusion systems. Performance of the stereo live electronics version requires a laptop running Max Patch 1 and Ableton Live (Stages 1 and 2 of the signal path only, see *6.2 Development in Max and Live, and signal path overview*). Performance of the 8-channel live electronics version requires the complete setup as outlined in Figure 22 (Stages 1 to 3 of the signal path), as originally used in the production of the fixed media 8-channel version.

[129] Sound materials in Section 1of the fixed media version were not real-time generated from Max and would therefore require playback of a pre-rendered file in order to be included in live electronics performances.

[130] The stereo live electronics version of *Iteration/Banger* was debuted at the *Off the Beaten Track* event curated by Matthew Bourne, as part of the proceedings of *iFIMPaC*, Belgrave Music Hall, Leeds, 11 March 2016.

roles in the development of materials for the fixed 8-channel version) hold potential for further embellishment during live performances.

While the composition clearly holds potential for extending aspects of *liveness* in fixed acousmatic performance (specifically referring to the live 8-channel version), my intention with *Iteration/Banger* was to explore the production of discrete performable versions, as opposed to researching ways to merge and extend diffusion performance practices in acousmatic listening situations.[131] Berezan (2007), and Moore (2007, 2008) among other composers have contributed research to strategies for the potential fracturing of the fixed nature of acousmatic performance. In exploring multiple alternate formats, the intention was to produce a work that can accommodate a broad range of technical setups, allowing an increased possibility of programmed performances of the work not restricted exclusively to acousmatic listening situations. The diffusion of fixed works remains a primary research interest.

Conclusion

Iteration/Banger explores an alternate (related) compositional methodology to those employed in previous works, through the creation of an instrument paradigm and the development of a soundworld inspired by alternate genres of popular electronic music. Here the process of generating sound materials differs from previous works, but a bottom-up approach to sound organisation (on a structural level) is retained. In addition, the work provides further evidence of the potential forging of relationships between live electronics performance and fixed media compositional practices, resulting in multiple performable variations of a composed work.

[131] The live electronics versions were a secondary outcome of compositional research. Production of a fixed media work through the development of generative and aleatoric processes in Max coding is the primary research outcome.

CHAPTER 7. CONCLUSIONS AND CONTRIBUTION TO RESEARCH

> 'The composer can never forget, however, that the most important process is always one of intuition and judgement (often based on "insufficient evidence"). No matter how extensively the composer engages in rigorous research, confidence should never be lost in the power of simple musical thinking.'[132]

7.1 The music

The work presented here covers a broad exploration of possible approaches to spatial acousmatic composition, unified by qualities inherent in my personal approach to composing with sound and given coherence through the methodologies adopted and developed. An exploration of spectromorphology and space-form analytical concepts (initially undertaken during the period of study for my MusM degree) have, in turn, considerably influenced my approach to composition.[133] When applied to analysis of the works they reveal a variety of defining characteristics, providing clear insight into my compositional processes.

My composed music is predominantly gesture-led, and focused on transformed and synthesised sound, deployed in composed space for dramatic musical development. Where sound sources – either real or generated – are masked for the most part of my compositional output, gestural shaping proposes an energy and physicality that is intended to enhance the listener's chances of forming source bonded links between sounding materials, suggesting possible extrinsic associations via transmodal perceptual experience.[134] I am concerned with sonic detailing in both the development of spectromorphologies and space-forms. My methods are informed by techniques of improvisation and aleatoric development,

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[132] Machover, 'Thoughts on computer music', 91.

[133] Composers have previously identified the potential of applying analytical concepts of spectromorphology and space-form to the compositional process. See Blackburn, 2009.

[134] 'Transmodal linking occurs automatically when the sonic materials seem to evoke what we imagine to be the experience of the world outside the music, and in acousmatic listening (not just acousmatic music) transmodal responses occur even though these senses are not directly activated in order only to listen. In listening to acousmatic music, rather than suffering some kind of sensory deprivation, I am led spontaneously to contemplate the, possibly unique or unfamiliar, virtual transmodal richness afforded by the aesthetic configurations of the music.' Smalley, 'Space-form', 39.

and prioritise intuition and aural response over concept-driven or predetermined methodologies for composition. My influences are derived from electroacoustic repertoire, published research, contemporary electronic music forms and popular music forms. Methods adopted and developed have been shaped in part by the composers who have mentored my progression and through engagement with the broader research community, concert and conference attendance and meaningful discourse with other composers and electronic music practitioners.

7.2 Responses to research questions

The following responses reflect my current thoughts and findings on research topics outlined in this commentary as arrived at via practice-based research, and propose practical uses for areas highlighted.

- How does the electroacoustic composer create musical coherence when employing predominantly abstract sound materials in non-linear musical structures?

As is the case with the portfolio works presented, considerations of aurally perceptual relationships between spectromorphologies and use of structural functions applied to recurring sound types allow for compositions to be structured in unpredictable ways while maintaining a coherence that may be perceivable by the listener. Abstract sound materials are not devoid of source bonding, and through use of related variations of sound types the listener may – consciously or otherwise – identify spectromorphological bonds and find a sense of musical grounding through familiarity and predicted directionality, as a work unfolds over time.

- What approaches might be adopted in order to extend and embellish composed multi-channel fixed media works through concert presentation, in relation to contemporary sound diffusion methods?

The diffusion strategies outlined in Chapter 5 highlight two approaches that have proved suitable for further exploration in my work: the first is a willingness to detach from the notion that all multi-channel works must be presented maintaining

a central sweet-spot position in the centre of the audience. This potentially allows for radical spatial reinterpretations of fixed surround works (an example of this being to transition from an 8-channel circumspatial image to an exclusively panoramic spatial image featuring all eight composed channels). Secondly (where possible given the wide variety of acousmatic performance technical setups), by incorporating reduced stem mixes of multi-channel works into performance alongside the full multi-channel versions of compositions, further possibilities are proposed for greater performer interaction to occur in the diffusion of multi-channel works.[135] Not all works will be suited to these approaches, but as I continue to explore their potential within my own practice, I would argue that the highlighted strategies propose greater possibilities for spatial development in performance through bold fragmentations of composed space in seeking a more gratifying performed concert experience.

- How might tonality be successfully employed alongside abstract sound materials in acousmatic works?

I employ tonality to create an additional layer of musical contrast in my pieces and to provide a sense of grounding for the listener that may enhance a work's accessibility. This is certainly the case with longer works such as *Transmissions/ Intercepts* where an appreciation of the piece requires extended concentration on the part of the audience and where the majority of materials featured are remote in nature. Tonality and second-order surrogate sounds are applied intuitively in my works and function as musical components that may aid the listener in appreciation of potentially challenging electroacoustic works.

- What potential might the creation of multiple performable variations of composed works hold for the composer/performer?

As highlighted in Chapter 6, this holds potential for broader performance possibilities and a widening of the potential exposure for composed and performed works. It also proposes further investigation (see *7.3 Research contribution*) as

[135] Stansbie highlights issues around multi-channel diffusion '[…] the presentation of multichannel works often involves corrective agential acts that present the music *as heard during the compositional process.* With this in mind, one is often dealing with multichannel *playbacks* rather than *performances*.' Adam Stansbie, 'The Acousmatic Musical Performance: An Ontological Investigation', 2013, Unpublished Doctoral thesis, City University London.

certain types of fixed media works (an example being *Iteration/Banger*) may prove suitable for reinterpretation through live electronics performance formats, further developing links between acousmatic compositional processes and live electronics practices.

- How might aleatoric processes be successfully incorporated into composition and sound generation techniques?
- How can relationships between studio-based composition and live electronics performance practices be merged to strengthen composed musical outcomes?

As highlighted in Chapters 3 and 4, the aleatoric development of materials via live electronics performance holds potential to produce alternative, contributory elements to compositional outcomes – elements differing from those arrived at in the studio environment. Further possibilities are elaborated in the following section.

7.3 Research contribution: harnessing aleatoric elements in electroacoustic composition

Analysis of my work leads me to identify a personal compositional methodological model, cultivated during my time at the Novars Research Centre and outlined here as my contribution to electroacoustic research:

Figure 24 outlines a strategy for the forging of a reciprocal, mutually beneficial two-way interactive system between studio composition and live electronics performance practices, incorporating aleatoric elements of sound montaging, shaping, generating and transforming (I include here spatial transformation), resulting in a feedback loop where one practice directly influences and shapes potential outcomes of the other. As previously illustrated (see *6.6 Multiple performable outcomes*), outcomes may include multiple performable versions of composed works, but the model also suggests possibilities for compositions and live electronics performances featuring identical or related sound materials, where musical developments may differ considerably.

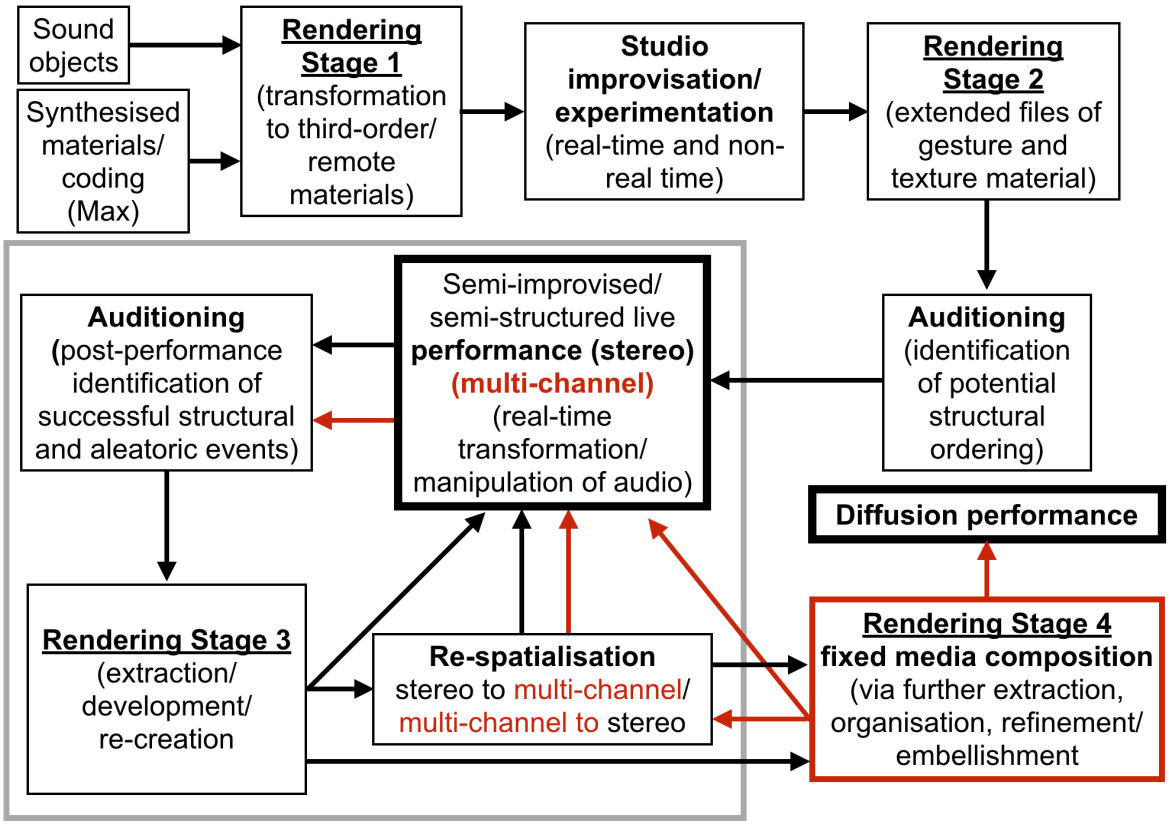

Figure 24: A mutually beneficial methodology for the merging of acousmatic composition and live electronics practices.

From the initial recording and/or synthesis of materials, a process of rendering and transforming is undertaken; in my own work materials are often transformed into third-order or remote surrogates as the immediate stage after recording or synthesis (Figure 24, Stage 1). Studio experimentation leads on to Stage 2 rendering, resulting in extended files of spectromorphologically varied sound materials. Potent musical materials are identified, as are potential combinations of spectromorphologies and initial structuring ideas. Materials are then explored through (recorded) semi-improvised live performance, following a prototype structural plan. Post-performance auditioning leads to further identification of structural coherences, specifically via aleatoric moments achieved in live performance. This leads to rendering Stage 3; post-performance extraction, refinement and/or recreation of materials (stereo or mono). From here, materials may be re-spatialised into a multi-channel format. Alternately materials may be reinserted into the performance situation, further exploring aleatoric development with newly refined spectromorphologies; here a feedback loop is established between the live performance stage and rendering Stage 3. Stage 4 (following the

possible re-spatialisation stage) is the *composing stage*, being the organisation of combined extracted, refined, multi-channel, stereo and mono renders to produce a fixed media outcome. As seen in Figure 24, this outcome (or elements of the final fixed media work) may later be extracted or dismantled and inserted back into the performance stage, either compacted down to stereo or, depending on the environment, as multi-channel renders for application in semi-improvised multi-channel performance.[136]

Fixed media and live performance outcomes may be structurally related, or structurally disassociated, while being potentially linked by spectromorphological association between materials developed and deployed. The final *diffusion performance stage* may appear isolated in the model, as an end point to the process – this may or may not be the case. I have often reworked aspects of compositions after first exploring them in the concert hall performance environment; diffusion may therefore inform further development of composed (and/or live electronics performed) space-forms, among other compositional concerns.

In conclusion, the proposed model highlights the potential for live semi-improvised performance practices to directly contribute to composed outcomes; processes of montaging, transformation and wilful subversion of prototype structural frameworks through spontaneity and persistence in performance, allow the harnessing of aleatoric musical events for featured inclusion in composed works and future performances.

7.4 The future

My five year immersion in acousmatic electroacoustic music has provided me the time to develop and refine technical processes and aesthetic thinking, and will continue to inform my ongoing musical development. As I conclude my work at the Novars Research Centre, I consider the end of my time here to mark the beginning

[136] To date I have performed two semi-improvised live electronics sets in multi-channel (quadrophonic) environments, utilising mono, stereo and 4-channel rendered files for spatial effect. The performances were *METANAST* at Chorlton Arts Festival, Manchester, UK, 17 May 2015, and (as contributor to a collaborative semi-improvised work curated by artist Rachel Goodyear and composer Sam Weaver) *A Line Fractured Into A Thousand Aberrations*, Samarbeta residency, Islington Mill, Salford, UK, 27 August 2015.

of a new stage of development as both composer and performer. Most immediately, I imagine my work will pursue explorations in combining sound synthesis, coding, chance procedures, rhythmic focus and space-form in acousmatic composition and performance. I will continue to develop live electronics performance practices, seeking ways to further strengthen bonds between the disciplines. This journey feels to have brought me full circle, concluding in some ways back where I started (as a performing electronic musician), reinvigorated to pursue new approaches, explore new possibilities and to cultivate outcomes worthy of presentation to the broader research community, in contribution to the ongoing development of electroacoustic music as a performed art.

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Appendix A: Programme notes and key performances

Frictions/Storms (2013)
8-channel fixed media
Duration: 12:17

Frictions/Storms explores source materials that are linked through friction, as integral to the cause behind sound generation. Sources include the push-pull of sawing on wood, the back and forth action of bowing a violin, the dragging of clay tiles across one another and ceramic tiles struck together (producing resonances). Recorded materials were heavily processed to create textural passages that recall shifting weather patterns, heavy winds, (electronic) storms and thunder. The identifiable sound of the violin provides a degree of grounding in a piece employing prominent use of third-order and remote surrogate sound transformations.

Key performances:

- *MANTIS Festival*, University of Manchester, UK. 3 March 2013 (premiere).
- *Toronto Electroacoustic Symposium (CEC/NAISA co-presentation)*, Wychwood Barns, Toronto, Canada. 15 August 2013.
- *MANTIS Curated Concert*, De Montfort University, Leicester, UK. 15 January 2014.

Rise (2013)
Stereo fixed media
Duration: 12:10

Rise explores the application of abstract transformation types as primary sound materials, the use of reductive transformation processes (such as distortion and bit reduction), space in the stereo image and expectation in acousmatic composition. The work features remote sound materials that are given coherence through the application of what Denis Smalley identifies as *structural functions*; these deal with expectation and the possible predicted directionality of a piece of music. During the developmental stage I identified what were to become two key texture passages in the work; using Smalley's descriptors, these suggested classifications of *arrival*, *statement* and *prolongation*. The creation of contrasting sections and transitions that direct motion towards and away from these focal points provide flow and structural development. Further coherence is achieved through use of related variations of gestures presented in a series of transformational states throughout the work. Source bonding in *Rise* is therefore explored via aurally perceivable relationships between featured sound-shapes, as opposed to notions of (identifiable) real-world sources and causes.

Key performances:

- *Eighth Biennial International Conference on Music since 1900*, Liverpool Hope University, UK. 11 September 2013 (premiere).
- *MANTIS Fall Festival*, University of Manchester, UK. 27 October 2013.
- *Embracing Rhythm, Welcoming Abstraction Sonic Fusion Conference*, University of Salford, UK. 8 November 2013.
- *Duration Concert*, UCLan, Preston, UK. 22 April 2015.

Glitches/Trajectories (2014)
8-channel fixed media
Duration: 11:29

This piece, as the title suggests, explores audio faults (digital 'glitches') and space (specifically trajectories of sound) articulated through an 8-channel image. I chose to work with sequences of audio containing digital faults created through simple subversion of audio playback and transformation tools. Denis Smalley's spectromorphology syntax is suitable in discussing the work; focus throughout is on *behaviour* and *motion and growth processes*. Earlier sections contain a degree of imitative and reactionary behaviour (exploring *activity/inactivity, instability, emergence/disappearance and empty/full* spectral density*).* Later, spatially trajectorial sound materials explore interaction and *agglomeration/dissipation* growth processes. As the composition came into focus I found the lines between gesture and texture becoming increasingly blurred. This is emphasised through the structuring of a final extended section featuring variations of sound materials that may be perceived as equal parts gesture and texture, exploring perspectival space and vectorial space in circumspace.

Key performances:

- *MANTIS 10 Year Anniversary Concerts*, University of Manchester, UK. 2 March 2014 (premiere).
- *Sonic Fusion MANTIS Concert*, Media City, University of Salford, UK. 3 April 2014.
- *METANAST Concert*, Underland, Manchester, UK. 9 April 2014.
- *New York Electroacoustic Music Festival*, Abrons Arts Centre, New York, USA. 5 June 2014.
- *Sound, Sight, Space, Play Conference*, De Montfort University, Leicester, UK. 18 June 2014.
- *ICMC/SMC*, Onassis Cultural Centre, Athens, Greece. 18 September 2014.
- *Sonic Fusion Festival*, Media City, University of Salford, UK. 19 February 2015.
- *IfIMPaC*, Leeds College of Music, UK. 12 March 2015.
- *Sound As Being*, Lancaster University, UK. 20 March 2015.

Transmissions/Intercepts (2015)
5-channel fixed media
Duration: 24:32

Transmissions/Intercepts is a large-scale multi-channel work themed on the mysterious undisclosed soundworld of government shortwave radio broadcasts known as *number stations*. These broadcasts (widely understood to be a form of spy code) may be intercepted by anyone in possession of a shortwave radio, and generally take the form of a brief 'tune-in' tone or melody, followed by several minutes of morse code, or a voice relaying a sequence of numbers, concluded with a signifying 'end' or 'out' message. There is an eerie, lifeless quality to the broadcasts; the voices themselves are clearly automated, and it is in the merging of what Denis Smalley terms as *utterance space* (space produced by the human voice), *mechanised space* (identifiable as non-human in causality), and *mediatic space* (space associated with communications, mass media, and broadcast), that a basis for sonic exploration is found. The piece therefore focuses on the source bonded qualities of the human voice in conjunction with abstract sound materials, in attempts to produce a work rich in electroacoustic musical language.

Throughout the piece the voice is explored as a sound object; numbers relayed, words spoken (the phonetic alphabet), and numbers read out in different languages (number stations are a global phenomenon) have no inherent meaning beyond that of sounding words or words associated with broadcast. I also opt for tonal content to feature in the work; stable pitch drones may imply a connection to the concept of the piece (as metaphor for multiple continuant radio broadcast streams to be intercepted). In addition, tonal content establishes a degree of musical grounding for the listener, while providing an appropriate texture-setting in which remote and noise-based gestural materials unfold.

Key Performances:

- *MANTIS Festival*, University of Manchester, UK. 28 February 2015 (premiere).
- *Musical Chit-chat Concert*, Contact Theatre, Manchester, UK. 14 April 2015.

Reductions/Expanses (2015)
8-channel fixed media
Duration: 13:39

This piece focuses on the production of expansive perspectival space and notions of suspended and extended time. By reducing frequency content of surround sound materials it becomes possible to create the illusion of spatial transcendence (events occurring beyond the performed space, as defined by the concert hall and loudspeaker placements within).

Structurally in two halves, *Reductions/Expanses* features a shorter opening section that explores clustered tonality and spectral reduction resulting in a murky soundworld. In contrast, the second half focuses on tonality via the merging of abstract resonant content (developed from metallic objects including sheet metal, iron rods and U-shaped iron ground hooks) with more grounded, tonally-based materials created from source recordings of (attack-decay) acoustic guitar notes and chords. Guitar recordings have in part been (aurally) selected to mirror component spectral content found in the metal resonances, allowing the possibility of timbral metamorphosis to play a compositional role. The illusion of extended and suspended time is achieved via several processes, including the creation, layering and spatialisation of multiple continuant spectral resonances (via granular synthesis) resulting in texture-carried pericentral spatial motion. Behaviourally active gestural materials also feature, providing timbral and musical contrast while a textural dominance is maintained throughout the work.

Key performances:

- *MANTIS Festival*, University of Manchester, UK. 17 October 2015 (premiere).
- *Echocroma XIV*, Leeds Beckett University, UK. 24 November 2015.
- *New Music North West Festival*, Martin Harris Centre, University of Manchester, UK. 25 January 2016.
- *iFIMPaC*, Leeds College of Music, UK. 11 March 2016.

Iteration/Banger (2016)
8-channel fixed media
Duration: 7:51

Iteration/Banger is an intense electronics workout inspired by rave and post-rave music, incorporating genre-specific sound materials and developed using MaxMSP coding software. Taking the principle of audio-rate sequencing as a starting point (to generate timed events with a *phasor~* ramp object for sample-accurate sequencing), the main programming patch manipulates a primary sine wave, up to three synthesised kick drums, additional gated and processed gestural noise materials and some simple FM synthesis. The resulting computer instrument is capable of producing unpredictable rhythmic output with timbral variation. The output is further shaped through several complex effects processing chains via Ableton Live. Finally, the stereo signal from Live is sent to a third transformative stage (a second Max patch) designed to manipulate sound spatialisation for an 8-channel output. Materials were generated using this three stage process, then selected and organised by ear.

Structurally the work applies iteration on both micro and macro levels (as is often the case in rave music); repetition defines the work, sections decay into dense sound drones to then dissipate, followed by bursts of variational and complex rhythm. While certain sound materials have been developed to create a sense of vectorial spatial movement and perspectival space-forms, the work primarily features chance spatial outcomes achieved through aleatoric processes, and the majority of sound materials, by design, exist in proximate circumspace.

Key performances:

- *MANTIS Festival*, University of Manchester, UK. 6 March 2016 (premiere).
- *Off the Beaten Track* curated by Matthew Bourne, proceedings of the *iFIMPaC* conference, Belgrave Music Hall, Leeds, UK. 11 March 2016 (stereo live electronics version, premiere performance).

Appendix B: *Iteration/Banger* technical information

The following elaborates on the functionality of the two Max patches (included in *Appendix_C/Software*) and the Ableton Live setup designed and implemented in the production of *Iteration/Banger* producing a three stage signal path (see *6.2 Development in Max and Live* and Figure 22).

B.1 Patch 1: sound generation and sound triggering

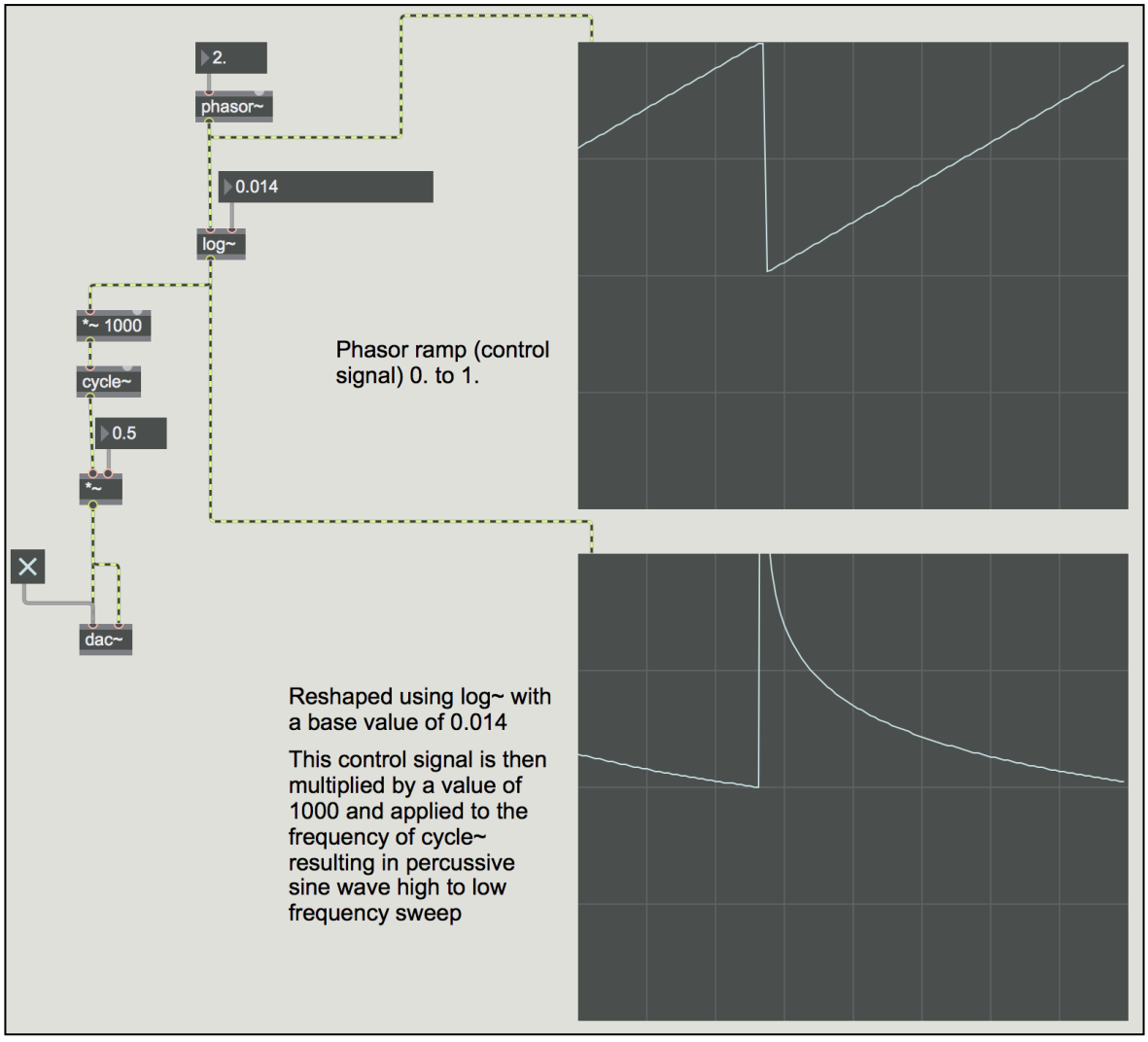

Figure 25: Reshaping phasor~ ramp signal via log~.

Sine wave shaping

Taking the principle of audio-rate sequencing as a starting point (to generate timed events with a *phasor~* signal ramp object for sample-accurate sequencing), the

signal generated from a phasor~ object (ramping from 0. to 1. at a rate determined by an inputted frequency value), acts as a master clock.[137] This signal is used to create and control a combination of (synthesised) real-time shaped elements and pre-rendered audio, triggered through chance procedures as dictated by the patch's algorithms.

The phasor~ signal is fed into a *log~* object that calculates and outputs a signal composed of the logarithms of its input values, determined by a given logarithmic base value (see Figure 25 for a visualisation of the reshaping of the phasor ramp signal via log~). The new signal out from the log~ is multiplied by a value of 1000 and sent to the frequency inlet of a *cycle~* object (a sinusoidal oscillator), now outputting the multiplied signal within audible frequency range. The resulting output from cycle~ is a signal comprising stable iterative variations of high to low sine wave sweeps. The rate of iteration is determined by the frequency of the Phasor~ (in the case of *Iteration/Banger*, the frequency value most maintained is 10).

The phasor~ is also used to create a sample-accurate *bang* (a trigger message also outputting at the rate determined by the frequency of the master phasor~). This bang is used to generate random numerical values that are then scaled and sent to the log~ base value inlet. By feeding the log~ base value inlet a stream of random values (generated by a *random* object and scaled to be within a given minimum/maximum range as determined by arguments given to a *scale* object), the signal output values from log~ are recalculated, reshaping the audio output of cycle~, resulting in timbral variation (a constant reshaping of high to low frequency sweeps, allowing different frequency ranges to be more or less audible on each iteration). The resulting audio output is a rapid, stable stream of iterations with chance timbral variations. This real-time generated sine wave output formed the basis for the creation of *Iteration/Banger*.

[137] See MAX online reference for more information on audio-rate sequencing. [online] Available at <https://cycling74.com/wiki/index.php?title=MSP_Sequencing_Tutorial_1:_Audio-Rate_Sequencing>, accessed 4 May 2016.

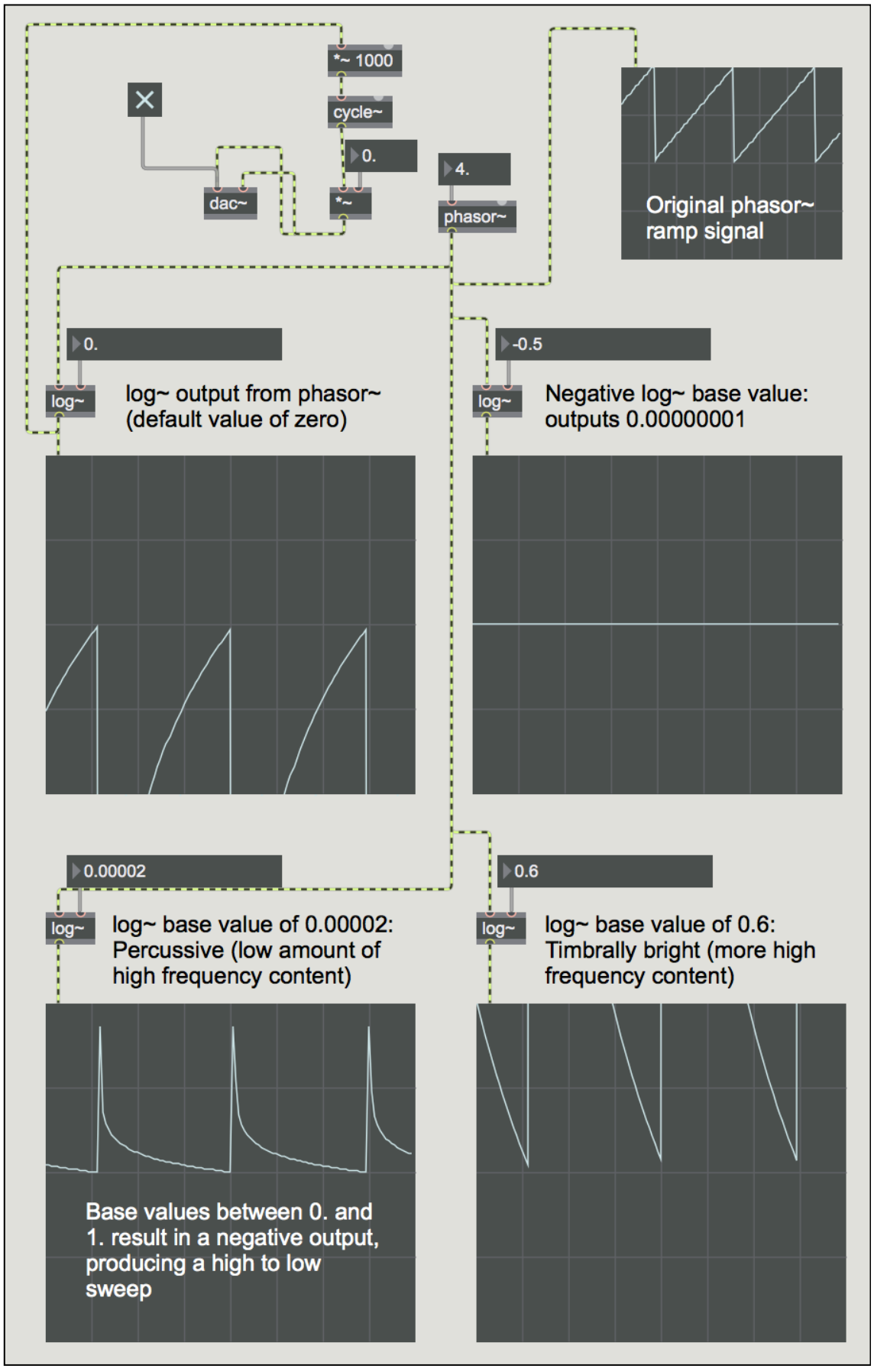

Figure 26: Logarithmic output of the phasor~ signal (four examples).

Chance silences

Base values between 0. and 1. fed to the log~ create high to low frequency sweeps. Feeding the log~ base a negative value results in an output of 0.00000001; when this signal is multiplied and sent to the cycle~ object it results in silence. By scaling the minimum/maximum range of random values fed to the log~ base, to fall between positive and negative values (for example, minimum value: -3, maximum value: 0.9999), the regularity of the log~ output signal (as determined by the frequency of the phasor~), becomes fragmented; here chance procedure determines that the output from cycle~ will either be a high to low sine sweep, or a silence, resulting in indeterminate rhythmic output. Figure 26 displays four examples of reshaped phasor ramp signals via log~ with different base values.

Synchronicity, triggering of rendered audio and real-time FM gestures

A stream of random values are created in the *PHASOR_LOG_BASE MANIPULATOR* sub-patch, triggered by the sample-accurate bang. These are sent to multiple scale objects, that feed output to the log~, in turn changing the timbral shape of the cycle~ sine wave output. *Toggle* objects (on/off switches) and *gswitch2* objects (allowing the switching of one input between two outputs) are used to switch data flows, sending the random values outputted to selected scale object inputs. Each scale object is given different minimum/maximum range arguments. Output values from the current active scale object (as chosen via toggle switch selection) are sent to the log~ base inlet. By sending random values to different scale objects, the sound/silence output ratio is changed. The scale objects therefore function as pre-set states that vary both the amount of chance rhythmic activity and also the timbral shaping of the sine wave iterations.

The random values are also sent to the *KICKPATCH* sub-patcher, where synthesised kick drum sounds are triggered (on receiving a positive value) using *buffer~* and *groove~* objects for storage and playback of pre-rendered audio. Playback of audio therefore occurs in conjunction with the cycle~ object's audio output, synchronising the shaped sine wave iterations with the kick drum output. Two settings are available to change the output of the kick drum sub-patcher. The first state restricts the output to trigger a single kick drum sample. The second

state uses *counter* and *gate* objects to access and trigger up to three kick drum samples. Here, the output of pre-rendered, triggered audio is sequential (a fixed order of events where positive values to log~, create bangs that are outputted from the gate object outlets in sequence, accessing the three groove~ objects containing kick drum samples). The use of an odd numbered 19-step sequence in combination with with the non-triggering of samples on receipt of negative values to log~ creates undeterminable variations in the output, producing aleatoric rhythmic outcomes.

In addition, generated random values are scaled and sent into *split* objects. The split objects are given arguments that send positive and negative input values to separate outlets, allowing the creation of discrete positive or negative bang messages. These bangs are then used to trigger discrete events. For example, when FM rhythm (generated by the *FM_addition* sub-patcher) is engaged and the toggle object connected to inlet 4 of *PHASOR_LOG_BASE MANIPULATOR* is also engaged, additional FM gestural output is produced independent of the sine wave output from cycle~ ; here, FM gestures continue to be triggered when the sine wave output is silent, creating further rhythmic diversity and syncopation.

The sub-patcher *FM_addition* generates short gestural bursts of randomised FM synthesis using the Max *simpleFM~* sub-patcher. Random objects triggered by bangs received from the *PHASOR_LOG_BASE MANIPULATOR* sub-patcher generate values that alter the carrier frequency and harmonicity ratio. The modulation index and amplitude are shaped by pre-set envelopes, determined by two *function* objects (breakpoint function editors). The toggle switch attached to inlet 2 of *FM_addition* provides two settings for the duration of gestures (while retaining the pre-set envelope shapes) resulting in very short gestures, or longer gestures (both durations are under 1000ms).

An alternate triggering procedure

The sub-patcher *MORE_RHYTHM_RANDOMS* produces chance output of triggered audio and silences via an alternate method. Here the sub-patcher is constantly fed the sample-accurate bang signal, and a selection of 25 groove~ objects are continually and randomly selected and triggered in no fixed sequence

via a gate object. Some of the buffer~ objects contain no audio and therefore when triggered result in silence. Random values between 0 and 29 are sent to the gate object (dictating the outlet through which the bang signal is sent), although the gate object itself has only 25 outlets. Therefore when the gate object receives values between 26 and 29 this also results in silence, creating further rhythmic variation.

Possible changes to the state of aleatoric audio outputted from Patch 1 include timbral shaping, the adjusting and acceleration/deceleration of tempo, active/sparse output, rhythmic/non-rhythmic output and synchronised/syncopated output. Please refer to *Appendix_C/Tutorials/Patch_1_Tutorial.mov*, for a comprehensive video introduction to Patch 1's musical functionality.

B.2 Stage 2: Ableton Live real-time transformation and MIDI control

The Ableton Live session created for *Iteration/Banger* relies on third party plug-ins from several audio software companies (including iZotope, Waves Audio, and Cycling 74's Max for Live) and as such a copy of the original Ableton setup was not possible for inclusion here. Instead, an alternate session is provided that demonstrates a reduced and simplified version of the Live processing chain, using plug-ins native to Live 9 standard edition (see *Appendix_C/Software/Iteration_Banger_Ableton_Session/Iteration_Banger_Ableton_Session.als*). Table 4 lists the key transformative processes featured in the original Live session, and identifies their application to channels/audio outputted from Max Patch 1 (via ReWire).

A Novation Launch Control XL MIDI interface is used to manipulate the Ableton session; Figure 27 displays assignments of physical dials to software sends (controlling dry/wet signals) and controller buttons to on/off toggle states of plug-ins. Some toggles are used to control multiple plug-in states, for example, when band-pass filtering is applied to Max channel outputs 1 and 2, the frequency reduction results in a loss of amplitude. Therefore when band-pass is engaged a utility object is also engaged in order to boost the volume to an appropriate level.

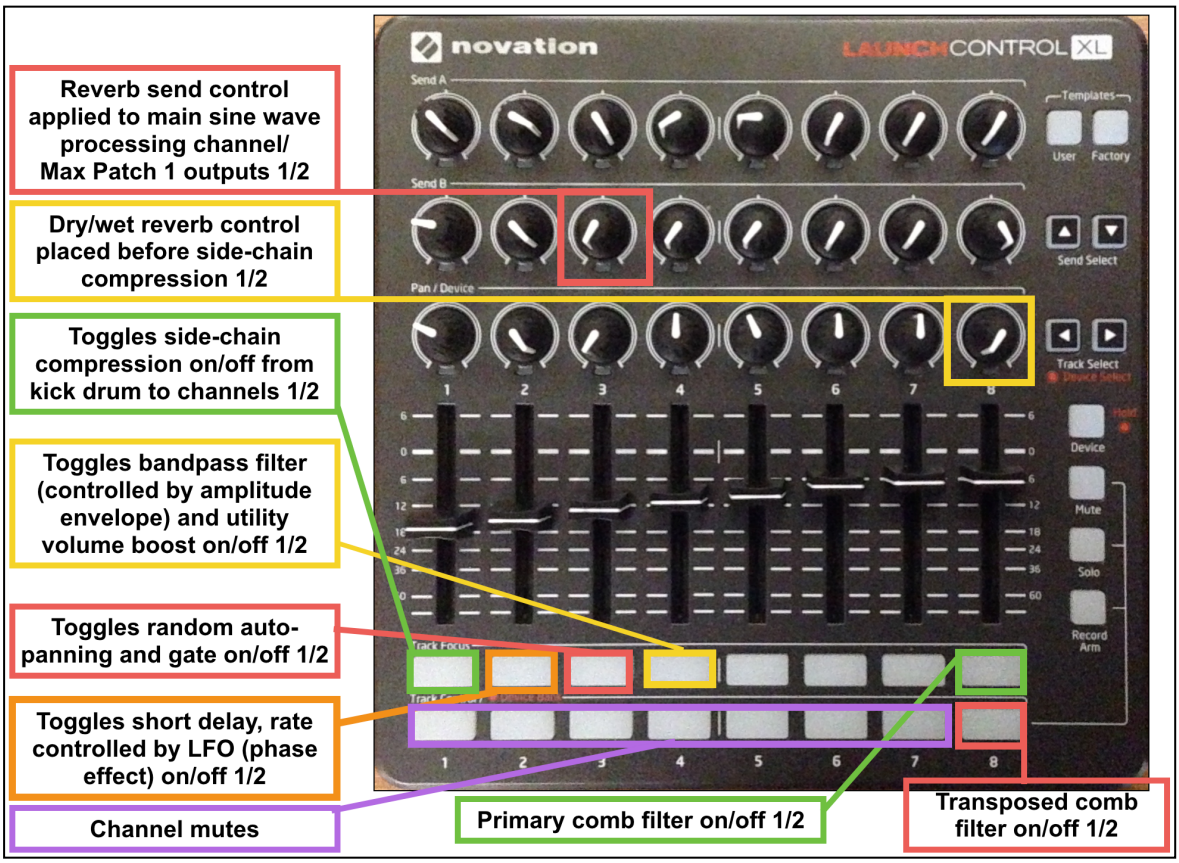

Figure 27: MIDI controller assignment overview.

For performance purposes the MIDI controller communicates with Ableton and the MacBook Pro's trackpad is used to adjust states of toggle switches in Patch 1. The *udpsend* and *udpreceive* objects included in the Max patches allow for various Patch 2 spatialisation states to be controlled by activating toggle switches in Patch 1 (via Ethernet). See *Appendix_C/Tutorials/Patch_2_Tutorial* folder contents for more information.

Max Patch 1 output channel to Live	Sound type:	Real-time generated or pre-rendered playback:	Triggered by:	Processing (Ableton Live):	Musical effect
1/2	**Sine wave shaped by phasor~ and log~**	Real-time	Positive values to the log~ base	Comb filtering (switching between two settings)	Tonality and transposition
				Auto-panning/ Gating	Random fragmentation of the stereo signal
				Band-pass filter controlled by amplitude envelope	Wah-wah like effect
				Long reverb/ sidechain compression from 5/6 kick drums (reverb is placed before compression in the signal path)	Spectral density/ compactness
				Long reverb 2 (via send)	Sustain and decay suggestive of perspectival space
				Short delay (time varied by LFO)	Phase effect
3/4	**FM synthesised gestures** (two durations)	Real-time	Positive values to log~ base/ independent	None	Two variation lengths of short unstable gestures
5/6	**Kick drums** (single kick or three variations)	Pre-rendered	Positive values to the log~ base	Bass enhancement (Waves Maxbass plug-in)	Low frequency content boosted/ enhanced
				Saturation/ Distortion (via send)	Spectral density
7/8	2 x alternate **kick drums** and **snare-like noise burst**	Pre-rendered	Sample-accurate bang (triggered empty buffer~ objects result in silence)	Frequency shifted up, distorted and low-pass filtered (controlled by LFO)	Transforms kick drums into a new gesture (shorter noise-based variations), all with real-time filter shaping
				Gating	Creates an attack-closed termination

Table 4: Max Patch 1, 8-channel output to Live overview.

B.3 Patch 2: randomised automated spatialisation

Patch 2 receives audio out from Ableton and redistributes the stereo signal by randomly outputting to any two of eight possible output channels at any one time. This randomised, automated spatialisation process is achieved by scrambling and repacking a list of channel numbers that are sent to a *matrix~* object functioning in *non-binary mode*. In this mode matrix inputs and outputs have variable linear gain stages allowing for crossfading between audio signals, as such, avoiding unwanted audio clicks. Bangs sent from Patch 1 (received by Patch 2 via udpsend and udpreceive objects) change the rate of occurrence of spatial reassignments and crossfade times (switching between a slow rate with more gradual crossfades and a rapid rate with shorter crossfades). A further udpreceive object provides the option to reassign spatial distribution in synchronisation with changes to the on/off state of Patch 1's DAC~, providing an alternate spatialisation method when the *DAC_DYNAMIC_ON_OFF* sub-patcher in Patch 1 is engaged; this was specifically designed for the generation of 8-channel audio featured in Section 5 of *Iteration/Banger* (5:00 - 6:31, spectrally sparse passage).

Patch 2 also features additional matrix~ objects in conjunction with sfplay~ objects, that allow the possibility of up to two 8-channel audio files, and one stereo file, to be randomly redistributed spatially. The stereo sfplay~ features pitch-shifting and time-stretching functionality. See *Appendix_C/Tutorials/Patch_2_Tutorial* folder contents for a tutorial video of Patch 2.