SOUNDING MATERIALITY

Explorations in Resonant Practice

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Declaration

I hereby declare that the work in this thesis has been carried out by myself except as otherwise specified.

Signed,

JAMES BULLEY

London, 19 August 2018

Acknowledgements

This thesis would not have been possible without the unending patience of my wife Havva, and my parents and siblings, who have been unfailingly supportive through the many years of this endeavour. I would like to dedicate this project to my as yet unborn child, who is soon to enter the world, and who has grown up over these final months listening to each and every word of this writing.

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Abstract

How might we explore material agency in sound arts practice to promote more ecological ways of knowing our world? Through practice-based inquiry what methodologies might emerge that can provide a framework for novel, open ways of exploring the relation between sound and materiality?

Sounding Materiality is an account of arts research that works at the intra-face (Barad 2000) of theory and practice. Through the critical analysis and portrayal of three case-studies, the thesis contributes two novel sound practice techniques of 'live composition' and 'locative sound', which it is proposed enable a closer and more fruitful relationship between materiality and sound. Within the case-studies that underpin the thesis, the process of experimenting with an expanded source bond between sound, meaning, and materiality leads to diverse explorations with natural systems, haptic art, phonography, sonic spatialisation, and participatory practice. Three sound-based installations are the catalysts for these inquiries, including two place-specific works driven by natural processes, *Variable 4* and *Living Symphonies*, and the haptic sound installation *Tactus*, conceived as a direct communicative artwork for the blind and visually impaired. These iterative works took place over the seven-year duration of this thesis (2010–2017) and have been exhibited publicly, with cross media documentation of their occurrences imbricated in this text. In their critical analysis two distinct contributions to sound practice emerge: 'live composition', a framework that uses sonification and generative techniques to drive real-time sound composition based on live source data, and 'locative sound' a technique that promotes the placing of sound in the reality of the world, drawing relationships of 'synchresis' (Chion 1994) between materiality and composed 'sonic events' (Cox 2015).

A methodological framework of 'resonant practice' inspired by Schön's 'reflective practitioner' (Schön 1987) emerges by reflection on these case-studies, portraying a praxis built on specific methodologies of 'material thinking' (Carter 2004), iteration, dialogic collaboration, and communication of knowing through an 'artstext'. 'Resonant practice' takes an 'acoustemological' approach (Feld 1994), venturing that an arts research project rooted in sounding materiality promotes unique, ecological and vibrant ways of knowing through sound. Through a resonant practice artists working with sound can aim to propagate a 'vibrant materialism' (Bennett 2010), forwarding communicative, ecological and sustainable approaches to our sonic and material environment.

Illustrations

The illustrations (visual, sound and film) referenced within this thesis are included in the physical copy on a USB pen drive. Within the digital .pdf version, illustrations are directly linked to or embedded within the text, or can be downloaded as a collated .zip file.[1]

Visual illustrations

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Fig.2 *The Weather Project* by Olafur Eliasson at the Tate Modern, 8 January 2004. Photograph: James Bulley.

Fig.3 Visitors to the Dungeness installation of *Variable 4*, Dungeness, 23 May 2010. Copyright: Ed Gillett.

Fig.4 Visitors at the *Variable 4* installation, Dungeness, 23 May 2010. Copyright: Louis Mustill.

Fig.5 Visitors to *Variable 4* installation, Snape Maltings, Aldeburgh, 29 May 2011. Copyright: Drew Cox.

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[1] See https://www.dropbox.com/s/s9qxmcsinpvjm94/Sounding%20Materiality%20-%20James%20Bulley%20-%20Media%20Archive.zip?dl=0.

[2] See https://creativecommons.org/licenses/by-nc-nd/4.0/.

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Fig.90 Listener at *Living Symphonies* installation, Cannock Chase, Staffordshire, July 2014. Copyright: Imogen Lloyd.

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F4. *Tactus No.1* Kaunas Biennial film, braille locative sound excerpt, 2015 [00'17"]. Excerpt from documentary film that was produced and edited by Kaunas Biennial. Copyright: Kaunas Biennial.

Practice Map

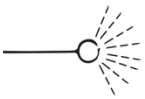
Key

SOUND

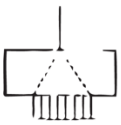
FILM

SPEAKER

WEATHER STATION



LOCATIVE SPATIALISATION



AMPLIFICATION

GENERATIVE PROCESSES

ATMOSPHERIC CONDITIONS

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Preface

An art practice does not arise from nothing. For me, a *jolt*[3] in my thinking occurred in the early 2000s, a number of years before the work in this thesis began. In early 2003 I visited the Tate gallery in Liverpool. Meandering around the huge industrial redbrick building, I found myself in a large sunlit room in the centre of a standing array of forty black block speakers, each emitting a different voice. The intonations of these speakers detailed the preparations and performance of the Tudor composer Thomas Tallis' *Spem in alium*, with the contrapuntal voices both separated and woven together in the space, framed and reframed by the perspective of the listener. The piece was Canadian composer Janet Cardiff's *Forty-Part Motet* (2001).[4] Cardiff was an artist I knew nothing about at the time, and the intimacy and expressiveness of the work astonished me—I'd never heard a piece of music or experienced an artwork in this way—with such degree of choice and spatiality: I wandered back and forth amongst the installation, listening to first one voice, then two, then walked to the back of the room to hear the collective merge into one auditory field formed from the acoustic reflections of the space. It seemed to me that Cardiff's approach prioritised the listener, it was both participatory, communal and provided a unique listening experience.

In early January of the following year I visited the fourth Unilever commission in the Turbine Hall of the Tate Modern, London.[5] Walking down the slow grey sloped entrance into the hall, a giant sodium sun bathed the vast misted space from high at the far end, the entire ceiling a mirrored reflection holding an image of its audience basking chromosome-like on the floor, recumbent in sublime British dialogue.[6] *The Weather Project*, by the Danish-Icelandic artist Olafur Eliasson, placed the audience at the centre of the work (in actual reflection, and in perspective).[7] I spent hours considering the

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[3] I consider a *jolt* in this practice-based context to mean a chance-orientated situational burst of energy causing a marked change of course or attitude. The usage is analogous with that of 'chance-encounter' and with Walter Benjamin's usage of the word: "The jolt in the movement of a machine is like the so-called *coup* in a game of chance" (Benjamin 2007, 177).

[4] Photographic documentation and further context for the 2003 Tate Liverpool installation of Janet Cardiff's *Forty Part Motet* can be found on the Tate website, here: http://www.tate.org.uk/whats-on/tate-liverpool/exhibition/janet-cardiff [accessed 2017/05/02]. At the time of exhibition, Janet Cardiff, *40 Part Motet* (2001) was on long term loan from Pamela and Richard Kramlich and the American Fund to the Tate gallery: http://www.tate.org.uk/art/artworks/cardiff-40-part-motet-l02502 [accessed 2017/05/02].

[5] A journal entry of photographs taken on that day can be found here: http://www.jamesbulley.com/journal-/2004/1/10/olafur-eliasson-the-weather-project-20032004 [accessed 2017/05/01].

[6] In *The Weather Project* Eliasson was inspired by nascent social conversations on global warming and by the British obsession with the weather.

[7] *The Weather Project* was an entirely different work when its audience were not present, as Frances Morris, the current director of the Tate Modern has noted: "I remember turning to my friend Donna De Salvo, who is now deputy director at the Whitney in New York, and saying, 'Gosh, this is a bit disappointing, isn't it?' and she said, 'Yes, a bit foggy,' and we both felt a bit gloomy. Thirty minutes later we came out of the press conference and there were about

work, lying on the floor, walking around the hall and behind the sun, talking with those I was with, looking at the effect such ostensibly simple techniques could produce. In a press release for the installation, the Tate has described Eliasson's process, noting the intentionality of the moment where the audience become conscious of the construction of the work, where they reach the end of the hall, where the workings are "deliberately exposed to the viewer".[8] For me, standing under the two hundred sodium-lamp semi-circle looking up at its wiring was not an Icarus-like melting of illusion: the exposure furthered the work—it captured my attention as to how it was communicating. In the years that have followed I have drawn deeply from two aspects of Eliasson's way of thinking: the implication of audience in artwork (a stepping into the world by both artist and arts institution), and the possibility that art can be made that *has reality*.[9]

300 people doing these Busby Berkeley things on the floor and it was just brilliant. All that activity!" (Morris quoted in Bailey, 2016).

[8] (Tate Press Office, 2003)

[9] In interviews about the turbine hall installation Eliasson has said that he intended the piece as a form of critique, both of art institutions and their machinations, and of notions of art as meta-perspective. In an interview with BOMB magazine Eliasson has observed: "Art and its institutions are not holy areas where you step out and all rules are off so that you can do weird things that you don't have to account for. I think that having an art experience is stepping into the world, it is having reality" (Eliasson quoted in Gilbert, 2004).

Fig.1 *Forty Part Motet* by Janet Cardiff at the Tate Liverpool.
2 February 2003.

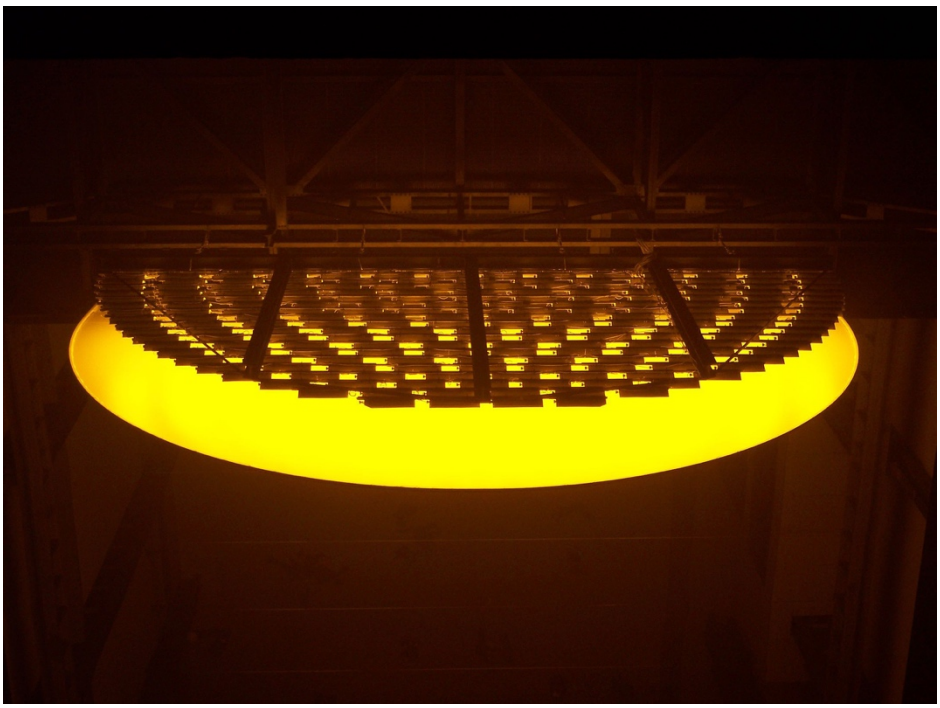

Fig.2 *The Weather Project* by Olafur Eliasson at the Tate Modern.
8 January 2004.

1. *Introduction*

Sounding

"A term for any procedure that involves penetrating the natural environment to make observations"[10]

"An observation of weather conditions aloft,
above the range of the normal surface weather observation"[11]

"Information or evidence ascertained as a preliminary step before taking action"[12]

"A measurement taken by sounding"[13]

"Resonant, Sonorous"[14]

This exploration in praxis is drawn from my working life as an artist in the period 2010–2017. As an arts research project,[15] the thesis explores two questions. How might we explore material agency in sound arts practice to promote ecological ways of knowing? What methodologies might emerge in practice that can provide a framework for novel, open ways of exploring the relation between sound and materiality?

From the three case-studies that underpin the thesis has emerged a methodology of 'resonant practice,' drawn from critical reflection upon the creation and iteration of the works.[16] Through intertextual and documentary analysis of the projects I have mapped the fundamental paths of inquiry that make up a 'resonant practice,' a methodology that engenders an open, fruitful and ecological mode, a way to successfully explore the intra-acting[17] of sound and materiality. In practice there always exists method, known or unknown, and by communicating and delineating my methodology I hope to share and demystify, illustrating the open contiguous relation between process and encounter.

My art practice is intrinsically dialogical, one of constant cooperation and collaboration, and I offer my indebtedness to those many friends and colleagues who

[10] "Sounding: Mining Engineering" In *Academic Press Dictionary of Science and Technology*, edited by Christopher G. Morris. 4th ed. Elsevier Science & Technology, 1992: http://search.credoreference.com/content/entry/apdst/sounding/0?institutionId=1872 [accessed 2017/09/28].
[11] "Sounding: Meteorology" In *Academic Press Dictionary of Science and Technology*, edited by Christopher G. Morris. 4th ed. Elsevier Science & Technology, 1992: http://search.credoreference.com/content/entry/apdst/sounding/0?institutionId=1872 [accessed 2017/09/28].
[12] "Sounding" In *Oxford English Dictionary* (2nd ed revised, 2005).
[13] "Sounding" In *Oxford English Dictionary* (2nd ed revised, 2005).
[14] "Sounding." In *Merriam-Webster.com*. https://www.merriam-webster.com/dictionary/sounding [accessed 2017/10/23].
[15] 'Arts Research' is a term that is expounded in Chapter 2.02 *Sound Practice Research*.
[16] 'Resonant Practice' is a novel methodology that seeks to draw together an acoustemological approach (Feld 1994) with Donald Schön's 'Reflective Practice' (Schön 1987). It is the subject of the following Chapter 2. *Resonant Practice*.
[17] I will be exploring the notion of 'intra-acting', which is derived from Karen Barad's writings, throughout this thesis.

have aided in the conception and creation of the case-studies detailed in this thesis - the works would not have come to be without them. I am not what George Steiner has termed "a solitary explorer opening up silent seas"[18] and threaded throughout this thesis are numerous attributions and references to the contributions of others. A particularly notable spur and companion on this pathway has been Daniel Jones.[19] Our ongoing collaboration as Jones/Bulley began in 2010 with *Variable 4* and continues through *Living Symphonies* and other works.[20] I must express my profound gratitude to Jones for allowing me to comment, outline and illustrate parts of this dissertation with works that we have borne together. 'Dialogic collaboration'[21] is a foundation of my practice, and it is through the constant generosity and patience of Daniel and others that I have been able to experiment, create and exhibit in what has felt a diverse and uninhibited manner.

My interest in sound has been a constant presence in my life. From a young age, I studied music composition and performance, learning a number of instruments at school before arriving in London to study music production, studio composition and sonic arts, first as an undergraduate, and then at master's level. Over this time, I developed a broad and wide ranging artistic practice, allowing cross-disciplinary techniques and learnings to freely intermingle. During the period of this thesis (2010–2017), I have been fortunate to have had the opportunity to undertake a large body of work that explores and extrapolates the ideas discussed here. This has included the scoring and sound design of two documentary feature films,[22] the scoring of a number of theatre and scenographic pieces at venues across the UK,[23] exhibition of film-sound installations,[24] a premiere realisation (with Shiva Feshareki and the London

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[18] See George Steiner's "The Mandarin of the Hour-Michel Foucault" in the *New York Times*, February 28, 1971.

[19] See Jones's online portfolio here: http://erase.net/ [accessed 2017/12/01].

[20] See the *Jones/Bulley* website for further information: http://jones-bulley.com [accessed 2017/10/02].

[21] Methods of dialogic collaboration are explored further in Chapter 2.05 *Ways of Making*.

[22] *Island* directed by Steven Eastwood (2017) is a lyrical, slow cinema description of the temporality and phenomena of dying, exploring the transition away from personhood. For more information about *Island*, see this recent article by Eastwood in the Independent: http://www.independent.co.uk/arts-entertainment/films/features/island-steven-eastwood-bfi-london-film-festival-a7979466.html [accessed 2017/11/01]. *E-LIFE*, directed by Edward Scott-Clarke (2017) investigates the social and environmental consequences of electronic waste and is soundtracked by a field recording based score derived from locative recordings in Agbobloshie, Ghana. For more information about *E-LIFE* see http://www.elifefilm.com/ [accessed 2017/11/01].

[23] These have included *The Weather Machine* with David Shearing at Stage, Leeds (more information: http://www.jamesbulley.com/the-weather-machine/ [accessed 2017/11/01]) and *You'll See Me (Sailing in Antarctica)* with Non Zero One at the National Theatre, London (more information: http://www.jamesbulley.com/youll-see-me-sailing-in-antarctica/ [accessed 2017/11/01]).

[24] This has included the generative film sound work *Progress Music*. Originally commissioned by South Kiosk, the piece draws on archive film material that was once broadcast across the screens of the nation, demonstrating the changes that were occurring in architecture, industry and culture in the 1960s, shown through a generative film and sound installation. The rhythm of the film is defined accordant to the behaviour of an indeterminate sound score, which composes the film in real-time from a repository of thousands of archival fragments. The nine-channel installation is presented so that the viewer becomes positioned within the material, as opposed to merely a spectator of footage from a bygone era. For further information see http://www.jamesbulley.com/#/progress-music/ [accessed 2016/07/07].

Contemporary Orchestra) of the historic 1948 work for orchestra and turntables *Still Point* by British composer Daphne Oram,[25] the exhibition of a number of autonomous sound sculptures,[26] and the curation of exhibitions and events.[27] Whilst the majority of these projects are not referred to within the main body of this text,[28] I mention them here to note that all of these works have had an implicit and permeable effect on the ideas outlined: they are part of the same body of practice. However, in order that I might lend detailed insight into the specific ways of knowing that have emerged in this time, I have chosen to restrict the works that I will use as case-studies to only three projects: *Variable 4*, *Tactus* and *Living Symphonies*. The unique challenges and sitings of these works has inspired, defined and driven my field of enquiry and from it my methodology:[29] through critical reflection the methodology of 'resonant practice' has emerged. The conceptual creation of the works also necessitated the development of novel compositional techniques, including those of 'live composition' and 'locative sound' as analysed in this thesis. Before I unfold these techniques, methods and theorisations in depth, I will present a brief overview of the three case-studies, outlining the territory from which these new ways of knowing has emerged.

[25] In 1948, whilst working as a radio programme engineer at the BBC and assisting the composer Ivor Walsworth, Daphne Oram began work on a new and highly innovative symphonic piece, entitled *Still Point*. The work was never performed, and the finalised copy of the score has been lost since Oram's death, with only a hundred or so detailed pencil draft pages remaining in her archive (now housed in the Special Collections at Goldsmiths, University of London). In 2015, I worked in collaboration with composer and turntablist Shiva Feshareki to research and explore the work. On 24 June 2016, we realised a world premiere performance of *Still Point* with the London Contemporary Orchestra at St. John's Smith Square, London. The premiere was part of Oliver Coates and the Southbank Centre's 'Deep Minimalism' Festival that took place 24-26 June 2016. Further information about the project can be found here: https://www.ft.com/content/4ca76a2c-3c4c-11e6-8716-a4a71e8140b0 [accessed 2016/07/04].

[26] This has included the Jones/Bulley works *Radio Reconstructions* (2012—), a live spatial composition of real-time analogue radio signals, and *Vespers* a sound installation that draws a notated vocal score in real-time based on the online activity of the UK, which was exhibited in the Royal Festival Hall, London (May–September 2015). Further information about these works can be found on the Jones/Bulley website here: http://jones-bulley.com/ [accessed 2017/07/07].

[27] This has included co-curation of the exhibition *SHO-ZYG* (2012) with Kathrine Sandys, which took its name from an improvisatory instrument, the Shozyg, invented by Hugh Davies, founder of Goldsmiths Electronic Music Studios. The exhibition sought to explore the rich tapestry of sound practice at Goldsmiths, University of London, both past and present, tracing lines through from the late 1950s to the present day. Selected works from over 50 artists were included, encompassing a broad range of practice: from acoustic ecology to generative musics, and from vocal utterance to audiovisual composition. See the exhibition website for documentation and a sound walk: http://sho-zyg.com/2012/sho-zyg.html [accessed 2017/10/09]. Other curatorial projects included the public curation project *Oramics to Electronica* at the Science Museum (see here: https://group.sciencemuseum.org.uk/our-work/research-public-history/research-projects/past-research-projects/oramics-to-electronica/ for further information [accessed 2016/08/09]), and the co-curation of *Longplayer Day 2017* with Helen Frosi and Philip Serfaty (see here: http://www.jamesbulley.com/#/longplayer-day-2017/ for further information [accessed 2017/08/09]).

[28] For a full list of works and activities undertaken during this thesis period see Appendix IV.

[29] See Chapter 2 *Resonant Practice* for a discussion of the methodologies underpinning my arts research.

Variable 4

Variable 4 (2010–),[30] created in collaboration with Daniel Jones as Jones/Bulley, is a remote, long-durational outdoor sound installation driven by second-by-second changes in the atmospheric conditions at its site. Gaining its name from variations in the Beaufort wind scale heard late one evening on the BBC Shipping Forecast, it was first installed in Dungeness, Kent in May 2010. A further three installations followed at Snape Maltings, Suffolk (May 2011), Elizabeth Castle, Jersey (September 2011) and Portland Bill, Dorset (September 2014).

At each installation of *Variable 4*, the audience senses minute alterations in atmospheric conditions reflected in immediate changes in the sonic events that emanate from eight speakers hidden in the surrounding landscape. The live composition that underlies *Variable 4* is based upon a twenty-four movement generative sound score, composed in response to the materiality of the place of its installation. Parameterisation of second-by-second streams of weather data (wind speed, precipitation, solar radiation, humidity, tropospheric variance, temperature) trigger and control numerous aspects of the process and spatialisation of a live composition, from movement selection to panning behaviours and note-by-note changes.[31] Further information about *Variable 4* including a project website and journal can be found online.[32] Two articles discussing *Variable 4* can be found on the New Scientist website[33] and the Quietus website[34]. A list of acknowledgements and further commentaries is included in Appendix I at the end of this thesis.

[30] The three projects discussed in this thesis are all ongoing, and as such, there is no end date to the period of their taking place. This reflects an 'iterative' approach to making work, something I will discuss further in Chapter 2. *Resonant Practice*.
[31] *Variable 4* has been supported by the Performing Rights Society Foundation (PRSF), Royal National Lifeboats Institute (RNLI), Aldeburgh Music, Faster than Sound, Branchage festival and B-side festival.
[32] See http://www.variable4.org.uk [accessed 2017/01/04].
[33] See https://www.newscientist.com/blogs/culturelab/2011/07/the-sounds-of-sunlight.html [accessed 2017/11/10].
[34] See http://thequietus.com/articles/06337-variable-4-snape-maltings-faster-than-sound [accessed 2017/11/10]

Iterations

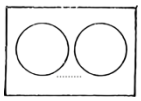
Dungeness, Kent, UK
22–23 May 2010
(supported by PRSF and the RNLI)

Snape Maltings, Suffolk, UK
28–29 May 2011
(supported by Aldeburgh Music and Faster than Sound)

Elizabeth Castle, Jersey, UK
22–25 September 2011
(supported by Branchage festival)

Portland Bill, Dorset, UK
5–14 September 2014
(supported by B-Side festival)

Film



F1. *Variable 4* Snape Maltings documentation film[35]

2011

04'21"

A film documenting the Snape Maltings installation of *Variable 4* was captured over the period 22–23 May 2011 by Drew Cox.[36] It was edited in the months that followed the installation by Jones/Bulley and is soundtracked by field recordings from the Hepworth Lawn site made using an Audio Technica BP4027 stereo shotgun microphone.[37]

[35] See https://www.dropbox.com/s/xzr6k4dd6lzjzaa/F1_V4_Snape_Maltings_documentation_film.mp4?dl=0.
[36] For more information about Drew Cox's film and photography work see http://drewcox.co.uk/ [accessed 2016/06/06].
[37] A time-lapse of the *Variable 4* installation at Snape Maltings (with thanks to Louis Mustill) is also available here: http://www.variable4.org.uk/stream/video [accessed 2017/04/04].

Fig.3 Visitors to the Dungeness installation of *Variable 4*.
Dungeness, Kent, 23 May 2010.

Fig.4 Visitors at the *Variable 4* installation.
Dungeness, Kent, 23 May 2010.

Fig.5 Visitors to *Variable 4* installation.
Snape Maltings, Aldeburgh, 29 May 2011.

Fig.6 Visitors to *Variable 4* installation.
Snape Maltings, Aldeburgh, 29 May 2011.

Fig.7 Elizabeth Castle installation site for *Variable 4*.
Elizabeth Castle, Jersey, 24 September 2011.

Fig.8 *Variable 4* installation at Elizabeth Castle.
Elizabeth Castle, Jersey, 24 September 2011.

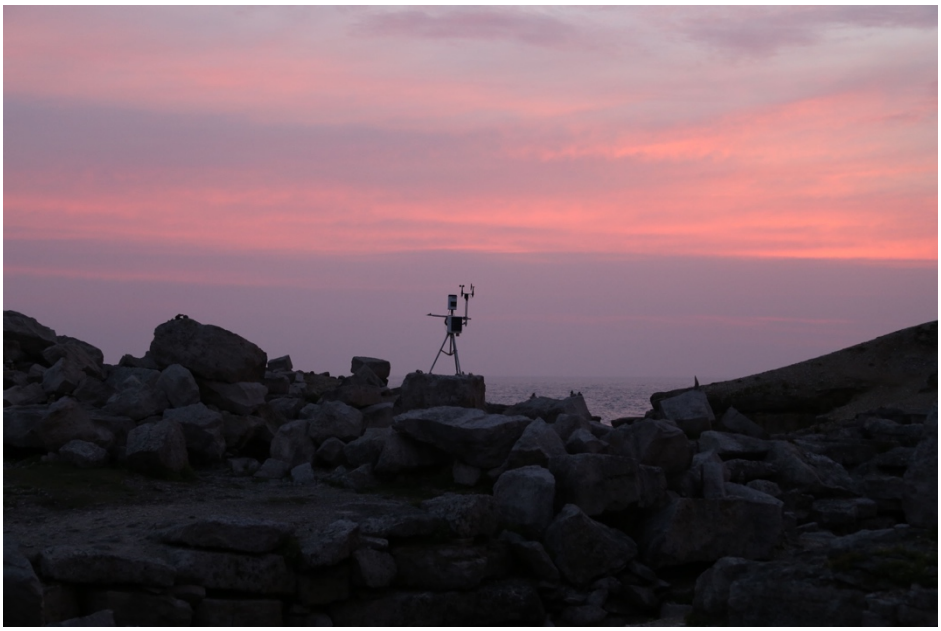


Fig.9 Sunset at *Variable 4* installation site.
Portland Bill, Dorset, 13 September 2014.

Fig.10 Children at *Variable 4* installation site.
Portland Bill, Dorset, 12 September 2014.

Living Symphonies

Living Symphonies (2014–), created in collaboration with Daniel Jones as Jones/Bulley, is a sound installation that explores the interrelations of a forest ecosystem. Through a highly detailed ecological model of the forest's flora and fauna, driven by real-time atmospheric conditions and behavioural research, the work creates an ever-changing generative spatialised live sound composition heard in real-time amongst the ecosystem. At the core of each *Living Symphonies* installation is a three-dimensional software model, developed through an in depth on site research period which includes manual surveying, observation and academic research. This ecosystem model is parameterised in real-time by weather conditions and time of day, and populated by a detailed taxonomy of the forest site. The real-time activity of agents within this model act as spatialisers and conductors for a composition that characterises the ecosystem through locative sound. *Living Symphonies* is heard as an 'auditory field'[38] of indeterminate duration, emanating from a twenty-four channel speaker system carefully embedded in the forest's undergrowth, foliage and canopy, with each species' sonic representation located where it might be expected to occur.[39] Further information about *Living Symphonies*, including documentation of the tour, visiting details and a journal can be found on the project website.[40] Two commentaries on the work can be found online on the BBC website[41] and the Guardian website[42]. A list of acknowledgements and links to further commentaries is included in Appendix II at the end of this thesis.

[38] I shall explore Don Ihde's conception of the 'auditory field' within Chapter 3.01 *Sonic Events*.
[39] *Living Symphonies* was commissioned by Forestry Commission England and Sound and Music with funding from Arts Council England to tour across England in 2014, where it visited four forest sites.
[40] See http://livingsymphonies.com/ [accessed 2017/08/09].
[41] See http://www.bbc.co.uk/news/uk-england-27256881 [accessed 2017/08/09].
[42] See https://www.theguardian.com/music/2014/aug/28/living-symphonies-james-bulley-daniel-jones-forest-orchestra [accessed 2017/08/09].

Iterations

Thetford Forest, Suffolk, UK
24–30 May 2014

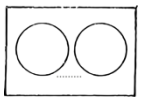
Fineshade Woods, Northamptonshire, UK
20–26 June 2014

Cannock Chase Forest, Staffordshire, UK
26 July–1 August 2014

Bedgebury National Pinetum & Forest, Kent, UK
26–31 August 2014

The 2014 tour was supported by Sound and Music, Forestry Commission England and Arts Council England.

Film



F2. *Living Symphonies* documentation film[43]
2014
03'14"

A film documenting the 2014 tour of *Living Symphonies* was captured by director Edward Scott-Clarke.[44] It was edited in the months following the tour by Scott-Clarke and Jones/Bulley and is soundtracked by unedited field recordings made by Jones/Bulley and Giles Stogdon at the four sites that *Living Symphonies* toured to in 2014. A documentary created by a film team from the journal *Nature* detailing the processes behind *Living Symphonies* is available online.[45]

[43] See https://www.dropbox.com/s/88adyoy4wvjs8lq/F2_LS_2014_tour_documentation_film.mov?dl=0.
[44] For further information about Edward Scott-Clarke's films, see http://www.edwardscottclarke.com/ [accessed 2017/06/06].
[45] See http://www.nature.com/nature/videoarchive/living-symphonies/index.html [accessed 2017/08/09].

Fig.11 Visitors at *Living Symphonies* installation.
Thetford Forest, 30 May 2014.

Fig.12 Visitors to *Living Symphonies* installation.
Thetford Forest, 29 May 2014.

Fig.13 *Living Symphonies* installation site.
Fineshade Woods, Northamptonshire, 24 June 2014.

Fig.14 Listener at *Living Symphonies* installation site.
Fineshade Woods, Northamptonshire, 24 June 2014.

Fig.15 Site view at *Living Symphonies* installation.
Cannock Chase, Staffordshire, 30 July 2014.

Fig.16 Listener at dusk at *Living Symphonies* installation.
Cannock Chase, Staffordshire, 30 July 2014.

Fig.17 Visitor to *Living Symphonies* installation site.
Bedgebury Pinetum, Kent, 30 August 2014.

Fig.18 Visitor to *Living Symphonies* installation site.
Bedgebury Pinetum, Kent, 30 August 2014.

Tactus

Tactus (2015–) is a gallery-based sound art work that investigates the potential of touch-sound works as a direct communicative art form for the blind and visually impaired. In exploring a textile-print score through touch, the audience composes the indeterminate work in encounter with a haptic sound landscape where sonic and textile materiality combine. The sound score of *Tactus* is heard through twenty locative speakers hidden beneath the surface of the haptic score. The project was conceived with a two-fold imperative: the creation of a direct communicative art form for the blind and visually impaired, and an interrogation into the curation of sound-based art in galleries and museums. *Tactus* was developed and showcased as part of a residency at London Printworks Trust in February 2011 and exhibited in its first iteration, *No.1*, at the Mykolas Žilinskas Art Gallery as part of the Kaunas Biennial in Lithuania (September 2015–January 2016).[46] Further information about the Kaunas exhibition of *Tactus No.1* can be found in an interview hosted on the Crafts Council website.[47] A list of acknowledgements is included in Appendix III at the end of this thesis.

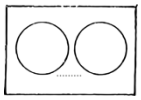
[46] *Tactus* has been supported by London Printworks Trust, Crafts Council England and Kaunas Biennial. *Tactus No.1* was exhibited in the *Sonic Pattern* exhibition curated by Janis Jefferies and Karen Gaskill at the 10th Kaunas Biennial.

[47] See http://www.craftscouncil.org.uk/articles/speakers-corner-james-bulley-and-myrto-karanika/ [accessed 2017/09/08].

Iterations

Sonic Pattern, Kaunas Biennial, Mykolas Žilinskas Art Gallery, Lithuania
18 September 2015–1 January 2016 (*Tactus No.1*)

Film



F3. *Tactus* Kaunas Biennial film[48]

2015
01'53"

Included here is an excerpt from a film documenting a visit by the local musician and composer Silvija to the *Tactus No.1* installation at the 10th Kaunas Biennial, produced by the Biennial team. The full film includes an interview and discussion about the making of the work.

[48] See https://www.dropbox.com/s/my5o2g5hjcan42f/F3_2015_Tactus_Introduction_Excerpt1.mov?dl=0.

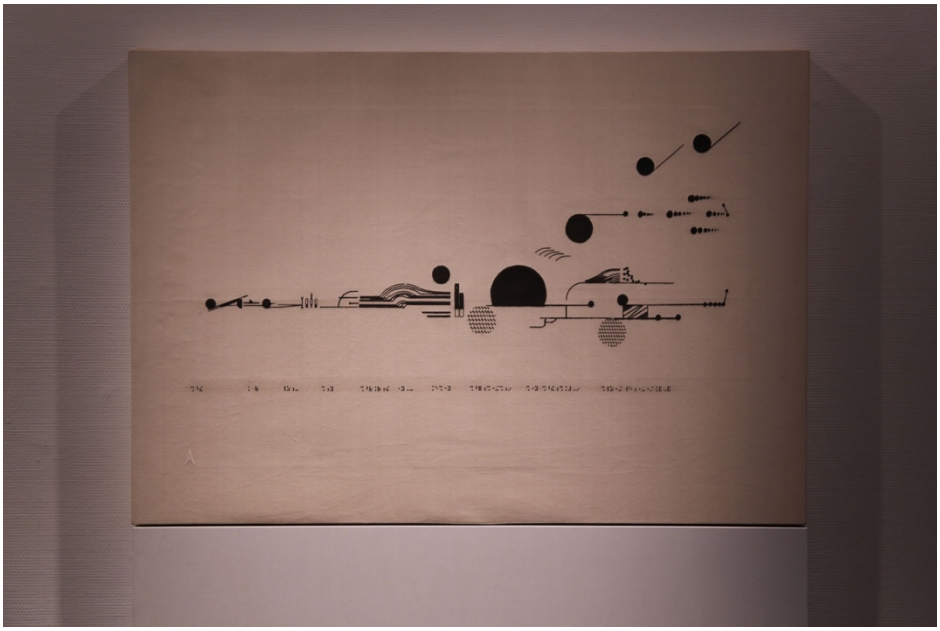


Fig.19 *Tactus No.1*.
Mykolas Žilinskas Gallery, Kaunas Biennial, 19 September 2015.

Fig.20 Visitors at *Tactus No.1*.
Mykolas Žilinskas Gallery, Kaunas Biennial, 19 September 2015.

Chapter Outlines

Chapter 2. *Resonant Practice* lays out the methodological framework that has emerged from a period of critical reflection on the case-studies detailed in this thesis. An open general attitude of 'resonant practice' is described, a form of 'sound practice research'[49] that uses an acoustemological[50] approach to creative sound-making. At its basis, this stance seeks out and propagates communicativeness, fluidity and resonance with materiality, harnessing the potentialities of Andrew Pickering's 'mangle of practice.'[51] 'Resonant practice' folds the specific methods of 'material thinking'[52], 'dialogic collaboration', 'iteration' and 'experimentation' into its path, seeking to create novel actualities that convey unique and meaningful sonic experiences *with* materiality.[53] At this intra-face[54] is found the title of this thesis: *Sounding Materiality*, the practicalities of which are explored through documentation, critical reflection and bundled theorisation in Chapter 3.

Chapter 3. *Sounding Materiality* conveys a critical analysis of my arts practice through reflection on the documented occurrences of the three case-studies. This analysis takes place using an 'acoustemological' approach, what Steven Feld has called "one's sonic way of knowing and being in the world."[55] This approach is shown to be a core tenet of a methodology of 'resonant practice.'[56] Techniques for sounding materiality are explored from diverse vantages, leading to critical reflections upon the creation and exhibition of the case-studies, including their use of technology. Experiments with Michel Chion's 'spatial magnetization' and 'synchresis' are discussed,[57] and explorations into the compositional tenets of Umberto Eco's 1962 *The Open Work*, Brian Eno's framing of generative music,[58] and notions of haptic sounding and covibration (inspired by sound system culture and the sound sculptures of Harry Bertoia) are undertaken.[59] Don Ihde's groundbreaking 1976 study *Listening and Voice* is referenced throughout this thesis: Ihde explores the locative aspect of listening with

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[49] See Chapter 2.02 *Sound Practice Research* for further discussion on the necessity for methodological discussions surrounding the use of sound in arts research.
[50] (Feld 1994)
[51] See Andrew Pickering's *The Mangle of Practice: Time, Agency & Science* (1995).
[52] (Carter 2004)
[53] Vibrant matter and ideas of materiality are explored in Chapter 3.02 *Sonic Vibrancy* and form the cornerstone of Chapter 4. *Sounding Materiality*.
[54] (Barad 2000)
[55] (Feld 2004, 462)
[56] See Chapter 2.02 *Sound Practice Research* for details of 'acoustemology' and the ways in which Feld's approach is reflected through resonant practice.
[57] Chion ventures the ideas of 'spatial magnetization' and 'synchresis' in his 1994 book *Audio-Vision: Sound on Screen*. For an in-depth discussion on these two notions see Chapter 3.04 *Locative Sound*.
[58] See Chapter 3.03 *Live Composition* for discussions of the application of Eno's tenets of generative music.
[59] See Chapter 3.01 *Sonic Events* for experiments with covibratory composition in *Tactus*, and Chapter 3.04 *Locative Sound* for a discussion of haptic, locative sound.

remarkable clarity, providing an inspiring agential theoretical bridge between sound and material.

Beginning with a focus on the fundamentals of sound, guided by Christoph Cox's 'sonic events' and Don Ihde's 'auditory field,' Chapter 3 starts by exploring how sound operates in space, investigating its 'transversal'[60] nature through practical examples of 'covibration,'[61] significance and resonance. A recent project assisting the artist Bill Viola to install the spatial sound piece *The Talking Drum* illustrates how sound signifies with, and is altered by, the space in which it is heard. The bisensorial, covibratory aspect of sound is then interrogated in depth in the case-study *Tactus*, allowing the opportunity to consider the relations between sound and touch, a vibrational duality that defines our daily encounters with materiality.

In Chapter 3.02 *Sonic Vibrancy* the potent vibrancy of sound is mapped theoretically in relation to Jane Bennett's *Vibrant Matter* (2010) as well as current notions of new materialism. This discussion allows for the consideration of how sound might be employed in an agential and vibrant way *with* materiality. By exploring materiality in its metaphysics and phenomenology we might consider what actually occurs when we 'sound' materiality, seeking to create what Bennett has termed 'vital materialism'.[62] Contemporary ideas of agency and new materialism are then elaborated with reference to Karen Barad's 'agential realism' and Pickering's 'dance of agency.'[63]

In Chapter 3.03 *Live Composition* we explore the case-studies in depth, considering how through the creation of new techniques for sound composition we can 'sound' materiality in practice. Starting from the raw matter of material itself, the notion of 'sensing materiality' is demonstrated in the use of capacitive and atmospheric sensors with sonification and pattern recognition techniques in *Tactus*, *Variable 4* and *Living Symphonies*. Explorations are made into the different types of sonification present in the works, and an analysis is undertaken of the ways in which each diverges from and challenges conventional definitions. *Variable 4* and *Living Symphonies*,[64] which respectively take the materiality of the atmosphere and forest ecosystem as formal definition, are then discussed and drawn from in depth. These case-studies lead to a definition of 'live composition,' a descriptive term that clarifies and distills the

[60] (Guattari 1984, 18)
[61] 'Covibration' is discussed in detail in Chapter 3.01 *Sonic Events*.
[62] A discussion of Bennett's 'vital materialism' can be found in Chapter 3.02 *Sonic Vibrancy*.
[63] See Chapter 3.02 *Sonic Vibrancy* for a further discussion of Barad's 'agential realism' and Pickering's 'dance of agency.'
[64] Both *Variable 4* and *Living Symphonies* are collaborative works created in partnership with Daniel Jones as Jones/Bulley.

simultaneously determinate and indeterminate elements of each work. In understanding the works as examples of 'live composition,' it is proposed that they become forms of 'assemblage,'[65] sounding materialities where sound functions *with* materiality. In this way the works can be considered as 'agentic assemblies,'[66] promoting unique, ecological and insightful ways of knowing through sound practice.

A further sound practice technique, inspired by the work of Chion and Dennis Smalley, and developed throughout the case-studies, is 'locative sound', a spatial practice detailed and discussed in 3.04 *Locative Sound*. Evolving initially from a naive reading of Smalley's 1997 writing on 'source-bonding,' the technique highlights that the spatial and locative ability of hearing is often overlooked. Chion's notion of 'causal vagueness,' discussed here with reference to my work on Bill Viola's *The Talking Drum*, and the experience of composing and installing the weather-based installation work *Variable 4*, enables us to traverse the ever-shifting terrain of what is understood to 'cause' sound. Specific and defined notions of sonic causality are interrogated through Chion's dual concepts of 'synchresis' and 'spatial magnetization,' both techniques that are illustrated in the case-studies, demonstrating strong potential to draw the listener into closer relationships with materiality. An expanded idea of synchresis is then proposed, one with a multi-sensory aspect, inclusive to the sensory domain of touch. This is explored through an in-depth critical reflection on the haptic sound work *Tactus*, and it is ventured that by making work with and for the blind and visually impaired we can gain unique insight into the locative relationship between touch, sound and materiality. Finally, the forest-based installation *Living Symphonies* is analysed as an extended example of 'locative sound,' within which 'synchretic' sound techniques are employed in forest ecosystems to create successful communicative intra-actions with the materiality of the natural world.

[65] A framework proposed by Felix Guattari and Gilles Deleuze in their book *A Thousand Plateaus* (1980). For further explorations of Deleuze and Guattari's formulation of the 'assemblage' see Chapter 3.03 *Live Composition*.
[66] See Chapter 3.03 *Live Composition* for a discussion of Morton's ideas of 'dark ecology'.

2. *Resonant Practice*

2.01 *Arts Research*

If I could it, I'd do no writing at all here.
It would be photographs; the rest would be fragments of cloth,
bits of cotton, lumps of earth, records of speech,
pieces of wood and iron, phials of odours,
plates of food and of excrement.

—James Agee
in 'Let Us Now Praise Famous Men', 1941[67]

In reflecting on the three case-studies presented in this thesis, a particular set of methodologies has arisen. These methods are summarised in this chapter as those of a 'resonant practice,' an open and processual stance that affords creative and insightful interrogations of the relation between sound and materiality. When analysing my arts practice, one of the more complex issues has been to reflect upon what Michael Polanyi has called 'tacit knowing.'[68] In the creation and development of each work, things happened intuitively, before, and in and around linguistic process. This highlights a key concern of 'arts research': how can we communicate an artwork in, between and beyond its instantiation. Whilst lines of text are the foundation from which human knowledge has proceeded, for me, successfully communicating tacit experience has required the development of forms of cross-media testament imbricated with critical intertextual analysis.

[67] (Agee 2006, 10)
[68] See Michael Polanyi's 1966 book, *The Tacit Dimension*.

The museum is not an illustration of the novel,
and the novel is not an explanation of the museum.

—Orhan Pamuk
in 'The Innocence of Objects', 2012[69]

Arts Research

In parallel with research being installed as the bedrock of knowledge in the late twentieth and early twenty-first centuries, there has been a creeping crisis in professionalism, manifest in an appetite for the public dismissal of expertise. Following Schön, we might attribute this to an overt dependence on 'Technical Rationality', where practitioners are considered the solvers of well-formed instrumental problems, utilizing theories and techniques derived from systematic and ideally scientific knowledge.[70] With 'Technical Rationality' practices of complexity, uniqueness, value-conflict and instability emerge as troublesome and problematic. What can follow is a situation of stasis, or as Carter has argued: "the new is commissioned on the condition that it merely intensifies what already exists".[71]

The concerns of the artworks discussed in this thesis which include the weather, forest ecosystems and haptic sound surfaces, are complex and ever-changing. We can see from the breadth of techniques utilised in the case-studies that they call for innovative cross-disciplinary forms of research including novel techniques and methods. Arts research documents this opening out from conventionally reductive and empirical ideas of research. Instead of seeking narrow and highly defined research questions from the outset it employs what Paul Carter has termed 'creative research,' a term which might soon be recognised as tautological, but currently still finds itself buttressed against the technical rational approach, which makes inventiveness simply too difficult to execute and document. Through creative research we shift our focus from solely the instance of the works and look toward what philosopher Bruno Latour has termed a "matter of concern": a view across the whole scenography, a shift of attention from stage to the "whole machinery of a theatre".[72] This communicative overview is a key criterion for arts research and one for which there are clear challenges.

What artistic practice 'is' remains persistently divisive, and art's epistemological relations—its generation of, participation in and contribution to knowledge commodities—remain a contested political domain. In this evasiveness however, art can be characterized: its slipperiness provides a spur toward inventiveness and the creation of new knowledge. Even with this wide-open view, the functioning of artistic practice can still be analysed and communicated methodically. The concomitance of arts and research produces unique and innovative results and is constituted of possibilities. As

[69] (Pamuk 2012, 17–18)
[70] (Schön 1987, 3–4)
[71] (Carter 2004, 7)
[72] (Latour 2008, 39)

Simon Sheihk notes, it is a privileged "intermediary between different fields, modes of perception and thinking."[73] As the fundamental of artistic practice is a concern with materialising ideas, arts research is then defined by creative process: artists act "mythopoetically,"[74] perceiving analogy between things far apart and dissimilar, bringing things into being that were not there before. To achieve concomitance of artistic practice and research, theorist Christoph Brunner has proposed that process must be foregrounded with end result.[75] All research deals in matter that signifies: it is a discourse of material signs. But in arts research, as Carter has it, "matter becomes mobile."[76] Through its mobility we find that arts research defends complex systems of communication from over-simplification, exploring the always unfinished processes that surround us, and recognising them as such. Arts research does not produce a singular discovery, but instead opens up new fields of understanding, making alignments between diverse cultural elements in a unitary manner that, as Andrew Pickering has noted scientific practice has often struggled with.[77]

But it is not only in challenging positivist scientific practice that arts research finds purchase. It has become increasingly commonplace in publications on material culture for authors to register a general complaint against academic social science for its tendency to reckon as if there were no things or objects in the world, only persons.[78] Arts research, especially since the dematerialisation of the art object in the 1960s, has found a focus upon exterior materiality as core to our existence, knowledge and understanding. Following post-modernism's keening for self-reflexivity in the early 1990s, the framing of art practice with research-based processes has fostered a thriving reflexive cross-disciplinarity, acting as a catalyst that draws together wide domains and forms of knowledge production, interrogating organisational systems, standards, and codes of communication. This has enabled arts research to be an experimental, observational and resonant zone, transgressing boundaries and questioning, probing and problematising to create new fields of knowing. Artworks are no longer a "frozen, timeless deposit on the flypaper of culture."[79] Through arts research, practitioners find methodologies that illuminate and animate the processual form with the practical product, unravelling new fields of knowledge.

Artstext

[73] (ibid., 5)
[74] (Carter 2004, 7)
[75] See Brunner's article "Research-Creation: the Generation of Novel Textures" (2010).
[76] (Carter 2004, 182)
[77] See Pickering's account of the experiments of physicist Giacomo Morpugo (Pickering 1995, 94).
[78] An excellent text on this matter is Bjørnar Olsen's 2010 book *In Defense of Things: Archaeology and the Ontology of Objects*.
[79] (Morris 1995, 73)

The form of this thesis is an example of what I have come to call an 'artstext,' an intertextual analysis, inclusive of knowledge sources and interleaved with a wide variety of art-media documentation, including photography, schematics, sound and film. The notion of an artstext is an expansion of what art historian W. J. T. Mitchell has termed an 'imagetext,'[80] a form conveying "composite, synthetic works."[81] The thesis as artstext presents an archive of concomitant arts research, to be considered alongside the occurrence of the works themselves. As a framework, artstext allows us to unpack the relation between sound and materiality by testament to what artworks do in a network of social and material relations, not solely what they mean.

Arts research as artstext calls for the promotion of a poiesis that is emergent and responsive, involving the adoption, adaption and invention of new documentation methods as ongoing process. These methods are eclectic and hybrid, what Norman Denzin and Yvonna Lincoln have called a 'bricolage': "a complex, dense, reflexive collage-like creation."[82] Through critical and reflective analysis of my practice I shift attention from the stage outwards, exploring the whole machinery of the theatre, placing the works in media res, within the dance of agency.

[80] See Mitchell's 1995 book *Picture Theory: Essays on Verbal and Visual Representation* and Christine Wiesenthal and Brad Bucknell's 2000 "Essays Into the Imagetext: an Interview with W.J.T. Mitchell."
[81] (Mitchell 1995, 89)
[82] (Denzin and Lincoln 2010, 4)

2.02 *Sound Practice Research*

> Rain has a way of bringing out the contours of everything;
> it throws a coloured blanket over previously invisible things;
> instead of an intermittent and thus fragmented world,
> the steadily falling rain creates continuity of acoustic experience.
>
> —John Hull
> in 'Touching the Rock', 1990[83]

Over the course of the last seven years, an array of general and specific methodologies have arisen from my artistic practice. As graduate representative for the Unit for Sound Practice Research at Goldsmiths,[84] I have been fortunate to be part of a thriving community of arts research practitioners, providing me with the opportunity to analyse, discuss and debate my methods at numerous talks, conferences and symposia.[85] Indeed, 'sound practice research' as a genre-specific form of arts research is a useful way of conveying the frame that surrounds this arts research project. 'Sound practice research' imbricates practice (creation and portrayal) with research (reflection on process and practice), layering the two as one intra-communicative project. The production of sounding artworks is a fundamental part of research process, and as Henk Borgdorff describes, "art is partly the result of research."[86] By considering this arts research project as concerned with 'sound practice research,' I can hone its epistemological communications, defining from the start exactly what is at play in utilising sound as an incisive tool in practice-research projects.

[83] (Hull 1990, 29–31)
[84] The Unit for Sound Practice Research (SPR) is a research group that integrates and advances the innovative activities of EMS composers and researchers. The Goldsmiths Electronic Music Studios (EMS) has been a leading centre for electronic music and the sonic arts since its founding in 1968 by Hugh Davies. See http://www.gold.ac.uk/spr/ [accessed 2017/09/10].
[85] See Appendix IV at the end of this thesis for a full list of talks and conference presentations undertaken 2010–2017.
[86] (Borgdorff 2006, 1)

Sound

Whilst Robert Morris has pointed out that when art-making is defined as process rather than product the artificiality of media-based distinctions can drop away,[87] in considering my own practice I find it useful to describe the distinctive qualities that sound brings to arts research. The delineation of these affordances is made challenging by the confusion of sound's basic definition. As Albert Bregman has noted, the word sound "refers indifferently to the physical sound in the world and to our mental experience of it."[88] As such, I have come to an open understanding, where sound is an immaterial form that acts both on and within materiality, and as an experience. Within my practice, sound is auditory information and sonic experience that is always in process. Whilst I will not discuss the phenomenological or semiotic aspects of sound in depth here,[89] the unique attributes of sound—as in-between and ever-becoming, both immaterial and with material—clearly encourage its deployment to provoke innovative ways of knowing materiality.

During long stretches away from home wandering deep amongst the various forests that hosted installations of *Living Symphonies* in 2014, it became clear to me that I was involved in what Steven Feld has called a 'situational engagement.'[90] These installations were explorations into the relationality of knowledge production in the forest, both contextual and experiential. My approach to creating these sound-based artworks is perhaps best described as 'acoustemological,' a term coined by ethnomusicologist Steven Feld in the 1990s which theorises sound as a way of knowing. In the forest, as Jones and I worked amongst the trees, calibrating and mixing the twenty-four speaker work we had created, we were engaged with acoustics at the plane of the audible, defining sound as simultaneously social and felt, what Feld calls "an experiential nexus of sonic sensation."[91] Our approach in both *Living Symphonies* and *Variable 4* was an acoustemological one, employing sounding and listening in an ongoing cumulative and interactive process of participation and reflection with materiality.

An acoustemological approach has crucial differences to that ventured in fields such as acoustic ecology, established by Canadian composers, R. Murray Schafer, Hildegard Westerkamp and Barry Truax, and instituted in the foundation of the World Soundscape Project in the late 1960s.[92] Acoustemology concentrates on agential,

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[87] (Morris quoted in Carter 2004, 7–8)
[88] (Bregman 1994, 10)
[89] See Chapter 3. *Sounding Materiality* for further discussions of ways of listening and sonic eventfulness.
[90] (Haraway 1988)
[91] (ibid., 12)
[92] See Schafer's 1977 book *The Tuning of the World* for perhaps the most influential text on this area.

relational and positional methods of listening and sounding. To analyse and reflect upon the works, which all promote what sound artist David Dunn has called "a means to practice and engender integrative behaviour,"[93] I find myself therefore adopting a quasi-ethnographic approach inspired by the writings of Hal Foster (in particular his 1995 writing "The Artist as Ethnographer?"). My approach is grounded in the principle that we cohabit with others-in-relation, attentive and attuned to innumerable actants—both material and immaterial, human and non-human. Employing ethnography in this way has enabled an interdisciplinary, alterior perspective, one that harnesses qualitative analysis of culture through self-critique. A quasi-ethnographic, acoustemological approach allows me to turn what are most typically theorized subject-object relations into something that to me represents a closer reality of an ecological, experiential, embodied subject-subject relation with materiality.[94]

When reflecting on my practice, it is clear that what Christoph Cox has termed a 'sonic philosophy' has emerged, an approach that investigates our material surroundings by sounding. Sound is allowed to generate conceptual thinking rather than be objectified by it. We ordinarily operate with a conception of things that begins and ends with the objects of our everyday experience, a tendency that orients us towards solid matter and results in the senses of sight and touch determining our everyday ontologies. The ephemeral and invisible arenas of smell, taste and hearing often inhabit the shadows. But sound is omni-present and inescapable, and we are immersed in it in a way that we not in the world of visible objects. By exploring these unique properties of sound in situ we can be provoked to modify our everyday ontology and change our general conception of matter. This shift can lead to what Cox describes as a "conception of being and matter that can account for objecthood better than an ontology of objects can account for sounds."[95] Here then, is what the 'sound' in 'sound practice research' might be: a forerunner for an acoustemological, rigorously experiential approach to practice, a sonic philosophy that avoids objectification in favour of sounding out subject-subject relations of matter.

Practice

In this arts research project, practice can be thought of as the vibratory in-between of process and product: it is the multiplicity of articulations and the multiple modalities of expression that have emerged from the processual activities underpinning the work. Whilst as Pickering has noted there are two ways of understanding practice,

[93] (Dunn 1997, 3)
[94] (Feld 2015, 19)
[95] (ibid., 124)

both singular (relating to specific repeatable sequences) and plural (as a set),[96] my practice is definitively the latter, culturally affective, generic: "the work of real-time cultural extension and transformation."[97] The works in this thesis came into being through this transformative process and they embody what Estelle Barrett has called an "experiential and performative form of knowledge production."[98]

In accounts of artistic practice the operation of logic is often overlooked, and it is important to note that in the creation of all of the works detailed, artistic strategies were not pre-determined but occurred 'in-the-game,' emerging and operating according to specific demands of action, logic and movement in time.[99] Ways of functioning were decided by choosing between multiple approaches, and exploring novel ways of combining them. Within the habitual embodied actions of my day-to-day artistic practice, temporal rhythms and cultural spaces have also caused innumerable tacit, generative and improvised changes to this process.

[96] (Pickering 1995, 4–5)
[97] (ibid., 218)
[98] (Barrett 2013, 63–64)
[99] (Bourdieu 1990, 66).

Research

Research is a term that has multiple lives, a reflexive processual surveying that is at once verb and noun. The term originates from the Middle French 'rechercher', meaning 'to look carefully,' with the root word 'search' generally defining a thorough investigation or exploration, and the prefix 're' meaning to go back and do it again with perhaps a bit more intensity. From the outset research has been inextricably bound to the slippery notion of paradigm: a typical pattern or model that might be considered a legitimate contribution to knowledge.[100] As we have previously discussed, research is most commonly related to the development of a static body of knowledge, with fixed and narrow research questions resulting in a definitive, quantifiable result. But in 1962 when physicist Thomas Kuhn defined a paradigm as "sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve"[101] he challenged this convention of positivist research. Knowledge became knowing and research began to be understood as requiring what Alanna Thain has called an "attentive posture,"[102] one that prioritises the "creative inbetween."[103]

Whilst in the present-day definitions of research have seemingly opened out to embrace Kuhn's proposition of paradigm, the introduction of the arts and humanities within the academy has required new methodologies to be developed that communicate the unique challenges of arts research. Datasets and quantitative analysis have rarely been adequate, and explorations have been made into the surrogacy of documentation as articulated evidence of research, as audit-worthy reportage. The form of this thesis seeks to contribute toward this discussion by way of the cross-media 'artstext' conveyed here.

[100] See Ego G. Guba's edited volume *The Paradigm Dialog* (1990) for further discussion on the subject of paradigms.
[101] (Kuhn 1962, 10)
[102] (Thain 2008, 2)
[103] (ibid., 2)

Praxis

'Sound practice research' as a form of arts research allows us to turn from the reasoned, logical research question toward what Brian Massumi has described as the 'thinking-feeling'[104] of research propositions. As Alfred Whitehead has suggested, at some point in the entertainment of a proposition, "judgment is eclipsed by aesthetic delight:"[105] propositions are hybrids of potentialities and actualities, neither actual nor fictive. They are the tales that might be told about particular actualities, from a given perspective, that enter into the construction of that very perspective. A proposition is an element in the objective lure proposed for feeling, and when admitted into feeling it constitutes what is felt. This articulation of the lure of feeling provokes the need for an integrated yet differentiated theoretical practice in arts research, something that I have come to call (following Barbara Bolt), a 'praxical knowing'. An artwork is unlikely to be an expression of research in itself (although this is possible), but knowing becomes derived from a performative relationship between artwork, material and artist.[106] My arts practice is one where I gain experience by handling materials in practice, whether it be working to integrate speakers and cabling into the forests for *Living Symphonies*, notating music scores for performance, or screen printing and developing of the textile-based haptic landscapes of *Tactus*. For me, an artwork embodies research findings which are symbolically expressed. Not only is a symbolic body of knowledge created with the work, but pathways are mapped for further knowings. To then create an affective 'praxis' in sound practice research, the symbolism of the artwork has to be combined with the communication of tacit knowledge and explicit process and it is only then that there exists the potential to engender knowledge.

[104] See "The Thinking-Feeling of What Happens", an interview with Brian Massumi, in *Inflexions* journal (2008).
[105] (Whitehead 1978, 185)
[106] See Barbara Bolt's *Art Beyond Representation* (2004).

2.03 *Ways of Knowing*

As we have discussed, arts research is concerned with both the creation of novel communicative entities, and the lived experience of those realities. It is in between the two that as Thain has proposed: "research-creation minds and mines that extended moment."[107] In putting aside the fixity of technical rationality, knowing becomes an active process, a "reflection-in-action" (Schön 1983)[108] more valuable than the temporal body of knowledge. Schön's core concept of 'reflective practice' has been of significant inspiration in charting the emergence of my own 'resonant practice' methodology. Put simply, knowing 'what' is important, knowing 'how' is crucial. Practice is imbricated as an active agent of inquiry, one that tacitly acknowledges the practitioner's own unique perspective.

Across the case-studies, knowing in and through practice and exploring its extended moment has allowed for the construction of knowledge, and its critique. At this reflexive conjoining of creative and critical we can uncover the pivot of knowing in each work. This experiential perspective on knowing finds its roots in the work of American pragmatist philosopher John Dewey, who stated that unless there is a continuity—a carrying over of learning from a previous situation to a new one—experience is 'disorderly'.[109] Barrett has drawn on Dewey to argue for the essential role of experiential learning in practice-led research, calling for "an intensification of everyday experience from which new knowing or knowledge emerges."[110] The weather-based installation *Variable 4* is an apt example of this intensification. The audience have their attention drawn to the everyday operations of the weather, with minute variations in the atmospheric conditions that surround them communicated by the continuously changing spatial sound composition of a twenty-four movement score.

In reflecting upon the artwork *Tactus*, which explores the idea of touch-sound artworks for the blind and visually impaired, I have also come to recognise the fundamental role of sensory experience in generating insights and understanding. When exhibiting the work, it became clear that 'making sense' is an aspect of knowing which is not only a sensory exploration but also a sense making. Through touch, the indeterminate sound score unfolds in time, generating the form of the composition.

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[107] (Thain 2008, 2)
[108] (Schön 2013, 50)
[109] See Dewey's *Art and Experience* (1934) and *Experience and Education* (1938).
[110] (Barrett 2007, 115)

Intuition

In seeking pathways to understand and analyse the processes of my practice and the knowing that has emerged, I have come to accept what Polanyi has stated: "we can know more than we can tell."[111] This is what Henri Bergson has called 'intuition'[112]—an introspection toward life and its vital processes that is hard to describe. Intuition is a sensual stratagem, an inverting of the intellectual that effects our awareness of duration. My acquisition of knowledge through intuition in practice can be understood as a sense-based activity. It makes use of what Polanyi calls 'tacit knowledge,'[113] which is always implicated in human activity and learning.

Bergson and Polanyi's writings have led me to recognise that in my own practice the distinction between explicit knowledge and tacit knowledge is false, they exist together, threaded inextricably in the process of becoming and knowing. Arts research is often motivated by personal, emotional and subjective concerns, operating not only on the basis of explicit and exact knowledge, but also on tacit knowledge. It is, as Graeme Sullivan has it, "a messy process."[114] Discussion of these intuitive and messy processes can bring in new social and exterior realities that are either marginalised or not yet recognised in established social practices and discourses. Whilst it is a challenging task to portray the tacit, intuitive knowing that has occurred in the making of work, the analysis of Chapter 3. *Sounding Materiality* endeavours to highlight noticeable points where intuition has been in action.

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[111] (Polanyi 1966, 4)
[112] See Henri Bergson's *Creative Evolution* (1907) and *Matter and Memory* (1896).
[113] See Polanyi's *The Tacit Dimension* (1966).
[114] (Sullivan 2006, 3)

Schön's notion of the reflective practitioner has its shortcomings: it might be said that it fails to fully capture the fluid lattice of multi-directional responsive interrelations present in practice. Reflections do not cause synchronicities of occurrence: they do not propel forward. In this praxis, I propose 'resonance' as a more apposite term to apply. Derived from the Latin term "resonare" meaning "to re-sound,"[115] it promotes a multiplicity of existence. Its utility is apparent across disciplines: physicists use it to describe intra-active oscillating molecular energy transfers, astronomers describe the periodic gravitational influences between orbiting bodies with it, and the structuring of in-between de-localized electrons in chemistry are detailed as 'resonant structures.'[116] The term resonance is also used widely in the language of day-to-day society, denoting an affective activation of memory and emotion. It manifests too in philosophical writing, as a rich metaphor that seeks to negate the distancing and objectification of knowledge. Resonance calls into question the notion that the nature of things resides in their essence, and that this essence can be exhausted only by a sign, a discourse, a logos. It can be seen to evoke being in the in-between, and as Veit Erlmann notes, it can "dissolve the binary of the materiality of things and the immateriality of signs."[117] In his 1964 book *Proust and Signs*, Deleuze ruminates on Proust's imagined writings of the village of Combray:

> what is produced by the process of resonance, in the resonance machine, is the singular essence, the Viewpoint superior to the two moments that set up the resonance, breaking with the associative chain that links them: Combray in its essence, as it was never experienced; Combray as Viewpoint, as it was never viewed.[118]

Deleuze then expands this, embodying artist and reader in a resonant epiphany:

> the artist, and the reader in his wake, is the one who 'disentangles' and 're-embodies': setting up a resonance between two objects, he produces the epiphany, releasing the precious image from the natural conditions that determine it, in order to reincarnate it in the chosen artistic conditions.[119]

Here we can see that resonance applied artistically can bring together the material and immaterial, setting up ways of knowing.

Resonance emerges from acoustic roots, stretching back to the Vitruvian architectural 'echeas', the networks of vases embedded in the walls of Roman theatres thought to improve acoustics. Through an investigation of the acoustic phenomenon of resonance German physicist Hermann von Helmholtz came to his work *On the Sensations of Tone* (1863), a study that advanced a highly influential theory of signs and

[115] (Augoyard and Torgue 2005, 108)
[116] For an overview of different applications of 'resonance', see Veit Erlmann's *Resonance* (Erlmann 2015, 175–182) in David Novak and Matt Sakakeeny's *Keywords of Sound* (2015).
[117] (Erlmann 2015, 181)
[118] (Deleuze 2008, 98)
[119] (ibid., 100-101)

perception.[120] In contemporary descriptions of sound and listening, resonance is often conflated, used to describe places whose architecture renders them particularly susceptible to exceptional amplitudes. An example of this is the 'Ear of Dionysus', a cave in Syracuse, Sicily given its name in 1586 by the painter Caravaggio because of its resonant acoustics and shape. After its hollowing out for water storage in Roman times, Dionysius I of Syracuse used the cave to imprison political dissidents, and was rumoured to prize its acoustics, which allowed him to eavesdrop on the plans and discussions of his captives. For me, this use of the term is too imprecise for use in theories of acoustics for it risks including too wide a variety of acoustically comprehendible sonic effects. A more specified detailing of resonance forms the vital actor in principle accounts of hearing, including Richard Lyon's 'auditory image theory'[121] where 'place-resonance theory' is combined with other parallel theories to create a unified framework within which we might consider hearing. Often attributed to Helmholtz, in 'place resonance theory' structures within the cochlea vibrate in phase with particular oscillations in the outside air, producing a sense of 'pitch'. For a brief overview, see the entry on theories of hearing in the fourth edition of *The Penguin Dictionary of Psychology* (2009). Whilst within sound studies there are multiple meanings of resonance, their common-ground is the promotion of an intra-active oscillation between forms, and as Augoyard and Torgue have observed, it is possible within this to define a set of four necessary conditions for resonance that might apply both inside and outside of the auditory:

> 1. The system must have a characteristic frequency.
> 2. It must be maintained with a constant energy input (because of the loss of energy due to friction, which must always be taken into consideration).
> 3. The loss of exterior energy must be low enough that the transmitted energy remains superior or equal to the internal loss of the system.
> 4. The exciting frequency must be equal or almost equal to the characteristic frequency of the system.[122]

In considering resonance and its application in the case-studies described, I find that my practice is shaped between the investigating subject and object, between conception, materialisation and documentation: as ongoing process. A 'resonant' practice conveys this multi-layered feedback of experience, innovation and chance, involving convergent and divergent manoeuvres, inductive and deductive tactics, imaginative and derivative operations, experiments and interpretations, as well as analytic and synthesising procedures. By undertaking a resonant practice, we tap into salient aspects in a way that not only communicates the present, but informs forward in time: an open, permeable method. In a resonant practice, 'poesis', which Plato defined as that which passes from not being into being,[123] is equated in a quadrumvirate with

[120] For a thorough exploration of Helmholtz's influence on cultural modernity and listening, see Benjamin Steege's book *Helmholtz and the Modern Listener* (2012).
[121] (Lyon 2017, 29)
[122] (Augoyard and Torgue 2005, 99–100)
[123] (Sennett 2013, 211)

theory, practice and encounter, imbuing arts research with what Derek Whitehead has described as a "leading into being"[124] that opens up new ways of knowing. As a methodology it can also serve as a corrective to over-learning: through resonance it is possible to surface and critique extant tacit knowledge embedded in practice, by sounding and re-sounding.

[124] (Whitehead 2003, 4)

Material Ecologies

Creative knowing cannot be separated from either the 'loom'[125]—the process that begets it—or the dualistic materiality that defines it. On the one hand, there is brute materiality, and on the other the material artifact, formed from the mute material. This idea of 'brute' or 'raw' material bears resemblance to common conceptions of human nature as a raw substrate of base instinct, which can only be transcended through thought, language and intelligence: those attributes which are often ventured to 'elevate' the human from other living organisms. Together and inbetween, the raw and the artifact form a 'material ecology.' By establishing and investigating this material ecology we can gain insight as to how we might employ sound to highlight and extrapolate materiality.

When seeking to establish a deeper relationship between design objects and their environments in 2015, the designer Neri Oxman and her colleagues at the Massachusetts Institute of Technology (MIT) defined their approach as one of 'material ecology,' whose key realisation was that dimensionality of environmental space is so vast that to bridge it with design and artistry requires a spatial, holistic view. Works would have to be 'ecological from the outset.'[126] In considering *Variable 4* and *Living Symphonies* as examples of 'material ecology,' we can observe that they constituted from both what Ingold has termed a 'hylomorphic' model of creation, where "culture furnishes the forms, nature the materials,"[127] and from correspondence with 'morphogenesis' or material variability (understood through intuition or tacit knowing) in the dimensionality of environmental space. This ecological approach to thinking with materiality is vital because as Ingold recognises, pre-existing notions promote "finished artifacts over material properties"[128] and stop up "the flows of energy and circulations of materials"[129] on which life depends. Living things are sidelined in human historical accounts: plants, animals and living matter are either excluded as impact factors, or are included as what Ingold terms "quasi-humans or pseudo-objects."[130] An example of this arose in the fertile crescent in the early ninth millennium, with what Morton has termed the 'agrilogistical project' which continues to drastically effect the circumstances of the

[125] (Carter 2004, 1)
[126] See Neri Oxman, Christine Ortiz, Fabio Gramazio, and Matthias Kohler's article "Material Ecology" (2015).
[127] (Ingold 2012, 432)
[128] (ibid., 427)
[129] (ibid., 427)
[130] (ibid., 431)

non-human beings on earth.[131] The sidelining of living things is further interrogated in the artist John Gerrard's work *Sow Farm* (2009),[132] a year-long film that portrays a fully automated pig farm in Libbey, Oklahoma, whose inhabitants are visited just once every 156 days. Ingold's call for a new consideration of an ecology of materials is informed by these grotesque machinations: at our most extreme, humans subjugate the material living non-human being to a relentless objectification in pursuit of efficient production and globalised commodities. To redress the treacherous imbalance of our current ecology we can turn from objectification to act with, not on, the lives and processes of both living and non-living material things. This ecological attitude has become an intrinsic part of my practice over the years and is the direct impetus behind *Living Symphonies* in particular.

When Heidegger proposed his ideas of 'things,'[133] he wrote of a gathering together of materials in movement, a joining with the matter-flow. Materials, in contrast to the fixity of objects, are substances-in-becoming: they have potential. It is in this process of becoming, in an immanent material ecology, that a discourse of arts research grounded in material thinking can arise. In seeking to draw relation between sound and materiality in practice, we embrace, following Deleuze and Guattari, that matter is always "in movement, in flux, in variation."[134] In a material ecology nothing is finite, matter is in a state of 'intra-active becoming,'[135] it is a doing—what Barad terms "a congealing of agency."[136] An artistic practice that engages with a material ecology is one that then undertakes to co-respond, creating a material discourse. Later in the body of this thesis I demonstrate this concept explicitly with reference to the work *Living Symphonies*, which co-responds (through 'live composition' and 'locative sound') with a forest ecosystem to act as a platform for understanding the forest ecology through sound.

Human history, as Daniel Miller has written, can be seen as a process of objectification.[137] For Miller following Heidegger, an object is already made, finite, we cannot correspond with it. As Vilém Flusser has put it, "an 'object' is what gets in the way, a problem thrown in your path like a projectile […] the world is objective, substantial, problematic as long as it obstructs."[138] But as George Herbert Mead

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[131] See Timothy Morton's *Dark Ecology* (2016).
[132] See stills from John Gerrard's *Sow Farm* (2009) in the Tate collection here: http://www.tate.org.uk/art/artworks/gerrard-sow-farm-near-libbey-oklahoma-2009-t14279 [accessed 2017/09/18]. Further information on these pieces can be obtained from the artist's website: http://www.johngerrard.net/sow-farm.html [accessed 2017/09/18].
[133] See Martin Heidegger's chapter 'The Thing' in *Poetry, Language, Thought* (2001).
[134] (Deleuze and Guattari 2005, 409)
[135] (Barad 2003, 822).
[136] (ibid., 822)
[137] See Daniel Miller's *Material Culture and Mass Consumption* (1987)
[138] (Flusser 1999, 58)

remarked, objects are not only finite and obstructive, they have agency: "the chair is what it is in terms of its invitation to sit down."[139] The chair doesn't determine the action (the actor may or may not sit), it embodies an unrealised future toward the actor. The chair invites, instigates, has potentiality. This potentiality is hidden in what Miller has referred to as the "humility of objects"[140] and it is a capacity that we must seek to uncover. Firstly, we might note Latour's thinking on 'purification' which points out the impossibility of separating subjects and objects, humans and nonhumans.[141] For Latour, any engagement with materiality must occur before one with culture, rather than opposing it in the modernist name of objecthood. Christopher Pinney has taken up Latour's argument, observing that then "the artifact becomes an empty space, of interest only because of the 'meanings' that invest it with significance."[142] Secondly, we might usefully distinguish between artifacts (things shaped or modified by human activity including domesticated plants and animals) and what Michael Schiffer has called "externs:"[143] a blanket category that covers everything else independent of people including "sunlight and clouds, wild plants and animals, rocks and minerals, and landforms."[144] For Ingold, Schiffer's division holds the key to what his ecology of materials is about. A reintegration of material culture into ecological anthropology has to bring in these externs, including not only living things, but the weather conditions and forces that shape our world.[145] Furthermore, we must note that despite their ubiquity, it is not always the case that artifacts matter more to people than artifice: they are often discarded. In hunter gatherer societies for example, artifacts are not as important as the ability to create the artifact itself, which after use is commonly discarded.[146] In analysing my practice these discussions surrounding material ecology have proven vital in understanding the motivations and machinations behind my work. The adoption of 'material thinking' as part of my methodology has allowed a move away from the conversion of nonhuman organisms to pseudoartifacts, and given me the scope to explore making work with and in materiality itself, using sonic and material thinking to create novel and communicative material ecologies.

[139] (Mead 1934, 279)
[140] (Miller 1987, 86)
[141] See Bruno Latour's *We Have Never Been Modern* (1993).
[142] (Pinney 2005, 257)
[143] (Schiffer 2008, 13)
[144] (ibid., 13)
[145] (Ingold 2012, 431)
[146] (Ingold 2012, 430).

Material Thinking

As we have discussed, we can consider the arts practice presented here as one that embodies an attitude of 'material thinking.'[147] Informed by hylozoism but not defined by it, material thinking recognises what Paul Carter has called the 'creativity' of materials and the "plastic wisdom of the craftsperson."[148] Material thinking is complex, what Carter describes as 'humid,'[149] a product of complication, eager for recombination. Material thinking harnesses the vibrancy of matter, a concept which we shall explore in depth later in this writing.[150] For now we can consider it an engagement in a dance of agency and creation, for as Deleuze and Guattari have observed, "artisans are those who follow the matter-flow as pure productivity."[151]

In thinking through material, we can gain insight from 'Actor Network Theory' (ANT),[152] developed by Michel Callon, John Law and Bruno Latour. ANT is what Law has referred to as "a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located."[153] This has important ramifications for material thinking and as Pickering has observed, it promotes practice "as a field of human and nonhuman (material) agency,"[154] one that considers all actors equal.

When considering material thinking, Bolt usefully reconceptualizes the use of technologies as "co-collaborators in the revealing of being."[155] She calls for a "post-human pedagogy"[156] of creative practice, one where we are intimately bound with technologies that are interactive, responsive and extend our creativity in unforeseen ways. However, this form of posthumanism can raise complexities and hierarchies that cloud our cause. According to Katherine Hayles, a posthuman perspective privileges "informational pattern over material instantiation"[157] and renders the situation infinitely complex by positing "no essential differences or absolute demarcations between bodily

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[147] See Carter's book *Material Thinking: Collaborative Realisation and the Art of Self Becoming* (2004).
[148] (Carter 2004, xii)
[149] (ibid., 189)
[150] See Chapter 3.02 *Sonic Vibrancy*.
[151] (Deleuze and Guattari 2005, 411–412)
[152] For an overview of 'Actor Network Theory' see John Law and John Hassard's edited volume *Actor Network Theory and After* (1999). Other key texts include Latour's *Science in Action* (1987) and his further thoughts in *Reassembling the Social* (2005).
[153] (Law 2008, 141)
[154] (Pickering 1995, 11)
[155] (Bolt 2006, 4)
[156] (Bolt 2006, 6)
[157] (Hayles 1999, 2–3)

existence and computer simulation, cybernetic mechanism and biological organism, robot teleology and human goals."[158] This breaching of the human/machine and real/virtual distinction echoes Donna Haraway's 2002 *Manifesto for Cyborgs*.[159] Whilst it is not the concern of this writing to explore these debates and their relation to material thinking, it is important to note that these ideas question the stability of current conceptions of reality and materiality, and we can gain important insight from the open, flexible and adaptive approaches to technology and virtuality granted by posthumanist perspectives.

Material thinking is not a closed dialogue between artist and materials. As Carter has highlighted, and I have maintained throughout my practice, collaboration—the ability to share and demonstrate what Haraway has termed "situated knowledge"[160]—is intrinsic, and I will discuss this further in 2.05 *Ways of Making*. We should consider that the work of art, created through material thinking, becomes a cultural and social agency. Through collaboration this creative vision is pushed back and forth, heightening the artist's sensitivity to 'kairos'—the critical timing in decision making—and helping to develop a sense of 'right timing.'[161]

[158] (ibid., 2–3)
[159] See Haraway's *A Cyborg Manifesto: Science, Technology and Socialist-Feminism in the Late Twentieth Century* (2002).
[160] See Haraway's article "Situated Knowledges: the Science Question in Feminism and the Privilege of Partial Perspective" (1988).
[161] (Carter 2004, 14–15)

The Mangle of Practice

As Delday and Gray have noted, creative practice is a fluid, folding material process, flexible enough "to accommodate the affordances of 'problem' identification and solving."[162] In Pickering's *The Mangle of Practice* (1995) the author explores the agency of material in practice through a series of observations in experimental science laboratories. Pickering observes an "important real-time structure,"[163] one "determined by the emergence in time of resistances."[164] It is the accommodation of these liminal resistances as part of human purpose that forms the 'mangle of practice.' This is an ontological, relational perspective, one that recognises a chance-orientated 'dance of agency'[165] that causes emergent forms to arise from the open-ended becomings of both human and non-human.[166] For Pickering, the relativism of the mangle is not social or technical, it is a relativism to culture, which itself can find its boundaries "mangled, destabilized and restabilized, in practice."[167] For Pickering, this patterning or 'mangle' "draws attention to the emergently intertwined delineation and reconfiguration of machinic captures and human intentions,"[168] and he employs it both to encompass this metaphysical aspect and as a descriptive term for a practice that embraces these processes. From Pickering's writings we can see that when looked at from an open perspective, there is much to be gained from analysis of scientific experimentation. Arts research should not be set up as a binary with scientific research: each can learn from the other.

In *The Mangle of Practice* Pickering calls for a shift toward a temporally emergent and decentered concept of practice, occurring at the technological interface in response to what he calls "material agency."[169] This posthuman situatedness of practice, where "the world makes us in one and the same process as we make the world"[170] is a wonderfully expressive way of conveying the surprise and intuition that occurs in technological engagement with materiality over time. Pickering's 'dance of agency' and its tenets of resistance and accommodation have become a core attribute of my own ideas of resonant practice, demonstrated particularly in the conception and creation of *Living Symphonies* where machinic captures and human intentions are entwined to

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[162] (Delday and Gray 2011)
[163] (Pickering 1995, xi)
[164] (ibid., xi)
[165] I will explore this 'dance of agency' further at the end of Chapter 3.02 *Sonic Vibrancy*.
[166] (Pickering 2009, 1)
[167] (Pickering 1995, 204)
[168] (ibid., 23)
[169] (ibid., xi)
[170] (ibid., 25–26)

create a vibrant and communicative material ecology. Pickering's argument for a shift in interpretive sensibilities is timely and relevant to my own practice, and through it I find focus on the decentered and emergent processes that form such a key aspect of material thinking.

Amongst this discourse of sound, materiality and its interrelation, there must first be a behaviour that Bourriaud has described as "that set of moods and acts whereby the work acquires its relevance in the present."[171] This behaviour creates a 'transparency' of freely chosen gestures that form and inform, a reciprocal relationship between process and product. A resonant arts research practice embodies these ways of making, foregrounding dynamic relations—the relations of process to things, the making-of to the thing-made—on a tapestry woven from the relations of power to knowledge. There is a broad acceptance that as Pickering has noted, "interspersed between these bursts of human activity [are] periods of human passivity, which can be seen symmetrically as periods of material activity."[172] A resonant way of making considers and learns from these periods of human passivity, wondering and worrying at what is occurring in the inbetween.

Affect

Material thinking is concerned with producing intensities of 'affect'. Writing in 2004, Nigel Thrift delineated the numerous meanings of affect to include embodied knowledge, biologically differentiated positives and negatives, emergent capacity of interaction (Spinoza and Deleuze), and the neo-Darwinist understanding of affect as a deep-seated psychological change "written involuntarily on the face".[173] This leads to a crucial summation: we might understand affect broadly as "the form of thinking,"[174] as thought *in action*. As Deleuze has noted, "affects are not feelings, they are becomings that go beyond those who live through them (they become other)."[175] It is in this transitive potential, a moving in between, across and past experience, in what Deleuze and Guattari have called 'transversality' that affect conveys its true import.[176] These 'intensities of affect' are what is at play in my arts research practice and through critical analysis of them I can gain insight into the ways of knowing that have emerged in the works.

Although the artist Barnett Newman once argued that aesthetics for artists was "like ornithology for birds,"[177] for me, considering the aesthetics of my work has

[171] (Bourriaud 2010, 41–42)
[172] (Pickering 1995, 51)
[173] (Thrift 2004, 64).
[174] (Thrift 2004, 64)
[175] (Deleuze 1995, 137)
[176] We shall explore Guattari's conception of 'transversality' further in Chapter 3.01 *Sonic Events*.
[177] (Newman 1992, 304).

afforded additional insight into their affective potential. In the West, as Rancière has observed, for two centuries 'aesthetics' has been used as a categorical designation of "the sensible fabric and intelligible form of what we call 'Art'."[178] For Rancière, the conditions that make aisthesis possible are entirely material: "performance and exhibition spaces, forms of circulation and reproduction - but also modes of perception and regimes of emotion, categories that identify them, thought patterns that categorise and interpret them."[179] This 'sensible fabric of experience' makes the feeling and thinking of art possible and by foregrounding Rancière's notion of 'Aisthesis,'[180] a mode of experience which we might understand, following architect Nahir Lahiji's analysis as the "space of appearance,"[181] we gain a holistic notion of sense perception connecting embodied experience and intensities of affect to initiate a resonant, fluid, and permeable framework for artistic research. This framework can trigger innovation in forms of experimentation, observation and interpretation. An approach that considers Rancière's aisthesis has helped me to overcome habitual divisions between disciplines, object and material, between thought-research and doing-creation, and it offers new vantage points for insight and understanding. In its foregrounding, I aim to convey a heightened awareness of, and attuning to, artistry as a collaborative, embodied and sentient process. The acoustemological resonant approach I take in this thesis is one of material sensibility, using sound to know and be in a holistic sensory-environment. This is where we might gain new understanding and knowledge, taking note of Rancière's historical warning "one must leave the studio to study the passions as inscribed on bodies elsewhere."[182]

[178] (Rancière 2013, ix)
[179] (ibid., ix)
[180] See Jacques Rancière's *Aisthesis* (2013).
[181] (Lahiji 2014, 55)
[182] (Rancière 2013, 4)

Where, on the other hand, attention moves towards
the observation and audition of many things at once,
including those that are environmental—
becomes, that is, inclusive rather than exclusive […]

—John Cage
1955[183]

Iterations and the experimental

Deleuze and Guattari's infinite becoming cancels out any claim to the totality or completion of an artwork. Through it, in the context of a resonant practice, making and knowing transfer from being objects of philosophical reflection to processes of becoming. This bears similarity to Schlegel's observation that the real essence of art is that it should "forever be becoming and never be perfected."[184] The potency of this 'openness' in arts practice is a vital communicativeness that I have employed as a general technique across the works discussed in this thesis. An example is the specific methodology of 'iteration' employed across all three case-studies. Iterating work encompasses the successivity of problem-solving and new knowing that occurs in each new instantiation. The notion draws rich inspiration from Umberto Eco's writing that "every performance makes the work an actuality."[185]

I cannot help but observe that these iterative and open methods bear similarity to the existing area of sound practice which composer Michael Nyman delineated in 1974 as "experimental music."[186] For Nyman, experimental composers are "excited by the prospect of outlining a situation in which sounds may occur, a process of generating action."[187] Christoph Cox and Daniel Warner have furthered this definition noting that experimental music invites us into a world of "evolving sounds rather than one that is constructed (composed) for us in advance."[188] My own compositional methods might then be understood as relating to this genre of experimental music, aligning closely with what musician Brian Eno has contended on the subject. For Eno, the primary focus of experimental music is toward "its own capacity to produce and control variety, and to assimilate "natural variety"—the "interference value" of the environment."[189] For me, the aim is to create systems for composition that create unique, but not necessarily repeatable outputs, exploring their nature and affect through iteration. This is what Eno refers to as seeking a "class of goals" rather than one specific one, and is distinct to the

[183] (Cage 2012, 13)
[184] (Schlegel quoted in Miller 2001, 25)
[185] (Eco 1989, 15)
[186] See Michael Nyman's *Experimental Music* (1974).
[187] (Nyman 2015, 211)
[188] (Cox and Warner 2015, 207)
[189] (Eno 2015, 227)

notions of goalless indeterminacy described by Cage as “purposeless play,”[190] that have been a hallmark of experimental music since the early 1960s.[191]

[190] (Cage 2012, 12)
[191] (Eno 2015, 227)

Collaboration

A strong collaborative practice is one of give and take, both passive and active. Collaborative practice intervenes differently in the network of social relations exactly because it is the result of a complex web of social relations wherein its processes are non-linear, and the boundaries between its actors' activities are blurry and 'ill-defined'.[192] As Thomas de Quincey wrote in 1853, discourse is a 'trade of notions',[193] of immediate intuitions, it is mediate—a vibrancy between. To work collaboratively is to be concerned with these shared intuitions, with resistances and accommodations, to create the space for shared discourse to emerge. Carter ventures that the precondition of collaboration is a 'mutual inclination', something he describes as a "willingness to abandon the statuesque poses associated with *orthotic* thinking and to be light-footed."[194] A collaborative, resonant approach to practice is then one that abandons "orthotic" thinking.

In Richard Sennett's book *Together* (2013), the author explores cooperation as a craft. Through his analysis Sennett observes that cooperation can work against tribalism, defining it simply as "an exchange in which the participants benefit from the encounter."[195] It can be formal and informal, wrapped in mutual pleasure, and for Sennett it "emerges from practical activity."[196] One of the most important aspects of fruitful collaboration is a specific skill, what Aristotle defined as *techne*: to cooperate meaningfully requires a social adeptness and a willingness to compromise. Sennett terms this skill-set 'dialogic skills.'[197] To collaborate means to listen, to be tactful, to navigate disagreements, to not necessarily find common ground. It is this open-endedness that defines the difference between dialogic and dialectic communication. In dialectic communication, there is commonly a putative solution and agreement. In dialogic exchange,[198] participants expand their understanding of both themselves and others through a relativistic, situated, open-ended process of becoming. The plot thickens, ends deaden but new pathways always unfold. At the heart of dialogic collaboration is attentiveness. As Sennett observes: "exchanging is built from the ground up."[199]

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[192] (Carter 2004, 4)
[193] (De Quincey 1853, 237–238)
[194] (Carter 2004, 179)
[195] (Sennett 2013, 5)
[196] (ibid., 6)
[197] (ibid., 6)
[198] The terms dialogic and dialogism were first used by the Russian philosopher Mikhail Bakhtin in *The Dialogic Imagination* (Bakhtin 1981).
[199] (Sennett 2013, 19–20)

In reflecting upon my practice across these last seven years, numerous collaborations with other individuals have occurred. These have proved highly inspirational to my practice and I have gained numerous unique experiences through the generosity of those various collaborators. Collaboration is an intrinsic part of all contemporary arts practices that operate within the social interstices, as Bourriaud has noted: "art is the place that produces a specific sociability,"[200] and it is my experience that sound practice affords particularly unique opportunities for collaboration. It operates across disciplines, as an omnipresent, combinatory and flexible discipline. Collaborative experiences have supported and augmented my practice, causing what Grant Kester has called a "dialogical aesthetic,"[201] presenting the role of the artist as one of openness, as attentive listener, as willing to accept dependence and intersubjective vulnerability. Whilst it is important to note the dialogical benefits of collaborative methods, it is also vital to define what knowledge has been gained collaboratively, and what is ventured by me as a result of collaboration. I have approached this through attribution, crediting, and discursive commentary. Where there are so many people that it is impossible to include their contributions in the body of this thesis, I have included credits in the appendices detailing the work they were involved with. This is particularly true of *Living Symphonies* for which there were over a hundred-different people involved in the realisation of the 2014 tour.

[200] (Bourriaud 2010, 16)
[201] See Kester's "Dialogical Aesthetics" (2014).

2.06 *Conclusions*

Informed by Brunner's four-point map of research-creation as a 'mode of becoming' I have found utility in summarizing a flexible structure for 'resonant practice' through the following five stages:

> 1. *Space for experimentation* - these open spaces exist without pre-definition of terms (such as product-orientated goals), problems can be shared, solved, generated: the situation for actualization is created.
>
> 2. *Experimentation with technicity* - explorations of technique, technology and their conjunction with materiality and the environment.
>
> 3. *Iteration and frame experiments* - embrace failure and reproblematise, renew critical inquiries, repeat and iterate to explore new ways of knowing. This point is inspired by Schön's concept of 'frame experiment' wherein, problem solving can take place by constructing a new way of setting the problem.
>
> 4. *Collective communication* - ways of knowing and learning occur in a social context involving formal and informal interactions, providing opportunity for 'co-reflection' and what Belenky (1997) calls 'connected knowing'—the connected knower develops ways to access the knowledge of others—at the heart of this is a "capacity for empathy."[202]
>
> 5. *Encounter* - the creation of experiential ways of knowing the work, and explorations of ways in which the work can engender encountered knowing through participation with place and materiality as material ecology.

From this framework, two ends of the spectrum of ways of knowing in arts research emerge: 'art-generates-knowledge' and 'making-to-understand'. In resonant practice we must think through the middle, *par le milieu*—as Stengers reminds us through Deleuze[203]—to get a grasp of what is happening. It is easy to miss alternate ways of knowing generated in practice that may not be readily apparent, those 'different remainders'. Following Peggy Phelan's statement that "performance's being […]

[202] (Belenky 1986, 113)
[203] See Isabelle Stengers's "Introductory Notes on An Ecology of Practices" (2005).

becomes itself through disappearance,"[204] Rebecca Schneider, in her essay "Performance Remains" (2012), has described that which remains from performance as a different way of knowing:

> To the degree that it remains, but remains differently or in difference, the past performed and made explicit as (live) performance can function […] almost in the sense of an echo […]. If echoes […] resound off of lived experience produced in performance, then we are challenged to think beyond the ways in which performance seems, according to our habituation to the archive, to disappear. […] We are also and simultaneously encouraged to articulate the ways in which performance, less bound to the ocular, "sounds" […], differently, via itself as repetition—like a copy or perhaps more like a ritual—like an echo in the ears of a confidence keeper, an audience member, a witness.[205]

If we privilege only the performative encounter itself, we might remain ignorant of other ways of knowing that exist past instantiation, as document or archival inscription.

In the general methodology of resonant practice that has emerged, through material thinking, iteration and experimentation, I aim to foreground overlooked properties of materiality through sound, drawing in the living and non-human to the realm of a commonly closed-off and objective material culture, fusing biotic and abiotic worlds. It is my contention that through a resonant practice sound practitioners have a unique opportunity to convey that material is what Barad calls "an active participant in the world's becoming."[206]

Resonant practice aims to generate a mode of sonic inquiry that is neither theory not singular method but a wider mode of problematising what Massumi has called the "thinking-feeling of what happens."[207] Through a resonant practice, sound practice research details and propels the potentiality of thinking-feeling that emerges in artistry. This is not only a critical reflection, but also a thinking forward, where we attend to the potentiality of reflections.

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[204] (Phelan 1993, 146)
[205] (Schneider 2012, 146)
[206] (Barad 2003, 803)
[207] See Massumi's "The Thinking-Feeling of What Happens" (2008).

3. *Sounding Materiality*

3.01 *Sonic Events*

Questioning the nature of sound often begins awkwardly: we posit sound as material, as mind or matter. But, following Ingold, we can consider sound as a medium of perception, as experience: "it is what we hear in."[208] Sound is an experience *amongst* the material world. Not physical matter—although copresent with it—but a constant process of becoming, intermedial to energy. Chion usefully distinguishes sound from vibration, reviving "verberation"[209] to encompass the aural dimension as distinct, but alongside: sound is *with* the vibratory. Sound communicates, is altered, it binds, it agitates, and as outlined in Christoph Cox's 'sonic event,' it is "intangible, ephemeral, and invisible."[210] Cox echoes Schaeffer's 'sound object' in considering sounds as distinct from their source but he removes the objective status bestowed by Schaeffer: sound is "not tied to objects or minds."[211] Cox recognises that in the sifting out of object from materiality we risk open distance from the relational and co-vibratory capacity of sound: from its eventfulness. Within my practice, Pierre Schaeffer's conception of the 'sound object' has been employed occasionally as an educational tool, but generally I reiterate the thoughts of Augoyard and Torgue, in that "it can hardly be used as a fundamental concept for the description and analysis of urban sounds"[212], I would venture that the sound object is also limiting in its utility to describe the activity of sound in the general environment. For me, the active 'event' in Cox's 'sonic event' usefully overflows Schaeffer's delimitation of an 'object' from the whole. In Schaeffer's objectification, as Chion has observed, we also find a lack of "dialectic between localization and provenance,"[213] a locative irreconciliation betwixt sound, object and materiality. Chion illustrates the dilemma with the example of a brook or stream, a statistically constant flowing noise where "the object that causes this sound has no bounds."[214] There is nothing static, object-like or bounded in the sound of a stream. By thinking through sound as object we highlight a problem that has beset sound studies: the need to analytically contain sound "like a genie in a bottle."[215] We might follow Cox in asserting that sounds are not static objects, they are "temporal events."[216] In my

[208] (Ingold 2007, 11)
[209] (Chion 2016, 16)
[210] (Cox 2015, 126)
[211] (Cox 2015, 126)
[212] (Augoyard and Torgue 2005, 6)
[213] (Chion 2016, 105)
[214] (ibid., 105)
[215] (Chion 2016, 105)
[216] (Cox 2015, 126)

praxis, I take a vectoral, experiential approach to sonic events, that focuses on the communicative relationality of sound and its intra-action with materiality, harnessing what Steven Connor has called the "diffuse nature of sound, which radiates and permeates."[217]

Auditory Field

In Don Ihde's premise of the 'auditory field,' we find a phenomenological perspective concerned with "the field-shape of sound."[218] This idea of field, as Morton has noted, "usefully dispenses with conventional notions of particles"[219] and aids in the conception of the vectoral immaterial nature of Cox's sonic events and effects. Within the auditory field we explore sound as a focused eventful experience *within* our overall experience, creating an opening that Ihde describes as "continuous and full, penetrating in its presence."[220] This is a field containing the agency of sound: it is one of 'animated liveliness.'[221] Furthermore, sound in the auditory field is not just animated, it has its own agency, it seems to makes things come alive. In this short view across the auditory field, we must be careful not to abstract too far, ignoring the dynamic effects of external conditions. In the works *Variable 4* and *Living Symphonies* for example, each iteration took place outdoors, in dynamic atmospheric conditions, and it was clear that the prevailing weather influenced the acoustic attributes of the auditory field in complex ways. Examples of this can be heard by comparing two stereo documentation recordings from the Thetford forest installation of *Living Symphonies*. Both recordings are unedited and uneffected, and were made on different days from the same perspective using the same equipment.

[217] (Connor 2000, 17)
[218] (Ihde 2007, 83)
[219] (Morton 2007, 104)
[220] (Ihde 2007, 82)
[221] (ibid., 82)

E1. *Living Symphonies* Thetford - rain conditions (field recording)[222]
23 May 2014
01'00"

E2. *Living Symphonies* Thetford - dry conditions (field recording)[223]
25 May 2014
01'00"

What we hear in the first recording is not only the sonic events of the rain falling in the forest, alongside the compositional effects that the atmospheric conditions are having upon the model-driven sound score that underpins the piece, but also the acoustic influence of rain in the auditory field. In rain's wetness, its moisture, sound travels differently, it reflects, sounds subtly brighter, more urgent, shimmering. This effect is more apparent in the real-time spatial experience of the work itself, lessening greatly through stereo recording. Similar atmospheric acoustic effects are found elsewhere, in recordings of *Variable 4*. The following documentation recording taken near dawn (about 5am) amongst the reed beds of Snape Maltings on a cold, crisp late-Spring day in 2011, conveys the acoustic clarity brought on by the low temperatures and clear sky at the time. What is clear is that the auditory field, and the sonic events that constitute it, are permeable, influenced by and influencing of their exterior materiality.

E3. *Variable 4* Snape Maltings - dawn (field recording)[224]
29 May 2011
01'00"

The auditory field is not only permeable, but as Ihde has noted, omnidirectional: "as a field-shape, sound surrounds me in my embodied positionality."[225] This is different to the visual field: if the auditory field were to be spatially modelled, it would be as a sphere, a field-shape exceeding that of sight.[226] Ihde also observes the clear presence of directionality:[227] "the auditory field surrounds the listener, and surroundability is an

[222] See https://www.dropbox.com/s/c06e1rkbx2ukkcq/E1_2014-05-23_LS_Thetford_wetconditions_Giles_Stogdon_recording.mp3?dl=0.
[223] See https://www.dropbox.com/s/ce8kta6zdcyjruf/E2_2014-05-25_LS_Thetford_dryconditions_Giles_Stogdon_recording.mp3?dl=0.
[224] See https://www.dropbox.com/s/xvawha1ivvh6g6d/E3_2011-05-29_V4_SnapeMaltings_0524_dawn.mp3?dl=0.
[225] (Ihde 2007, 75)
[226] (ibid., 75)
[227] (ibid., 76)

essential feature of the field-shape of sound."[228] We are able to vary auditory focus in relation to this surroundability, which is necessarily copresent with directionality. It is like the experience of being drawn into the overall music of an orchestra in a concert hall (surroundability), and then choosing to focus on a specific instrument or player for a time (directionality).[229] Within a given auditory field we vary the ratio between surroundability and directionality through 'auditory focus'. This is what Ihde has described as an 'auditory ray,' a process that allows focus to move from sound to sound within the auditory field without ever turning the head. This aspect of sound and hearing relates strongly to what is described in the distracting vocal and societal focus of the 'cocktail party effect,' a phenomena first discussed by the British cognitive scientist Colin Cherry in a paper entitled "Some Experiments on the Recognition of Speech, with One and with Two Ears" in *The Journal of the Acoustical Society of America* in 1953. The filtering, selecting, *and* spatial localising of auditory focus in the auditory field is what allows us to 'pay attention' to a sonic event.

However, we must note that auditory focus is a facet of hearing that is by no means the same from person to person. Psycho-physiologically the ability to selectively listen varies, and is heavily dependent on different mental and physical capacities for localising sound which includes binaural stereophonic hearing.[230] Within the auditory field surroundability and directionality are copresent in how we hear, in a state of constant flux and changeability, derived from both source and perception. This ever-shifting duality of surroundability and directionality is an aspect of sound arts practice often ignored, commonly flattened in the recorded medium, in the embrace of surroundability. But, the praxis presented here seeks to draw attention to what Ihde has called the "definite directionality of sound presence"[231] employing a specific methodology of 'locative sound,' which I will explore further in Chapter 3.04.

[228] (ibid., 76)
[229] (ibid., 77)
[230] (Chion 2009, 296)
[231] (Ihde 2007, 77)

Covibration

Sound is not mono-sensorial, it has cross-sensory effects. As LaBelle has noted, "sound and vibration are intimately linked, a partnership that extends the air-borne wave to the material world, as frictions and tactile feeling."[232] Chion defines the "bisensorial"[233] nature of sound as addressing not only the auditory but also affecting the body, in a process he terms "covibration."[234] This covibratory dualism of body and sound recalls experiences I had at Reggae sound system nights in Brixton's Recreational Centre and at Mass in St. Matthew's Church (2005–2007). At these events, sound was deployed in its most optimal bisensorially playful aspect, in a way which theorist Julian Henriques has described: "the sound just hits you. You can't ignore it. You have to feel it."[235] At a DMZ night in Brixton[236] (see fig.21–23), as DJs Mala, Kode9 and Loefah cued their dub-plates up, the voluble MC Sgt. Pokes would note which part of the body the bass line of the tune might target: "this one going right for your knee caps" was a particular crowd favourite. Derek Walmsley, in his primer on these seminal years of Dubstep, has noted that bass is the foundation of the music: it "pulses through your body, prickles the skin, presses upon your face, confounds sensations of distance and depth."[237] Reggae and dubstep musicians are perhaps then unique in the last 20 years in their interrogation of sound's bisensorial capacity for covibration.[238] This is not to say that the covibratory aspect of bass is not an important component of contemporary dance music globally, merely that in the UK dance music Dubstep, as with its originating Dub, the bass plays a highly definitive role. Many London clubs exhibit speaker systems that allow for this kind of bass-focus, including Fabric, which has a complex subsonic underfloor transducer system. Steve Goodman, who DJs under the name Kode9, evokes the covibratory capacity of sound system music in his 2010 book *Sonic Warfare*: "here is the in-between of oscillation, the vibration of vibration, the virtuality of the tremble."[239]

This bisensorial, covibratory capacity of the sound system event uncovered a parallel path from conventional discussions surrounding the nature of hearing for me,

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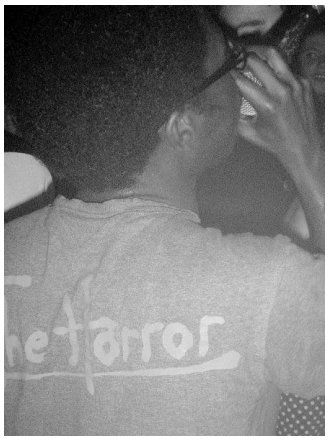
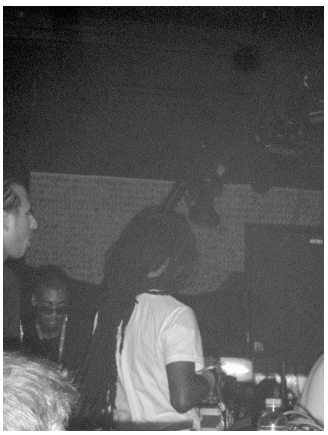
[232] (LaBelle 2010, 133)
[233] (Chion 2016, 206)
[234] (ibid., 206)
[235] (Henriques 2011, 457)
[236] DMZ is a club night run by *Digital Mystikz* (DJs Mala, Loefah, Coki and MC Sgt. Pokes). The bimonthly night took place at St. Matthew's Church in Brixton in 2007, and has since moved to different venues across London.
[237] (Walmsley 2007, 44)
[238] For more about Fabric's unique underfloor speaker system, see the following interview with sound and lighting designer, Dave Parry: https://thump.vice.com/en_uk/article/jpn7qy/dave-parry-fabric-matter-ministry-of-sound-camden-palace-sound-lighting-engineer-designer [accessed 2017/10/16].
[239] (Goodman 2010, 82)

and has become an important influence on my practice. Audiences to both *Variable 4*, *Living Symphonies* and *Tactus* have included a wide spectrum of physiological hearing types, and in the case of profoundly deaf people, who visited both *Living Symphonies* and *Tactus,* I came to realise, following Ihde, that they heard the works, but were hearing them "differently from the normal."[240] Here the covibratory engages as different hearing, where what a normative listener might consider a fringe aspect, for the deaf person is the focus itself. As the deaf percussionist Evelyn Glennie has observed: "some of the processes or original information may be different but to hear sound all I do is to listen."[241] Everyone hears, but we hear differently.





The Spaceape (fig.21), (fig.22) and Mala (fig.23), St. Matthew's church Brixton, 2007.

[240] (Ihde 2007, 44)
[241] See Glennie's essay statement on her deafness entitled 'Hearing Essay' (2010): https://www.evelyn.co.uk/hearing-essay/ [accessed 2017/10/25]

Tactus and Covibration

We might draw two observations from the bisensoriality of sonic events. Firstly, sound exists beyond normative ways of human hearing: each individual hears in profoundly different and equally important ways. As a result we should adopt Drever's scepticism of 'auraltypical'[242] notions of hearing, and as Jonathan Sterne has noted, we should consider "hearing the hearing of others."[243] Secondly, we might celebrate and explore the covibratory aspect of sound as providing us with what Shelley Trower calls "a basis for thinking about relations between the senses, moving beyond the differences between sound and vision."[244] Vibrations cross sensory thresholds, and are "simultaneously palpable and audible, visible and audible."[245] Whilst vibration and verberation are not material objects, Trower notes that vibration is "bound up with materiality: vibration moves material, and moves through material."[246] This covibratory movement through material is exactly what occurs in the touch-sound work *Tactus*. In the work, installed on the wall of a gallery space, the bisensoriality of sound is used as a method to enhance the tactility and communicative capacity of a haptic sound score. Sound emanates from twenty speakers embedded directly underneath the puff-printed surface. The sounds, triggered in real-time by touch, cause vibrations to be transduced through the speakers and the textile score itself. The sound score is composed to covibrate, to be heard and touched simultaneously. In subtly harnessing the covibratory capacity of sonic events, the tactility of the score is enhanced, drawing focus to the textual and tactual materiality of the work. The matrix of sensations created in *Tactus* highlights motifs in the score, drawing attention to haptic patterned fabric in concomitance with heard sonic event. This meeting of the auditory and the haptic provides a complementary sensory experience conveying the basic similarity between hearing (vibrations conveyed through sound-waves to auditory complex) and touch (vibrations conveyed through the skin). Co-vibration helps to instrumentalise the score,[247] and evokes Sennett's comments on the exploratory resistances of musicianship: "a pianist or a violinist must constantly explore resistance, either in the instrument or in the musician's own body."[248]

[242] (Drever 2017)
[243] (Sterne 2015, 74)
[244] (Trower 2012, 5)
[245] (ibid., 5)
[246] (ibid., 6)
[247] I will discuss the score as instrument further on in this chapter.
[248] (Sennett 2003, 482)

Fig.24 B10 from the *Tactus No.1* score.
September 2015.

▶

E4. *Tactus* B10 (excerpt from sound score)[249]

2015

00’20”

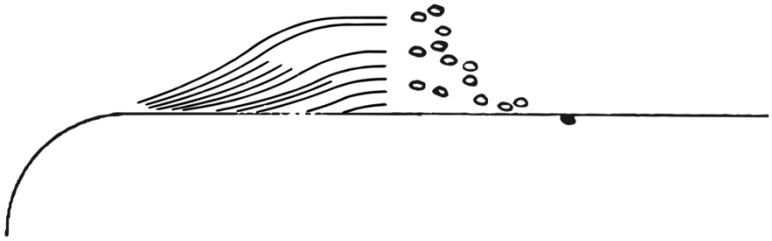


Fig.25 S13 from the *Tactus No.1* score.
September 2015.

▶

2015

E5. *Tactus* S13 (excerpt from sound score)[250]

00’10”

[249] See https://www.dropbox.com/s/imvs1sryatp347s/E4_2015_Tactus_covibration_B10.mp3?dl=0.
[250] See https://www.dropbox.com/s/zh8xdtyc7gp8jnl/E5_2015_Tactus_covibration_S13_excerpt.mp3?dl=0.

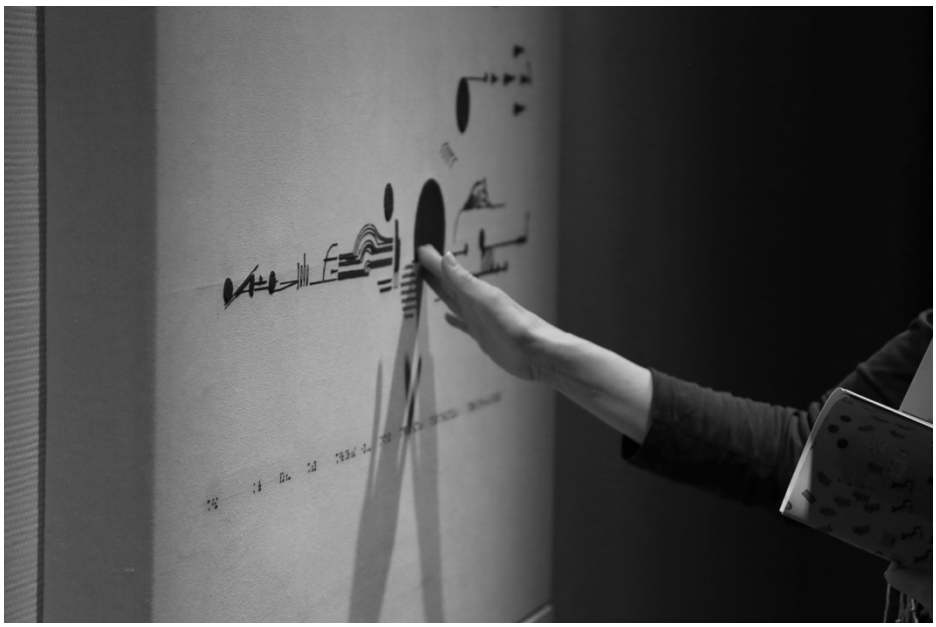


Fig.26 *Tactus No.1* score close-up.
Sonic Pattern exhibition, Kaunas Biennial, 19 September 2015.

Fig.27 *Tactus No.1* score close-up.
London, September 2015.

If, as Chion suggests, a sound wave "presupposes a medium of propagation"[251] then we might understand that sound exists 'bound' to materiality. But, whilst this culturally anechoic approach has utility in understanding sonic agency in the abstract, trying to understand what sonic events *mean* when introduced into the world in artistic practice is markedly more complex. Novak and Sakakeeny call sound a "semiotic web, woven by the complementarities and tensions of its entanglements in different intellectual histories."[252] We can understand from this that sound is both sensation and an organised movement of molecules and meaning. It is a combinatoric experience, its properties are 'mixture.'[253] In its pluralism we find its vitalism and appeal. As Raymond Williams once observed: "it is the range and overlap of meanings that is significant."[254] The exploration of meaning and sound is hidden at the core of Bill Viola's 1982 sound work, *The Talking Drum*. In an artist statement released as part of an exhibition at the Whitney Museum in 1997, Viola described the work as follows:

> Various natural sounds, such as dogs barking, people yelling, birds screeching, and machinery operating, are run through an electronic gate, a device that follows the loudness contours of an external sound, in this case the drumbeats. This allows these sounds to reach the speaker, and thus the room, only when the drum is struck. They fade out as the drumbeats die out in the space. However, the loudness of the drum at the moment when it is struck overpowers these sounds and momentarily masks them, so that they are only present in the room as sonic "afterimages," audible primarily within the time that the dying reverberations trail off in the space. At first, it is only apparent to listeners that the character of the echoes has changed, but then gradually they become aware of the new sounds contained within the individual drumbeats. The more the drum is beat, the more the shadow sounds are heard.[255]

In *The Talking Drum,* there is not only a phenomenological event occurring, there are significant and suggestive 'afterimages' hidden in the intricate patternings of the low drum beats that dominate the composition. In July 2015, shortly after I was commissioned to assist Viola, alongside his partner Kira Perov and artist Tom Richards in installing a new version of *The Talking Drum* in Brewer Street Carpark, Soho, I stood in the dark cavernous basement listening to early test tapes of the work.[256] There, immersed in the ubiquitous low beatings emanating from the multi-channel speaker system we had installed, I encountered sonic events that were "bound with a universally

[251] (Chion 2016, 16)
[252] (Novak and Sakakeeny 2015, 4–5)
[253] (Chion 2016, 10)
[254] (Williams 1983, 91)
[255] (Viola 1997)
[256] For an in-depth discussion and explanation of *The Talking Drum* and Viola's contributions to *Dry Pool Soundings*, see Bulley, James, and Astra Price. 2018. "The Talking Drum. (forthcoming)" Leonardo Electronic Almanac, 1–24.

understood code of meaning."[257] Viola's use of the drum was a signifier, referring to a sonic event heard throughout human existence, a singular expression of biorhythm and communication.[258] In perceiving sonic events that resonated my memories, I was experiencing what Augoyard and Torgue have called 'anamnesis,' a semiotic effect described as "the often involuntary revival of memory caused by listening and the evocative power of sounds" [259]. But anamnesis was not the only effect at play. I was experiencing an additional mode of what Dennis Smalley has called 'technological listening,'[260] a form of listening that occurs when a listener 'perceives' the technique or technology behind what they hear. Here the listener as Seth Kim-Cohen has noted, interacts with a "matrix of symbolic grids, located roughly on the side of production,"[261] represented in this case by the process of recording, Viola's presence in the recording, and an auditing of the spatial speaker system in use. Not only this, but as I listened, I felt my breathing and heartbeat adapting to the undulating tattoo, a subconscious rhythmic response.

[257] (Price 2015)
[258] For more information on Talking Drums, see J. F. Carrington's 1969 book *Talking Drums of Africa*.
[259] (Augoyard and Torgue 2005, 21).
[260] (Smalley 1997, 109).
[261] (Kim-Cohen 2009, 182–183)

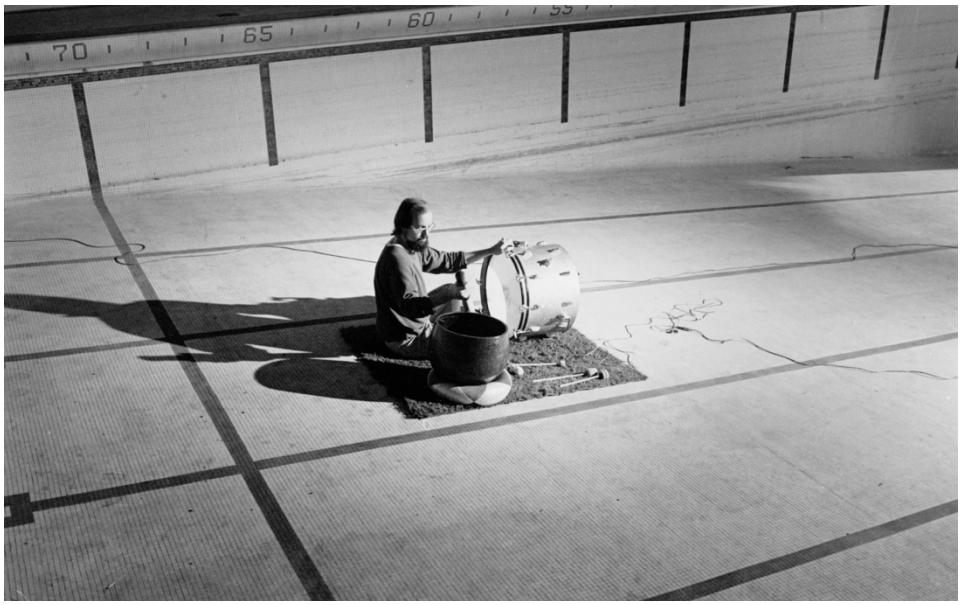


Fig.28 Bill Viola performing and recording *Talking Drum*, 1982.

Fig.29 Bob Bielecki and Bill Viola testing systems for *The Talking Drum*, 1982.

Resonance

In considering sonic events as significant we accept that they are innately referential, they *resonate*. As Jean-Luc Nancy has written:

> all sonorous presence is thus made of a complex of returns [*renvois*] whose binding is the resonance or "sonance" of sound, an expression that one should hear—hear and listen to—as much from the side of sound itself, or of its emission, as from the side of its reception or its listening: it is precisely from one to the other that it "sounds."[262]

In its bisensorial physical and referential resonance, sound has a disposition for unification and communication, something which has for me been demonstrated through numerous cross-disciplinary collaborations in the last seven years, including working with film and theatre directors, choreographers, conductors and software designers. In their constant delocalisation, and the focal flux of surroundability and directionality, sonic events are able to bind with and influence mediums, physicalities and histories. Sonic events (as both acoustic and discursive) might then be understood following Félix Guattari (1984), as transversal. Guattari explains transversality as "a dimension that tries to overcome both the impasse of pure verticality and that of mere horizontality: it tends to be achieved when there is maximum communication among different levels and, above all, in different meanings."[263] Sound combats dualism and in its process of becoming offers high levels of communicativeness. Sound moves between, through and within bodies, and in its elusive but ever-present nature it offers a platform for exploring the heaped networks of knowing that we confront in postmodern existence.

Chion terms perceptions that move from one sense to another 'trans-sensory perceptions': those "perceptions that belong to no one particular sense but that may travel via one sensory channel or another without their content or their effect being limited to this one sense."[264] The effect of the rhythm of *The Talking Drum* on my heartbeat and breathing as I stood in the carpark is an example of this, and whilst for clarity, detailed explorations into trans-sensory dimensions will not be possible here, it is worth briefly commenting on the phenomena of synaesthesia. Cross-sensory activity is a vital constitute of the auditory field: the hearing of sound alters, and is altered by, other sensory perceptions. At the Thetford Forest installation of *Living Symphonies*, you could smell the mossy dampness at one end of the site which combined with and lent context to the sound heard from that area. Sound employed in a vibrant multi-sensory environment like this might then be fruitfully explored as a transversal synaesthetic

[262] (Nancy 2009, 8)
[263] (Guattari 1984, 18).
[264] (Chion 2009, 496)

experience. As we discussed earlier in this thesis, sonic events convey transitive potential, and in their becoming they move in between, across, and through materiality.

In sum, we might take note of the resonant trans-sensorial potency of sonic events, and follow Viola in observing that "all objects have a sound component, a second shadowy existence as a configuration of frequencies."[265] In the writings that follow, I detail the varied approaches I have taken to intra-relating sound and materiality, adopting a resonant and aurally diverse approach in creating sonic events as experience.

[265] (Viola 1995, 155–158)

Fig.30 *The Talking Drum*, Brewer Street Carpark, 2015.

Vital Materialism

In recent years, proponents of new materialism have been concerned with the potential of active or agential matter in retuning the relationship between human and non-human being. Tracing a lineage from Democritus and Lucretius' atomic theories of swerving atoms, through to Henri Bergson's 'vital impetus,' new materialists seek to confront and explore present day ecological concerns. As Barbara Bolt has observed, "with its acknowledgement of agential matter, neo-materialism questions the anthropocentric narrative that has underpinned our views of humans-in-the-world since the enlightenment, a view that posits humans as makers of the world and the world as a resource for human endeavours."[266] The division of the world that new materialism seeks to counter—from which it derives its urgency—has caused detriment to what Bolt calls "the actual (which is to say ecological) world."[267] Across disciplines, scholars and practitioners are now exploring the agency of matter. From Haraway[268] and Morton,[269] we can begin to consider that the "I" as presented is no longer necessarily human, but seeks to cross what Bolt describes as "human and non-human, the social and physical, and the material and immaterial."[270] Here, as Bolt notes, "in these new configurations the material and the discursive mingle and mangle."[271]

Arising from new materialism is 'vital materialism,' drawn from the work of Bergson and Hans Driesch,[272] those critical vitalists who opposed a mechanistic view of nature, adopting 'élan vital' (Bergson)[273] and 'entelechy' (Driesch)[274] as scientific approaches that acknowledged incalculability and nonhuman agency. As Bolt has observed, these perspectives align too in the writings of Martin Heidegger, who, in his 1977 essay "The Question Concerning Technology,"[275] discussed createdness in the formulation of a silver chalice, shifting consideration toward material agency. From this,

[266] (Bolt 2013, 2)
[267] (ibid., 3)
[268] See Haraway's *The Companion Species Manifesto* (2003) for an inspiring and wide-ranging discussion on the relationship between humans and dogs.
[269] See Morton's explosion of the human-nature divide in *Dark Ecology* (2016).
[270] (Bolt 2013, 3)
[271] (ibid., 3)
[272] Hans Driesch was a German biologist and philosopher (1867–1941).
[273] In his 1907 text *Creative Evolution* Bergson defined creativity as intellectual freedom and through Darwin, Haeckel and Kant, critiqued the mechanistic finality of the Leibnizian school of thought, proposing the idea of an 'Élan vital' or 'vital impetus' to account for the complex self-organisation and morphogenesis of organisms.
[274] Driesch's term 'entelechy' is borrowed from Aristotle, and Driesch used it to denote a life force that is unquantifiable and present in everything. For a comprehensive overview of Driesch's ideas, see his *Science and Philosophy of the Organism* (1908-09).
[275] Heidegger's exploration of the causes and making of a silver chalice are explored in *The Question Concerning Technology* (1977).

Bolt furthers that "art is a co-collaboration, not a form-matter synthesis, and matter as much as the human has responsibility for the emergence of art. In other words, matter has agency."[276] In my practice these thoughts have led to exploring a distance from the artwork as thing created only by the human, the ordering of mute matter, the raw material with which humans craft. Instead I take Carter's 'material agency' as discussed earlier, as a starting point, making my praxis a co-collaboration with material, where matter has agency. From this neo-materialistic perspective, all artistic acts are co-collaborative, whether or not they recognise the potential of this agency. Barrett frames this as a different but insightful stance: "in creative production, there is no opposition between inside and outside: consciousness and materiality are mutually constitutive, enfolded and emergent."[277] Instead of placing consciousness at the centre of artistic making, we might consider that there is no centre, more that artistic making can be considered a resonant engagement amongst the agencies of materiality, amongst Ingold's 'meshwork'.

[276] (Bolt 2013, 5)
[277] (Barrett 2013, 72)

Vibrant Matter

Jane Bennett's evocative advocation of agency in her 2010 book *Vibrant Matter* brings the human to combination with the material. But this vibrancy is often discreet, what Deleuze and Guattari have described as "a material vitalism that doubtless exists everywhere but is ordinarily hidden or covered, rendered unrecognisable, dissociated by the hylomorphic model."[278] Bennett recognises that this vitalism can propagate connectedness with the non-human world, lending us an enlightened understanding of our situation, an effective comprehension that aids in the promotion of ecologically sustainable culture. Vibrant matter seeks to answer an ecological concern: by considering matter as dead, or what Bennett calls "thoroughly instrumentalised,"[279] we impede the emergence of more viable ecological ways of being, including sustainable modes of production and consumption. As Bennett writes in a description of the process of writing her book: "what is at work here on the page is an animal-vegetable-mineral-sonority cluster with a particular degree and duration of power. What is at work here is what Deleuze and Guattari call an assemblage."[280] This assemblage is not governed by a centrality, for as Bennett notes: "no one materiality or type of material has sufficient competence to determine consistently the trajectory or impact of the group."[281] In Bennett's conception of agency, Latour's 'actants' play an important role, and she describes these as "a source of action that can be either human or nonhuman; it is that which has efficacy, can do things, has sufficient coherence to make a difference, produce effects, alter the course of events."[282] Bennett's *Vibrant Matter* describes a more 'distributive' agency, it is not that within this assemblage there is equality between the actants, but there is "a polity with more channels of communications between members."[283] Bennett's "lively matter"[284] is governed by emergent rather than linear or deterministic causalities.[285] What follows is that to explore an approach that embraces vibrant matter, we must develop techniques that act with and are inspired by the behaviours of these non-human assemblages. An account of some of these activities is what constitutes the following section, 3.03 *Live Composition*. In both *Variable 4*, *Tactus* and *Living Symphonies*, indeterminate, parameterised and model-driven techniques aim at a vibrancy that Bennett describes adeptly: "a vital materialism interrupts both the teleological organicism of some ecologists and the machine image of

[278] (Deleuze and Guattari 2005, 411)
[279] (Bennett 2010, ix)
[280] (ibid., 23)
[281] (ibid., 24)
[282] (ibid., viii–ix)
[283] (ibid., 104)
[284] (ibid., 112)
[285] (ibid., 112)

nature governing many of their opponents."[286] In developing and employing these methods I seek to follow Bennett, highlighting and extending our human awareness of "our interinvolvements and interdependencies."[287]

[286] (Bennett 2010, 112)
[287] (ibid., 104)

Sounds proclaim movement,
the voice proclaims a being endowed with sense;
only animate bodies sing.

—Jean-Jacques Rousseau
in *Essay on the Origin of Language* (1781)[288]

Sonic Vibrancy

In this praxis, I employ Bennett's 'vibrant matter', Barad's 'agential realism' and Pickering's 'dance of agency' in understanding and exploring the agential intra-active potential of Cox's 'sonic events'. These capacitive investigations recognise a 'sonic vibrancy' that is tricky to pin down: actants in space never meld as one collective body, but maintain a constant autonomous and emergent sensibility, causing independent variations amongst the assemblage.[289] In understanding sound as vibrant we cut across subject and object in the auditory field, placing sound within Ingold's 'meshwork' and highlighting its impact and intra-relation with the world: a call to focus on the shared holism of materiality.

We are inextricably in the world as it sounds: our footsteps are not only ours, they also convey the response of the ground, that is, the world sounding back at us. By walking we sound materiality: through sound (alongside touch, and other vestibular and proprieoceptary senses), the materiality of our surrounding communicates itself to us. As Ihde has remarked: "sound dances timefully with experience."[290] In the resonance of sonic events, we gain a sense of time—sound is vibrant: it presupposes movement, its occurrence heralds a state of becoming, it is entwined and inseparable from vibration and vectorisation. As LaBelle has observed, sound is "an optimal medium to put to use in developing interactive work,"[291] because its temporality, ability to generate a sense of life, and the very fact of its dynamism means it has 'affect'. It exhibits what Goodman has described as "the ability of one entity to change another from a distance."[292] With sound this often occurs both aerodynamically and through solid material, through covibration, as we have discussed previously.

Chion describes one aspect of sonic character as 'materializing indices'. These indices can be increased through a higher 'definition' of sound: "a more defined sound, containing more information, is able to provide more materializing indices."[293] Although it seems obvious, it is often left unremarked that through use of high quality sound

[288] (Rousseau 1997, 291)
[289] See Bennett for a much more in depth discussion of the assemblage as vibratory: (Bennett 2010, 34–5).
[290] (Ihde 2007, 85)
[291] (LaBelle 2015, 288)
[292] (Goodman 2010, 83)
[293] (Chion 1994, 99)

recording and transduction techniques, it is possible to create "a more lively, spasmodic, rapid, alert mode of listening, particularly to agile phenomena that occur in the higher frequencies."[294] For Chion, increasing material indices allows one to "make palpable the materiality of its source and of the concrete conditions of its emission."[295] In my own practice, I have paid heed to Chion's indices, seeking high levels of definition in the recording and transduction of the sounds heard, exploring meaningful resonance between the materialities of the sites of the works, and the originating source materiality. Because materializing indices act as indicators of the physical nature of their source—a heard violin note materializes the wooden, resonant chamber of the violin, as well as the horsehair of the bow and catgut of the string—these indices conjure the source materialities into action in the assemblage of the work. Within the vibrancy of sonic events are expressions of material indices, and these provide the potential for meaningful intra-actions. This intra-active process is complex, and in the resonance of sonic events the expression of materialized indices is always in flux. In a more reverberant acoustic for example, sound often expresses more of the materiality of the space than its original source, whereas in a more acoustically deadened space, we might find the opposite, with a higher level of referral to its origination. We will explore this 'source bonding' further in Chapter 3.04 *Locative Sound*. [296]

[294] (ibid., 99)
[295] (Chion 2009, 480)
[296] For an excellent primer on the relations between sound and space, see Barry Blesser and Linda-Ruth Salter's 2007 book *Spaces Speak, Are You Listening?*

Fig.31 *Forest floor at Fineshade Woods*, Northamptonshire, 2014.

▶

E6 *Living Symphonies* Fineshade Woods (field recording)[297]
24 June 2014
00'47"

Fig.32 *Silver Birch at Cannock Chase*, Staffordshire, 2014.

[297] See https://www.dropbox.com/s/kkgftnx9d9y2m47/E6_2014_LS_FineshadeFR18_fliescloseandfar.mp3?dl=0.

Fig.33 *Forest floor at Fineshade Woods*, Northamptonshire, 2014.

▶

E7. *Living Symphonies* Fineshade Woods (field recording)[298]

24 June 2014

00'56"

Fig.34 *Forest floor at Fineshade Woods*, Northamptonshire, 2014.

[298] See https://www.dropbox.com/s/2xvhxq1syaeudi3/E7_2014_LS_FineshadeFR6_generalambience2.mp3?dl=0.

Fig.35 Shingle beach.
Dungeness, 22 May 2010.

E8. *Variable 4* Dungeness beach (field recording)[299]
22 May 2010
02'32"

[299] See https://www.dropbox.com/s/qhn9pjdgu78mrbl/E8_2010_Dungeness_Sea-Beach_recording.mp3?dl=0.

Fig.36 View of reed bed from installation site.
Snape Maltings, 28 May 2011.

▶

E9. *Variable 4* Snape Maltings reed beds (field recording)[300]

28 May 2011

04'06"

[300] See https://www.dropbox.com/s/7p3rbhk72kw0538/E9_2011-05-26%20%E2%80%93%20Variable%204%20Snape%20Maltings%20field%20recording.mp3?dl=0 .

Value resembles a dance, not a statue.
—Raymond Ruyer
In *La Philosophie de la Valeur* (1952)[301]

The Dance of Agency

As Karen Barad observes, it takes two or more things to create action: it is not possible to subtract one thing that will retain its agency outside the relationship, "agency is a matter of intra-acting; it is an enactment, not something someone or something has."[302] Barad's theorisation of 'agential realism' illustrates that the "world kicks back:"[303] agency is "the ongoing reconfigurings of the world"[304] whose primary units of meaning are material-discursive practices that map out its bounds. Pickering explores agential realism in his 'mangle of practice,' calling upon the weather to observe that humans "could not survive for any length of time without responding in a very direct way to such material agency."[305] Agential realism is a theory of knowledge, resting on the premise that reality consists of what Barad describes as "*phenomena* that are reconstituted in *intra-action* with the interventions of knowers."[306] This intra-action refutes the separation of object and agency, avoiding the reinscription of a contested dichotomy. For Barad, agential realism "provides an understanding of the interactions between human and nonhuman, material and discursive, and natural and cultural factors in the production of knowledge."[307] Pickering explores agential realism in the balancing of human and non-human agency in texts: "in texts, agents (actors, actants) are continually coming into being, fading away, moving around, changing places with one another, and so on. Importantly, their status can easily make the transit between being real entities and social constructs, and back again."[308] Pickering describes a breaking down of the classic subject-object dualism, favouring a cleaving with material agency that he calls a "dance of agency."[309] Pickering notes that "the dance of agency, seen asymmetrically from the human end, thus takes the form of a dialectic of resistance and accommodation."[310] For me, I consider my practice as an interlocked "dance of agency" between human and material, framed by a theoretical and material "mangling," a mutual transformation occurring in praxis. I draw from what Morton has described: "instead of

[301] (Ruyer 1952, 204)
[302] (Barad 1998, 112)
[303] (ibid., 112)
[304] (Barad 2003, 818)
[305] (Pickering 1995, 6)
[306] (Barad 2000, 15)
[307] (ibid., 15)
[308] (Pickering 1995, 12)
[309] (ibid., 22)
[310] (ibid., 22)

trying endlessly to get rid of the subject-object dualism, dark ecology dances with the subject-object duality."[311]

Perhaps paradoxically, the interdisciplinary recognition of material agency has been birthed in the age of the computational machine, often regarded as entwined in a sea of immaterial communications. Whilst we certainly now live a networked existence, a teeming 'internet of things'[312] that hums, chirps and vibrates amongst us, this ubiquitous machinic corpus does not portray solely immaterial agency: it hinges upon vast physical data centres and technical infrastructures. Vital materialism then admits what Bennett notes: "humanity and nonhumanity have always performed an intricate dance with each other. There was never a time when human agency was anything other than an interfolding network of humanity and nonhumanity: today this mingling has become harder to ignore."[313] This artistic practice recognises the dance of agency at its basis, as a temporal emergence that might provide insight and knowing through agential realism. In this engagement with material agency, this dance, I employ technologies and methods that enable human-material intra-action through sound. The techniques used in the three works included in this thesis are discussed in Chapter 3.03 *Live Composition*, where we investigate how sonic vibrancy can increase levels of communication between actants in the assemblage.

[311] (Morton 2007, 185)
[312] The "internet of things" was a term coined by Kevin Ashton in 1999. Ashton discusses the principle in a 2009 article for RFID journal, see http://www.rfidjournal.com/articles/view?4986 [accessed 2017/09/09].
[313] (Bennett 2010, 31)

3.03 *Live Composition*

The grand narrative has lost its credibility

—Jean-François Lyotard
In *The Postmodern Condition*, 1979[314]

Amongst the day to day conversations, meetings and makings of my artistic practice these last seven years, I have found it necessary to employ new terminology to detail what is happening. Two of these neologisms are extrapolated in the sections that follow; 'live composition' and 'locative sound.' I will detail these specific methodological frameworks as an integral part of my praxis. Both terms have come about through the extension and exploration of extant terminologies, emerging from discussions with my collaborators and informed by conversations that have taken place with audiences at the public exhibitions and installations of the works. For me, the terms have been highly useful in describing the works to others. In exploring their meaning, I can unfold the practical techniques that have created intra-actions between the works and their materialities.

In the early months of devising *Variable 4* in 2010, Jones and I challenged each other to come up with novel autonomous processes that could trigger and compose sound in real-time. Our impetus was the creation of a weather-driven sound composition that would be heard on the exposed shingle-plains of Dungeness Beach, Kent. We began with a number of simple movement studies, initially notated, then recorded, for which we composed software algorithms. We explored triggering these miniature algorithmic compositions with incoming weather data, whilst simultaneously using the data to alter the sequencing and micro-composition of the playing sound motifs in real-time. We began exploring a form of "open" composition.[315]

We had chosen Dungeness as a location for *Variable 4* as we felt it provided a dynamic and exposed situation for the atmospheric composition. In early 2010 we were fortunate to gain a small grant to support the work from the Performing Rights Society Foundation (PRSF). The first iteration of *Variable 4* opened to the public on 22 May 2010 for a twenty-four-hour duration. Visitors included local people, and those who travelled from further afield via a scheduled service from Victoria Coach station in London. One morning we were surprised by the arrival of the ITV Meridian weather team, who broadcast their daily report from the centre of the installation site. They stood

[314] (Lyotard 37, 1984)
[315] This openness refers to both John Cage's use of the term 'open composition' and the tenets of Eco's 'Open Work'.

backdropped by the Campbell Scientific weather station,[316] whose second by second data was relayed back one hundred metres to the compositional system housed in a Royal National Lifeboat Association (RNLI) outhouse, triggering the composition of sonic events over the eight-speaker system hidden at the site. As Luke Turner described in an article about *Variable 4* on the website *Caught By the River*, "the music reaches us via speakers that are arranged in a circle, and hidden under pieces of flotsam and jetsam, driftwood, rusted steel cable, fragments of net."[317] Visitors were free to explore the work over any time period they wished over the twenty-four hour duration the piece was open. At this first installation of *Variable 4*, as Jones and I met and discussed the piece with others, the true double meaning of an "open" work became apparent. The interpretation of *Variable 4* was open to encounter, by both audience, and cause (in this instance the weather). The composition of the work was always unfinished; it was open in what Umberto Eco has referred to as a "tangible way."[318]

The experience of *Variable 4* at Dungeness led to what might be termed an 'iterative approach' to the work - after the installation, we immediately began planning and working toward a future iteration of the work, keen to learn from our experiences and develop the piece further. Further installations demonstrated to us what Pierre Lévy has observed: "every actualization reveals a new aspect of the work."[319] This iterative approach recognised one of the tenets of open form, which Eco has described: "an incomplete knowledge of the system is in fact an essential feature in its formulation."[320] There is knowing in the unknown, and in the incorporation of experimental, processual thinking through iteration, each installation of *Variable 4* became an actuality that is part of all of the performances of the work: "every performance makes the work an actuality, but is itself only complementary to all possible other performances of the work" [321] As Jones and I have observed in other writings about *Variable 4*, the work is always developing, as we hone and rework different aspects of its systems-based composition: "in many cases, several iterations and combinations of processes, scales and dynamics took place before the deployment of an algorithm was satisfactory."[322]

In the months that followed the Dungeness installation of *Variable 4*, we worked on a second iteration of the work as part of an artist residency at Snape Maltings in

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[316] We received the Campbell Scientific BWS200 weather station used in *Variable 4* after a conversation with Iain Thornton at Campbell Scientific that began in October 2009. Iain and his company kindly sponsored the work by loaning the weather station on a long-term basis.
[317] (Turner 2010).
[318] (Eco 1989, 4)
[319] (Pierre Lévy quoted in Cox and Warner 2015, 206)
[320] (Eco 1989, 15)
[321] (Eco 1989, 15).
[322] (Bulley and Jones, 2011)

Suffolk. We studied the work of a number of musicians and composers, ranging from Mozart's *Musical Dice Game. K.294.*[323] to La Monte Young's *Anthology of Chance Operations* (1963).[324] We compared notes and discussed Brian Eno's 2011 talk 'Composers as Gardeners,'[325] listened to the process composition of Christopher Hobbs' *Sudoku 82* (2009)[326] and debated the iterative nature of the electronica duo Icarus' release of an album in a 1000 variations (2012).[327] Our work sounded a long historical lineage from which we drew influence and language. This included investigating the transdisciplinary fields of systems art and systems theory which provided us with a broad framework for understanding the world and its interactions that emphasised a holistic view of interrelated things. The composition of *Variable 4* was not only a process of applying a priori systems of mental logic, but one of working co-operatively at the pivot of atmospheric-process interaction. As Robert Morris has observed of the work of Jackson Pollock: "the work turned back toward the natural world through accident and gravity and moved the activity of making into a direct engagement with certain natural conditions."[328]

In taking *Variable 4* into the outdoors to compose autonomously in real-time, we probed John Cage's delineation of two broad categories of open composition; 'indeterminate with respect to composition and determinate with respect to performance,' and, 'determinate with respect to composition and indeterminate with respect to performance.'[329] With *Variable 4*, as the weather conducted, re-composed and spatialised the real-time sound out across the Hepworth Lawn at Snape Maltings, we had created a combinatory open form, both *indeterminate in its composition* and *indeterminate in its performance*. The composition of *Variable 4* is indeterminate in the chance-based processes woven into the compositional software and sound processing (the touch-triggering in *Tactus* and the improvisatory recordings sessions for *Living Symphonies* are other examples of this, as we shall discuss later in this section). *Variable 4* is indeterminate in its performance because the autonomous, semi-chaotic behaviour

[323] Whilst *Musical Dice Game. K.294* is attributed to the composer Wolfgang Amadeus Mozart, this has not been conclusively proven. It is however one of the earliest documented examples of the use of chance operations in musical composition.
[324] See La Monte Young's *An Anthology of Chance Operations* (1963).
[325] Eno gave the talk 'Composers as Gardeners' on Sunday October 16 2011 as part of the Serpentine Gallery's 'Garden Marathon'. A transcript of the discussion is available here: https://www.edge.org/conversation/brian_eno-composers-as-gardeners [accessed 2017/05/02].
[326] For more about Christopher Hobbs' *Sudoku 82* see http://experimentalmusic.co.uk/wp/emc-catalogue-list/recordings-by-post/br0036-christopher-hobbs-sudoku-82/ [accessed 2017/08/10].
[327] For further information about Icarus' digital release, which generated a bespoke album and artwork for each individual download, see http://cdm.link/2012/02/making-digital-one-of-a-kind-inside-icarus-generative-album-in-1000-variations/ [accessed 2016/10/09].
[328] (Morris 1995, 78)
[329] Cox and Warner illustrate these using the examples of Cage's *Music of Changes* (1951); indeterminate/determinate, and Earle Brown's *December 1952;* determinate/indeterminate (Cox and Warner 2015, 165).

of on-site atmospheric conditions defines the choices of movements, granular composition and spatial activity of the composition in real-time. Here is where we find live composition situated, challenging and blurring boundaries between audience, composer, work and materiality.

Fig.37 *Variable 4* installation site.
Dungeness, Kent, May 2010.

Fig.38 *Variable 4* installation site.
Snape Maltings, Suffolk, May 2011.

Generative Music

Live composition employs the tactics of generative music, an open form of composition which Eno has described as "a set of conditions by which something will come into existence."[330] This means that, as LaBelle has noted, "what is often made then is not so much a final sound composition but a system that will build a certain sound production."[331] For Eno, generative music is akin to horticulture, and the generative sonic form can "respond to conditions during its growth."[332] In many examples of generative music, the actuality of sound composition is imbricated in programming, and this is the case with *Variable 4*, *Tactus* and *Living Symphonies*. The three works are underpinned by bespoke software that controls the playback of generative music driven by the dynamic materiality of their situation. The softwares are the product of a creative process of code writing, the result of highly skilled interactions between human and machine. Software is a term that has been in common parlance since the creation of early computers in the 1950s. At first its usage referred to only a few simplistic lines of code but over recent decades these lines have grown into to what Thrift has called "a forest of code covering much of the globe in a profusion of over two hundred different languages."[333] In the present day, software is ever-present, existing in all manner of everyday devices. Software has become a conversational process, it acts as a mediary with its own powers, but is still enveloped, as Pickering notes, "by the gestures, skills, and whatever is required to set machines in motion and to channel and exploit their power."[334] We might consider then that this compositional software, devised for each work,[335] is a machine-logic that can be considered to have agency. It creates what we might call a 'material complexification,' that often exists, as Mark Hansen notes "outside of the phenomenal field of subjectivity."[336] Compositional software is unconsciously present, reflecting the constant embrace of the code-logic that underscores our day-to-day existence. The liminal machines of live composition exist as conduit between the material and non-material world. Through generative technique, live composition gains performative image.

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[330] (Eno, quoted in Toop 2015, 242)
[331] (LaBelle 2015, 287)
[332] (Eno, quoted in Toop 2015, 242)
[333] (Thrift 2005, 240)
[334] (Pickering 1995, 16)
[335] Whilst Jones/Bulley is an equal collaboration, it would be remiss of me not to note that Jones's skills with software coding are on a much higher level than mine. His background is in computer science, mine is in music composition.
[336] (Hansen 2003, 17)

Studio Composition

The composition of these works was made possible through the use of recording and production techniques that took place in the sound studio. Creating sound in the studio is a direct, intuitive and material process which in the present day has distinct differences to traditional understandings of music composition. As Eno has noted "there is no transmission loss"[337] in the sound studio. When I sit down to compose a movement of *Living Symphonies*, I work directly with the sound recordings from the session with the musician, in an intuitive, sculptural process, like a painter with paint. The sonic events are captured in the recording session, and become malleable through editing and effects. In my practice, which is rooted in working with sound phonographically through digital and analogue processes, I find the possibilities for sonic variation too endless to list. What is certain however is that I use what Lee Brown has described as 'phonography' in my techniques, employing "recording machinery for an intrinsic aesthetic purpose."[338] However, my practice diverges from Brown's definition of phonography in the generative nature of live composition. For Brown, phonography cannot be performed, but as pianist Glenn Gould has observed, the authentic can be a creative phonographic product derived from live performance.[339] Live composition is a performative, expanded idea of phonographic activity, using its techniques of recording and production and weaving them with generative and dynamic triggering.

The three-main works discussed in this thesis were developed in the studio, a space that for me is often transient, as I move from residency to residency and place to place. The wide variety of techniques at play in my studio practice include editing, production, development of generative motifs, spatialisation testing, and mixing and mastering. The studio is a complex, entangled place, where a wide-manner of experimentalism, performativity and trial-and-error takes place: acoustic spaces are constructed, deconstructed and reconstructed, takes are retaken, and what Ihde has called 'active construction' is the norm.[340] As audiences, it is often the case that we listen to recorded music 'blind' to the processes that have taken place, with this artifice so carefully woven into the fabrication of the produced sound that it is invisible to perception. A notable exception to this has been discussed with reference to *The Talking Drum*. This is what Smalley has termed 'technological listening' which "occurs when a listener 'perceives' the technology or technique behind the music rather than the music itself."[341]

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[337] (Eno 2015, 129)
[338] (Brown 2000, 363)
[339] (Cox and Warner 2015, 113)
[340] (Ihde 2007, 260–261)
[341] (Smalley 1997, 109)

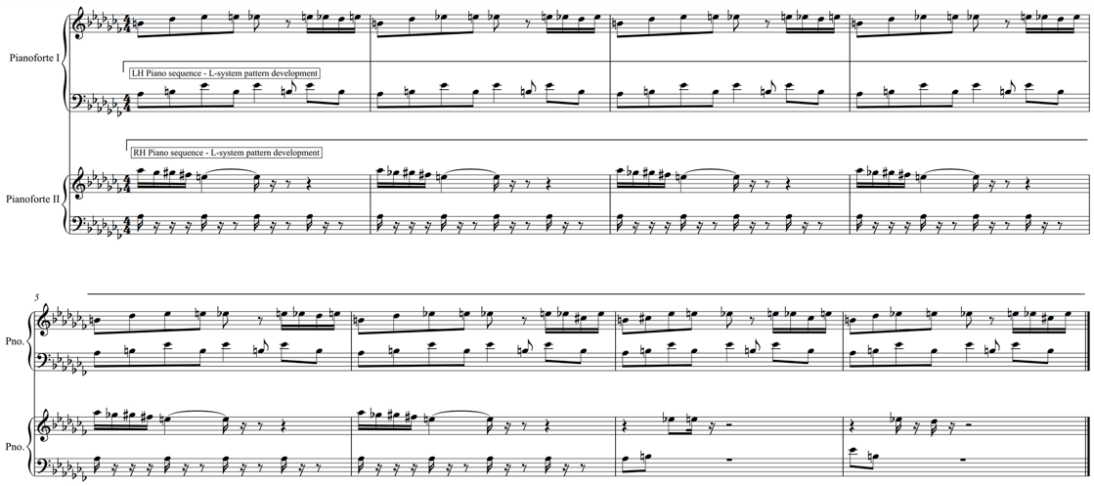

Fig.39 Example score excerpt from recording session for movement 18 (Ab Minor) of the *Variable 4* Elizabeth Castle sound score.
2011.

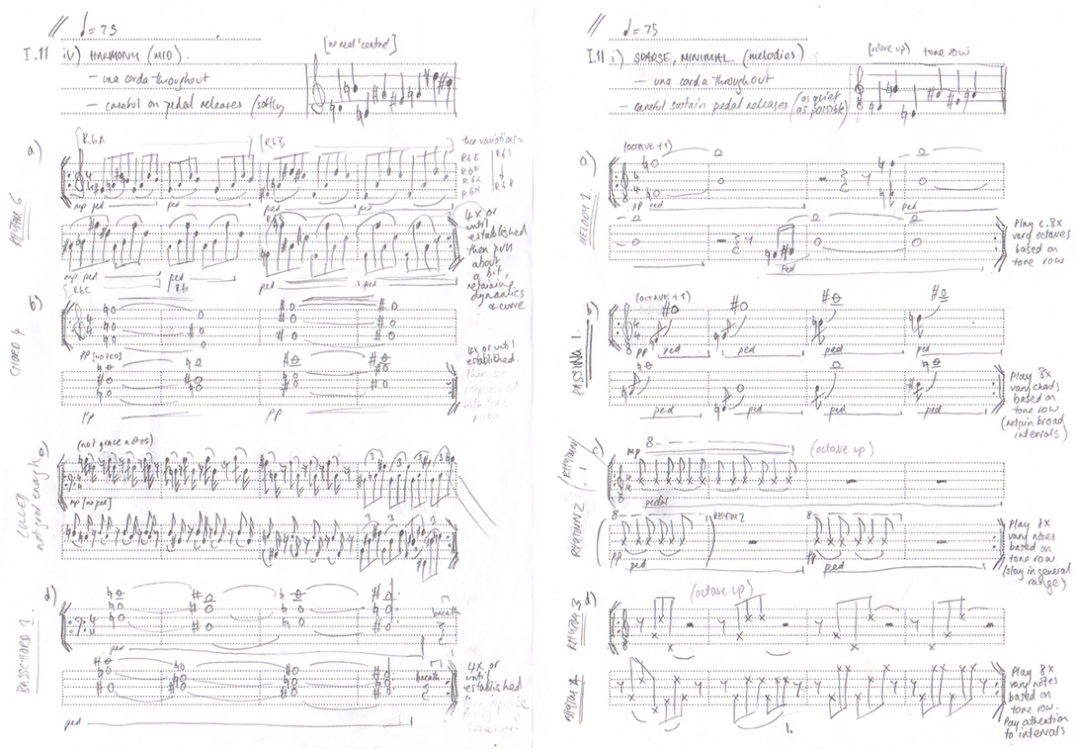

Fig.40 Example score excerpt from recording session for movement I.11 *Arachnid* of *Living Symphonies*.
2014.

Sonification

In its initial form, *Variable 4* was conceived as an autonomous installation that would use sonification to achieve a dynamic composition of a complex sound-score using real-time weather data. In recent decades, the technique of 'sonification' has increased awareness of realms that are considered silent, translating them into the range of human hearing—foetal doppler systems, the large hadron collider and radio astronomy are three recent examples. In Kramer et al's 1999 prototypical definition of the term, sonification is defined as "the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation."[342] Thomas Hermann has expanded this definition to "a technique that uses data as input, and generates sound signals (eventually in response to optional additional excitation or triggering),"[343] and he has outlined a series of prerequisites:

> (C1) The sound reflects objective properties or relations in the input data.
> (C2) The transformation is systematic. This means that there is a precise definition provided of how the data (and optional interactions) cause the sound to change.
> (C3) The sonification is reproducible: given the same data and identical interactions (or triggers) the resulting sound has to be structurally identical.
> (C4) The system can intentionally be used with different data, and also be used in repetition with the same data.[344]

Following Hermann, Walker and Ness have surmised that sonification "seeks to translate relationships in data or information into sound(s) that exploit the auditory perceptual abilities of human beings such that the data relationships are comprehensible."[345] By utilising sonification techniques on specific agential materialities, we can intensify the sonic perception of that materialism, beyond the auditory reality. The communicative potency of sonification is its 'indexicality,' which as Barrass and Vickers explain "becomes a measure of the arbitrariness of a mapping."[346] An example of sonification that exhibits high indexicality is 'audification,' when "waveforms of periodic data are directly translated into sound."[347] Whilst direct and simple in form, audification requires datasets containing large amounts of information, constituted of wave-like signals with a high level of complexity. Examples of audification abound in artistic practice, from Daphne Oram's drawn sound technique

[342] (Kramer et al 1999, 4)
[343] (Hermann 2008, 2)
[344] (ibid., 2)
[345] (Walker and Ness 2011, 9)
[346] (Barrass and Vickers 2011, 157)
[347] (Walker and Ness 2011, 17)

'Oramics',[348] to Bill Fontana's 'Harmonic Bridge'[349] and Christina Kubisch's 'Electrical Walks'.[350] But audification is not a creative action in itself, it does not actually explain things: the pattern pre-exists, it is re-presented.

[348] For more on Daphne Oram's 'Oramics' technique see Peter Manning's article "The Oramics Machine: from Vision to Reality" (2012).

[349] Fontana's *Harmonic Bridge* (2006), used vibration sensors and microphones attached to the Millennium Bridge in London to convey the long drone-like sounding of the structure of the bridge as people walked over it. This audification was spatially rendered simultaneously into the turbine hall of the Tate Modern and in the main concourse of Southwark London Underground station. For more information on Bill Fontana's 'Harmonic Bridge,' including recordings, see http://resoundings.org/Pages/Harmonic_Bridge1.htm [accessed 2017/04/05].

[350] In Kubisch's walks, the artist reveals a hidden aspect of the urban environment by utilising bespoke headphones to render audible the invisible networks of electromagnetic induction that surround us in our everyday life. As Kim-Cohen notes, "the service provided by Kubisch is not the one typically assigned to composers, painters, and poets, but rather that of scientists, educators, and whistle-blowers: to alert us to the presence of previously undisclosed facts" (Kim-Cohen 2009, 110). Here then is a pause for artists who work with sonification: by nature, they work at an intersection of art and science.

Parameterisation

'Parameter Mapping Sonification' involves what Grond and Berger describe as "the association of information with auditory parameters for the purpose of data display."[351] This means it is well suited for portraying complex and varied arrays of data, and as a result it is flexible and affective. By mapping of parameter, data can cross from field to field, mapped one to the other. As a result, 'parameterisation' has found a wide range of applications, particularly within artistic practices that utilise sonification.[352] The essence of parameterisation is mapping, a move from here to there that presents two challenges; finding an appropriate linking mechanism between sound and data, and engaging in what Grond and Berger describe as the "elusive perceptual domain."[353]

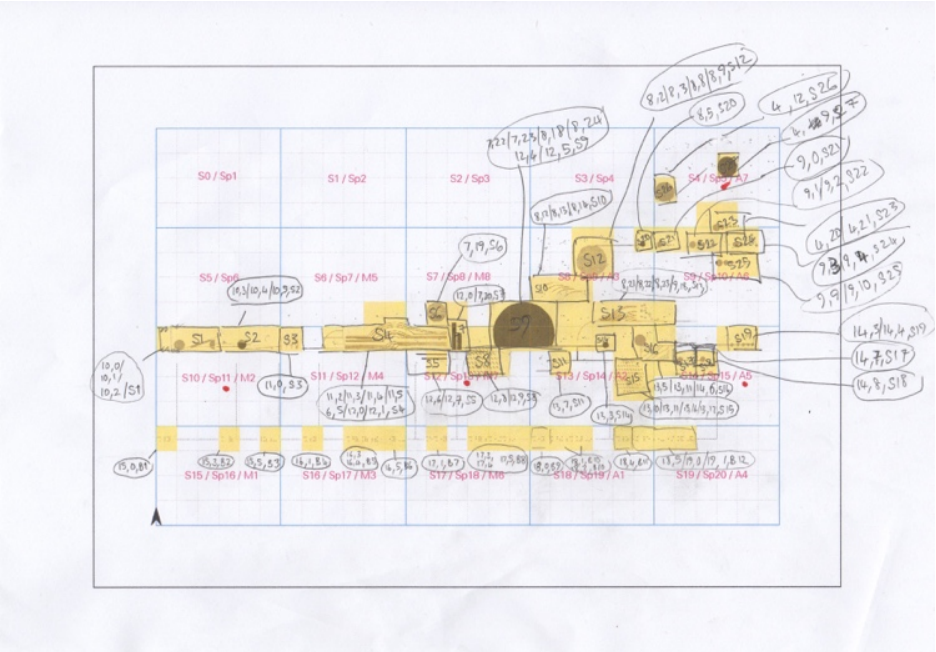

Fig.41. *Tactus No.1* parameterisation mappings between capacitive touch board and sound score.
Digital scan of print and hand drawn image.
August 2015.

[351] (Grond and Berger 2011, 363)
[352] The aesthetic potential of sonification as a medium has been developed by sound artists including Andrea Polli. Polli has made extensive use of sonification techniques in the public art project *Atmospherics/Weather Works,* whose goals she describes as follows: "the development of a software system for the creation of sonifications based on meteorological and other data to be used in performances and installations, the presentation of live and recorded musical performances, and the creation of a web site for an interactive presentation of the sonifications" (Polli 2005, 31).
[353] (Grond and Berger 2011, 367–368)

Fig.42 Weather Station at *Living Symphonies* installation site.
Fineshade Woods, Northamptonshire, June 2014.

Fig.43 Weather station at *Variable 4* installation site.
Portland Bill, Dorset, September 2014.

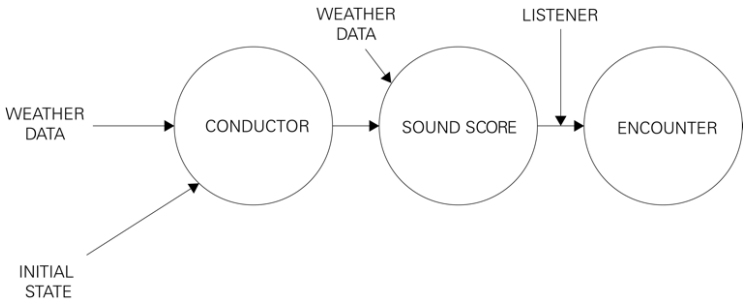

Fig.44 The sonification of weather data via the conductor to the sound score in *Variable 4*.

If at an installation of *Variable 4*, out amongst the reed beds early one morning, it is unseasonably warm, humid, and there is a slight breeze in the air, then a specific movement intended for these conditions will be selected by the 'conductor' that controls the work.[354] The generative composition of the movement will unfold based on parameterisation of incoming weather data, captured from the weather station at the centre of the site. Within this single movement of the sound score there are numerous generative processes woven amongst the hundreds of part-composed sound fragments, ranging from indeterminate note-to-note sequences to motif-to-motif selection and spatialisation patterns. Some examples of aleatoric and extended compositional techniques that Jones and I have used within the *Variable 4* sound score include Markov Chains, L-Systems, Levy Flight and Chord Generators. The behaviour and triggering of these processes is controlled in real-time by atmospheric changes. As the breeze swells, you might hear the speed of the movement increase alongside a rise in density of notes, whilst a dominant motif in the composition rotates slowly around the eight-speaker system hidden in the surrounds.

[354] See fig.47 for an example of movement selection during the Snape Maltings installation of *Variable 4*.

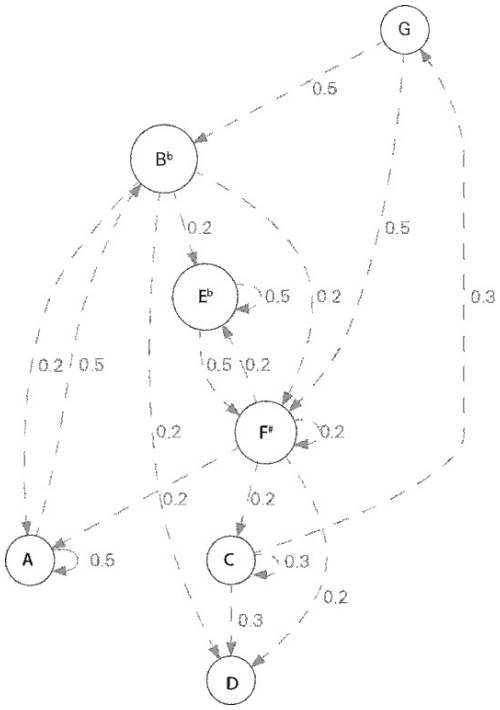

Fig.45 Example of Markov chain generative process applied to G Minor motif sequence in Movement 11 of V*ariable 4* Dungeness.

A form of parameter mapping sonification drives the live composition of *Variable 4*, where real-time atmospheric data, read second-by-second by the weather station parameterises a twenty-four-movement sound score (fig.46). The primary sensing input of *Variable 4* is the Campbell Scientific BWS-200 weather station, with an additional rain gauge and pyranometer for reading solar radiation. This is connected to a computer via a serial-USB interface, with an RS-484 "long drop" extender for communications over several hundred metres. Incoming sensor data from the weather station provides streams of data; air temperature, relative humidity, wind speed, wind direction, solar radiation and precipitation (see fig. 47), and additional derivatives[355] are calculated by a software framework written in Python.[356] The second-by-second rate allows for near instant sonification at the sonic event level. The data is also accumulated, creating gradual longer-term changes to the composition. The Python framework is interwoven with a 'conductor' software, written in Max for Live (M4L)[357] which works by scaling the incoming data and using it to trigger different areas of the sound score. This score is hosted in the live area of the sequencer software 'Ableton Live'[358] and events are triggered using internal MIDI Control Change signals.[359] Relevant movements

[355] Derivatives include changes in temperature and humidity over time. Other data includes the current time of day, and its derivations into dawn, day, dusk and night, which demarcate a global temporal aspect to the live composition.
[356] See https://www.python.org/ [accessed 2017/01/04].
[357] See http://www.ableton.com/maxforlive [accessed 2017/01/04].
[358] See http://www.ableton.com/live [accessed 2017/01/04].
[359] MIDI Control Change (CC) signals are part of MIDI, a communications protocol that allows a vast array of sound devices and computers to communicate with each other.

and generative processes are cued by the conductor by reference to an 'instruction score'. Formally, this instruction score can be considered the logic for the piece, and it consists of a table of information rendered in code[360] that defines what movement should play and in what manner, given a specific array of weather conditions. A two-dimensional rendering of the instruction score for *Variable 4* can be seen in fig.46. In developing *Variable 4*, Jones and I also created a 'simulator' software, allowing us to research historic weather conditions in advance of an installation, emulating them using manual controls. The simulator allowed us to explore and develop different states of the composition. This was vital both in the studio and onsite, not only so that we could compose and balance the multi-channel composition, but also so that we could calibrate the conductor's scaling of the work in advance, based on an average weather situation for the particular site and date.[361]

This technique of sonifying real-time atmospheric conditions is similar to Alvin Lucier's seminal 1965 work *Music for Solo Performer*, where Lucier monitors his brain activity through electrodes on his scalp, triggering the real-time beating of an array of automated percussion instruments. Lucier's work is often taken as a prototypical example of biofeedback and a clear example of parameter mapped sonification. More complex real-time parameterisation of data has only become possible in recent years as a result of advances in computation. As Grond and Berger have noted, this now allows for "the possibility of highly effective multivariate displays and the potential to represent both physical and data spaces in a variety of ways that allow for exploration and observation monitoring."[362] This more complex, multilayered form of parameterisation is what happens in *Variable 4*, with the data parameterising the sound score at both a global and a local level simultaneously. But we ought to recognise a problem when describing *Variable 4* as a sonification. In Hermann's definition, category (C3) requires some consideration. Given exactly identical input data on two different days at the installation site, the generative processes woven into the sound score would mean that the audio signal sent to the speakers would never be an exact match. The overall auditory field produced would be similar, but on the level of sonic events, fragments of sound and their behaviour would always differ. In this sense, the work diverges from a core tenet of sonification, that of reproducibility. As such, we can understand that the live composition taking place in *Variable 4* utilises sonification techniques but is not a

[360] Generally, as a .csv data table.
[361] For example, the period average data for September 2011 at Elizabeth Castle, Jersey, based on the period 1971 to 2011; mean daily temperature 16.1°C, mean maximum temperature 19.3°C, mean minimum temperature 12.9°C, highest maximum recorded 33.3°C, lowest minimum recorded 6.0°C, mean relative humidity 77%, mean total global solar radiation for the month 344.2mWhrcm-2, mean total diffuse solar radiation for the month 166.8mWhrcm-2, total monthly sunshine 182.3 hours, mean total monthly rainfall 70.3mm, highest rainfall 203.6mm, lowest rainfall 4.3 mm, mean monthly wind speed 10.6 knots.
[362] (Grond and Berger 2011, 380)

sonification in itself. The divergence from sonification present in *Variable 4* was a conceptual necessity—it is in this space that the composition of the work explores the wonderfully chaotic irreproducibility of the weather, seeking a bonded mimicry of unpredictable agency through generative process.

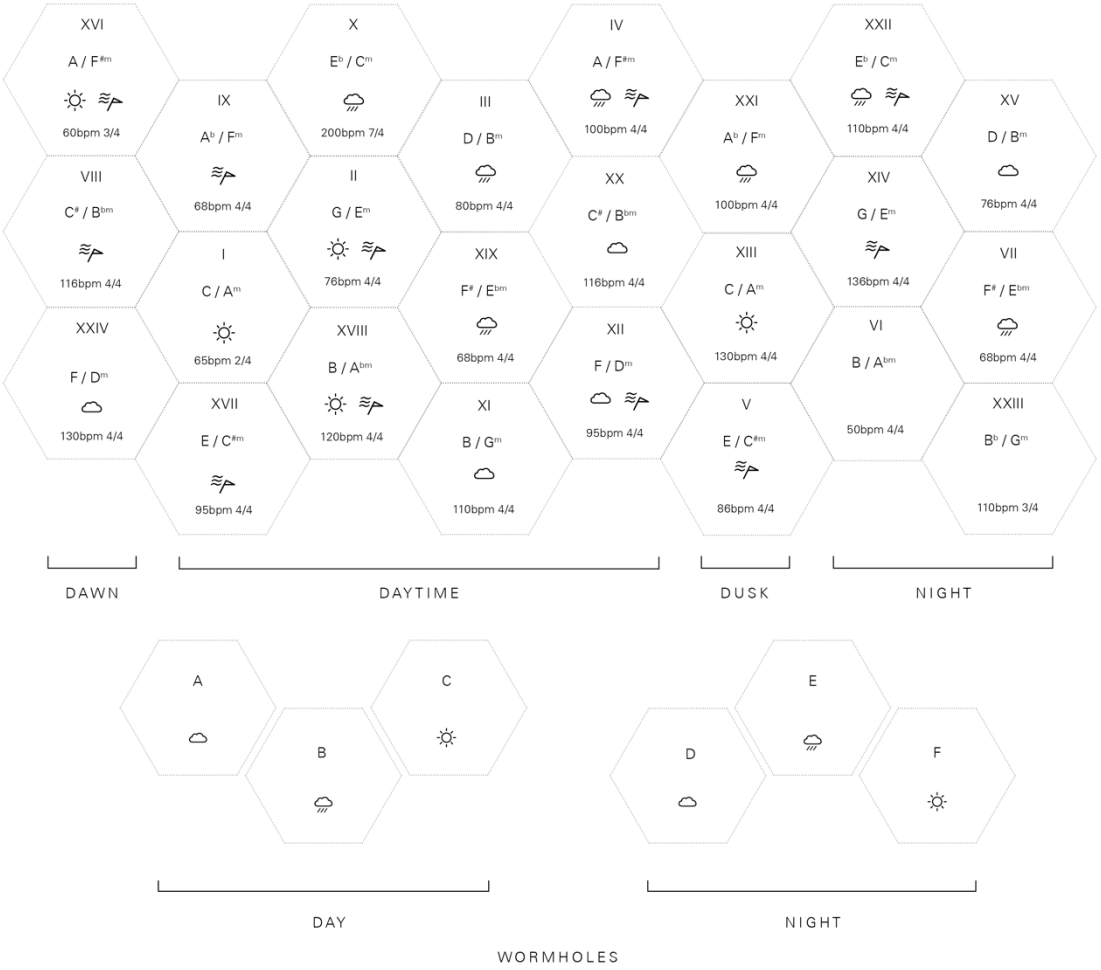

Fig.46 *Variable 4* instruction score visualised as a two-dimensional hexagonal lattice.
Each hexagonal cell corresponds to one of the twenty-four movements that make up the total composition.
Six wormholes are employed to smooth transitions when sudden changes of weather occur.

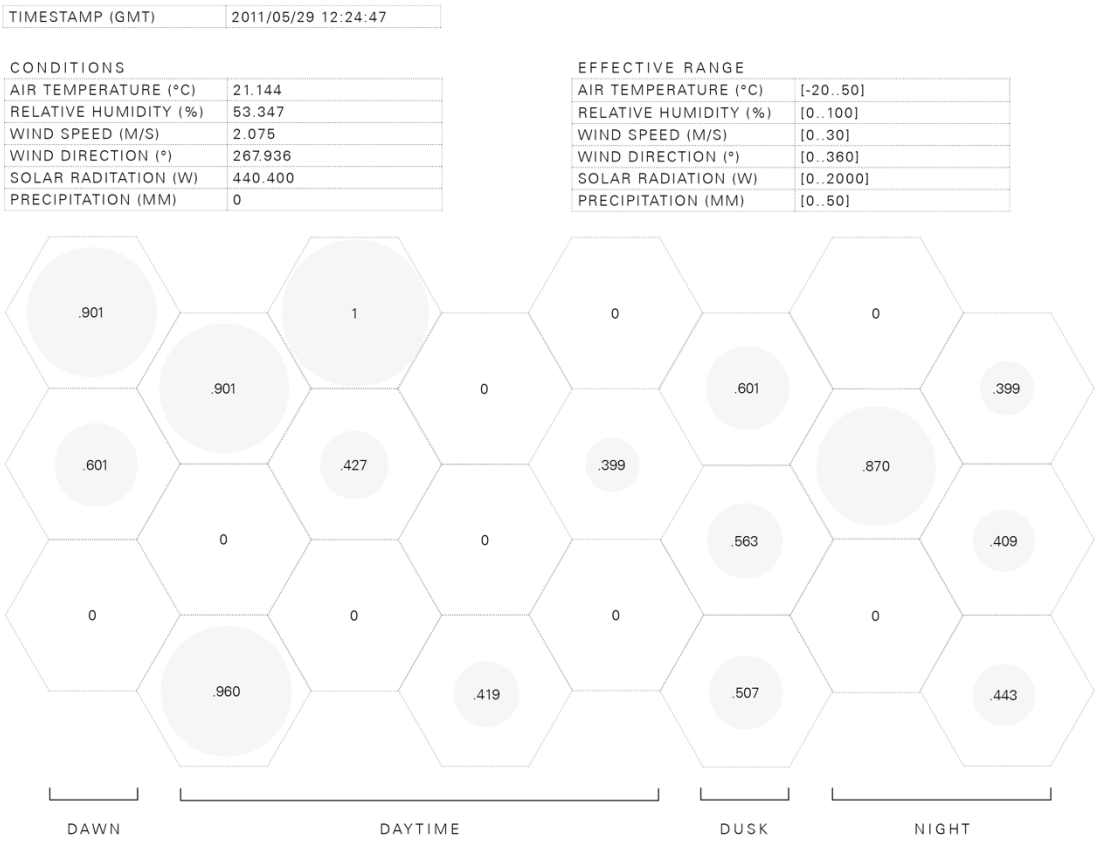

Fig.47 Example visualisation of movement selection by the conductor at the *Variable 4* installation at Snape Maltings.

Variable 4 as Live Composition

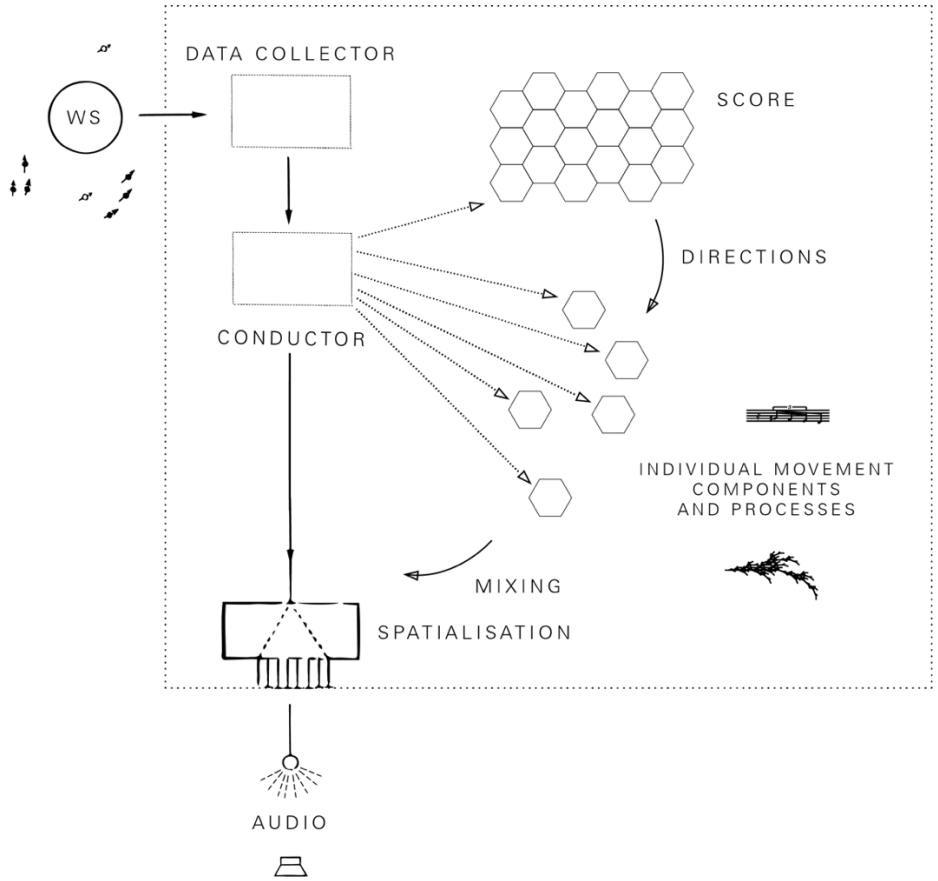

Fig.48 Overview of *Variable 4*.

As Ingold has observed, "the absence of weather from anthropological accounts of human ways of being and knowing is little short of extraordinary"[363] and it is from this omission, caused partly by the temperamental, chaotic behaviour of the atmosphere, that the weather is excluded from most formulations of materiality (which generally constitute landscape, human and non-human organisms, and artifacts). For Jones and I this omission became a driving force in realising *Variable 4*. Ingold deems the weather "the very temperament of our being,"[364] and it is apparent that the weather is a critical but often overlooked relation between our bodies and our ways of knowing. In composing *Variable 4*, we set out to explore the semi-chaotic and emergent materiality of the weather, aiming to create a platform from which the listener might gain unique insight to this matter of weather, hidden in plain sight.

[363] (Ingold 2010, S132)
[364] (Ingold 2010, S112)

In 1961, Edward Lorenz was working on models for weather prediction, when he noticed a peculiar phenomenon; it was possible that a deterministic system (a system whose future behaviour is fully determined by its initial conditions) was not predictable. He observed weather patterns that "come and go in the atmosphere, families of eddies and cyclones, always obeying mathematical rules, yet never reproducing themselves."[365] Lorenz named this behaviour 'deterministic chaos', now simply understood as 'chaos'. The study of chaos in subsequent decades has become a thriving cross-disciplinary area, and as Gleick has noted: "it has brought together thinkers from fields that had been widely separated."[366] For Jones and I, this chaotic, cross-disciplinary nature was fascinating, presenting a challenge as to how to convey this in sound composition. The weather also served as an analogue for ways of understanding our world. Olafur Eliasson describes it as "the broadest of all sources of collective awareness"[367] noting how it "cultivates complexity and unpredictability."[368] Connor observes its unique propensity as metaphor, drawing from the writing of Michel Serres to call it "a veritable *mappamundi* for the movements of information."[369] In the United Kingdom we have a particular fixation with the weather, perhaps because we live, as Richard Mabey has noted "on an island in the middle of the Atlantic Storm Belt, just offshore from a huge, breathing land-mass, our meteorological lot is messy and erratic, whether we like it or not."[370]

When choosing the sites for *Variable 4*, Jones and I sought out those locations that exposed the audience to a wide dynamism of atmospheric conditions. We sited the work firstly on the remote shingle plains of Dungeness, Kent, then amongst the vast skies and flat landscapes of East Anglia, at Snape Maltings, before journeying to the windswept island of Elizabeth Castle, looking out over the yacht strewn coastline of St. Helier, Jersey from atop of an abandoned German World War Two bunker. Most recently, in the late summer of 2014, we installed *Variable 4* amongst an abandoned stone quarry at the end of a rocky outcrop on Portland Bill, Dorset, where the piece was flanked by a lighthouse on one side and the fenced off outpost of multinational defence company Qinetiq[371] on the other.

In the earliest days of *Variable 4*, listening to test movements amongst the rust strewn landscape of Dungeness beach, we realised that a purely derivative

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[365] (Gleick 1988, 12)
[366] (ibid., 5)
[367] (Eliasson 2002, 141)
[368] (ibid., 141)
[369] (Connor 2010, 11)
[370] (Mabey quoted in Harding 2013, 22)
[371] See https://www.qinetiq.com/ [accessed 2017/10/02].

parameterisation of the weather could not possibly convey the depth and resonance that we sought with the work. From then on, we focused on extending our compositional technique, including exploring the semiotic effect of anamnesis: using associative sound sources in the score that could cause the merging of "sound, perception and memory."[372] For us, the weather was not only a data source, to be objectified in direct-communicative sound, it had deep cultural significance, and was inextricably bound to the materialities and societies of the places where the work was experienced.

Unsurprisingly, artistic practice has often engaged with the social and sculptural impact of weather conditions and predictions. In his 2005 work *The Weather,* the poet Kenneth Goldsmith transcribed a year's worth of radio weather forecasts[373] in response to Alan Licht's *New York Minute* (2001), a sound piece in which Licht cuts and contrasts weather forecast recordings taken every day in a month.[374] We also find numerous historic examples of weather driven art in Aeolian music, including the work of British artist Max Eastley who employs the wind to conduct his freestanding Aeolian sound sculptures.[375] *Variable 4* is conceived with many of these influences in mind and its compositional processes have developed through its four iterations and the research periods leading up to them.

After Jones and I returned from that first installation at Dungeness, we decided that each iteration of *Variable 4* should have a fresh sound score composed for it, exploring both the types of weather conditions allocated to each movement and the materiality and cultural history of its place. Before each iteration we embarked on research trips, met local people, recorded musicians, read books, took photographs and film, and made field recordings around the site. In following months, a process of intuition and material thinking was employed as each generative movement was composed and recorded in the studio. The movements became a response to specific weather conditions and also a resonation of the cultural history and materiality of the site where the piece was installed.

As detailed in fig.46, the global structure of the *Variable 4* instruction score has Western traditional roots. The 'tonal centres' of each of the twenty-four movements find general harmonic structure from the key signatures of the Western major and minor

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[372] (Augoyard and Torgue 2005, 21)
[373] See Kenneth Goldsmith's *The Weather* (2005). *The Weather* is presented online here: http://epc.buffalo.edu/authors/goldsmith/goldsmith_year01.html [accessed 2017/10/19].
[374] Excerpts from Licht's *New York Minute* are available on UbuWeb: http://www.ubu.com/sound/licht.html [accessed 2017/10/19].
[375] Carl Engel's 1882 article in the *Musical Times* "Aeolian Music" gives an enchanting account of historic aeolian practices and stories.

scales and relate to each other through consonant relationships based on the circle of fourths and fifths. Whilst the tonal centres of *Variable 4* are based on the twenty-four key signatures in the Western classical tradition, this is a "broad strokes" approach. Movements in *Variable 4* often use different scales, microtonalities and non-tonal manipulated recordings. The 'tonal centre' approach is not a strict rule system, but aims to aid in exploring consonant and dissonant transitions as the work moves around the score: it allows for both intentioned and unexpected consonance between two or more movements playing simultaneously. The pre-composition of each movement starts with the intuitive creation of a notated or graphic score, which is interpreted and performed by a musician or group of musicians in a studio-based recording session. The recordings are then edited and part-composed using phonographic techniques as movements within the audio production software Pro Tools.[376] The sonic fragments that make up a given movement (generally around four or five hundred per movement) are then exported to the Ableton Live sound score, where they are interwoven with planned generative elements, mixed and mastered, and allocated certain patterns of parameterisation.

To create gradual and coherent transitions across the sound score as the weather undulates and changes over the course of a day or night, movements are selected based on a constantly updated rating system (see fig.47). Firstly, this system considers the overall characteristic of the weather and current time, then what the next most consonant tone centre would be based on the circle of fifths and fourths (see fig.46). As the weather changes, the material from the next most appropriate movement will begin to play in combination with the material of the initial movement, which then dissipates. The tempo of the sound score will gradually change, drawing closer to that of the new movement. If the weather conditions change very suddenly, the piece moves from movement to movement across the sound score via 'wormholes'. These are generally atonal and arrhythmical movements, often field recording based, that act as transitions and serve to highlight sudden changes in atmospheric conditions. There is an additional rule system built into the work, that ensures that no movement plays endlessly given similar weather conditions over longer durations. In this rare situation (given the exposed locations that the work is sited in), the next most appropriate movement will begin.

Over the four iterations of *Variable 4*, the composition of the movements for each site have varied widely. Some movements focus almost entirely on the characterisation of certain weather conditions, such as this early prepared piano composition from the first installation of *Variable 4* at Dungeness, allocated to

[376] See http://www.avid.com/pro-tools [accessed 2017/09/15].

conditions of heavy rain in the daytime and derived from recording sessions with Rashad Selim's *Geo-piano*:[377]

E10. *Variable 4* Dungeness - Wormhole C (excerpt from sound score)[378]
20 May 2010
01'00"

In following iterations of *Variable 4*, the composition became far more developed, drawing closer links with the materiality of place. An example of this can be heard in the twenty second movement of the *Variable 4* Snape Maltings score, a cello octet re-imagining of Benjamin Britten's *Tema Sacher*. The original *Tema Sacher* which inspired the composition of this movement was one of the final works composed by Benjamin Britten. It was written in 1976 at the bequest of the cellist Mstislav Rostropovich as a seventieth birthday present for the Swiss composer Paul Sacher. Britten and his partner Peter Pears built the concert hall at Snape Maltings in 1967, and the composition of this movement pays tribute to their legacy, which created such a rich and enjoyable residency period for Jones and I, working out amongst the reed beds.

E11. *Variable 4* Snape Maltings - Movement 22 *Tema Sacher* (field recording)[379]
29 May 2011
01'00"

[377] More information about the piano and Selim's work can be found here: http://www.therecessionists.co.uk/middle-eastern/rashad-selim-painter [accessed 2016/05/04].
[378] See https://www.dropbox.com/s/35yvg3nf8ax7pco/E10_2010-04_V4_2010_Dungeness_WormholeC_excerpt.mp3?dl=0.
[379] See https://www.dropbox.com/s/4aemier3gewc8cy/E11_2011-05-28_V4_SnapeMaltings_Tema_Sacher.mp3?dl=0.

Tactus and Parameterisation

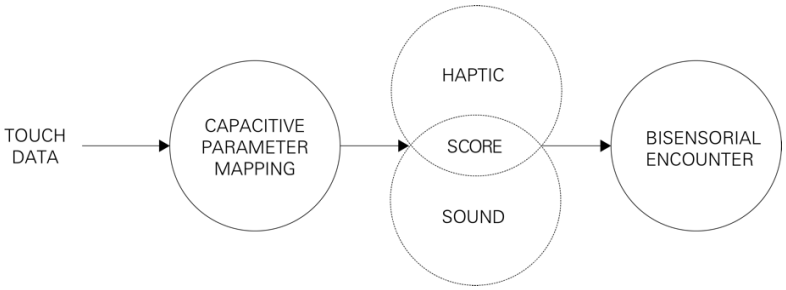

Fig.49 Parameter based sonification of touch data via capacitive mapping in *Tactus*.

As with *Variable 4*, the touch-sound work *Tactus* works with a form of parameter mapping sonification. In encountering the work, touches on specific areas of the wall-mounted textile-print landscape are monitored through capacitive touch boards[380] and custom software hosted on Arduinos,[381] embedded under the surface of the work. The software translates the received data of the location and pressure of the touch, and maps these parameters by reference to a table,[382] spatialising the sonic events with their related motifs in the haptic score. Events are heard instantaneously from the speaker underneath the point at which the score has been touched. As we shall discuss further in Chapter 3.04 *Locative Sound*, *Tactus* has a hidden twenty-speaker system, and in *Tactus No.1*, the first work that has been created in the series, there are around thirty-nine separate trigger areas across the textile-print landscape. The capacitive touch boards of *Tactus No.1* were designed with the help of engineer Arron Smith from Artists & Engineers.[383] The software was developed with my long-term collaborator Daniel Jones[384] enabling the translation of touch to control parameters across the sound score, hosted in Ableton Live. The capacitive boards, which are calibrated toward a fingertip level of precision, have a series of perforations drilled through them (see fig.51), which allows for sound from speakers mounted behind them to travel through to the textile surface. An illustration of the twenty-board capacitive layout for the *Tactus No.1* score is included in fig.50.

[380] Capacitive sensing utilises a process of capacitive coupling, which involves measuring the dielectric difference from air.
[381] Arduino boards are an open-source electronic prototyping platform that enable the creation of interactive electronic objects. See https://www.arduino.cc [accessed 2017/06/04].
[382] In this case a .csv file.
[383] For more about the work of Artist & Engineers, see http://www.artistsandengineers.co.uk/ [accessed 2016/05/06].
[384] See Jones's website and portfolio of works here: http://erase.net/ [accessed 2016/05/05].

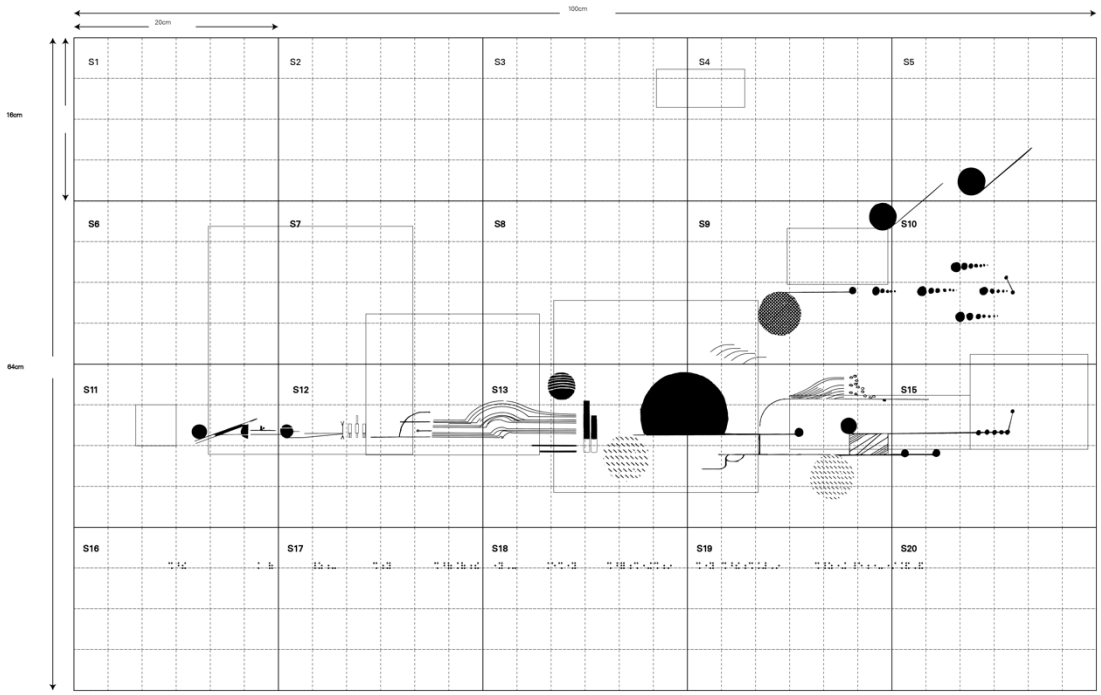

Fig.50 Capacitive touch board PCB layout, *Tactus No.1*.
2015.

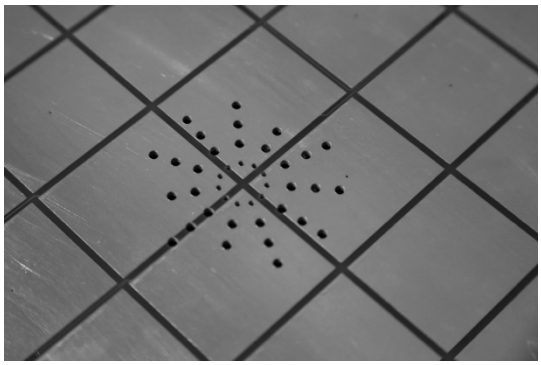

Fig.51 Capacitive touch board underneath *Tactus No.1* score
with perforations for speaker attached underneath.
2015

In mapping touch with sound, *Tactus* aims to imbricate the audience and haptic sound score as one assemblage, in which tactility and hearing mangle and intra-act. Touch is the sensory mode that inextricably integrates our worldly experience with that of ourselves, and the work seeks to heighten our sensation to this delicate nature. The capacitive touch boards underlying the textile-score are calibrated carefully when the work is installed in each location, such that they are triggered by the finest of touches: the aim is to encourage a careful, lightness in touch, and the piece swiftly becomes discordant and overbearing when numerous score events are triggered simultaneously. The work encourages sensory exploration, not game play.

Fig.52 *Tactus No.1* at the Kaunas Biennial.
September 2015.

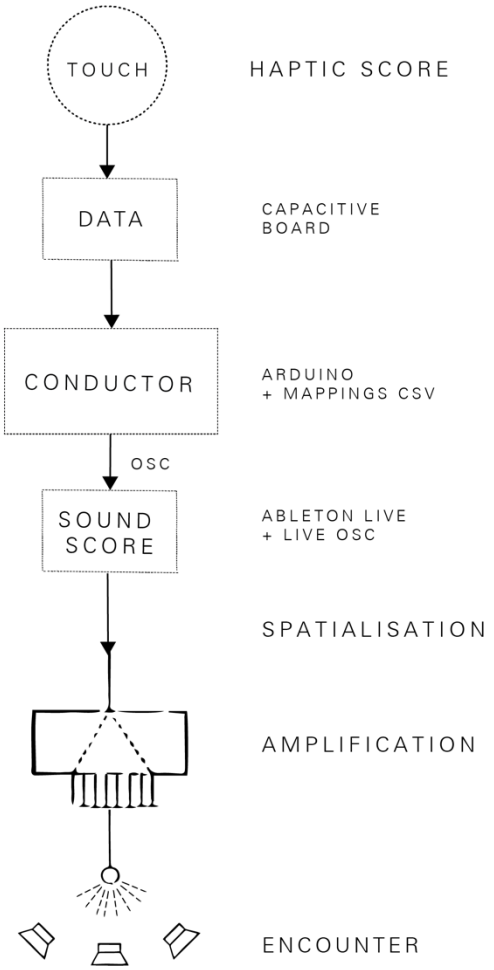

Fig.53 Overview of live composition in *Tactus*.

In late 2011, I began the *Tactus* project as an investigation into the potential of a direct communicative artwork for the blind and visually impaired. As such, the reader is asked where possible to consider this detailing of its workings from a non-visual 'point of view'. *Tactus* has developed over a four-year period up to its first exhibition, *Tactus No.1* at the Kaunas Biennial in 2015, where it was commissioned as part of the Craft Council's *Sonic Pattern* exhibition curated by Karen Gaskill and Janis Jefferies.[385] *Tactus* had derived its impetus from conversations with the blind musician and technologist Ian Rattray. We had been discussing the tactile drawings handed out at major art galleries across the world, and how despite their best intention, they always presented a secondary, poor relation to their related visual artwork, even in the case of a

[385] For further information see the website of the 2015 Kaunas Biennial: https://www.bienale.lt/2015/en/ [accessed 2016/04/03].

relatively geometric, line-based painting such as Pablo Picasso's *Nude Woman in a Red Armchair* (1932).[386] From our discussion, I realised that the unique bisensoriality of sound and touch might provide fertile territory for creating artworks that Ian could experience in a gallery with just as much depth, if not more, than a sighted person. An artwork of this kind might also allow investigation of another preoccupation I had at the time: the intra-action between sound, materiality and touch. I decided that the work should be publicly accessible, created to be installed in a gallery space where all could access it. This provoked consideration of the numerous issues I had come across in the exhibition and curation of sound-based art works in galleries over the years.[387] Not only was it difficult to anticipate the acoustic properties that work might be sited in, but there was also the issue of sound bleed and the soundtracking of other works in nearby space. I also had often experienced the issue of time-based media in gallery spaces, walking into a room and encountering pieces of video art half way through, or waiting for a sound piece to loop back round so I can catch it from the beginning. Further, the gallery spaces of recent decades have become sterile, monosensorial spaces, rife with 'do not touch' signs and discreet firm barriers. I began to consider how it might be possible to surpass these conventions. I came across the work of the Baschet brothers, whose playful, interactive sound sculptures encourage a wonderful contrariness, where art became a social function.[388] The brothers' sculptures illustrated the absence of physical barriers and countered the museum's convention of treating the tactile as impoverished prelude to the visual.

In February 2012, I was fortunate to be offered a residency at London Printworks Trust in Brixton to begin prototyping *Tactus*. I started by exploring ways in which I might design and screen print a raised, haptic notated score. I worked with a number of different textiles and print techniques, inspired and guided by Faye McNulty[389] and James Bosley,[390] two textile designers who I had met at Printworks. I have carried on working particularly closely with McNulty over the years since, and she has been instrumental in developing the bespoke raised 'puff' print technique that forms the durable, communicative basis of the haptic notation printed on the tactile scores.

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[386] This Picasso work was one that we had come across as a tactile image in the Tate collection. The Tate have in fact used Picasso's work in a number of different ways, aiming to provide heightened access for the blind and visually impaired. Their award winning online i-map project can be explored online here: http://www2.tate.org.uk/imap/femalenude-picasso.shtml [accessed 2017/06/05].

[387] The exhibition *SHO-ZYG,* which I co-curated with artist Kathryn Sandys stands out as a particularly formative experience in exploring how sound can work in exhibition spaces. A walk through of the 2012 exhibition, featuring over fifty different artists working with sound, can be found here: http://sho-zyg.com/2012/sho-zyg.html [accessed 2014/05/06].

[388] For more about the Baschet brothers' work see *Structures Sonores* by Bernard Baschet in *Sound Sculpture* edited by John Grayson (1975).

[389] For more about Faye McNulty's work see http://www.fayemcnulty.com/ [accessed 2017/01/04].

[390] For more about James Bosley's work see http://www.jamesbosley.co.uk/ [accessed 2017/01/04]

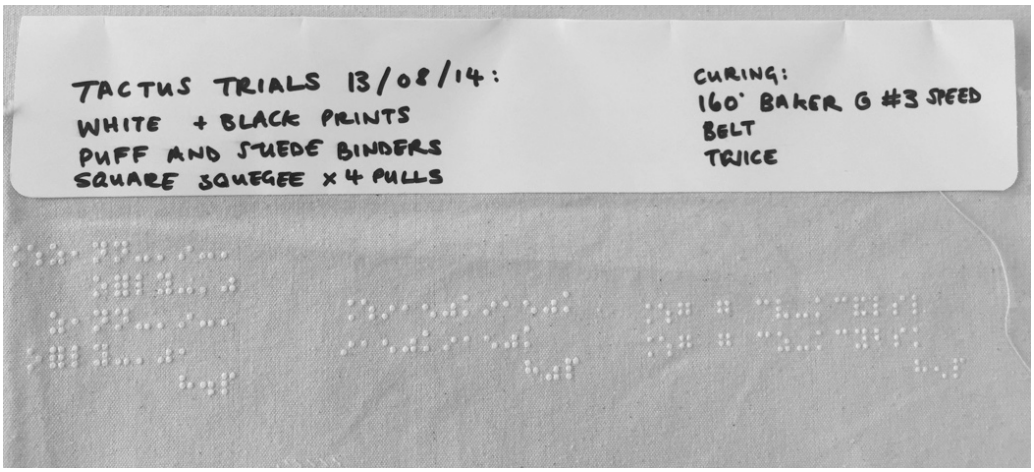

Fig.54 *Tactus No.1* screen-print trials with Faye McNulty.
August 2015.

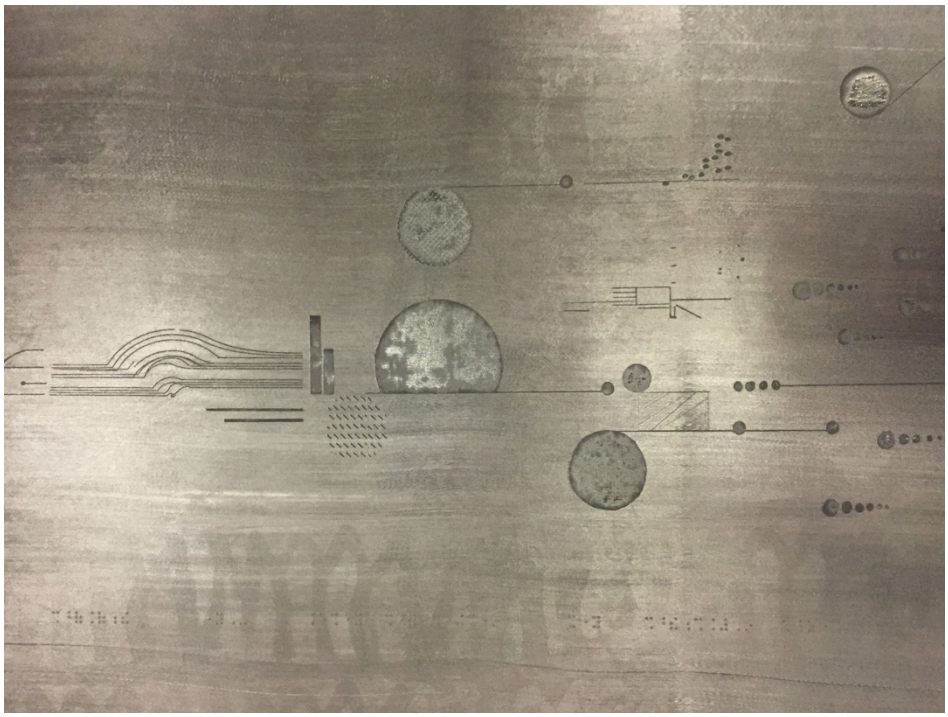

Fig.55 *Tactus No.1*, screen-print trials.
August 2015.

Fig.56 *Tactus No.1* screen-printing with Faye McNulty.
August 2015.

Touching textiles is a communicative experience, an intra-action between the body and the weave. *Tactus* 'touches' you back in haptic interaction, it is as Connor has observed: "when you touch something, your touch may result in the sensation of its touch on you."[391] Touch is a different kind of sense: "touching is an action in a way that looking and listening are not,"[392] and its employ in *Tactus* creates a bisensoriality. Sound and touch are often considered inseparable, those most intimate of senses, irrepressible in space, or as Schafer has it: "hearing is a way of touching at a distance."[393] The score is explored by hand, the part of our body from which we gain strength, that contains what Nan Shepherd has called "an infinity of pleasure."[394] Touching with your hands has an immediacy of appeal, the pull of it can, as Kenneth Frampton has noted, "only be decoded in terms of experience itself: it cannot be reduced to mere information, to representation or to the simple evocation of a simulacrum substituting for absent presences."[395]

In using the term haptic to describe the *Tactus* project we encounter a confusion of present terminology, especially within arts discourse. Vasta et al. have simplified it as "the perceptual experience that results from active exploration of objects by touch,"[396] but the term is also used to denote the reconception of touch through sight, when something is considered at distance. This notion of "haptic visuality"[397] is used prevalently in visual arts writing, and has a long critical discourse underpinning it. It is used to describe everything from the thick washes of J.M.W. Turner's brush strokes to the folds of Tracy Emin's *My Bed* (1998) and as Laura Marks has observed, "in the sliding relationship between haptic and optical, distant vision gives way to touch, and touch reconceives the object to be seen from a distance."[398] The historical Western art tradition of employing controlled abstract space in surrounding an artwork has only furthered this balancing act. In earlier times artworks occupied a singular plane, aligned with the audience and encouraging of touch interaction (petroglyphs, statues, mosaics etc.), but in the contemporary, it is rare to encounter an artwork that is dominantly haptic. *Tactus* seeks to recapture some ground in the active exploration of artwork by touch, employing the haptic in a direct sense to overcome physical distancing from materiality.

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[391] (Connor 2004, 263)
[392] (ibid., 263)
[393] (Schafer 1977, 11)
[394] (Shepherd 2011, 103)
[395] (Frampton 1983, 28)
[396] (Vasta et.al 1992, 202)
[397] (Marks 2002, p xiii)
[398] (ibid., xvi)

The composition of the haptic sound score for *Tactus No.1* explores and pays tribute to the braille music notation system of Louis Braille,[399] with a braille notated melody underscoring the piece. Each braille note or chord links to a haptic-sound motif above it, led via tactile cues rendered on the surface of the score. The design of the score was inspired by research into a wide number of artists who have worked with touch, including the 'tactile experiments' of the Czech surrealist animator Jan Švankmajer. In the 1970s, when banned from film making by the Czech authorities, Švankmajer turned to creating haptic experiments, culminating in the publication of a Samizdat in 1994 entitled 'Hmat a Imaginace' (Touching and Imagining),[400] containing documentation of his and others experiments in tactile art. The book contained the instructions for one of his works, which I have drawn upon to explore *Tactus* as a sighted person, as part of its unintended audience:

> Instructions for touching: First have a careful look at the drawing. Select a place from which to begin and start touching. Gently place fingers on the starting point, close your eyes and set off on a journey from memory. The whole way keep repeating in your mind: 'I will never see this again.'[401]

In developing the design, I not only found inspiration from tactile artworks, I also drew influence from architectural tactile codes for the blind, the particular spatiality of Russian Constructivist design, and the extraordinary graphic score of Cornelius Cardew's 1967 work *Treatise*, which Cardew described as consisting of "193 pages of graphic score with no systematic instructions as to the interpretation and only the barest hints (such as an empty pair of 5line systems below every page) to indicate that the interpretation is to be musical."[402] The non-linearity of the sound score for *Tactus* was firstly inspired by Terry Riley's proto-minimalist composition *In C* (1964)[403] and then sought harmonic influence from the crystalline piano formulations of Morton Feldman.[404] Another particular spur when thinking about the work as an assemblage was discovering the beautiful *Sonambient* sculptures of Harry Bertoia.[405] Watching people running their hands over Bertoia's fields of shimmering metal demonstrated the unique potency of intra-actions between touch, matter and sound.

Interactivity in an artwork is a tricky condition, for as LaBelle has noted "such works run the risk of simply obeying the commands of a visitor, offering back to

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[399] For an overview of the evolution of Braille music notation, see Fred Kersten's article "The History and Development of Braille Music Methodology" in the *Bulletin of Historical Research in Music Education* (1997).
[400] See the republished version of Jan Švankmajer's *Touching and Imagining: an Introduction to Tactile Art* (2014).
[401] (Švankmajer 2014, 132)
[402] (Cardew 1971).
[403] See http://terryriley.net/ [accessed 2017/08/08].
[404] Of particular inspiration was Feldman's last piano piece, *Palais De Mari* (1986). For more about Morton Feldman's work see Chris Villars' meticulous resource here: http://www.cnvill.net/mfhome.htm [accessed 2017/08/08].
[405] More about Harry Bertoia's sounding sculptures can be found on the Harry Bertoia foundation website, within which there is a portfolio of *Sonambient* imagery and recordings. See http://harrybertoia.org/about-bertoia-sonambient/ [accessed 2014/05/08].

themselves, in narcissistic plenitude, their own image, body or voice."[406] In *Tactus* the piece does not sound unless touched: the compositional determination comes from the person touching the tactile-sounding score. The work operates as a 'non-linear' live composition, bound to the haptic materiality of its textile-print surface. In the indeterminacy of this 'other' choice, I cede control of the global composition of the sound score, allowing for the audience to 'make the work'. This draws them into an intimate relationship with both haptic and sonic materiality, creating a communicative meshwork. The audience take up a vital agency in the assemblage, 'giving it life' and informing its vibrancy. The encounter gives rise to a time space which can be manipulated and decided by its audience.

Each *Tactus* score is composed of fragments of haptic-sound notation that form an overall composition. These notations are triggered by touch, as sound patterns heard back instantly across the spatial array of speakers invisibly embedded inside the body of the work. The sound score does not operate under a time signature or fixed linear arrangement but allows for recombination of rhythmic and harmonic score material through tactile exploration by the audience. The sounds heard within the work are derived from recording sessions that took place during its development. The braille music notation in the score for *Tactus No.1* for example (see fig.57) consists of a twelve-motif sequence, recorded in the Electronic Music Studios at Goldsmiths using a Yamaha Disklavier Grand Piano. This automated 'player piano,' allowed me to sustain the notes for long durations of time without the impact of noise from a human player, enabling piano notes within the score to decay naturally over seemingly impossible poised periods of time when triggered.

[406] (LaBelle 2015, 263)

E12. *Tactus No.1* B11–B12 (sound score excerpt)[407]

2015

00’34”

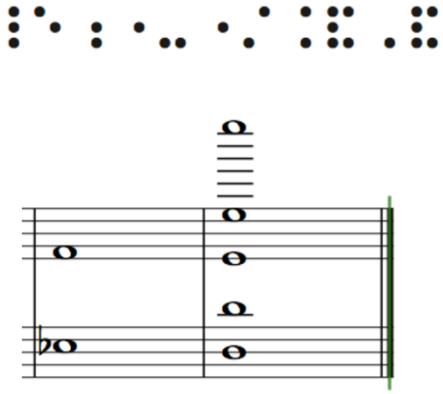

Fig.57 *Tactus No.1* B11–B12 (braille music notation score excerpt with translation). 2015.

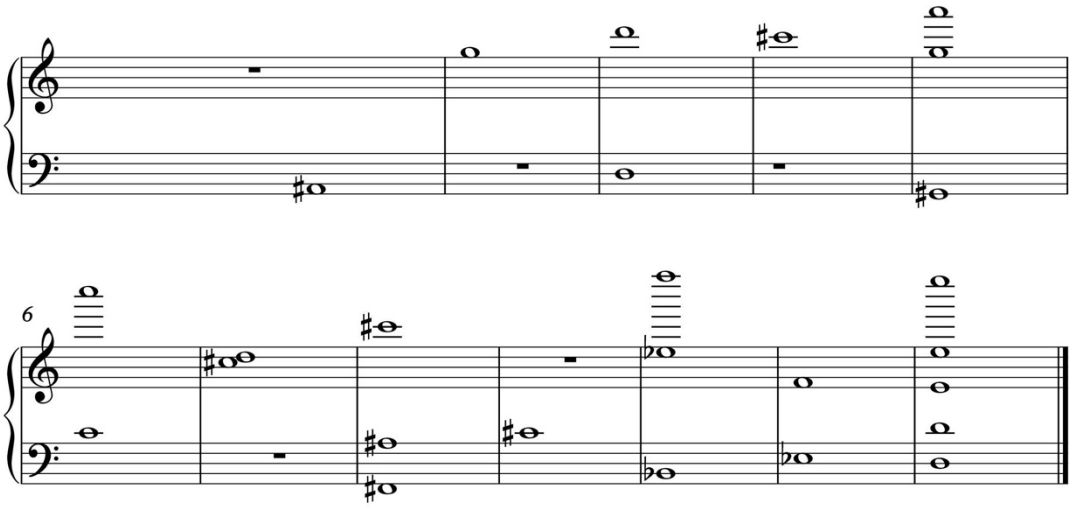

Fig.58 *Tactus No.1* example of twelve-part braille music notation transcription (visual translation). August 2015.

[407] See https://www.dropbox.com/s/c8jgx701foo13dr/E12_2015-09-01_Tactus_B11-B12.mp3?dl=0.

The non-braille based sections of the haptic score are used as instigation for part-improvised recording sessions, and the resultant material is further developed through phonographic experiment in the studio.[408] In the following excerpt from the *Tactus No.1* score, we hear the sound score motifs S4, S5 and S6, triggered in overlapping sequence.

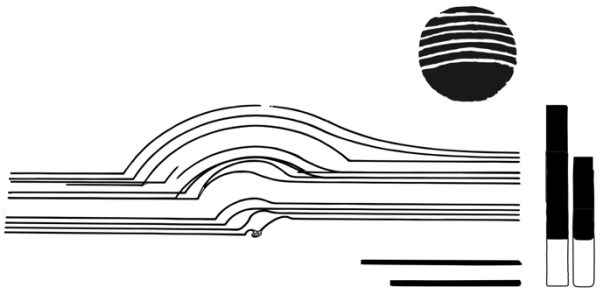

Fig.59 *Tactus No.1* S4, S5, S6 (haptic score excerpt).
2015.

▶

E13. *Tactus* S4, S5, S6 (sound score excerpt)[409]
2015
00'31"

Within the score, as motifs are triggered and die out, a lingering between each touch hints at the vibratory continuum beyond conventionally heard sound. In encounter, the score becomes instrumentalised by the touch of the audience, composition becomes instrument, what Adam Harper has called a "certain *configuration* of musical variables: a collection of certain musical variables together with their assigned values."[410] As Harper ventures, an instrument might be understood as "a musical work without a time limit"[411] and in this blurring of categorisation, apparent in the indeterminate nature of *Tactus*, is found what David Cope has described as "art as process. No beginning, no middle, no end: that is, no longer will "objects" of music exist in that sense, but each new performance, each new circumstance will create a continually variable process of ideas."[412]

[408] Sessions for *Tactus No.1* took place with the violinist Simon Hewitt-Jones (https://www.simonhewittjones.com/ [accessed 2016/07/09]), the cellist Alex Eichenberger, and the percussionist and multi-instrumentalist Keir Vine (http://keirvine.com/ [accessed 2016/07/09]).
[409] See https://www.dropbox.com/s/1qrjzwkev7hp0od/E13_2015-09-01_Tactus_S4-5-6.mp3?dl=0.
[410] (Harper 2011, 50)
[411] (ibid., 55–56)
[412] (Cope 1978, 166)

Model-based Sonification

Hermann has defined 'model-based sonification' as "the creation of processes that involve the data in a systematic way, and that are capable of evolving in time to generate an acoustic signal."[413] This approach involves the creation of a dynamic model, driven by data. In the model, "the acoustic response, or sonification, is directly linked to the temporal evolution."[414] A viable model-based sonification for Hermann requires a "general framework or paradigm for how to define, design and implement specific, task-oriented sonification techniques."[415] This is a kind of sonification that mediates between information and sound by way of dynamic model. In the forest-based sound installation *Living Symphonies* this technique defines the systems framework underlying the piece. The forest ecosystem data, derived from detailed surveying and taxonomic research, is teamed with real-time atmospheric and temporal conditions. This data does not directly determine the sound signal (as in audification), nor does it directly parameterise the composition (as in *Variable 4* and *Tactus*). Instead the information determines the architecture of a 'dynamic model',[416] which in turn parameterises sound.

Model-based sonification is a technique that invites us to understand hearing as Henriques has observed: "capable of recognising proportional relationships much better than vision."[417] *Living Symphonies* explores the potency of this proportionality in conveying the myriad intra-actions of the forest ecosystem, employing parameterisation (real-time data from the on-site weather station), researched taxonomies, and surveying to drive and populate a 'model-based sonification'—a detailed simulation of the forest ecosystem (see fig.62), which causes sonic events to be spatialised in real-time amongst the forest site.

[413] (Hermann 2011, 399)
[414] (ibid., 399)
[415] (ibid., 403)
[416] (ibid., 404)
[417] (Henriques 2011, 467)

Fig.60 Photographic survey of *Living Symphonies* site.
Thetford Forest, Norfolk, May 2014.

Fig.61 Photographic survey of *Living Symphonies* site.
Bedgebury Pinetum, Kent, August 2014.

Living Symphonies and Model-based Sonification

Living Symphonies was commissioned in early Summer 2013, the result of a meeting between Jones and I and the UK new music organisation, Sound and Music (SaM).[418] SaM asked us to work in partnership with the Forestry Commission (FCE) to produce a site-specific, forest-based sound work that could tour across the UK[419] in 2014, highlighting the diversity of forests maintained by the FCE. Jones and I accepted, and immediately began developing an idea we had been discussing in months previously, furthering our interest in natural systems to explore working with a forest ecosystem to drive live composition. As we discussed our ideas further, we realised that we would be unable to monitor the real-time behaviour of the flora and fauna across the forest in any meaningful way using sensors. The thriving interactions of an area of forest were just too complex and varied to measure in anything other than a peripheral, shallow manner. Furthermore, introducing an audience to a location where this was underway would immediately have an effect on the sensors that would likely run contrary to the aims of the work. We alighted upon a different methodology, a combination of parameterised and model-based sonification that required us to develop a detailed simulation of the forest ecosystem, using its design and taxonomy to create agency between the information space and sound score. The following schematic illustrates the model-based framework we defined for the piece.

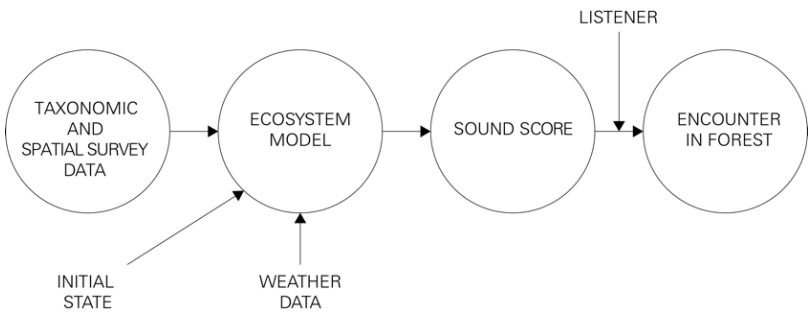

Fig.62 Model-based sonification in *Living Symphonies*.

In this framework, there is divergence from Hermann's definition of a valid 'model-based' approach to sonification. There is no human interference from the point that it begins, the work runs autonomously and the 'exciting factor', which Hermann defines as

[418] We had been originally going in to meet SaM for a discussion about a failed proposal we had submitted to another scheme that they were running at the time. See SaM's website here: http://soundandmusic.org/ [accessed 2016/05/08].

[419] Knowledge gained from touring *Living Symphonies* was formed into a toolkit, disseminated by Sound and Music and the Forestry Commission, and entitled "Planning and Producing Artworks in the Natural Environment," see http://soundandmusic.org/create/planningandproducingartworksinthenaturalenvironmenttoolkit [accessed 2016/02/03].

what happens when the user interacts, is not present. This human dynamism is replaced by the simulation of the ecosystem, defined by research into the characteristic behaviours of the species and parameterised by real-time weather conditions and the time of day. Within *Living Symphonies*, the term 'species' is used in a broad sense, and does not solely refer to living organisms, it also refers in this context to dead or rotting wood, which has a vital and intrinsic part to play in the balanced functioning of the whole forest ecosystem.

The development of the model for *Living Symphonies* occurred over a twelve-month period, and emerged from research at the four locations that we had decided upon after numerous group expeditions to potential locations in Autumn 2013. The four sites were decided based on a long list of FCE forests for the installation, and included Thetford Forest (Norfolk), Birches Valley, Cannock Chase (Staffordshire), Fineshade Woods (Northamptonshire) and Bedgebury Pinetum (Kent). Having met and interviewed ecologists and researchers at the sites, and investigated the behaviour of the organisms we encountered, we drew up a broad overview of the ecosystems, which acted as a basis for future, more in depth research and grid-based surveying. In this time period, it felt like we had become immersed in an 'ecological' manner of thinking. Coined in 1866 by the German biologist Ernst Haeckel, 'ecology' was initially brought to bear as the study of all dynamically interactive organisms in the world and their relationships. But in the present day, ecology has derived a broader meaning, reaching beyond science to philosophical thinking, and as Thrift has noted, it has also become a way of describing software and systems infrastructure: "programs have increasingly come to be framed as environments in their own right, motivated by quasi-biological principles."[420] The term came to have an important metaphorical perspective within discussions surrounding our work. Jones and I aimed for concomitance with the forest ecosystem in as close a manner as possible. On long forays deep into the forests, we noted that ecological thinking seemed to mean that relationships took precedence over objects, or as Viola has it: "value is based on interactive processes and not on some absolute hierarchy."[421] This transversal idea of ecology resonates with the 1970s theorisations of James Lovelock and Lynn Margulis, who proposed the 'Gaia' hypothesis, outlining ecology as where organic organisms react with inorganic organisms on the Earth, creating a complex, self-regulating system that is the reason life is maintained. With the looming catastrophe of global warming amassed on the horizon, we now see proof positive of how this self-regulation has been thrown out of balance by human behaviour.

[420] (Thrift 2005, 244).
[421] (Viola 1995, 236)

During the twelve-month period of working on the composition and structure of *Living Symphonies* I found solace in the work of Norwegian environmentalist Arne Naess, and in particular his book *Ecology, Community and Lifestyle* (1989).[422] Naess operates from a simple 'deep ecological' perspective: that humans are a life form amongst the universe, not its guardians and pivot. This in turn led me to the writings of Timothy Morton, who theorises Naess's deep ecological thinking even deeper, creating an approach that "mixes thoroughly with it,"[423] aiming to ensure we don't sit outside ecology when trying to think through it. For Morton, true ecological thinking ought to consider that nature might not exist: "in a truly deep green world, the idea of Nature will have disappeared in a puff of smoke, as nonhuman beings swim into view."[424] This reading, and my experience navigating the wildly varying attempts to construe and construct nature across FCE forests of the UK,[425] led me to change attitude, a realisation that to consider the true materiality of the forest "instead of trying to pull the world out of the mud, we could jump down into the mud."[426] This included embracing the systemic anomalies of the ecosystem, what Morton calls the "sticky wetness,"[427] and in a truly ecological practice, we embrace the blurry and mysterious nature of ecology as indicative of its rightful constituency and agency. It was clear that in order to create a model of the forest ecosystem that could portray its vital complexity and multi-layered nature we needed to undertake highly in depth research periods in each forest site, in and amongst their particular materiality. We had to survey, observe, and be co-present with the ecosystems for long periods, gaining tacit and intuitive knowledge for the representation and translation of ecosystemic behaviour into composed sonic events.

[422] For an excellent and comprehensive overview of Naess's 'Deep Ecology,' see George Sessions' *Deep Ecology for the Twenty-First Century* (1994).
[423] (Morton 2007, 12)
[424] (ibid., 205)
[425] As we visited different forests run by FCE, it became apparent that there were multiple competing ideals of 'nature' at play. On the one hand, the majority of these forests were in fact human creations (the FCE itself was formed to counter a wood shortage after the first world war) and as a result, most had relatively imbalanced ecosystems, dominated by pine trees that were quick growing and profitable for the timber industry. On the other, visitors to these forests are encouraged to follow 'nature trails' and there is a wealth of ecological experience amongst the friendly and welcoming Forestry Commission staff at the sites we visited. The Forestry Commission in some ways portrays the paradox at the heart of the ecological crisis that humankind currently finds itself within.
[426] (Morton 2007, 205)
[427] (ibid., 103)

In September 2013, we created a prototype of *Living Symphonies* at Thetford Forest, on the Norfolk/Suffolk border, which was to be the first of the forests the work would tour to across Summer 2014. Working with Richard Whitelaw and Alice Eldridge from SaM, and Anthony Mottershead and Hayley Skipper from FCE, alongside site manager Dave Charlesworth and producer Bella Scarr, we developed a plan for touring the work, including techniques for surveying the 30 x 20m area of the forest chosen at each location. The installation areas for the tour had been selected based on a level of remoteness within the forest,[428] good accessibility,[429] and most importantly, the balance and framing present in the ecosystem.

[428] Our installation sites across the 2014 tour were generally about a twenty minute walk from the nearest FCE outpost.
[429] Across the 2014 tour we aimed to ensure that the sites were wheel chair accessible and that the terrain at each site was not dangerous for the audience. Volunteers were on hand at each site during opening hours.

Fig.63 Cannock Chase survey with Friends of Cannock Chase volunteers.
June 2014.

Fig.64 Thetford survey with ecologist Neal Armour-Chelu.
April 2014.

Prior to each installation, a 30 x 20m forest site is surveyed, detailing its ecological composition and topography in three dimensions. Based on the broad surveys we had undertaken previously we were able to plan and outline bespoke surveying data-sheets that allowed input of specific values including percentage coverage (e.g. moss or grass) and numbers of organism (e.g. trees). By laying a grid on the forest floor, we oriented ourselves within the space, and the flora inhabiting each metre square was noted in data sheets, using iPads housed in waterproof casings. This setup allowed for easy export of the data into .csv format, ready to import into the master taxonomy, to inform the simulation and spatial diffusion of the live composition.

This holistic and highly detailed on-site survey process is essential to gain a true understanding of what organisms are present and what roles they play within the ecosystem. This data is not only used to populate the spatial and behavioural ecosystem model that parameterises the sound score in *Living Symphonies*. From the spatial mapping of ground flora, we are also able to derive knowledge as to how we might expect moving species such as birds or insects to then behave. This could include which specific flowers a butterfly might feed on, which trees squirrels were most likely to spend time in or the likelihood of ants and other insects being found underneath piles of rotten wood or fungus. The detailed spatial survey of the forest site is a challenging activity, involving laying out a 30 x 20m line grid across the forest floor, defining marked metre square areas. Over the four sites, by working with assistants and volunteers at each site,[430] we were able to record everything from the precise distributions of trees and plants, to the relative coverage of grass, fungi and dead wood across each site.

After the survey, we were then able to spatially map the topography of the site, using the data to populate the ecosystem model that parameterises the conductor and spatialiser of the sound score. Surveying was often a long, arduous and manual task. We were fortunate at each site of the tour to have an excellent team on board, consisting of numerous local volunteers, FCE staff and wildlife enthusiasts. An example tally from the Thetford installation site survey consisted of ninety trees across the site, predominantly hawthorn and ash, with a scattering of Scots pine, elm and sycamore. At each site, we found surprises: at Thetford, this was the discovery of an orchid rarely seen outside of ancient woodlands, identified with the aid of Forestry Commission ecologist Neal Armour-Chelu. In terms of animal life, Thetford was incredibly diverse, we

[430] We were fortunate to work with a number of groups of individuals who helped with the surveying of the four sites. These included: the staff of Thetford Forest, Fineshade Woods, Cannock Chase Forest and Bedgebury National Pinetum, and the Friends of Thetford Forest, Cannock Chase AONB and Friends of Bedgebury Pinetum. Further thanks go to Rory Gibb, Anthony Mottershead and Seb Scarr who assisted on a number of the surveys.

observed a number of resident bird species, including the rare Nightjar, groups of noisy Crossbills, and Buzzards soaring overhead. Armour-Chelu also showed us traces of three different species of deer that frequented the site. Surveying was often a time-pressured affair, for as Ingold has observed "the earth is forever bursting forth, not destroying the ground in consequence but creating it."[431] At Fineshade Woods for example, a tree fell down in the site just after we had finished surveying and returned to London, causing a fraught reworking of the model based on what we were told over the phone. A few days after we had completed the work required, we discovered that we needed to move the entire site about ten metres to the right, to avoid a pair of nesting bats that we did not want to disturb. We returned to Fineshade to resurvey the whole site again. From this experience, we learnt to conduct the surveying as close as possible to the installation period, to check carefully for nesting bats, and to plan to be able to adjust the model of each ecosystem based on ongoing observations and learning.

[431] (Ingold 2010, S126)

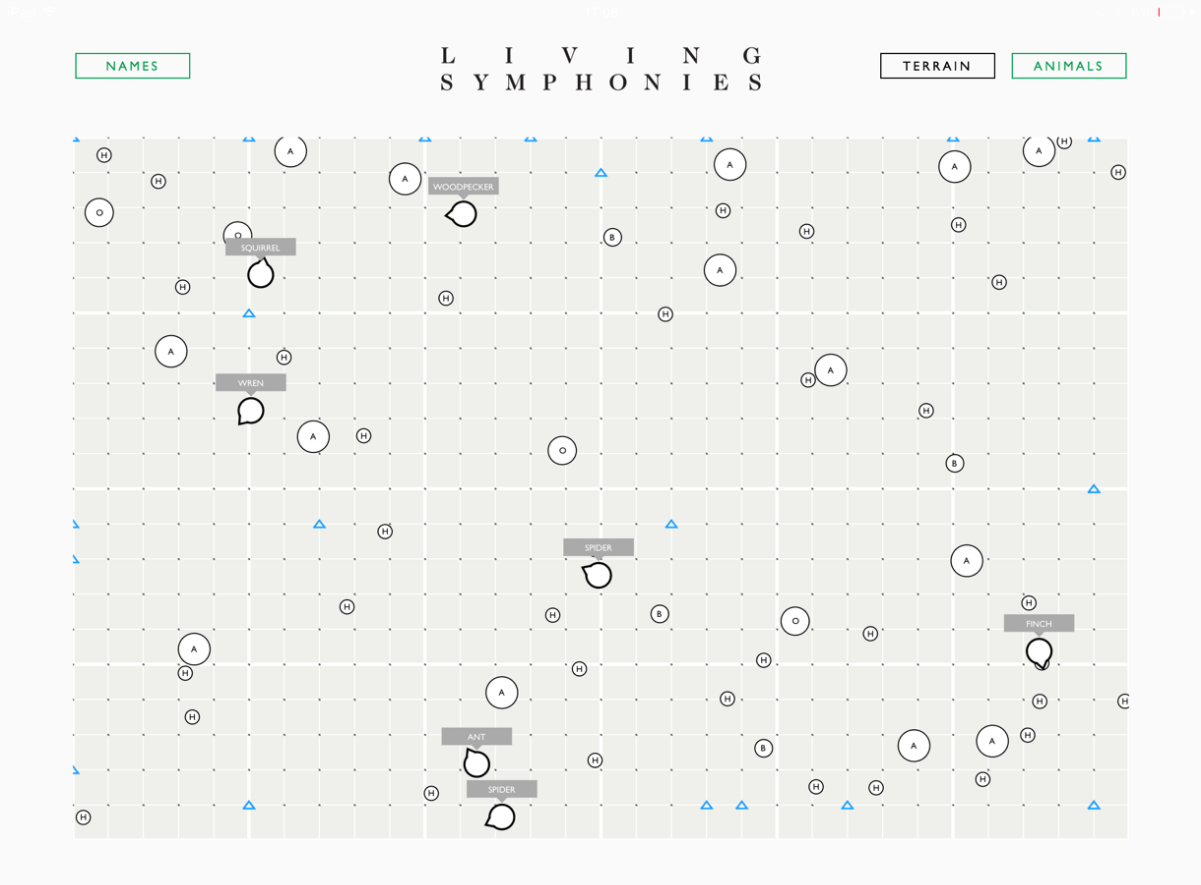

Fig.65 Thetford Forest model visualisation, showing spatial distribution of trees and animals. July 2014.

Class	Behaviour Group	Family	Code	Species	Latin	Flowers	Berries	Nuts	Thetford	Fineshade	Cannock	Bedgebury	Tone Row	Root BPM	BPM range	Metre
Tree	tree	Pine	T.01	Scots Pine	Pinus sylvestris			X	3		1		F#, [E], G, A, B, C, D	100	90-110	4/4
Tree	tree	Ash	T.02	Ash	Fraxinus				3	3			[E], G, B; F#, A, C#, D	110	100-120	4/4
Tree	tree	Hawthorn	T.03	Hawthorn	Crataegus				3	3			[F], G, Ab, Bb, C; Db, Eb	105	95-115	4/4
Tree	tree	Elm	T.04	Elm	Ulmus				3				[C#], G#, A, B, D, D#, E, F#, A#, C	115	105-125	2/4
Tree	tree	Birch	T.06	Silver Birch	Betula					2	3	2	[Ab], Eb, Db, E; Bb, B, C, G, Gb	100	90-110	4/4
Tree	tree	Oak	T.08	Oak	Quercus					2	1		[Bb], F, D; A, C, Eb, G	100	90-110	4/4
Tree	tree	Hazel	T.09	Hazel	Corylus					3			[A], C, E; B, D, F, G	95	85-105	4/4
Tree	tree	Chestnut	T.11	Chestnut	Castanea			X				1	[F], G, A; Bb, C, D, E	85	75-95	4/4
Tree	tree	Giant Sequoia	T.12	Giant Sequoia	Sequoiadendron giganteum							1	[E], G, B, D, F#, A, C, E, C#, Bb, Eb	90	80-100	4/4
Tree	tree	Lawson Cypress	T.13	Lawson Cypress	Chamaecyparis lawsoniana							3	[Bb], F, D; A, C, Eb, G	100	90-110	4/4
Tree	tree	Douglas Fir	T.14	Douglas Fir	Pseudotsuga menziesii							3	C, Eb, G, A, Bb	100	90-110	4/4
Tree	tree	Western Hemlock	T.15	Western Hemlock	Tsuga heterophylla							2	[Ab], C, Db, F, Eb, G, Bb	105	95-115	4/4
Tree	tree	Norway Spruce	T.17	Norway Spruce	Picea abies							1	Bb, Db, F, Gb; D, A, C, Eb, Ab	105	95-115	4/4
Tree	tree	Maple	T.18	Ground Ivy	Hedera							1	[Bb], Db, F, C, Eb, Gb, A	100	90-110	3/4
Tree	tree	Sweetgum	T.19	Liquidambar								1	A, C, D, G, F, Eb, Bb	100	90-110	4/4
Tree	tree	Rowan	T.20								1		C#, G#, C, D#, E, F#, A	100	90-110	4/4
Shrub	terrain	Rhododendron	S.01	Rhododendron	Rhododendron	X						2	E, B, F#, G#, B, C#, Db, Eb	120	110-130	4/4
Tree	tree	Holly	S.04	Holly	Ilex		X	X			2	3	[E], G, B, F#, C, D, A	120	110-130	4/4
Shrub	terrain	Bilberry	S.05	Bilberry	Vaccinium		X	X			1	1	[F#], C#, A, G#, B, D#, E	100	90-110	4/4
Shrub	terrain	Heather	S.07	Heather	Calluna vulgaris						2	2	[Bb],C, A, D, Eb, F, G, Gb, B	105	95-115	4/4
Shrub	terrain	Bramble	S.08	Bramble	Rubus fruticosa		X	X	3	1	3	3	D, F, [A], C, Bb, E, G	95	85-105	3/4
Shrub	terrain	Mahonia	S.09	Mahonia	Mahonia	X	X	X	3				[C], G, D, A, E	100	90-110	4/4
Shrub	terrain	Tormentil	S.10	Tormentil		X	X					2	[C], Eb, F; Bb	105	95-115	4/4
Ground	terrain	Bracken	G.05	Bracken	Pteridophyta					3	1	1	[C], E, G, A;	105	95-115	3/4
Ground	terrain	Nettle	G.07	Stinging Nettle	Urticaceae				3				G, Bb, D, Eb, F#, A, C, Db, E, G#, B, F	95	85-105	4/4
Ground	terrain	Moss	G.09	Moss	Bryophyta				3	3	3	2	C, Eb, G, D, Bb	100	90-110	4/4
Ground	terrain	Fungus	G.10	Toadstool	Fungi				3	1	2	1	C#, G#;	100	90-110	4/4
Ground	terrain	Dead Wood	G.11	Dead Wood	Lignа				3	3	3	3	[E], G#, B, A, A#, F#, D#, C#	100	90-110	4/4
Ground	terrain	Reed	G.12	Reed	Poaceae					3	3	2	G, Bb, D, Eb, F#, Db, G#, B, F,	95	85-105	4/4

Fig.66 *Living Symphonies* master taxonomy excerpt (trees and shrubs only).

The master taxonomy (fig.66) is a database of each of over one hundred animal and plant species that we came across in the four installations of *Living Symphonies* in 2014. It acts as a reference library for the model, describing the family, physical traits (size, wingspan, movement dynamics, circadian patterns, food sources), and sonic representations (tone row, BPM, metre, acoustic frequency range) of each species. The 'simulation,' which is coded in C++,[432] with a Cinder/Cocoa[433] User Interface, is a 3D agent-based model that comprehensively simulates the real-time behaviours of each organism in space. Mammals and birds are represented as individuals, pursuing food sources and responding to neighbours and environmental conditions; insects are represented as collectives. All actants, including trees and plants, respond to changes in light, wind and moisture defined by incoming weather data. The 'conductor', written in Python, receives updates on the ecological state from the simulation, using this data to parameterise the sound score, hosted in Ableton Live. The 'spatialiser', written in C++ and Objective-C,[434] is a standalone component that receives a mono audio channel for each organism or species, and distributes this appropriately across the twenty-four-channel speaker system within the forest space.

Over twenty thousand sound fragments make up the sound score for *Living Symphonies*, and these are housed within Ableton Live, whose internal triggering allows for complex manipulations to be rapidly performed on the entire set. Each species contains numerous motifs for each of four states, corresponding to activities from foraging and resting to photosynthesis, dependent on the organism. Motifs are tagged with a code that describes their behavioural and tonal content, allowing the conductor to interrogate and trigger clips appropriately based on the agency of the model. The relevant areas of the sound score are triggered by the conductor using the LiveOSC protocol.[435] We shall explore the spatialisation of the sound score in more depth in the following section 3.04 *Locative Sound*.

As we have briefly noted, atmospheric conditions also play a vital role in the model that defines *Living Symphonies*: if it is a sunny day, then we will likely find birds of prey circling on thermals overhead, watching for mice and rodents on the forest floor; if it is raining, worms and beetles will emerge from piles of dead wood, a rich food

[432] C++ is a general-purpose programming language with a bias towards systems programming. For further information, see http://www.stroustrup.com/C++.html [accessed 2017/06/07].
[433] Cinder::Cocoa is a programming language for exploring the creation of user interfaces. See further information here: https://libcinder.org/docs/index.html [accessed 2016/07/08].
[434] Objective-C is a general-purpose, object-oriented programming language. See further information here: https://www.tutorialspoint.com/objective_c/ [accessed 2017/10/09].
[435] LiveOSC provides an OSC interface for Ableton Live. Further information about its connectivity can be found here: http://livecontrol.q3f.org/ableton-liveapi/liveosc/ [accessed 2016/09/09]

source for small foraging birds. To integrate atmospheric conditions into the model that defines *Living Symphonies*, the 'collector' reads real-time data from a weather station located on site.[436] This weather data[437] is fed into the simulation to allow it to immediately reflect the environment. In the development of the work, historical weather data is used to calibrate the moment-by-moment behaviour of the simulation. This calibration allows for a scaling of the minimum and maximum values expected for each meteorological variable at a given location.

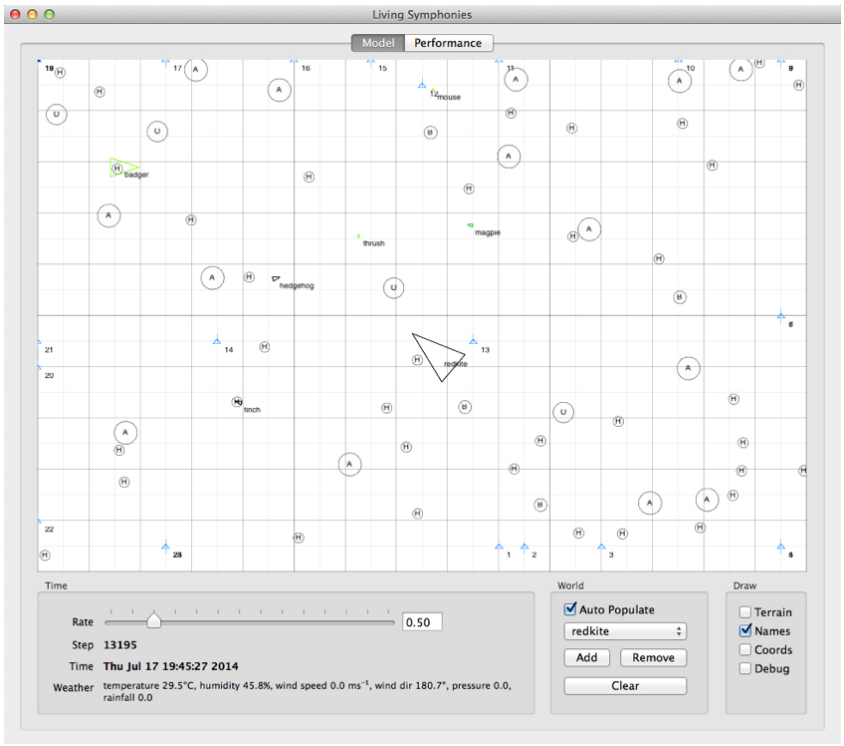

Fig.67 *Living Symphonies* software model, detailing animals, birds and trees. July 2014.

[436] For *Living Symphonies*, we used an Ultimeter 2100 Weather Station.
[437] Including wind speed and direction, humidity, temperature and rainfall.

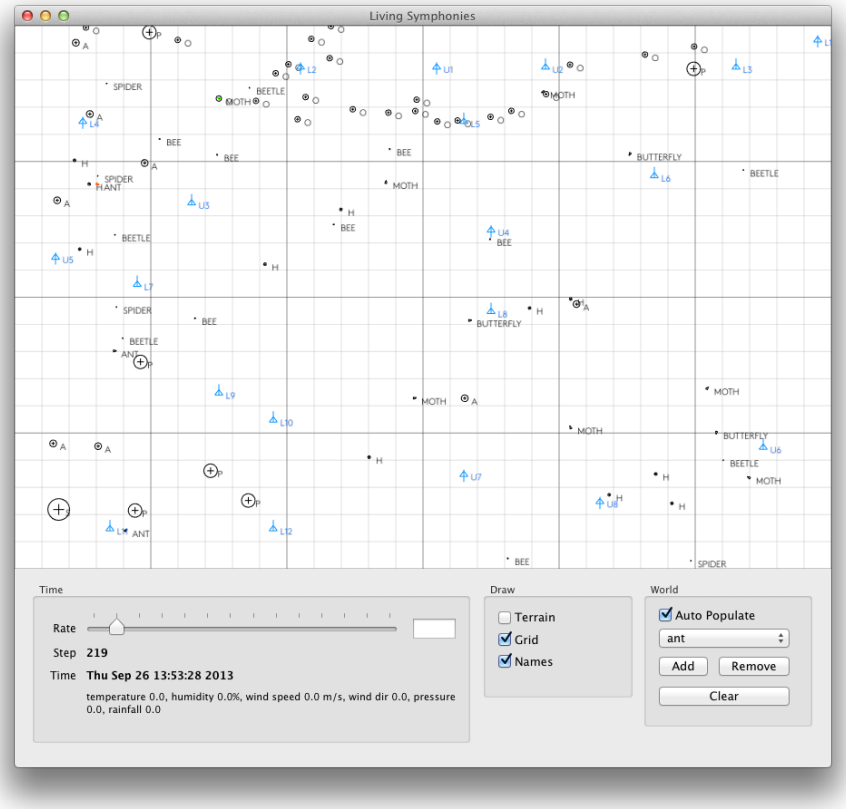

Fig.68 *Living Symphonies* software model, detailing insects in relation to speaker positions. September 2013.

In *Living Symphonies*, the model-based sonification employs spatial potency further than is common, locating the sonic results of data input amongst the material it has been drawn from.[438] This harnesses what Grond and Berger have described (following Bregman) as "the human auditory system's acuity to determine the source and distance of a sound based on temporal, spectral, and amplitude cues,"[439] and it conveys the often overlooked potential for exploring data through spatial real-time platforms. In its combinatory model-based and parameter mapped approach, and in its use of locative sound, *Living Symphonies* portrays a novel and innovative sonification amalgam that harnesses the potency of a real-time sonic-spatial exploration of forest ecosystems.

[438] We shall explore this technique of 'locative sound' further in Chapter 3.04.
[439] (Grond and Berger 2011, 383)

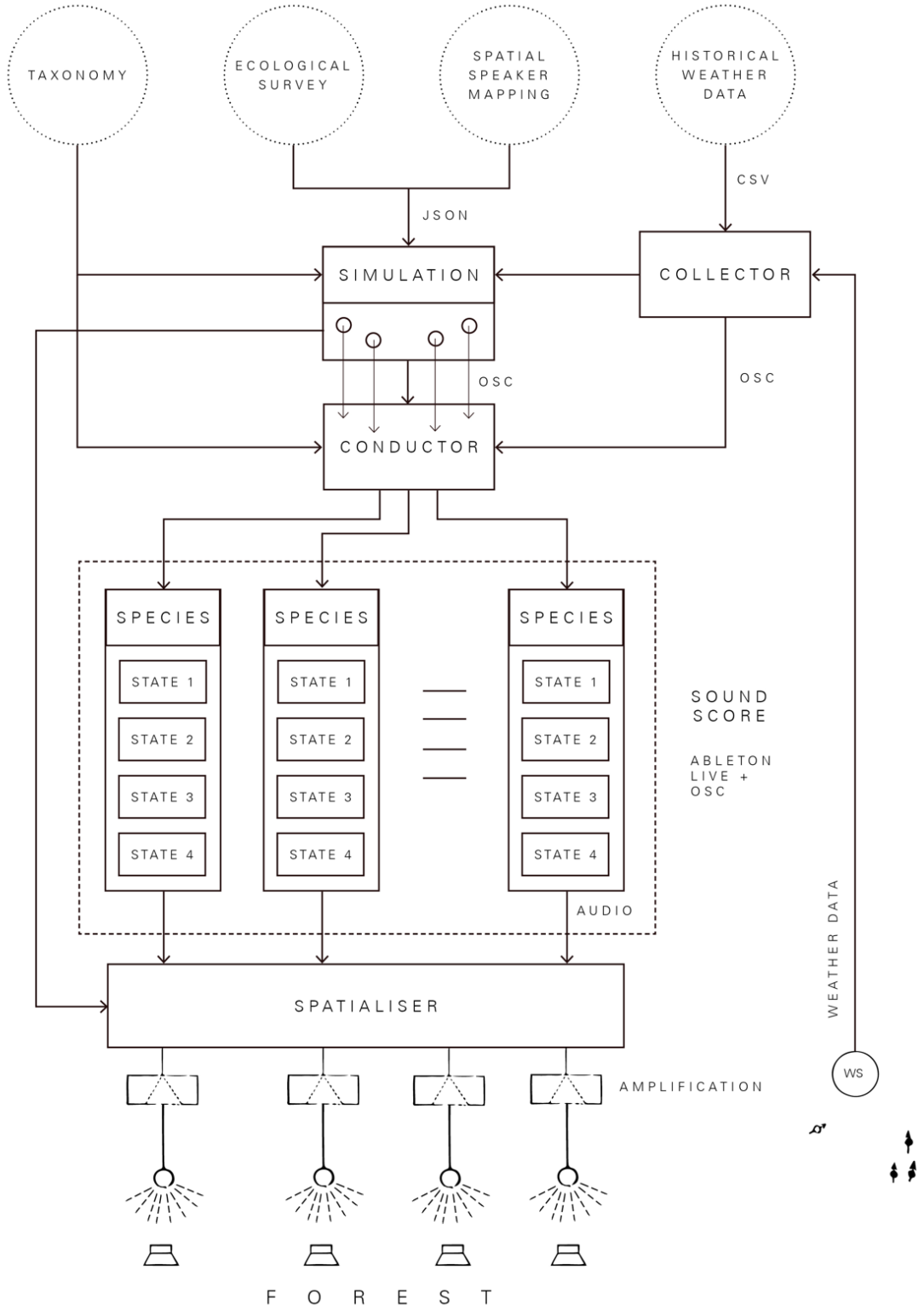

Fig.69 *Living Symphonies* live composition schematic. 2014.

On our return from the Thetford Forest prototype of *Living Symphonies* in Spring 2013, we began to explore the four forests that had been proposed for the 2014 tour. Accompanied by members of the FCE and SaM, we visited prospective sites at Thetford Forest (Norfolk), Fineshade Woods (Northamptonshire), Cannock Chase (Staffordshire) and Bedgebury Pinetum (Kent). We sought what the Greeks call 'Agrafa,'[440] those "unwritten places" nestled deep in the forest, both remote, welcoming, and exhibiting of a balanced and thriving ecosystem. At each potential site, we considered whether the ecosystem would provoke a varied spatial sonic composition for the work, and how the general area might frame the encounter, both acoustically, virtually and visually. In the selection of sites that we made across the four locations, we aimed to convey the wide variety of forest ecosystems across England. The chosen sites at Thetford Forest and Bedgebury Pinetum for example (fig.60–61), had contrasting ecologies, the former a pine forest seeded on the sandy plains of the Brecklands in the early twentieth century, and the latter an arboretum containing rare tree species from across the world. The sites chosen at Fineshade Woods and Cannock Chase were different again, the first an ancient woodland, and the second a swampy valley dominated by silver birch trees. During the site selection trips, Jones and I discussed how we would undertake the composition of the vast sound score necessary for the work. We made sure to study and document the vibrant materialism of the forest at close proximity, collating a rich research resource and broad topographical survey of the landscape and flora and fauna of each site. When we had decided on the location for the installation at each forest, we worked with FCE ecologists,[441] rangers and wildlife specialists to draw up a list of every species present, allowing work to begin in earnest on composing the sound score.

Over this development period, we ascertained that over a hundred process-based compositions would be necessary, each representing one species or collective. The sheer scale of the work involved in this holistic approach to composing with the ecosystem meant that we had to approach the composition as a painter might a mural, drawing out the whole structure in advance, and then focusing in on each species, one after another. This is similar to the approach that sound designer Walter Murch has described taking with his seminal work on Francis Ford Coppola's 1979 film *Apocalypse Now*. The film required such a complex array of sonic events in some sequences that Murch and his colleagues developed a mosaic-like approach to the composition:

> a grid of smaller sized elements of the whole, like a mosaic, so that when working up close on one of the grids, we would have a guide of what that section should sound like,

[440] Roger Deakin describes 'Agrafa' as those places that are unwritten or unregistered, and the name derives from "the remote and secret places in the Pindos mountains, bordering Albania and Macedonia, that were deliberately left off the map by inhabitants" (Deakin 2014, 93).
[441] The Forestry Commission ecologists we worked with included Neal Armour-Chelu for the East of England (Thetford Forest and Bedgebury Pinetum) and Adrienne Bennett (Fineshade Woods and Cannock Chase).

> and how it fits into the whole; trusting that we had planned well enough so that when we stood back from the work, all the grids would link together organically.[442]

In *Living Symphonies*, as we would be simulating behavioural and interacting patterns for species over time, driven by time of day and real-time weather condition, each species had to be composed individually whilst keeping in mind the frequency ranges and harmonic attributes of all of the others. Within the composition, we decided that each species would have four differing 'states' (fig.69). Each species was allocated a tone row, bpm and metre. Key to *Living Symphonies* is that the thousands of sound clips are each notated with a code, allowing the conductor to reference the harmonic characteristics of each and every clip playing at a given moment. To achieve this, detailed notated scores were composed as the basis for over fifty different sessions with twenty-five musicians that took place in the run up to the final composition of the work (see fig.40). These sessions provided the defined sound material for a studio-based pre-composition of each species with variations for its four states. These movements, as with *Variable 4,* were woven with generative techniques, and each different state for a species was linked to different behavioural characteristic triggers within the ecosystem model. In the process of their composition it was vital to continually refer back to the whole. This was an architectural manner of composition, an attitude that Iannis Xenakis has described as "building up the whole thing with rules, you have the whole in mind and think about the details and the elements, and of course the proportions."[443]

As we have discussed, sonic events in the *Living Symphonies* sound score are triggered based on the changing states of individual species in the model and are further altered on a sound clip level by the tone row of whichever species is currently 'dominant' within the ecosystem model. 'Dominance' in the context of *Living Symphonies* can be understood as an approach that defines which species is currently 'in focus' within the work. In function this mimics an auditory filtering akin to the cocktail party effect. On a technical level, this means that the tone row of a 'dominant' species acts to define the playback of the rest of the sound score. The dominant tone row triggers the deactivation of any notes that are not deemed 'consonant' with it, across the whole score. This technique serves both to provide focus on the dominant species—as all others fall into a 'harmony' with it—and creates a high level of indeterminacy in what is playing across the score. Crucially, it ensures that the auditory field does not become too cluttered by sonic events. The idea of employing dominance within live composition was derived from experiments that took place during the prototype at Thetford Forest, when we would often find that the piece became too complex and overwhelming and it was difficult to perceive more than three or four concurrent melodic motifs within the site at the same time. The tempo and time signature of the

[442] (Murch 2003, 93)
[443] (Xenakis 1992, 69)

overall live composition also follows the current dominant species, and is further moderated on a granular level by wind speed. The speed of the live composition of *Living Symphonies* thus continuously shifts, defined by the bpm of whichever species within the ecosystem is currently rated dominant. The simulation of the forest ecosystem allocates which species is 'dominant' based on a rated approach, which combines the relative interactive ecosystemic effect of a species at any given point with a simple memory-based approach that ensures that every species is highlighted at one point or another. A similar 'fatigue' notion as in *Variable 4* is employed within the conductor to ensure that no one species is dominant for an undue length of time.

The composition of the recording scores for each species took place in an intuitive way, inspired by the cultural representations, behavioural characteristics, and bioacoustic physiques of the species within the woodland. Forests in Britain, despite the fairy tales and crime reports, are safe areas for people to explore, and they are prime places for encounters with sound-based art works. Amongst the trees it is interesting to note just how quickly the sense of aloneness, masked silence and secrecy builds: you do not have to go far into the woods to experience this feeling. But as with many natural habitats, forest ecosystems are under threat, both from the agrilogistical project, and from commercial mining and construction activities across the world. Amar Kanwar's *The Sovereign Forest* was a work that came up a number of times in conversation as we developed the piece (at that time, Kanwar's work was being exhibited at Yorkshire Sculpture Park.[444] Within Kanwar's installation the devastating impact of mining and other commercial activities on the forest-based communities of Odisha (formerly Orissa) in India, are portrayed in film, text and sculpture. In reading about forests, through the work of writers Oliver Rackham,[445] Sara Maitland[446] and Roger Deakin,[447] it was notable how the forest is often understood as a haven—as Maitland observes, the idea of the forest as "both the place of oppression and the place to avoid or punish oppression goes very deep and still remains strangely resonant."[448]

Living Symphonies aims to highlight and communicate the vibrant materiality of the forest ecology and its species.[449] At its core, the work finds an ecological imperative, grown, as we have discussed, from the work of Lovelock, Naess and Morton. It aims to be what Kanngeiser has described as a "slower, more careful, reflective"[450] kind of

[444] For more information about *Sovereign Forest*, see https://thesovereignforest.wordpress.com/ [accessed 2017/06/07].
[445] See Rackham's compendium *Woodlands* (2006).
[446] See Maitland's *Gossip from the Forest* (2013), a tour of forest associated myths and folklore.
[447] Deakin's *Wildwood* (2008) is a wonderful excursion through woods and forests across the world.
[448] (Maitland 2013, 65)
[449] For an overview of the 2014 Bedgebury installation of *Living Symphonies* see Hannah Ellis-Petersen's description of her visit to the site for the Guardian: https://www.theguardian.com/music/2014/aug/28/living-symphonies-james-bulley-daniel-jones-forest-orchestra [accessed 2017/03/03].
[450] (Kanngieser 2015, 3)

activism, that communicates with the gradual and less visible processes of eco-systemic intra-actions. This slow considered activism is an attribute of a number of art works that I find inspiring, including Jem Finer's *Longplayer*, which seeks to explore notions of time, permanence and durability across its one-thousand-year duration.[451]

In the ecological approach we adopted with *Living Symphonies*, Jones and I aimed to derive every possible decision from the forest ecosystem. We sought to "tread lightly," to disturb its processes as little as possible, composing with and within its materiality, present and conscious of its goings on. One particular concern of ours was the effect that the sonic events from the speakers might have upon the calls and communications of the bird species present at each site. As a result, we ensured that the specific frequency ranges of bird calls were notated and written out of the sound score. We tested this technique at each forest site, and gratefully received visits from the RSPB's Laurence Rose[452] and various other ornithologists, who reassured us that our plan had worked and no distress calls were heard. The physical installation of the twenty-four channel speaker system was also carefully planned with FCE staff, ecologists, and contracted specialists, who ensured that no long-term impact was had on the ecosystem, whilst allowing for the speakers to be thoroughly and invisibly concealed amongst the canopy, foliage and ground flora of the site.[453] Through these installation methods we aimed to provide an open, conscientious and immersive platform for audiences to encounter the relation of sound and ecosystemic materiality, as one experiential assemblage.

During the making of the work, we were visited by a documentary team from the journal *Nature* who created a film and interviewed us about the piece.[454] As we discussed *Living Symphonies* across a number of interviews and site visits with the documentary team, it became clear that rather unwittingly we had created a scientifically unusual, holistic, model-based surveying method. Where usually ecologists would survey a single species within a forest site in a high level of detail, we had set out to convey the activities of every species present and to model their behaviours in real-time.

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[451] *Longplayer* is a sound-based artwork by Jem Finer that will last for one thousand years. It is currently sited at Trinity Buoy Wharf in London, with listening posts around the world. The piece started in the year 2000 and is scheduled to play without repeating until 2999, when the cycle will begin again. For further information see http://longplayer.org [accessed 2017/11/01].

[452] Laurence Rose runs a weblog about nature, music, poetry and birds. See http://www.naturemusicpoetry.com/about.html [accessed 2017/10/10]. For an article Rose wrote about *Living Symphonies* for *The Ecologist*, see http://www.theecologist.org/reviews/2423565/living_symphonies_in_the_forest.html [accessed 2015/04/04].

[453] We will discuss the installation of the speaker system for *Living Symphonies* further in the following section, 3.04 *Locative Sound*.

[454] To see the documentary that *Nature* made about *Living Symphonies*, see the archived version on their website here: http://www.nature.com/nature/videoarchive/living-symphonies/index.html [accessed 2017/06/07].

As we have discussed with reference to *Variable 4* and *Tactus*, live composition presents a unique set of challenges for the composer. Principle amongst these is that the goal orientated progression present in most conventional linear composition is no longer an important aim. In *Living Symphonies*, progression occurs through the triggering of algorithmic processes by the model-based simulation of the ecosystem. Each species is portrayed by generative motifs and has states that might include foraging, exploring, resting, or, in the case of trees and plants, undergoing photosynthesis and water uptake. These motivic constructs within the composition draw inspiration from both cultural understanding, and from the structures and behaviours of the organisms themselves. Instrumentation is intuitively selected to portray the species.

Jones and I discussed at length our instrumental and arrangement choices for the 2014 iterations of *Living Symphonies*, and these choices became one of the most challenging aspects in developing the work. *Living Symphonies* was broadly arranged for orchestral, acoustic instruments because as Chion has observed, orchestras are "an exemplary case of the accumulation of perceptible micro-actions and collisions."[455] As a starting point, this seemed apt as a broad palette for the teeming nature of the forest ecosystem. Working with acoustic instruments of this kind also gave us wide scope to harness the role of music as a stimulus for anamnesis: in arranging the work for instruments that have hundreds of years of historical canonic use behind them, we might explore the memories and feelings evoked by them. Put crudely, a fox represented by a French horn motif would have a certain memorial resonance in the British countryside, a clarinet motif for a bird might recall Prokofiev's *Peter and the Wolf*. As Augoyard and Torgue have noted, "music, more than other modes of expression, or even other aspects of the sound domain, possesses an evocative faculty that calls at the same time a feeling and a memory."[456] As we have discussed, a number of compositional techniques were at play within the large-scale composition, of which anamnesis was just one. Based on these considerations, instrumentation was part-intuitively selected to portray each species.

For example, a butterfly is heard as an arpeggiated whole-tone sequence of 'sul-ponte' cello harmonics, reflecting its flight behaviours and physical makeup; a squirrel is heard as a chattering 7/4 timbale pattern, increasing in intensity and complexity when it happens upon food in the treetop, and a bee is represented by an undulating, polyrhythmic composition of piano notes. Included in the sound examples is a field recording from the Fineshade installation at a point when the silver birch tree was dominant within the model. A further illustration of dominance is included from the Fineshade installation at a contrasting period in the day, where the Red Kite takes

[455] (Chion 2009, 38)
[456] (Augoyard and Torgue 2005, 24)

precedence in the model of the ecosystem. As with *Variable 4*, the recordings garnered in the studio sessions for *Living Symphonies* were edited and pre-composed in Pro Tools, and coded accordant to their harmonic and species-specific attributes. The clips were then input into the master sound score hosted in Ableton Live. In total for the 2014 tour there were around twenty thousand discreet sound fragments in the overall live composition.

E14 *Living Symphonies* I.01 *Butterfly* (sound score excerpt)[457]

2014

01’00”

E15 *Living Symphonies* M.11 *Squirrel* (sound score excerpt)[458]

2014

01’00”

E16 *Living Symphonies* I.10 *Bee* (sound score excerpt)[459]

2014

01’00”

E17 *Living Symphonies* Fineshade Woods I.10 *Silver Birch* dominant (field recording)[460]

23 June 2014

00’50”

E18 *Living Symphonies* Fineshade Woods B.19 *Red Kite* dominant (field recording)[461]

24 June 2014

02’36”

[457] See https://www.dropbox.com/s/wjbi7mirpcb1vy6/E14_LS_2014_Butterfly_Score_Excerpt.mp3?dl=0.
[458] See https://www.dropbox.com/s/jymmkdcgpo25q7w/E15_2014_LS_M11_Squirrel_excerpt.mp3?dl=0.
[459] See https://www.dropbox.com/s/eh2zeg63mbnuqui/E16_LS_2014_I10_Bee_Excerpt.mp3?dl=0.
[460] See https://www.dropbox.com/s/ahed4l52xs8324o/E17_LS_Fineshade_Birch_Dominance.mp3?dl=0.
[461] See https://www.dropbox.com/s/hgdqb9i5ahdf8sy/E18_2014_LS_Fineshade_Red-Kite_Dominance.mp3?dl=0.

The sonic elements inhabit a halfway station
Between servility of form
and the independence of nature

—Earle Brown after Jean-Paul Sartre,
In archival transcript, 1990[462]

Live Composition

Variable 4 and *Living Symphonies* explore the use of algorithmic processes in autonomous real-time sound installations, driven by the semi-chaotic and unpredictable behaviours of weather systems, and the thriving interactions of the forest ecosystem. The influence of new software-based technologies and the rhizomatic spread of communication and information networks has engendered new potential in process-based composition.[463] The motivations for formalising this experimental approach under the rubric of live composition is to enable these processes to be communicated and critiqued, furthering their potential for new knowledge. Live composition can be automated to introduce diversity and unpredictability, and through parametric and model-based sonification can be related to other domains of knowledge, including weather prediction, ecology, and tactile communications for the blind and visually impaired.

The use of sonification in the three works discussed can be considered as an attempt to convert the otherness of things into sound signals, and thence communication. Used as live technique, sonification harnesses the transversal communicativity of sound to provide real-time insight into structural properties and processes that are either not evident, or are too large and multilayered to easily comprehend: putting the 'live' in live composition. In the praxis documented here, the value of sonification, as Ballora has noted: "probably lies less in hard facts and more in how it may serve as a stimulant to curiosity."[464] At the places of each of the works discussed, I bore witness to the fact that sonification drew people into a more intimate relationship with the materiality of their surroundings. As we have discussed, the techniques of sonification used here exploit the fact that the auditory system of human hearing allows us to easily follow many different streams of sonic information simultaneously, and is a vital intra-active tool in communicating hidden properties of materiality, particularly in comparison to the visual.

What is clear then is that both *Living Symphonies* and *Variable 4* bend and probe at the definition of 'sonification' in conventional terms, particularly through their

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[462] (Brown 2015, 195)
[463] Recent software tools for generative sound composition include Ableton Live, SuperCollider (see http://supercollider.github.io/ [accessed 2017/10/10]) and Cycling 74's MaxMSP (see https://cycling74.com/products/max/ [accessed 2017/10/10]). Another notable recent development related to generative music is that of live coding, developed by the software artist and musician, Alex McLean. For more about live coding, see https://slab.org/what-on-earth-is-live-coding/ [accessed 2017/10/10].
[464] (Ballora 2014, 30)

apparent lack of reproducibility. In these pieces, sonification is not reproducible: the sound worlds might bear resemblance thematically, but their generative complexity, and integration in real-time environments means that to all intents and purposes they exist only in the moment. Hermann himself notes some vagaries in this stipulation of sonification as necessarily reproducible: "the use of the term "structurally identical" in the definition aims to weaken the stronger claim of sample-based identity."[465] In sum, we can consider that the parameter and model-based sonification techniques employed in *Living Symphonies* and *Variable 4* convey a high level of indexicality in the sonic and spatial communication of data, and this creates a rich platform for the live composition that unfolds. Whilst *Tactus* employs aspects of parameter-mapping sonification, the concept-driven, intuitive approach to its composition conveys resonance in the "elusive perceptual domain" beyond conventional sonification, creating open ground between the objective properties of touch input data and sonic events.

Data-driven sensing of materiality paradoxically acknowledges that matter is not brutish, and things are not just data. The open fusing of materiality, data, sensor and sound, allows us following Rancière, to "capture the common potential of these patterns."[466] But, there are cautionary tales to be had, for as Kim-Cohen notes, "contextless data is gobbledygook."[467] The well-worn gramophone needle tracing of Rilke's coronal suture masks any indication of the context of its meanings, and "as sound, it no longer maintains any connection to the conditions that produced it."[468] This caution does not only apply to sonification, for as Feldman has observed, there is an inherent danger in generative or chance-based music: we must write "for the ear" not purely in terms of "organisation."[469] The challenge in utilising sonification and generative techniques within materiality is to render the sounding of information transversally, so that it detaches from the intersubjective local-specific frame of 'pure' data and intra-acts within the meshwork of the artwork's experiential encounter. Explorations must be couched in understanding that there is still a difference between 'thing data' and 'thing experience', or as Morton has extolled: "we have raindrop feelings, raindrop thoughts, raindrop perceptions"[470] but we run the risk of never experiencing the actual raindrop.

Live composition as artistic strategy does not ignore what sound artist Francisco Lopez has termed "intentionality."[471] As Lopez has highlighted, there is a propensity to

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[465] (Hermann 2008, 4)
[466] (Rancière 2013, 106)
[467] (Kim-Cohen 2009, 100)
[468] (ibid., 101)
[469] (Feldman 2000, 60)
[470] (Morton 2016, 33)
[471] Lopez references this idea in much of his writing about sound, including the following excerpt from his website: http://www.franciscolopez.net/cage.html [accessed 2016/05/06].

ignore intentionality in sound studies, in favour of an objective abstraction most pronounced in the two dominant schools of thought surrounding the artistic employment of sound in recent decades, those of Schaeffer's *Objet Sonore* and Cage's "letting sound be themselves." Live composition recognises that there is always the initial act: a beginning. As Rousseau put it in his 1781 *Essay on the Origin of Language*: "it is not the mechanical flautist that plays the flute, but the engineer who measured the flow of air and made the fingers move."[472] Kim-Cohen has further illuminated this intention: "one must always make a decision on how to begin (or whether to begin at all)"[473] and live composition encompasses this intent, seeking to ally it with intuition and material agency in resonant practice. In live composition, materiality is not beholden to human instigation, nor vice versa, the approach is one of openness and balance, marking vital difference to those compositional strategies that Kim-Cohen describes as pursuing "sound-in-itself, not in sound's source, nor its semiotic capacities, nor the implications of its status as the result of colliding material in the world."[474]

For relationality to be successful in live composition, we must shift emphasis from interaction to lived relation, finding ways to operate on the qualitative level of 'thinking-feeling', creating attitudes of being and becoming, not solely focusing on eliciting behaviours.[475] We have seen this demonstrated in the case of *Tactus*, which whilst interactive, also has systemic limitations in its live composition. Across the works discussed in this thesis, a spectrum of interactive and non-interactive relational techniques has been used, from explicit but passive interaction in *Tactus* to the autonomous parameterised and modelled interactions of the weather with the sound scores of *Variable 4* and *Living Symphonies*. Whilst *Tactus* can be understood as an interactive artwork in that the audience must touch the work to hear the sound, we might call it a case of 'limited interactivity' as the audience are unable to define the course of the composition beyond the triggering of each motif in time. *Living Symphonies* and *Variable 4* are forms of relational art that suspend human interaction in favour of highlighting those natural systems that surround us. These three works illustrate that live composition as a specific methodology creates an intra-active experiential engagement with materiality. Or, as Massumi has it:

> you're in it, it's not in you. You live it in, rather than living it out. You don't go anywhere with it. It stays where it happened, as its own event. It's an intensive experience, rather than extension of it.[476]

In the cases of *Variable 4* and *Living Symphonies*, a deep ecological approach was taken to live composition, a dislocation of anthropocentric perspective, which sought to avoid

[472] (Rousseau 1997, 291)
[473] (Kim-Cohen 2009, 114)
[474] (ibid., 126)
[475] (Massumi 2008, 13)
[476] (Massumi 2008, 13)

a mode of what Heidegger has called "enframing", asking the audience to enter into the work, surrounded and defined by atmosphere and ecology.

Live composition has a complex relationship with duration: it manages its own temporal structure as it unfolds in time. The composition occurs only once and in this aspect, live composition bears analogy to performance, conveying similar challenges in attempts to document its workings. When considering the 'live' of live composition, it is useful to clarify that using this term does not seek 'aliveness' as such, but gestures to the posthuman contemporary posture that Hayles has called the "multilayered system of metaphoric and material relays through which "life," "nature," and the "human" are being redefined."[477]

The live composition of *Variable 4*, *Tactus* and *Living Symphonies* then seeks an immediate symmetrical engagement between the human and the nonhuman, situating itself at the intra-action between sound and materiality. At this pivot point we might play out what Pickering has called "the dialectic of resistance and accommodation in material and conceptual practice."[478] Live composition seeks to convey an "ontology of becoming,"[479] a novelty that emerges in time, in the thick of things, in the convergence of human and nonhuman, by way of compositional processes that are both open ended and forward thinking: composition as a real-time system. In some sense, we might see this as a logical next step on the journey from the indeterminacy of John Cage to the sound installations of Max Neuhaus, sonic architectures of Maryanne Amacher, environmental engagements of Hildegard Westerkamp, and the electromagnetic soundwalk sonifications of Christina Kubisch. With live composition, we embark with the generative streams of Brian Eno and take heed of what LaBelle has observed regarding generative music and its propensity to "locate sound in its actual generation and distribution rather than in objectness and immediate experience."[480]

In reflecting on the emergence of live composition as a specific methodology in my practice, I realise that a general breakdown in the concept of causation has been occurring across culture. Open strategies are not specific to music, they are paralleled across disciplines, reflecting a post-theological rhizomatic sphere where information of uncertain origin abounds. As Cox and Warner have noted, working with open sound composition strategies "productively challenges traditional conceptions of the composer and the work, and the roles of the performer and audience."[481] Accepting this challenging nature, we might understand the relative "openness" and dynamism of a live

[477] (Hayles 1999, 224)
[478] (Pickering 1995, 87)
[479] (Pickering 2009, 3)
[480] (LaBelle 2015, 287)
[481] (Cox and Warner 2015, 166)

composition as its susceptibility to a range of integrations. As Eco has noted: "structural vitality is still seen as a positive property of the work, even though it admits of all kinds of different conclusions and solutions for it."[482] As with Eco's "open work," live composition seeks to create novel agency between artist, audience and artwork. The presentation of what Brown has called the "actual event"[483] as opposed to representation, brings the audience and the work together, closing the gap between reflection and being-in-the-moment, creating resonance. Live composition is chronography, written in time.

[482] (Eco 2015, 173)
[483] (Brown 2015, 193)

3.04 *Locative Sound*

Humankind considers the ability of animals including shrews, bats and whales to locate sounds spatially in the auditory field as remarkable, but we rarely reflect on the intrinsic spatiality of our own listening.[484] We might attribute this, as Ihde does, to "the very "obviousness" not of experience, but of the traditions concerning experience"[485]— the spatialisable nature of hearing comes first, often instantaneously, and is commonly considered a 'weak' capacity of auditory experience.[486] Indeed, it took until the early twentieth century for the myriad activities of spatial listening to be clearly comprehended. In these last few years of documenting my sound-based practice it has become apparent to me that the production of sound recordings tends toward a 'flattening' of locative listening: a compression, or removal of spatiality. This area of practical inquiry is one of the most vital and vibrant investigative lines in this arts research project.

The operations of 'locative sound' are placed at the cornerstone of heard experience in the world, one where spatiality has been bewitched and dissipated in the compressed virtual space of sound recording. Humans have highly honed abilities to locate sounds, and we too have the echo-locative abilities of the bat and the dolphin, as Ihde has observed: "the mountains and canyons reveal their distances to me auditorily as my voice re-sounds in the time that belongs so essentially to all auditory spatial significations."[487] In this temporal mountain echo, it is not only the sense of distance presented, but also the surface echoed off: the projected sound returns 'imprinted' by the surface it has reflected from. The human technique of echo-location is of vital importance for the blind person, who listens more acutely than the sighted listener, and in the clicking of a cane can produce an auditory 'ray' that harnesses the particular communicativeness of the 'click' sound in spatial listening. This is not an exclusive experience to the blind, all might explore it with practice: "anyone who listens well may hear the same."[488]

The varying processes that occur when we attempt to locate sound in the auditory field are part of what Chion terms 'causal listening.'[489] In most current accounts of hearing the functions of sound localization occur through the interpretation of differences in intensity and arrival time of sound waves at the ear.[490] In combination or

[484] For example, see Thomas, Jeanette A, Cynthia Moss, and Marianne Vater. 2003. *Echolocation in Bats and Dolphins*. Chicago, Ill.; London: University of Chicago Press. There are however notable exceptions, including Jens Blauert's classic work on acoustics *Spatial Hearing* (1983).
[485] (Ihde 2007, 59)
[486] (ibid., 59)
[487] (ibid., 69)
[488] (ibid., 69)
[489] (Chion 2016, 170)
[490] For a more comprehensive account of how locative listening functions, see Blauert's *Spatial Hearing: the Psychophysics of Human Sound Localization* (1983).

separately, these differences allow us to use a process of physical augmentation via tensor tympani calibration and unconscious head movement to 'highlight' sounds from particular directions.[491] This is a process that is prone to error, and we must recognise the propensity of 'causal vagueness.' As Chion observes: "there is no solution but to situate sound in the symbolic comings and goings between cause and sensation."[492] When locating sound, we are beholden to interpretative error, to a causal vagueness that occurs in the conflation of locating sound and locating source. Causal vagueness "dampens sonic specificity"[493] and arises in the reflexive concomitance of sensual recognition, anamnesis, and the spatial coordinates at the 'core' of sonic events. This operational 'vagueness' provides an invitation to experiment with different aspects of *where* sound is located in the encounter. In my practice this manifests in a placing of sonic events within materiality, locating and spatialising them in dynamic and experimental configurations.

The works discussed here recognise the observation of blind author Jacques Lusseyran, that "sounds never came from one point in space."[494] Sonic events are multi-locational, they are "altogether an endless procession."[495] Lusseyran's writing has here inspired a spatial, multi-locational approach to working with sonic events, and in the analysis that follows we will explore the locative techniques at play in each work in turn.

We might consider the opposite to causal vagueness to be what Augoyard and Torgue have called "hyperlocalization."[496] This is a perceptive effect, linked to a sporadic sound source, one that irresistibly focuses the listener's attention on the location of the sound. When the source of the sporadic sound moves, there is a strong tendency for the listener to continue to follow it. Two common examples of this are the compulsive micro-locative sounds of mice running about on wooden floor boards, or the sound of marbles rolling across a concrete floor. Augoyard and Torgue have also defined a further effect that occurs in causal listening. The 'delocalization effect'[497] involves the recognition of an error in localizing a sound source. The effect occurs when "the listener knows exactly where the sound seems to come from, while at the same time is conscious that it is an illusion."[498] This has strong links to Chion's ideas of 'synchresis' and 'spatial magnetization' as we shall explore shortly.

The locative experiments described here are undertaken with the knowledge that the ability to locate sound varies for every person, something clearly demonstrated in the

[491] (Chion 2016, 24)
[492] (ibid., 108)
[493] (Chion 2009, 248)
[494] (Lusseyran 2014, 18)
[495] (ibid., 18)
[496] (Augoyard and Torgue 2005, 59)
[497] (Augoyard and Torgue 2005, 38)
[498] (ibid., 38)

difference between sighted and non-sighted listeners. In a 1998 paper Lessard and Pare identify through a series of spatial-audio tests in an anechoic chamber that early-blind human subjects localize sound sources better than sighted subjects. From this we might understand that the human experience of visuality can prove a hindrance in locating sounds in space.[499] When sighted people locate sound in the auditory field, there is a contribution made by the eye, one that remedies the 'causal vagueness' of listening. As Connor has described it: "the deficit of the ear is almost always made good by the contribution of the eye."[500] Here we understand just how much the locative spatial abilities of two different listeners can vary, and why locative listening is particularly attuned in the blind and visually impaired.

The locating of sound is also bound with other perceptual aspects of listening. Connor has made important observations concerning the 'segmenting' of hearing, which allows for the picking out of particular sonic events for attention, foregrounding them in the auditory field and backgrounding anything extraneous.[501] Due to the continuous and varying nature of hearing (as the dictum goes, "we have no earlids"), this filtering and segmentation is even more important in hearing than sight.[502] In our hearing, in segments, there are endless ways to hear the spatiality of things: solids and cavities, the proportions of space, the myriad reflections of sound's becoming.[503] This locational information, received by listening, often goes unremarked in favour of the latter significance and indices of anamnesis that inevitably follow.

[499] See Lessard, N, and M Pare. 1998. "Early-Blind Human Subjects Localize Sound Sources Better Than Sighted Subjects." *Nature* 395 (6699): 279–81.
[500] (Connor 2000, 21)
[501] (ibid., 16)
[502] (ibid., 16)
[503] (Ihde 2007, 71)

Source Bonding

Before the means became available to record sound, sonic events were generally bound to their originating source. There are exceptions: archaeo-acoustic investigations demonstrate that cave paintings seem likely to have been sited in specific acoustic spaces to create the illusion of sound emanating from them.[504] In this praxis I use the term 'source bonding' to describe the meeting of sound and source, inspired by Dennis Smalley's 1997 writings.[505] For Smalley, 'source bonding' is "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."[506] I wish to expand this area, incorporating a wide, open attitude toward all sorts of bondings and juxtapositions both internally, within the discourse of sonic events (which is Smalley's primary concern), and in the meshwork of intra-actions between those sonic events and their close material environs.

We could say that this concern with source bonding is a "logical reflection of our technical sound-effects-filled world:"[507] in our everyday life we are now accustomed to the idea of materials that emit sounds that have been placed on or with them, different to the sounds that they make themselves. This is a kind of 'schizophonic'[508] milieu—inhabited by touch screen interfaces, each tap a click, devoid of mechanical action.[509] The roots of this bonding and the creativity that it engenders run deep, all the way back to the artistry of puppetry and ventriloquism,[510] and the aforementioned 'sounding' of cave paintings.

For Smalley, "source bondings may be actual or imagined–in other words they can be constructs created by the listener,"[511] and the term has further descriptive utility in cutting to the quick of "the intrinsic-to-extrinsic link, from inside the work to the sounding world outside."[512] Not only do we relate sound and actual source, but we relate sounds one to another, through their associated origins.[513] This meshed bonding is a

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[504] See Steven Waller's chapter "Intentionality of Rock-Art Placement Deduced From Acoustical Measurements and Echo Myths." in *Archaeoacoustics* (2006) for further information.
[505] (Smalley 1997, 110)
[506] (ibid., 110)
[507] (Chion 2009, 141).
[508] 'Schizophonia' is a term I have borrowed from R. Murray Schafer. It describes the splitting of an original sound and its electroacoustic reproduction. For more on the term see Schafer's 1969 book *The New Soundscape*.
[509] This became particularly apparent in 2013 when working on the sound design for an app for the fashion designer Paul Smith. For more about the project see http://www.jamesbulley.com/#/paul-smith-1/ [accessed 2017/11/09].
[510] For an excellent cultural history of ventriloquism, see Steven Connor's *Dumbstruck* (2000).
[511] (Smalley 1997, 110)
[512] (ibid., 110)
[513] (ibid., 110)

"binding, inescapable engagement" between "all-types of sound matter and sound-making,"[514] and it has flexibility: there is a 'bonding play' that occurs in causal listening, as an inherent perceptual act.

In this play, we find different levels of decoding, unique to each listener. Smalley, for example, finds that "not only do we listen to the music, but we also decode the human activity behind."[515] From this, we gain psycho-physical information and this embedded cultural knowledge of human musical gesture offers artistic opportunity to affect the indices of causal listening. In experimenting with 'source bonding' we can create novel relations between sound and source. In forwarding a locative sound aspect to this sound arts praxis, I venture that the ears are highly disposed to directional and causal listening, and in our current sonic environment we find a marked dearth of attentiveness to this pre-eminent aspect of acoustic experience.

[514] (ibid., 110)
[515] (ibid., 111)

Sonic Causality in the Talking Drum

In the weeks before the installation of *The Talking Drum* at Brewer Street Carpark, I had long discussions with Viola, his partner Kira Perov and his assistant Astra Price. We discussed the best way to present *The Talking Drum* within Brewer Street, a former municipal car park turned arts venue in the centre of London's Soho district. The car park was an exceptionally difficult acoustic to work with as it consisted of a huge low-ceiling concrete space that created long reverberation times and myriad reflections. The digitisation process of the originating tapes had also been far more complex than expected: although the work had been presented to its audience as a live explorative performance at the end of a residency entitled *Dry Pool Sounding*, in an empty swimming pool at SUNY/Buffalo in 1979, Viola had returned to the piece in 1982, re-staging and re-recording the performance to technically improve the portrayal of acoustic space from the 1979 recordings. It was only in 2016 that Viola and Perov made a final decision as to which recording they best felt portrayed the work.[516] Viola and Perov (who was present at the 1982 performance) decided that a recording from the 1982 session best represented the piece, and this was the tape that was then mastered for the spatialised speaker system designed by Tom Richards and I for the Brewer Street Carpark installation.

This process meant that the tape was imbued by both 1979 and 1982 performances of *The Talking Drum*, drawing the spaces and significance of each together in one recording. The sound of the tape described these source materialities, not just in the composition of the work or the spatialisation that was then done to it, but innately, in its unaltered state. Recorded sound, after all, is always imbued and altered by the characteristics of its initial surrounding materiality, and furthermore by the substrate of its medium. In *The Talking Drum*, the spaces that Viola created in both the 1979 and the 1982 performances of the work were embedded within the recording, and it was this reality that was recognized, acknowledged and integrated into the Brewer Street space, whilst ensuring that the alternate sites for Viola' work, the internal experience of both audience and Viola as performer, were still present.

[516] (Bulley and Price 2018, 9)

Fig.70 *The Talking Drum and Hornpipes* installation view.
Brewer Street car park, October 2015.

Synchresis and Spatial Magnetization

The effect which Chion calls 'synchresis' is a core aspect of the specific methodology of locative sound outlined in this chapter. For Chion, synchresis consists of "perceiving the concomitance of a discrete sound event and a discrete visual event as a single phenomenon."[517] Chion derives synchresis from studying the interactions of sound and film, and in relation to it, he recognises a curious aspect of human locative hearing, the 'spatial magnetization' of sound by image:

> a psychophysiological phenomenon that results when we see a sound source (human, animal, machine, object) in a certain point in space, and for various reasons (e.g. reflection of sound off walls, electric amplification, the circumstances of audiovisual projection), the sound that comes from it, or supposedly comes from it, comes mostly from elsewhere in space and yet the image of the source attracts the sound, as though magnetically, and leads us mentally to situate the sound where we see its source.[518]

The psychophysiological phenomenon of spatial magnetization is what made the classical monaural sound film possible. We accept that whilst visually the actor moves, the sound does not. Furthermore, "offscreen" sounds are only so in our imagination, in monaural film they are commonly located in the exact centre of the screen. The phenomenon of spatial magnetization means that we readily bond sound and apparent visual source together, causing synchresis. We find spatial magnetization clearly apparent in the headphone-based cinema experiences of recent years, or when a single stable sound source for a film is placed in the back corner of a room away from the screen. We rapidly adjust and accept the concomitance of visual and sound as one source despite an obvious and distinct separation.[519] This effect provides fertile territory for exploration, but, as Chion notes, its impact is lessened in film-sound when these sonic events move dynamically:

> "If it constantly moves back and forth among loudspeakers, the image will have a harder time absorbing it, and the sound takes on a centrifugal force of its own that resists visual "attraction."[520]

For Chion, spatial magnetization no longer works if these imaginary movements and positionings are made *real* in space, by multiplication of audio tracks over independent speakers. He opposes the idea of the 'absolute' spatialisation made possible by multitrack film, favouring instead the unique affordances of the 'mental localization' conjured by the classical monaural approach.[521] This issue of the disruption of spatial magnetization must be regarded as quite specific to the flat, two dimensional aspect of the contemporary movie theatre, which operates, as Chion admits, on a "voluntary

[517] (Chion 2009, 492)
[518] (ibid., 491–492)
[519] (Chion 1994, 70)
[520] (ibid., 70–71)
[521] (Chion 1994, 71)

suspension of disbelief"[522] and where film conventions cannot tolerate an excess of realism.

The popularisation of mono and stereo sound recording productions across the twentieth century has contributed to the commonality of the spatial magnetization effect, normalising the dislocation of sound and originating source, and flattening the locative aspect of sonic situations within one and two dimensional auditory fields. Spatial magnetization occurs throughout our everyday life, and we might understand it as a remedial phenomenon that compensates for the often causally vague nature of sound, heard reflected or transmitted through surfaces, through displaced amplification and speakers, carried over great distances, buffeted on the wind.

For foley artists, synchresis *is* the art form. It is a powerful creative tool that allows us to "join results independently of any rational logic,"[523] establishing close interdependent relationships that ascribe to a single communal source sounds and images that might originate from very different sources, and have little in common in the reality of the presented sensory field. Synchresis is a 'psychophysiological phenomenon,' resulting not just from culture, but also from our nervous system. It is "as spontaneous as reflex"[524] and it is ripe for manipulation: "he or she will fall for every trick, accept every approximation, every expedient."[525]

Synchresis is particularly effective because of the 'lag' of sound: sonic events are more often the effect, not the cause of the event, and are around a million times slower than the speed of light. Adaptation to this delay is innate in our hearing: "this approximation is the basis of our experience of the world: the baby in its crib is sensitive from the outset to the synchronism of visible and audible phenomena."[526] There are however problems with this portmanteau of 'synchronism' and 'synthesis'. In synchresis the sonic event will remain itself, as will the related material, there is no 'synthesis'. To clarify, Chion declares "that which they work together to represent exists outside of them, like a projected shadow."[527] In synchresis then, we encounter a shadowy affordance in human perspective that allows us to overwrite the perception of realism, where an 'emblematic sound' might be preferred over reality.[528]

One particularly impactful moment in thinking about synchresis occurred when I was working on the spatial sound design for a performance lecture by the mathematics Professor Marcus Du Sautoy at the Barbican theatre in March 2013. In the lecture, Du

[522] (Chion 2009, 133)
[523] (Chion 1994, 63)
[524] (Chion 2009, 215)
[525] (ibid., 240)
[526] (ibid., 37)
[527] (Chion 2016, 155)
[528] (Chion 2009, 241)

Sautoy demonstrated the renowned 'McGurk' effect with the audience of the two thousand capacity hall.[529] Within the film produced of Du Sautoy for the lecture, the impact of vision on speech perception by synchresis was clearly demonstrated as the audience heard the syllables 'ba-ba' spoken over the visual lip movements of 'ga-ga,' and perceived it as 'da-da'. This synchresis takes advantage of what Jean-Luc Nancy refers to as the 'contemporaneity' of sound: whereas the visible or tactile presence might be thought of as occurring 'at the same time,' sound is always in process, or as Nancy terms it, sound is "presence in presence."[530] It is this processual nature of sound that is its resonant potential, rendering it uniquely pliable in artistic practice.

Within this praxis I wish to take both synchresis and the phenomena of spatial magnetization beyond the realms of film-sound from where they are derived, and employ them in the complex meshwork of surrounding materiality. In this arts research, we can understand that the involuntary nature of both synchresis and spatial magnetization affords rich opportunity to explore closer relations between sound and materiality. We will expand synchresis beyond sight and sound, taking a multi-sensory approach that encompasses the sense of touch. The exploration of synchresis and spatial magnetization as part of locative sound is concerned with what Chion has called the "figurative vagueness"[531] that occurs with synchresis: those combinatory extrasonic associations and representations that influence our perception of materiality and convey novel varieties of causal communication.

[529] The McGurk effect was first observed in 1976 by British psychologists Harry McGurk and John MacDonald. See McGurk and Macdonald's article in *Nature*: McGurk, Harry, and John MacDonald. 1976. "Hearing Lips and Seeing Voices." *Nature* 264: 746–48.
[530] (Nancy 2009, 9)
[531] (Chion 2016, 201)

Dynamic Spatialisation

The presence in presence and the processual "coming-and-going" of sound provide us with a rich source of information about the spatiality of the environment we are situated within. This is what John Hull has referred to when describing rain as having "a way of bringing out the contours of everything."[532] But, we must note that our perception of the spatiality of sound is commonly restricted, bound by the terrestrial activity of our bipedal nature. By dynamically moving sound and exploring the three-dimensional space of materiality, we might encounter a mysteriousness, an orientation that as Flusser has observed when writing of the flight of birds, allows us to be "in the presence of bodies that move freely within the three dimensions of space, and that assume three dimensional attitudes in all their gestures."[533] Within the forest-based sound installation *Living Symphonies*, through dynamic spatialisation and locative sound techniques, Jones and I sought to highlight those organisms in the exterior world that orient themselves dynamically within the three dimensions of space: this is a vital aspect of their reality, whose representation can be explored in spatial sound.[534]

In the creation of both *Living Symphonies* and *Variable 4*, compositional techniques were developed that utilised various examples of click-like percussive sounds as core aspects of movements within the works. In studio tests and outdoor prototypes, we noted these sounds' particular aptitude for dynamic spatialisation, as they drew our focused attention to their movements across the auditory field. It was only later when reading of the experiments of Georg von Bekesy (1960)[535] that I began to really understand what was happening in these experiments, why these click-like sounds proved so effective in communicating dynamic spatial movement. People gain a more precise sense of directionality when listening to clicking sounds than tones. As Ihde has observed:

> the clicking "language" of the porpoise, the tapping of the blind man's cane, the ping of sonar for directionality and location are not accidental but learned selections from the realm of sound for the type of sound appropriate to the highest degree of directional intentional fulfillment.[536]

This phenomenon is demonstrated in the following stereo recording from the Cannock Chase installation of *Living Symphonies*, where the percussive clicking background movements of M.11 *Squirrel* can be easily distinguished amongst the complex

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[532] (Hull 1990, 29–31)
[533] (Flusser 2013, 25)
[534] We will discuss the model-based dynamic spatialisation that occurs in *Living Symphonies* further on in this section.
[535] See Békésy's 1960 book *Experiments in Hearing*.
[536] (Ihde 2007, 78)

soundscape, scattered and traversing the forest floor and treetops whilst the R.02 *Snake* movement moves slowly across the front of the auditory field.

E19. *Living Symphonies* Cannock Chase - dynamic spatialisation (field recording)[537]
1 August 2014
01'00"

The early experiments that Jones and I undertook out on Dungeness beach in the run up to the first installation of *Variable 4* in 2010 have permeated throughout my practice. It was there that I recognised that moving and non-moving spatialised sound could be thought of compositionally, and had the potential to induce what I have here termed 'locative sound'. Through dynamic spatialisation, static placement of speakers and the exploration of synchresis therein, we can simultaneously mimic the spatial movement of atmospheric conditions and render the materiality of a place as agential: a 'sounding.' We also found that we could invert the highly locative aspect of sound: by creating complex atmospheric 'surrounding' effects across the installation sites using certain tones and textures, we could conjure a causal vagueness, a kind of static shimmering by dint of granular non-directional textures. This took advantage of what Ihde has pointed out: "constant tones, even modulating tones, show forth more dramatically the encompassing and less directional presence of sound."[538]

[537] See https://www.dropbox.com/s/ny7g682r5yeryxh/E19_Living_Symphonies_Cannock_dynamic_spatialisation.mp3?dl=0.

[538] (Ihde 2007, 78)

Locative Sound in Variable 4

Causal vagueness was perhaps most apparent at the *Variable 4* installation site at Elizabeth Castle, Jersey (September 2011). Here the speakers were embedded amongst the windswept grassy scrubland on top of an abandoned German World War Two bunker where they were highly exposed to atmospheric conditions. Many visitors heard the piece emanating from distance, echoing across the grounds of the castle, acting as an invitation to explore the source of the sounds and their close, tangible relations to the weather. In the following example, we hear a textural drum driven movement from the score, that uses the effect of causal vagueness in seeming to occupy and emanate from within the bunker itself.

E20. *Variable 4* Elizabeth Castle - causal vagueness (field recording)[539]
25 September 2011
00'28"

The spatial distribution of the sound score over the eight-speaker system that underpins *Variable 4* is controlled both algorithmically and through pre-composition. Broadly speaking, the points of the compass are mapped onto the directionality of the auditory field of the work: the dominant locative sound intensity on site often is a real-time reflection of wind direction mirrored by the wind vane of the weather station. Within the sound score, panning patterns and dynamics are also pre-composed for each of the movements, comprising of combinations of generative and linear sequences bespoke to each. An example of the spatial mimesis of wind and its effect on locative sound in *Variable 4* can be heard in the following field recording from the Snape Maltings installation, made at dawn on 29 May 2011.

E21. *Variable 4* Snape Maltings - spatial mimesis (field recording)[540]
29 May 2011
01'00"

By contrast in the following excerpt, captured just a few hours later on the same morning, when the wind had stilled, we hear a pre-composed spatial sequence from the score, part of the *Tema Sacher* movement written for the Snape Maltings installation.

[539] See https://www.dropbox.com/s/suce926sxnmfafr/E20_2011-09-25_V4_Elizabeth%20Castle_causal_vagueness.mp3?dl=0.
[540] See https://www.dropbox.com/s/pvq7e1avud818d9/E21_2011-05-29_V4_Snape%20Maltings_Dawn_Wind_spatial_mimesis.mp3?dl=0.

E22. *Variable 4* Snape Maltings - spatial sequence (field recording)[541]
29 May 2011
01'00"

We have installed *Variable 4* in a variety of locations, and each site affords new opportunities for atmospheric mimesis using spatial techniques of both direct and dynamic locative sound, and effects of causal vagueness. In combination with live composition, these techniques allow for minute gradations and changes in atmospheric conditions to become easily apparent, creating a bond with the spatial materiality of the weather. Jones, our site manager Dave Charlesworth and I have been presented with a number of challenges in integrating the *Variable 4* speaker system into the installation sites that the piece has visited. At Dungeness, we began with the relatively standard acousmatic premise of eight speakers in a circle as the array for the work. Out on the shingle we were confronted with a landscape strewn with the rusted debris of a disappeared fishing industry that had defined the recent society and culture of the area. These husks provided the setting for the physical installation, allowing speakers and cables to be easily embedded. Due to the unique nature of the shingle plain at Dungeness, we sought advice from Maurice Ede from the Dungeness estate as well as various local organisations about the best ways to lay the cabling under the surface of the shingle without disturbing any of the organisms present. As we can see in fig.71, we were then able to explore creating symbiotic synchretic relationships between the materiality of the Dungeness landscape and the speaker sound sources of the work, covibrating sound with materiality to create a figurative vagueness that the audience could understand as a sounding of Dungeness, conducted by its atmospheric conditions.

At the Hepworth lawn Snape Maltings installation site, synchresis and causal vagueness were more difficult to achieve. There was little extant material that the speakers could be embedded within or related to. As a result, we worked with the Faster than Sound curatorial team[542] to create custom speaker housings that were then placed underneath the surface of the lawn itself. The installation took place far enough in advance of public opening to allow for the grass to grow back over, creating the semblance that the sound came from the lawn itself, an illusory 'delocalization effect.'

The Portland Bill installation of *Variable 4* provoked even more complex challenges. There it was hard to achieve a causal vagueness or any form of circular speaker array, due to the nature of the abandoned stone quarry, structured by slabs of hewn Portland rock and other debris. The quarry created numerous reflective surfaces and cavities across the site, causing a great difficulty in the safe physical installation of

[541] See https://www.dropbox.com/s/imbrqokrt4dlo1c/E22_2011-05-29_V4_Snape%20Maltings_Dawn_Wind2_Tema_Sacher_spatial_sequence.mp3?dl=0.
[542] *Variable 4* was commissioned as part of the 2011 Faster than Sound programme curated by Joana Seguro, which took place at Snape Maltings. The installation of *Variable 4* was made possible by the work of both Tom Taylor and Dave Charlesworth, with the assistance of Louis Mustill and Arron Smith.

the speakers and cabling. This issue was countered through an in depth mixing process, and an extended installation period, resulting in the configuration of an unconventional eight speaker array that worked with both the sonic and physical architecture of the site (fig.75).

Fig.72–75 illustrate the configurations used at each of the four installation sites for *Variable 4*, detailing the differing synchretic juxtapositions of speaker locations across the sites, which then enabled the real-time generation of effective atmosphere-linked dynamic spatialisation, and pre-composed spatial patternings.

Fig.71 Speaker concealment at *Variable 4* installation site.
Dungeness, Kent, 22 May 2010.

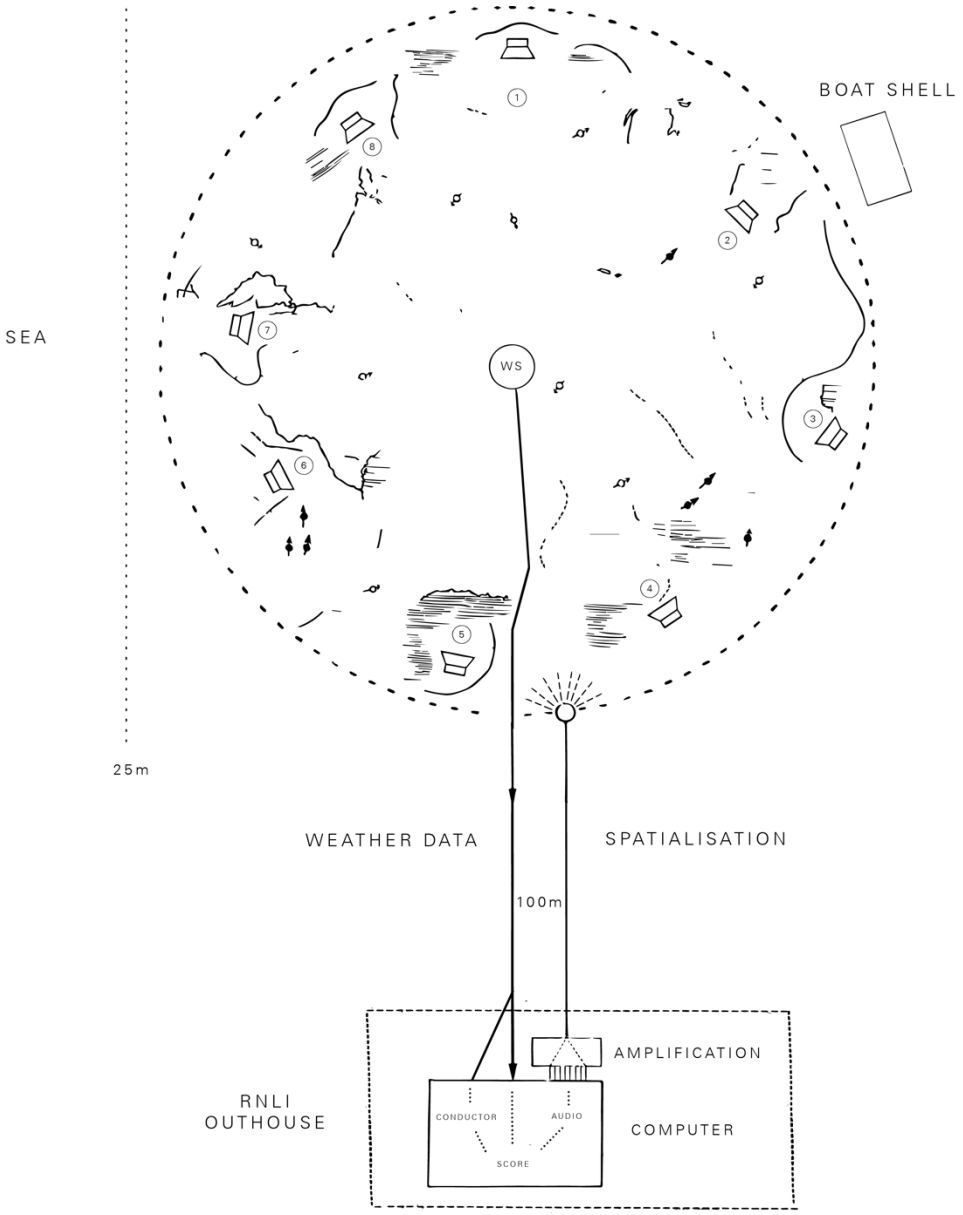


Fig.72 *Variable 4* Dungeness locative sound configuration.

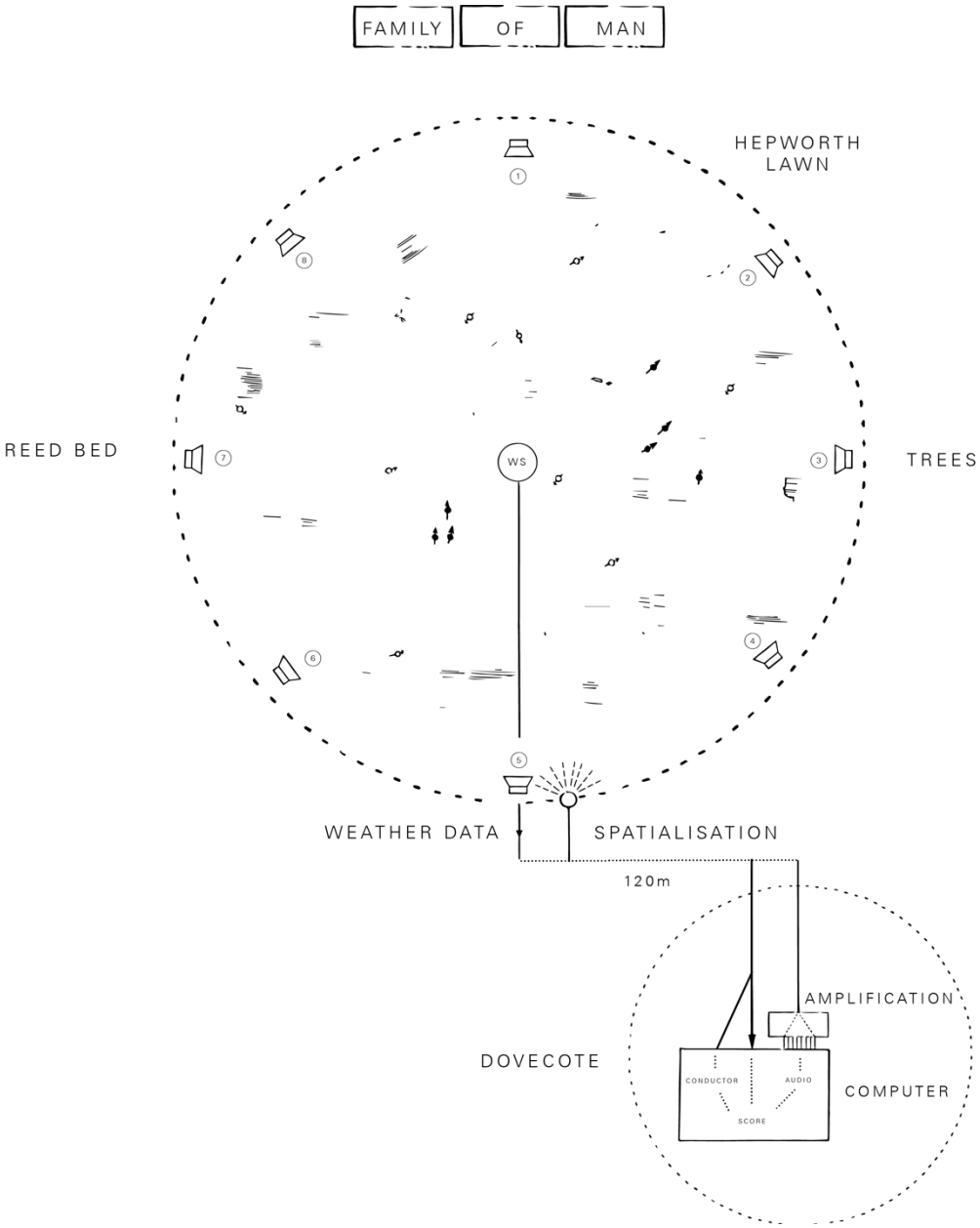


Fig.73 *Variable 4* Snape Maltings locative sound configuration.

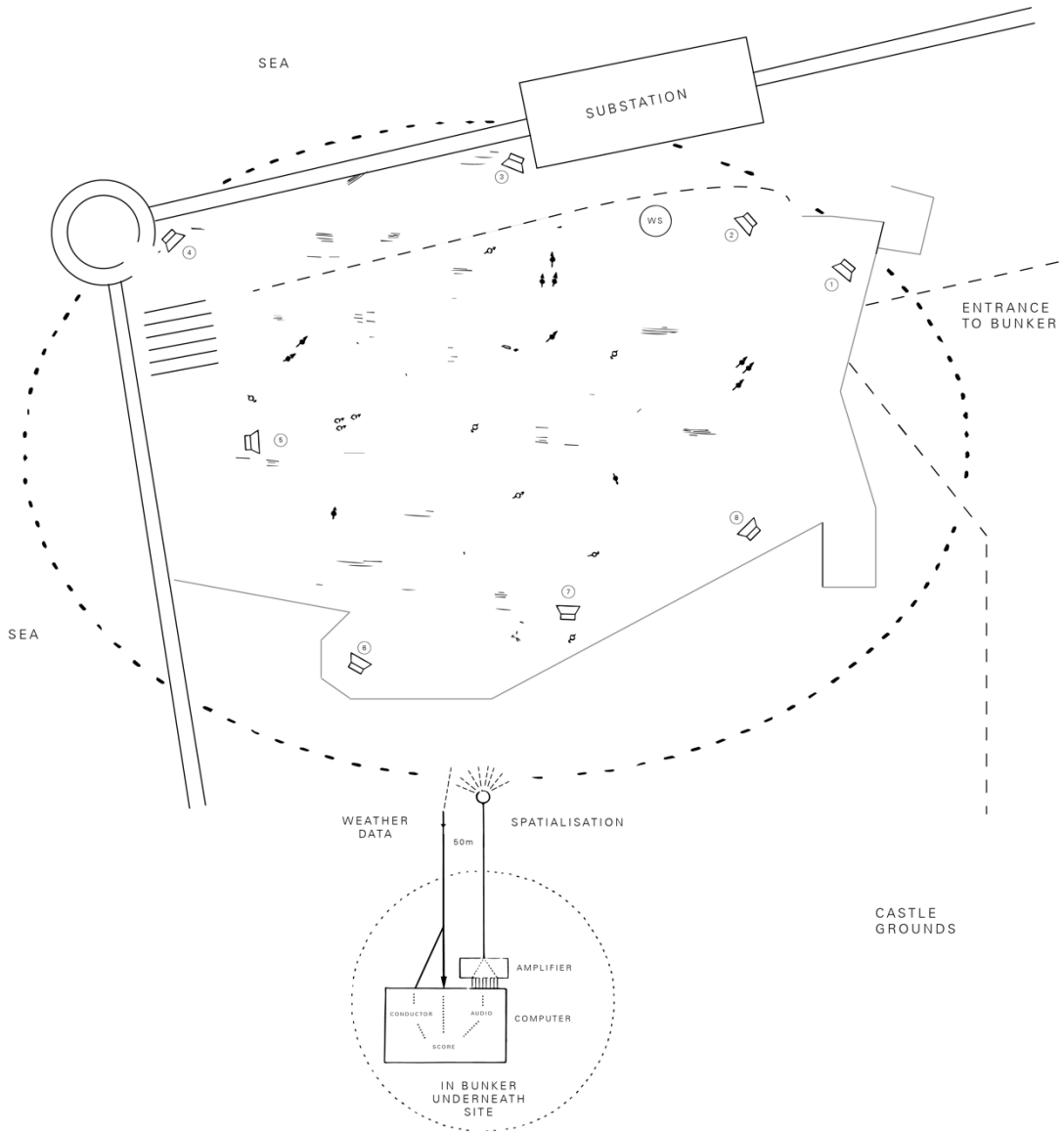


Fig.74 *Variable 4* Elizabeth Castle locative sound configuration.

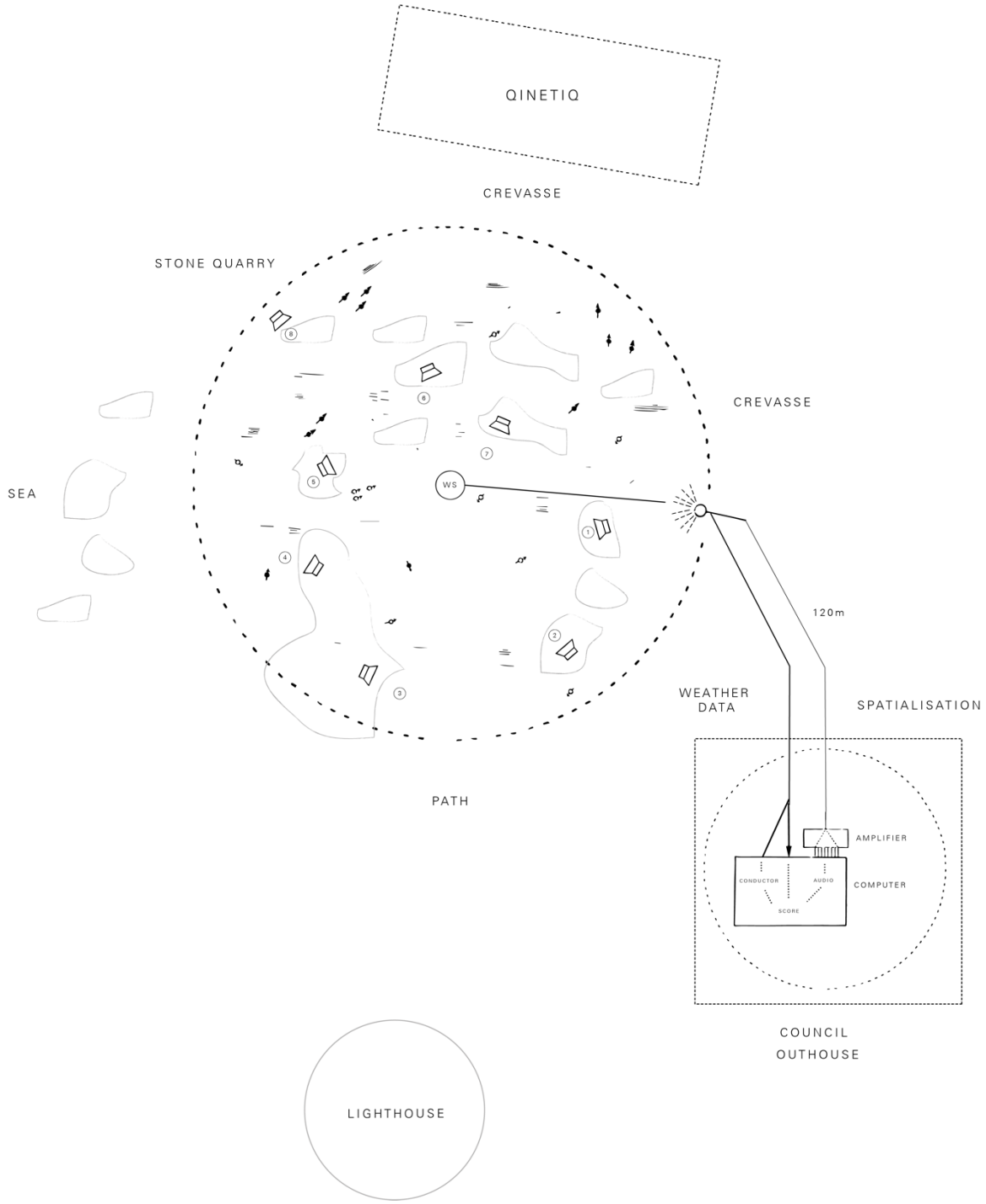


Fig.75 *Variable 4* Portland Bill locative sound configuration.

Locative Sound in Tactus

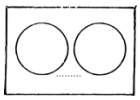
Within the touch-sound work *Tactus*, the effects of synchresis and spatial magnetization occur on a different scale and in differing sensory domains to those within *Variable 4* and *Living Symphonies*. The work takes its impetus in exploring the potential of haptic sound surfaces as dynamic and direct art forms for the blind and visually impaired. In *Tactus*, synchresis occurs in the concomitance of touch, tactile motif and sonic event. The work posits that sound-based artworks might be open to different forms of intelligence and experience beyond the visually dominated canon. Fiona Candlin points out that "touch enables visitors whose intelligence is 'bodily-kinaesthetic' to explore and understand objects that are usually presented in ways which appeal to 'logical–mathematical' intelligence."[543] *Tactus* can be understood as giving up the commonality of what Candlin calls "the equation between blindness, lack and touch"[544] and instead conveys touch not as illusionary Berensonian imagining,[545] but as real, material haptic-sound experience. In its first incarnation, as *Tactus No.1* (2015), there is a hidden twenty-speaker grid (fig.77) underneath the capacitive textile-print surface. For the audience, through this obscured spatial speaker system, sound is perceived to be located at fingertip precision with haptic sound motifs anywhere across the score. Through touch and granular locative sound, we increase the effect of 'hyperlocalisation,' controlling the periodicity of the sound through active participation and augmenting the effect by capacitive technologies and pin point calibration. Any slight misalignments in the directional sounding of the twenty speakers in relation to their thirty-nine separate haptic and braille-based motifs are compensated for by the effects of spatial magnetization and covibration, as sound resonates from and amongst the weave of the fabric print surface. Over the development period, I ascertained that as long as the real sound source was located within 10cm of the haptic motif, the concomitant illusion held, and a powerful synchretic relationship was derived.

As we have discussed in Chapter 3.03 *Live Composition*, the haptic and sonic motifs that make up the core of the *Tactus* score are developed together. In *Tactus No.1* a process of studio composition and recording sessions for the braille music notation translated the scored braille into recorded piano fragments. Further recording sessions based on part-notated scores, extended techniques, and improvisations, created intuitive synchretic source bondings between non-braille haptic score elements and composed

[543] (Candlin 2006, 138)
[544] (ibid., 151)
[545] See Bernard Berenson's classic *Florentine Painters* (1896) where the author extols a version of tactility divorced from the material world, purified and exalted within the haptic imagination of the viewer.

sonic events. The work as a whole forwards an intra-active haptic-sound experience, acting as a platform for focusing on our sense of touch, its relationship with textiles, hearing, and the potency of direct tactile languages within sound art practices. The arrangement of haptic sound motifs as assemblage in *Tactus* takes into account the fact that touching takes time, or as Candlin puts it: "touch doesn't take place in the blink of an eye; it is usually a slow, cumulative experience."[546]

Tactus was initially developed in 2012 as a purely braille music notated score (fig.76). In these early studies a simple synchresis was created between the braille music notation[547] and its piano recordings, which acted as a translation, highlighting and expressing the elegant six-dot based system of Louis Braille, rendering each note instantaneously comprehensible in sound.[548] The use of braille music notation continued in the score for *Tactus No.1*, composed over the years that followed. It is conveyed in the following excerpt from the film documentation of the Kaunas Biennial exhibition, 2015.



F4. *Tactus* Kaunas installation documentation film, braille locative sound excerpt[549]

2015

00'17"

Upon exhibiting early studies of *Tactus*, it became clear that only using braille music notation was a limitation for the aims of the project. Whilst the studies were successful as direct translation boards from braille to sound, they did not allow scope for more expansive, exploratory ways of knowing. Furthermore, in their exhibition it became apparent that there were relatively few blind and visually impaired audience members who could read braille music notation.

After the residency period, I worked on developing the first public version of the work, seeking to combine braille music notation with a distinct intuitive tactile language.

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[546] (Candlin 2006, 151)

[547] In 1829, at the age of 20, Louis Braille published *Method of Writing Words, Music, and Plain Songs by Means of Dots, for Use by the Blind and Arranged for Them*. As well as laying out a schema for Braille writing, the book created an elegant system for the tactile notation of music which has endured to the present day. Many challenges face those utilising Braille music notation, in particular its communication across the internet. For a description of recent valuable work underway to create a Braille Music Markup Language, such that braille music notation might be shared across online platforms, see Jessel, Nadine, and Benoit Encelle. 2009. "BMML: Braille Music Markup Language." *The Open Information Systems Journa*l 3: 123–35.

[548] The 1997 version of the Braille Music Code can be found online here: http://www.brl.org/music/ [accessed 2017/12/01].

[549] See https://www.dropbox.com/s/oqfydo0tvgve80t/F4_2015_Tactus_Kaunas_Excerpt2.mov?dl=0.

This tactile language was developed and inspired by research into the creation of tactile diagrams for the blind. In particular, the work of 'Art Education for the Blind' (AEB) was of huge help to me in the development of the *Tactus* project. Run by Elisabeth Salzhauer, and established in 1987, AEB seek to explore novel ways of making art, art history, and visual culture accessible to people who are blind or visually impaired.[550] Examples of this tactile grammar include the orientation arrow (fig.78) which is placed in the bottom-left corner of the score, acting to orient the work and provide a starting point, conveying that there is tactile information presented above. Different printed patterns create differing textures on the haptic score for *Tactus No.1*,[551] each of which have a specific communicative spatial function. A coarse pattern (fig.79) is used to represent background depth within an imagined three dimension of the haptic score, and a solid pattern (fig.80) is used to create a relief within the puff print, representing a foregrounding, a proximity of motif to audience, where a coarse pattern denotes a backgrounding, a distance.

[550] See http://www.artbeyondsight.org/sidebar/aboutaeb.shtml [accessed 2017/12/01].
[551] AEB's resource pack on tactile patterns directly informed the print patterning of the haptic score for *Tactus No.1*. For further information on these tactile patterns, see http://www.artbeyondsight.org/handbook/acs-tactilepatterns.shtml [accessed 2017/12/01].

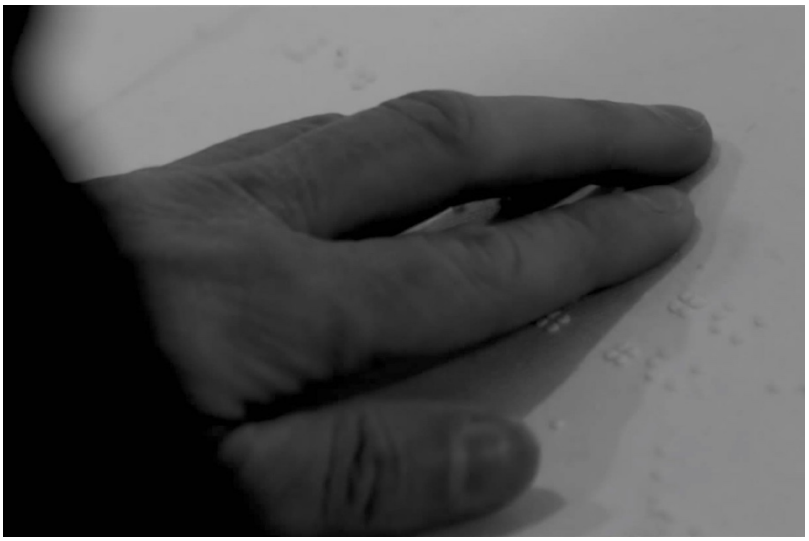

Fig.76 Ian Rattray with early score study of *Tactus*.
London Printworks, 2 September 2012.

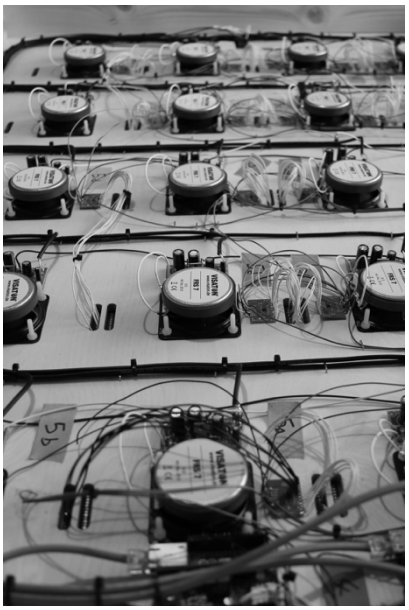

Fig.77 *Tactus No.1* twenty-channel speaker system behind the score.
August 2015.

Fig.78 *Tactus No.1* orientation arrow.

Fig.79 *Tactus No.1* coarse pattern.

Fig.80 *Tactus No.1* solid pattern.

Tactus is not only conceived for blind and visually impaired audiences (fig.82–83), although their experience is the dominant impetus in its conception and development. For non-blind audiences, the project aims to highlight the importance of tactile languages, and demonstrates the insight into perception that the blind and visually impaired provide regarding the operations of listening. This is not a new preoccupation for sound art practice. On the cover of the first edition of Dan Lander and Micah Lexier's collated anthology *Sound By Artists* (1990), a publication often thought to mark the point at which the term 'sound art' gained currency, the title is rendered in braille. This embossed intentional editorial reminder ventures the valuable and under-researched arena of the non-visual aspect of perception,[552] as well as the transitionary potency of braille.[553]

The locative live composition of *Tactus* proposes a formal solution for some of the dominant issues that have concerned me when exhibiting sound-based artwork in galleries and public spaces over the period of this thesis. I have often encountered situations of sound bleed when multiple works occupy shared reverberant spaces, and battled to avoid the employment of headphones that commonly results. This use of headphones curtails the potential of intra-activity between locative sound and materiality, outside of illusory spatial magnetization. The participatory touch aspect of *Tactus* seeks to avoid the seemingly atemporal ubiquitous loop, that endless never beginning that has proven an ill-fitting solution for so many vectoral film, video and sound works in the contemporary art gallery. *Tactus No.1* is composed such that locative sound is woven into its own tactile landscape, as part of its construct. Experiencing the work is an intimacy—it can only exist at close hand, through participation. Triggering locative sound through touch means that sound is heard at a very close proximity, rendering the acoustic of its exhibition space less impactful than is conventional for an acoustic listening experience in the brushed concrete reflective grey zone of the white cube. With *Tactus No.1*, it was interesting to observe that the spatial, proximal nature of the work created a low overall sound intensity—it is a quiet piece. Its non-linear, participatory live composition means that sonic events are sporadic, and for large amounts of time, the work remains silent.

Locative sound as employed in *Tactus* questions the passivity of those that attend art galleries and seeks to confound the clinically removed encounter in favour of an acted agential potential, a sharing and participation in the meshed materiality of the work itself. The project explores what Rancière has called an "ethical logic,"[554] that can "transform represented forms into collective ways of being."[555] Through its participatory form it enables communicativity, drawing creative synchresis betwixt textile and tactile materiality, engendering new ways of knowing through haptic listening.

[552] (Lander and Lexier 1990, 9)
[553] (ibid., 9)
[554] (Rancière 2013, 17)
[555] (ibid., 17)

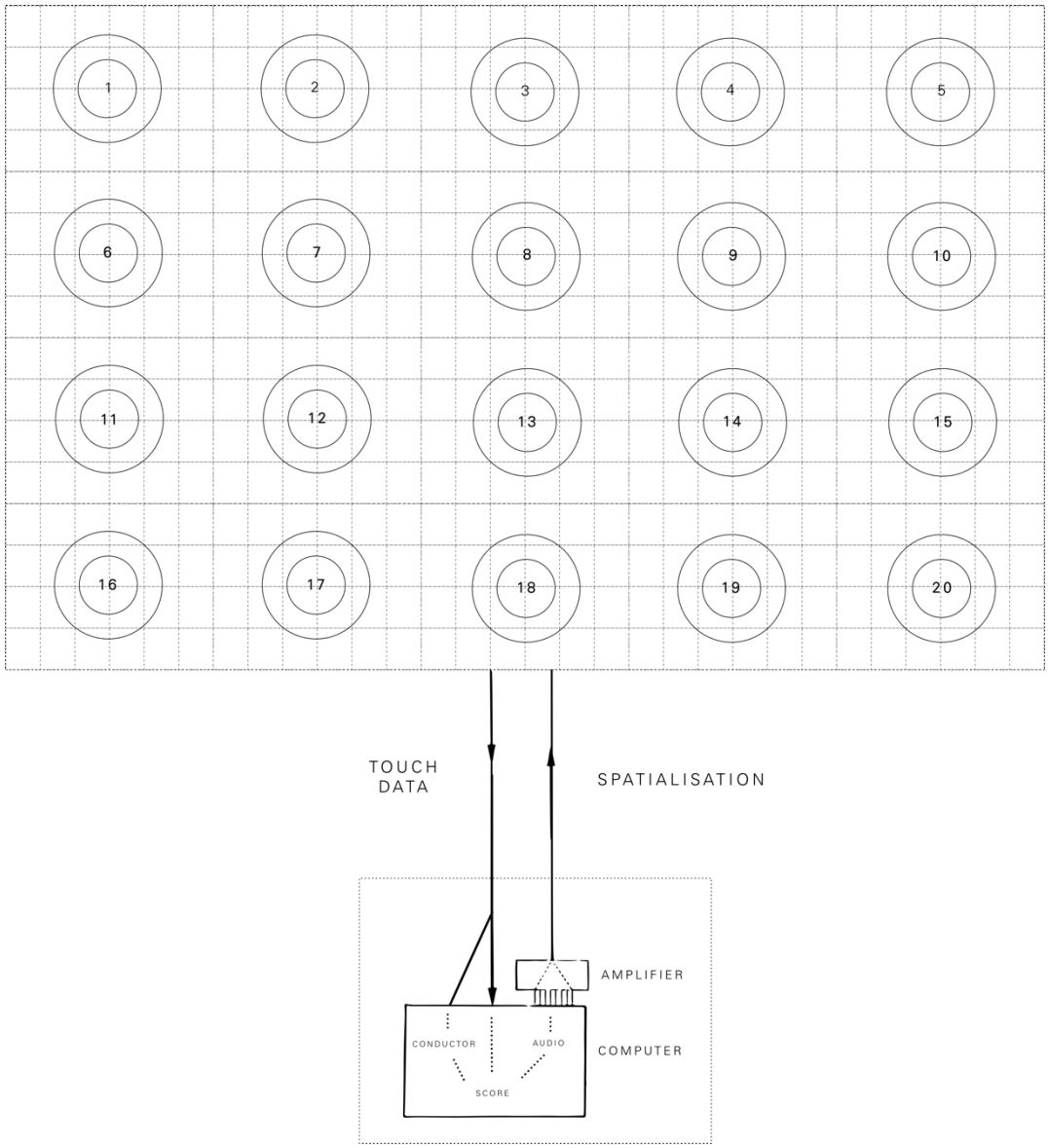

Fig.81 *Tactus* locative sound configuration.

Fig.82 Visitors at *Tactus No.1*.
Mykolas Žilinskas Gallery, Kaunas Biennial, 19 September 2015.

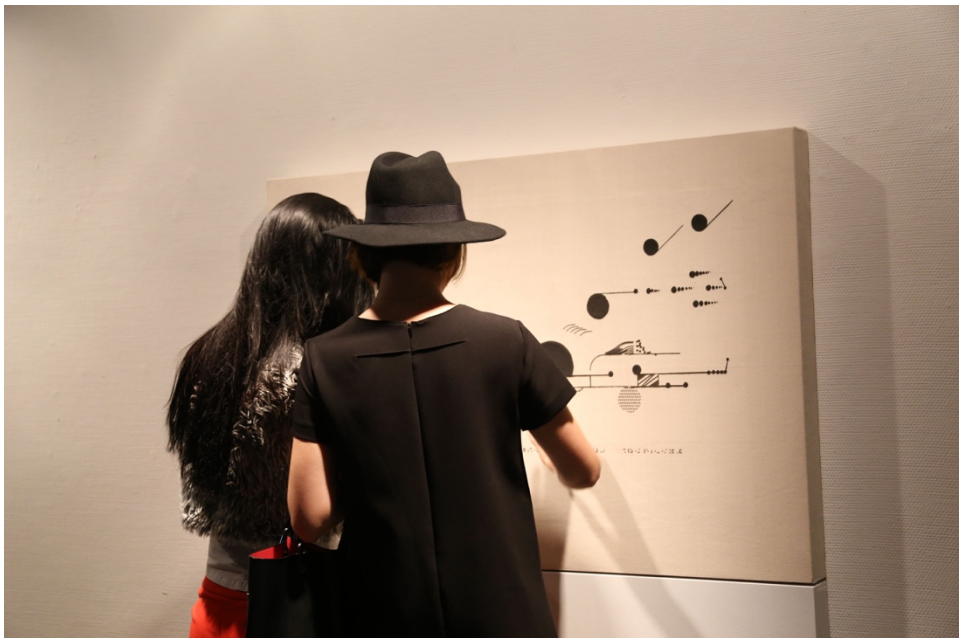

Fig.83 Visitors at *Tactus No.1*.
Mykolas Žilinskas Gallery, Kaunas Biennial, 19 September 2015.

Locative Sound in Living Symphonies

During the 2014 tour of *Living Symphonies*, the spatial, locative nature of the work was crucial in highlighting and drawing the audience into ways of knowing the forest ecosystem (see fig.94–95). Whilst touring the work, the spatial species sound that consistently captivated audiences was the magpie, a common diurnal resident in all four forests that the work was installed in. This particular species sound was composed from extended techniques and improvisatory sessions on the frame, body and bellows of an old harmonium using both contact and condenser microphones (fig.84). Recording sessions took place with musician Keir Vine in March 2014, starting from an initial, structural score notated with rhythmic patterns, suggested extended techniques, and gestural instructions. As well as recording the notation directly, improvisation around the material took place. Variations were recorded, edited and coded with their attributes. A few hundred of these fragments were then intuitively composed into the four states that make up the movement and were interwoven with chance-based rhythmic operations. For the magpie within the model for example, states correlated to resting, feeding, flying and calling. A short excerpt heard at the Fineshade forest installation can be heard in the following field recording:

E23. *Living Symphonies* Fineshade Woods - B.11 *Magpie* excerpt (field recording)[556]
25 June 2014
00’45”

This species sound exhibited a high degree of localisation in its sporadic, ‘clicking’ composition, and from the brief description of its creation, we might note that in a single sound species, one of a hundred at play within the work, we can attribute a multiplicity of sonic causalities. First, there is the originating movement that caused the sound: Vine’s improvisation on the wood and metal framework of the harmonium at the recording studio in London (fig.84). Further causal factors immediately become apparent, as we include the edited multi-microphone recording of the session, the computer it was housed upon, the recording software it was rendered with (and so forth). Further phonographic techniques were employed in the studio over following months, adding other causal factors including additional intuitive decision making in its composition.

[556] See https://www.dropbox.com/s/haswuaq32wmipuy/E23_2014_LS_Magpie_Fineshade_field_rec.mp3?dl=0.

We find then that the cause of a sound is a meshwork, a layered agential expression that triggers both novel and prior experience. During the exhibition of the work even more causal factors come into play, those of the software playback and the model simulation that triggers and dynamically places the sound within the auditory field. Out in the forest, through amplification across the speakers in the canopy, amongst foliage, or on the ground, there is brought a summative, 'associative' causal attribution of sound acting in concomitance with its material location. In the heightened material indices of this intra-activity, a dance of agency occurs, inviting in depth consideration of the sounding locative materiality itself.

In the cascade of different causal factors, the listener's causal knowledge varies widely dependent on their psychophysiological profile, involvement in the project, ability to undertake technological listening, knowledge of musical convention and other factors. A certain causal vagueness is thus common and natural for any listener. This vagueness is creatively explored through synchresis, as we have already discussed in relation to the direct haptic-sounding of *Tactus*, by engaging with the figurative nature of composed sounds, and spatially locating them in close relation to material subject. The composition of the sound score for the 2014 tour employed various techniques to aid in this locative sounding. These included anamnesis, the hyper-localisable attributes of particular sound types and patterns, and the use of phonographic production techniques. Through synchresis, Jones and I sought to create agential intra-activity between the source of both real and imagined species in the ecosystem, and their sounding. Fig.85 and fig.86 detail examples of the speaker placement that underpinned this locative bonding play within the forest.

Fig.84 Harmonium recording with Keir Vine.
London, 19 March 2014.

Fig.85 Speaker location at *Living Symphonies* installation site.
Fineshade Woods, Northamptonshire, 21 June 2016.

Fig.86 Canopy speaker at *Living Symphonies* installation.
Thetford Forest, 29 May 2014.

Within *Living Symphonies*, the spatialisation of the magpie sound species within the forest site is controlled dynamically by the activities of the software ecosystem model, which in turn is driven by real-time weather conditions and the time of day. The model is structured and populated by a detailed taxonomic index of species behaviours and characteristics derived from surveying (fig.87).[557] During the piece, the magpie's simulated location in the three-dimensional model is reflected instantly by its spatialisation across the twenty four speaker array embedded in the forest site. This dynamic spatialisation works via a species-specific radius measure: individual species are heard only through those speakers in their proximity. Moving creatures are allocated a speed property, which alters when different behavioural states are underway. Ground flora are heard statically, through speakers located in the undergrowth, and birds of prey sound circles around the canopy speakers installed up to thirty metres overhead. To achieve the three-dimensional aspect of each physical installation, we worked closely with forestry commission ecologists and tree surgeons to install the speakers in the canopy (fig.88 and fig.89).[558]

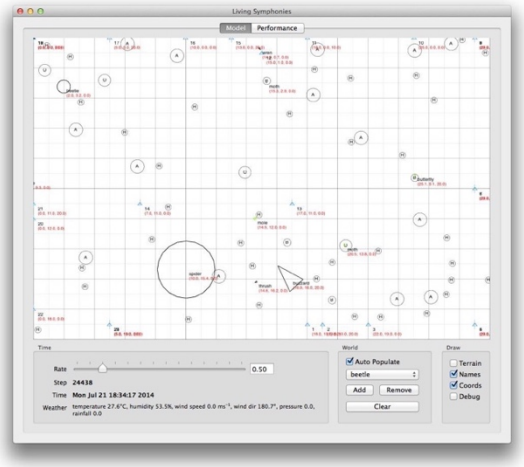

Fig.87 *Living Symphonies* ecosystem simulation.
Screenshot of software.
2014.

[557] This model is discussed in detail in 3.03 *Live Composition*.
[558] See http://www.livingsymphonies.com/news/2013/09/thetford-prototype-day-2/ for a journal article detailing the installation of speakers at the Thetford prototype of *Living Symphonies* [accessed 2017/12/01].

Fig.88 Tree surgeon Joe Oliver installing a canopy speaker at *Living Symphonies* installation site. Thetford Forest, Norfolk, 15 September 2013.

Fig.89 Installing canopy speakers at *Living Symphonies* installation site. Bedgebury Pinetum, Kent, 22 August 2014.

Each installation site for the 2014 tour provided a unique acoustic to work with. At the Thetford forest iteration, Jones and I decided upon a site that formed a concave oval bowl deep within the forest, rimmed by rows of pine trees and dense thickets of bracken. The site evoked the feeling and acoustic of an amphitheatre—sounds seemed simultaneously pin point and resonant across the space. The site had a particularly cohesive acoustic, as Laurence Rose described in his commentary article about the Thetford installation: "the sounds are coming from the ground and the tree-tops, melding across the whole 30-metre diameter sonosphere."[559] The differing acoustics of each site were fascinating to work with, and at each we spent a number of days designing the locative sound configurations that would best portray the ecosystem as a whole, whilst also working to balance and mix the piece within the natural acoustic of the place. Fig.96–99 illustrate the varying locative configurations used at the four sites.

One particularly striking and intimate example of synchresis occurred in relation to trees. At Bedgebury Pinetum for example, the sheer size and scale of the two Giant Sequoia trees within the site, meant that we were able to embed speakers seamlessly in the internal structure of the trees. This particular species-sound synchresis drew strong physical relations from the audience, something that Christopher Brown described on visiting the site: "at one point I felt that I was the tree – literally inside it!"[560] An example of the Giant Sequoia movement at Bedgebury Pinetum which Brown refers to, exported from the sound score, follows.

▶

E24. *Living Symphonies* Bedgebury Pinetum - T.12 *Giant Sequoia* (excerpt from sound score)[561]
20 August 2014
02'32"

[559] See http://www.theecologist.org/reviews/2423565/living_symphonies_in_the_forest.html [accessed 2017/12/01].
[560] (Brown 2014)
[561] See https://www.dropbox.com/s/ojzelt0yl8b6xwa/E24_2014_08_LS_Giant_Sequoia_excerpt.mp3?dl=0.

Fig.90 Listener at *Living Symphonies* installation.
Cannock Chase, Staffordshire, July 2014.

Fig.91 Visitor to *Living Symphonies* installation site.
Bedgebury Pinetum, Kent, August 2014.

Across the 2014 *Living Symphonies* tour, a number of blind visitors journeyed to visit the work (fig.93). This provoked inspiring and insightful conversations as we walked around the site together, discussing the locative nature of the piece. As writer and neurologist Oliver Sacks has explained, the blind provide a unique and highly specialised perception of sound: for "those born blind or early blinded, the massive visual cortex, far from remaining functionless, is reallocated to other sensory inputs, especially hearing and touch, and becomes specialised for the processing of these."[562] In the run up to the Cannock Chase installation, we were contacted by the blind facilitator and Clore social fellow Andy Shipley to organise two "SuperSense" walks at both Cannock and at the following site, Bedgebury Pinetum. These walks, which for sighted people were undertaken blindfolded, gave fascinating insight into people's differing experiences of the work. Sighted and non-sighted audience members discussed the heightened locative hearing and haptic sensuality of the forest ecosystem that occurs without sight (fig.92).[563]

The turn toward the non-visual that has occurred within the works discussed in this thesis is not seeking to negate the visual aspect of life, but to counter what Foucault has called the classical age's ingenious restriction of "the area of its experience,"[564] one that allowed for ease of classification and communication in areas like natural history, whose systems often exclude multi-sensory ways of knowing such as sound and touch. This restricted mode of experiencing privileges mid-distant sight above all else, and as Foucault describes, it "defines natural history's condition of possibility, and the appearance of its screened objects: lines, surfaces, forms, reliefs."[565] In working with Shipley and in encouraging non-visual experiences of locative sound in the forest ecosystem, we hoped to draw experience of the natural world away from the arms-length Linnaean regard, engendering new and vital attention to the materialities of the forest.

[562] (Sacks 2008, 175)
[563] For more about Andy Shipley's *SuperSense* workshops, see https://andyshipley-eclipse.org/supersense/ [accessed 2017/12/05].
[564] (Foucault 2005, 144)
[565] (ibid., 144)

Fig.92 *SuperSense* walk led by Andy Shipley at *Living Symphonies* installation.
Cannock Chase, 27 July 2014.

Fig.93 Visitors at *Living Symphonies* installation.
Thetford Forest, 29 May 2014.

Fig.94 Visitors to *Living Symphonies* installation.
Thetford Forest, 29 May 2014.

Fig.95 Visitors to *Living Symphonies* prototype.
Thetford Forest, 28 September 2013.

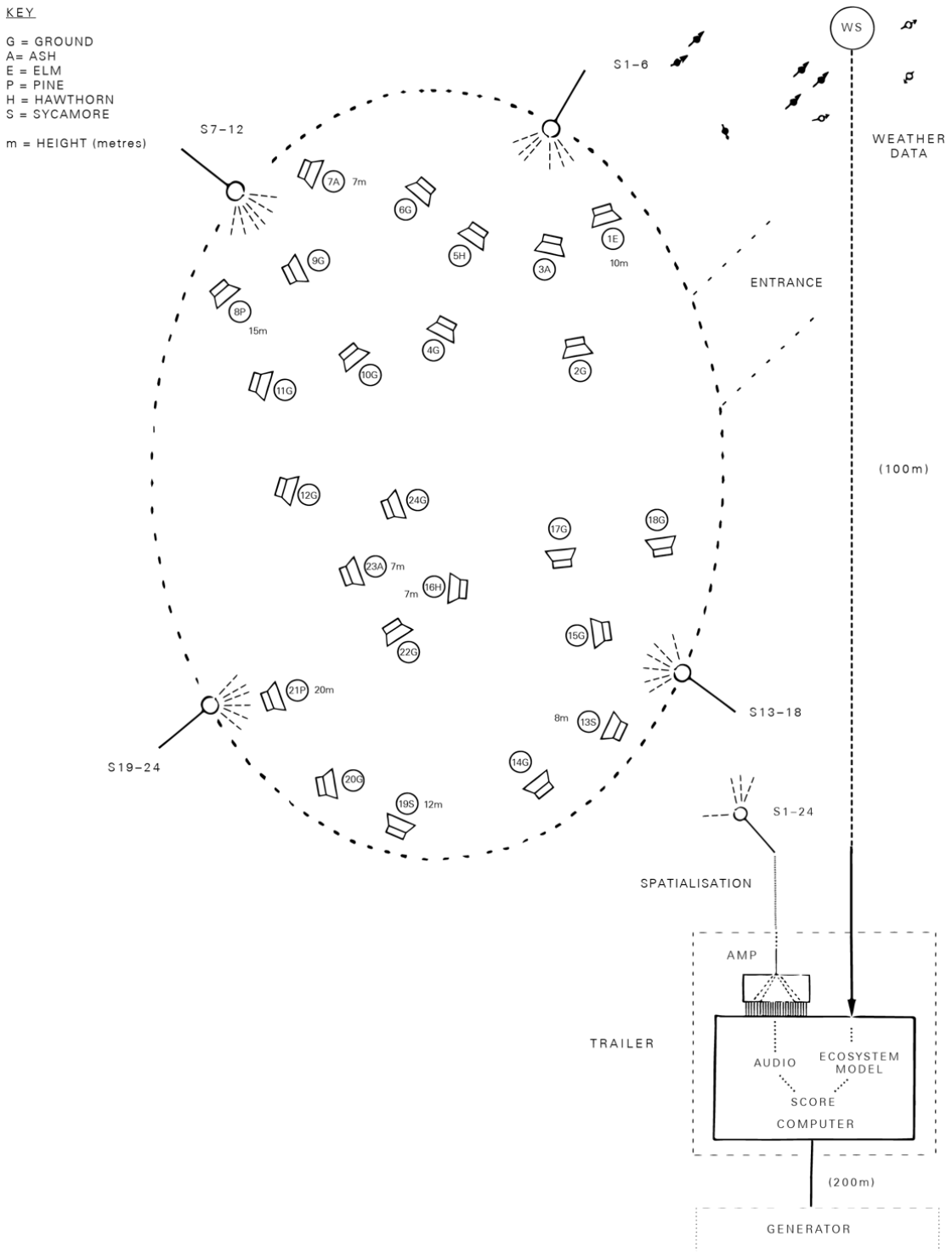

Fig.96 *Living Symphonies* Thetford Forest locative sound configuration. May 2014.

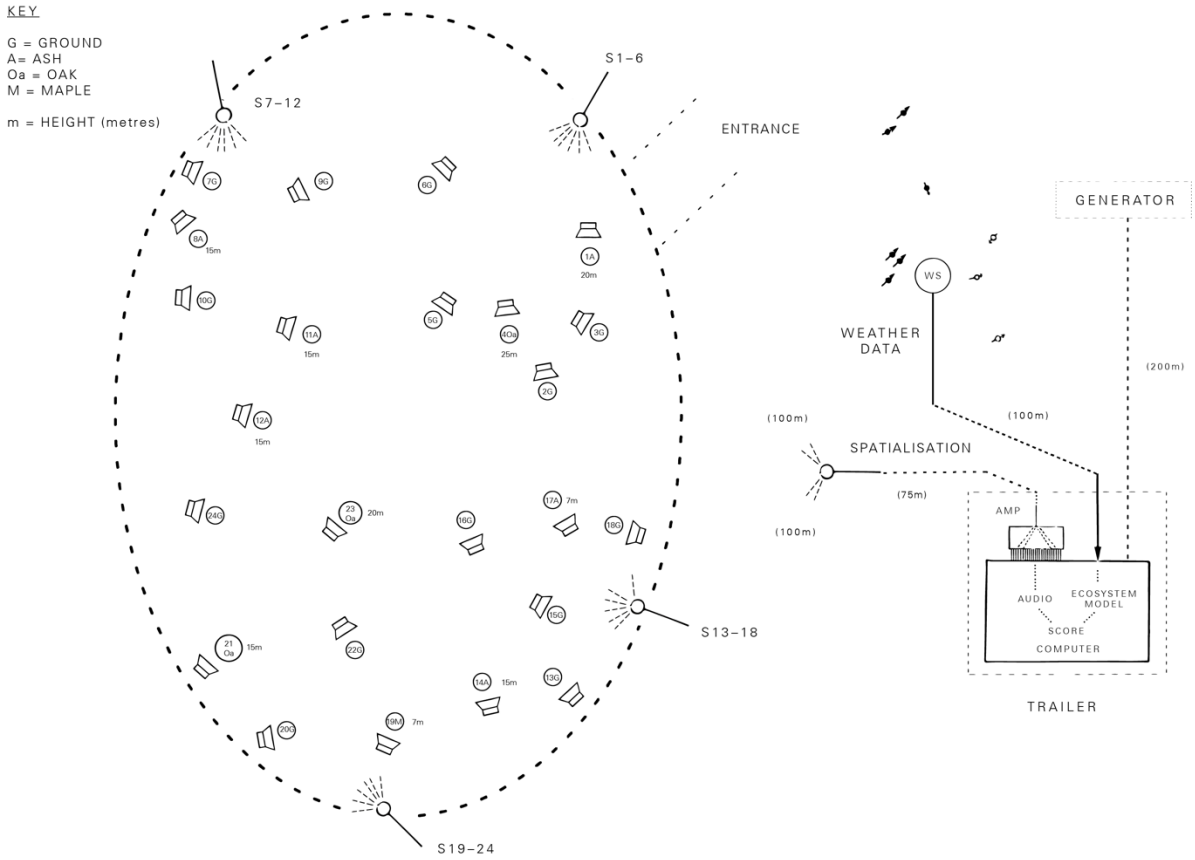

Fig.97 *Living Symphonies* Fineshade Woods locative sound configuration. June 2014.

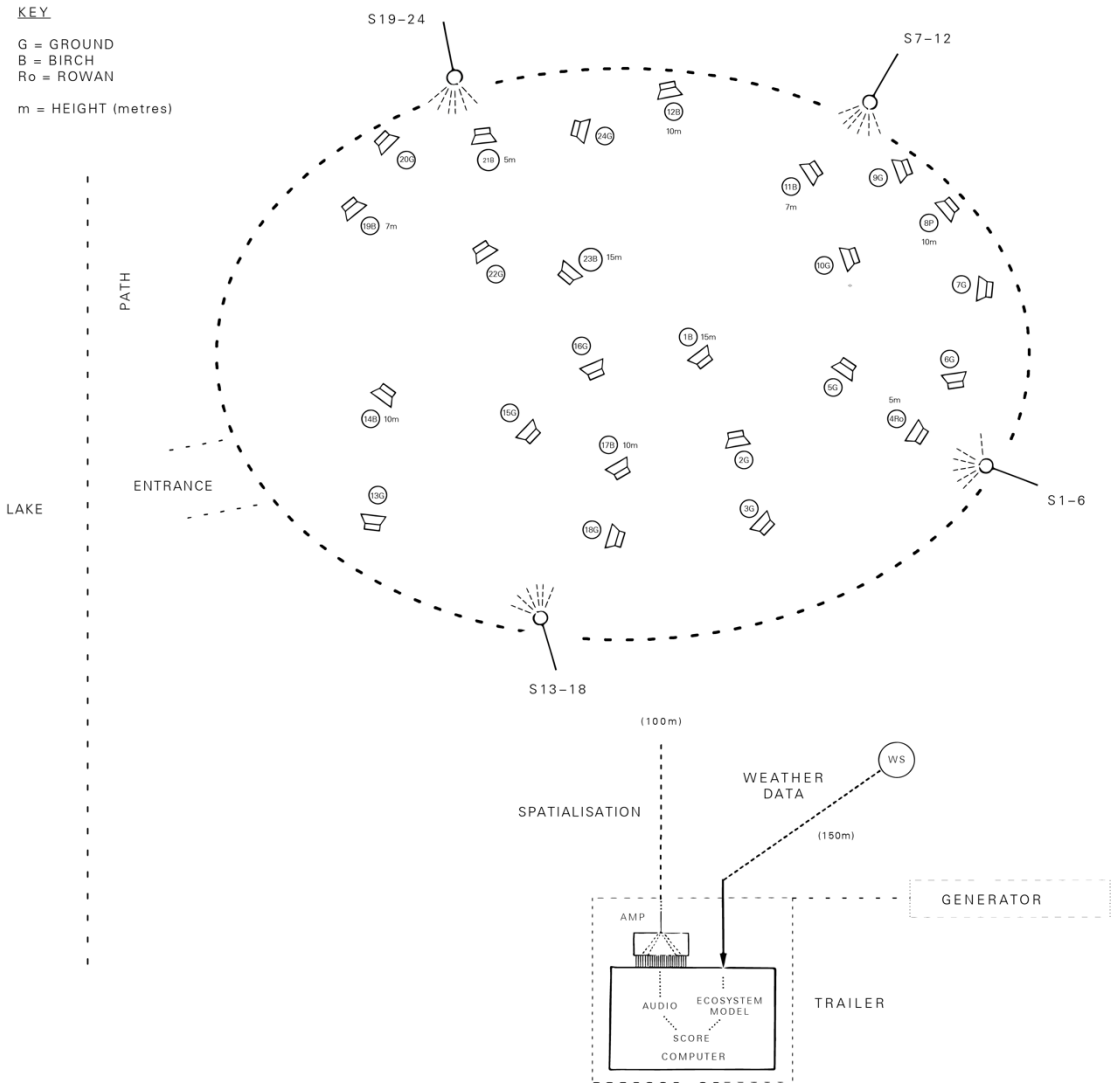

Fig.98 *Living Symphonies* Cannock Chase locative sound configuration. August 2014.

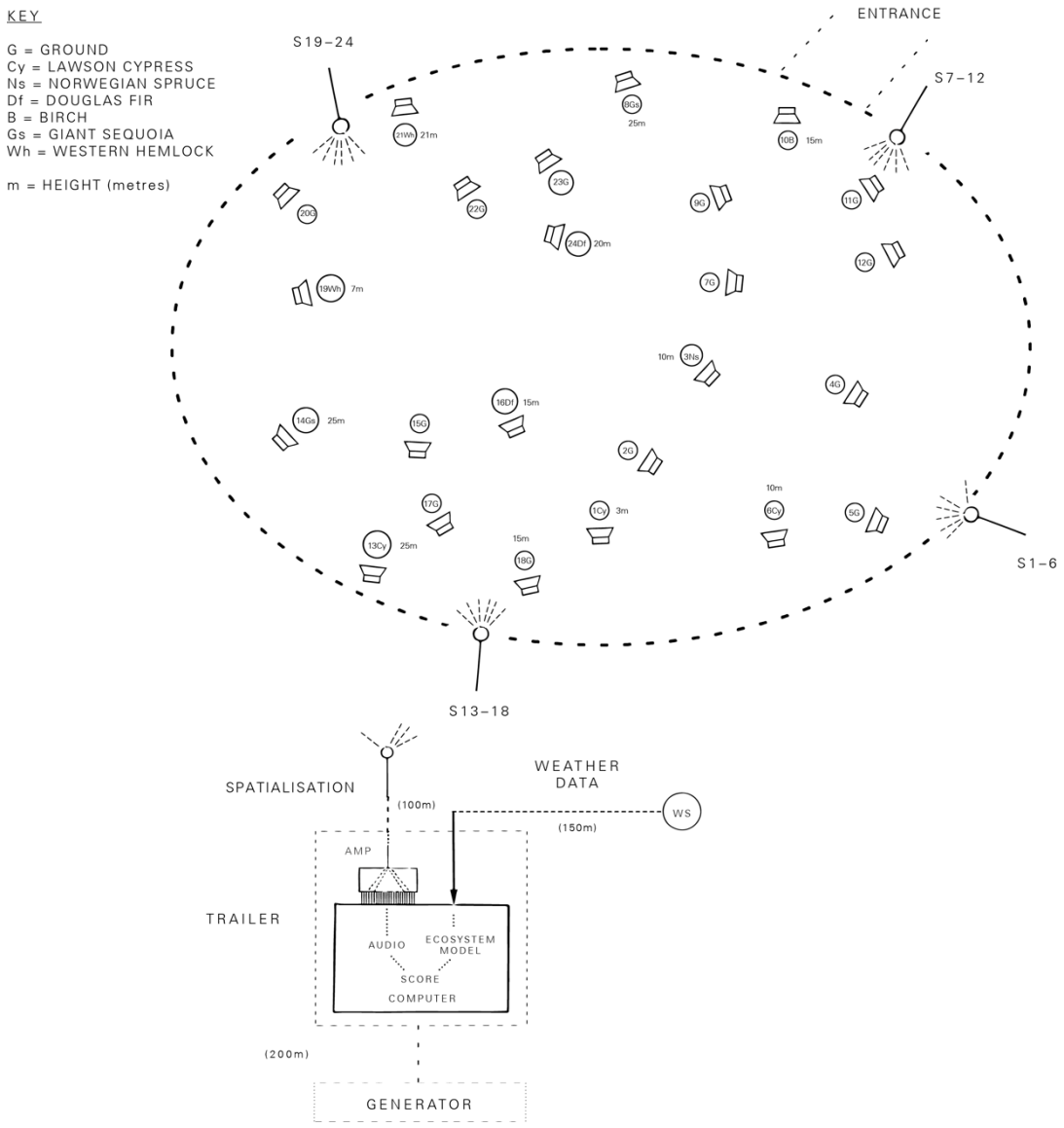

Fig.99 *Living Symphonies* Bedgebury Pinetum locative sound configuration. September 2014.

Locative Sound

The framework of locative sound as proposed and extrapolated in this sound arts research project takes its roots from the deep, multi-layered complexity of sonic causality that has arisen in the ubiquitous recorded playback technologies of the present day. As Chion has contended, "this confusion is inscribed also at the very heart of our experience itself, like an unsettling knot of problems."[566] In sound practice, causal vagueness is a challenge that creates potential for plays of causality. This 'bonding play' has been explored here in three different works, employing the effects of dynamic spatialisation, spatial magnetization, synchresis, and the specific locative properties of sounds, alongside intuitive figurative composition. Through these activities we might ascertain that with the specific methodology of locative sound we can draw the attention of the listener to communicative intra-activities between sound and materiality.

Schafer's coining of the term 'schizophonia,'[567] whilst useful in distinguishing difference between originating sound and electroacoustic reproduction, has imbued a nervous etymological disposition to the study of phonographic techniques in sound composition. It reveals a blurred and biased perspective, one predicated on an ableist imperative for the general suppression of recorded sound.[568] In seeking to resolve this issue, Heikki Uimonen has usefully defined the alternate term 'transphonia' as the "mechanical, electroacoustical or digital recording, reproduction and relocating of sounds."[569] The term embodies the open, resonant nature of sound, as through, across, processual. Uimonen has also made important observations of the ubiquity of transphonic technologies in our everyday life, noting that their prevalence not only "advocates background listening, but it also increases attentive listening."[570] This is a vital observation, as it highlights prevalent contemporary characteristics of human heard experience in an era that has given rise to the effects of spatial magnetization, synchresis and causal vagueness. In the contemporary soundscape, we veer readily through different listening modes: transphonic sonic events that might be considered ambient or backgrounded can draw our attention through auditory focus and the cause of sounds has become increasingly opaque and complex, their meaning derived from a seemingly infinite amount of levels. The term 'transphonia' is then a useful contemporary

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[566] (Chion 1994, 79)
[567] (Schafer 1977, 88)
[568] For a recent example of a critique of Schafer's term, see Elizabeth Ellcessor and Bill Kirkpatrick's *Disability Media Studies* (2017) which includes a discussion as to how Schafer's defining of this terminology as seeking a sense of "aberration and drama" (Schafer 1977, 91) can be understood as representing an "ableist phenomenology" (Ellcessor and Kirkpatrick 2017, 369).
[569] (Uimonen 2005, 63)
[570] (ibid., 31)

progression in conveying the operations of locative sound within the three works discussed in this thesis. Through recording and production, transphonic sounds have been composed, and their agential, figuratively porous nature has provided a medium for synchresis in locative spatialisation.

Within this praxis I have found focus on exploring novel relationships at the intra-action of sonic events and apparent cause, blurring distinctions, making things appear to sound. The loudspeaker in my work is not the place of sound's existence, nor where sound 'does its work,' but one level of transduction in sound's operations with materiality, and then with space. In the application of the spatial effects of source bonding, synchresis, and dynamic spatialisation, this resonant practice employs a framework of locative sound to place sonic events back in real space, out in the world, embodying an acoustemological agenda. *Variable 4*, *Living Symphonies* and *Tactus* all seek by means of locative sound to highlight and intra-act with their differing materialities of atmospheric conditions, the forest ecosystem and a textile-print haptic score. In the works, there emerges what we can call a 'diegetic materiality:' a combined sound-source-matter that provokes resonant ways of knowing. This term is inspired by Claudia Gorbman's groundbreaking book on film music *Unheard Melodies* (1987) where the author defines 'diegesis' as the "place of the action,"[571] and it follows that diegetic sound is where the source of sonic events seems readily apparent to an audience. Experimenting with the figurative nature of diegetic sound is exactly what is occurring in both *Variable 4* and *Living Symphonies*, with their use of synchresis and dynamic spatialisation, whilst in *Tactus* we find the field expanded into the non-visual sensory domain as synchresis and spatialisation take place across its haptic sound score.

[571] (Gorbman 1987, 3)

4. *Conclusions*

The two questions posed at the opening of this thesis have provided rich and rewarding pathways to explore across the seven years of this arts research project. Through the differing and iterative practice-based case-studies detailed I have critically reflected on a range of ways to integrate sound with materiality. By experimenting with practical approaches to illuminate material agency, the techniques of 'live composition' and 'locative sound' have been developed and employed in the creation of communicative public artworks that intra-act with the materialities they are concerned with, instigating new ways of knowing for their audiences. From documentation and reflective analysis of *Variable 4*, *Tactus* and *Living Symphonies*, a methodology of 'resonant practice' has arisen, distilling the tenets of an open, experimental and ecological manner of sound practice, promoting progressive, communicative and insightful explorations into the relations between sound and materiality.

Experimentation

In reflecting upon my practice, I have come to consider that experimentation is intrinsic to arts research. I operate across a range of seeming contradictions, harnessing the oppositions and separations of genre, discipline and category as fertile relations to be explored. Drawing this together is the form of the thesis itself, a resonant cross-disciplinary 'artstext' that seeks to create an open space where problems, challenges and developments in practice are shared, analysed and generated. The three transdisciplinary projects discussed have provoked wide-ranging and mutually beneficial collaborations and knowings. Indeed, the areas of cross-disciplinary interest that have occurred have often been surprising. In the documentary film created by the journal Nature about *Living Symphonies*, I was surprised to learn that our holistic approach to simulating the forest ecosystem was unique, and it was inspiring to see the interest and attention it created from ecologists and wildlife experts. From the afternoon I spent with the composer Silvija at the *Tactus No.1* installation in Kaunas, I learnt how experimental works can provide alterior and unexpected results. Silvija was captivated by the potential that the *Tactus* project demonstrated for her own work, considering it a method of breaking free from predominantly visual notation and keyboards to use dynamic haptic-sound surfaces as a basis for her composing. Experimentation in practice creates the climate for these unforeseen occurrences, with each work creating unique situations

where sound behaves transversally, in a manner that Sheihk has described as a privileged "intermediary between different fields, modes of perception and thinking."[572]

Technicity

Each case-study discussed has involved explorations in sonic technique, technology, and their conjunction with exterior materiality. These experiments with technicity, such as the creation of novel hybrid techniques of sonification, spatialisation, generative composition and synchresis, have taken place across a wide variety of locations, in sometimes challenging and complex environments. Two general techniques have been forwarded as enabling potent novel ways of understanding the materialities that surround us. Both hinge on the creative use of technology to solve technical, conceptual and site-specific challenges. Through 'live composition,' artists working with sound can explore the unending natural processes that surround us, highlighting and intertwining with them through real-time experience-in-practice. 'Live composition' can be understood as open, discursive and transitive: form is found in process, demarcating the intra-actions of sound and materiality.

The technique of 'locative sound' creatively explores the pre-eminent causal complexes of sonic events in the auditory field, sources which are so often spatially obscured with the use of PA systems, headphones and home sound systems. 'Locative sound' encourages us to use sonic events to provide focus on the spatiality of the real material world that surrounds us. Through synchresis and dynamic spatialisation, we can create 'play' with the material source of sounds, heightening and communicating a novel relation between sonic event and material environ.

[572] (Sheihk 2009, 5)

Iteration

An iterative approach to arts practice has arisen naturally across the research period. This results not just from basic curiosity and the need for repeated experimentation to fully explore the research questions, but also as a result of the commissions and opportunities that enabled each work. Iteration has emerged as a fruitful aspect of resonant practice, creating rare opportunities for focused re-problematisation through critical inquiry and dialogical communication. The exploration of multiple sites and places in the case-studies allowed me time for critical reflection at each stage of the artwork's development. The knowledge and experience gained from each public exhibition fed in to the development of techniques and methods for the next.

Collective communication

Conceptually, this praxis has engaged with what Latour has called 'matters of concern:'[573] subjects that are an ill fit within most knowledge models. In the three case-studies detailed, this has included sonic encounters with real-time atmospheric conditions, haptic textile scores and ecosystemic behaviours. In order to achieve a "shift from the stage to the whole machinery of the theatre"[574] in the analysis of the works, I have communicated the case-studies and ways of knowing that emerged as an 'artstext,' a form of cross-media document that seeks to imbricate documentation of the experience and creation of the works with critical intertextual analysis. Whilst arts practice on its own unravels knotted and not easily apparent ways of knowing, it is important to note that the majority of readers of this text will not have experienced the works detailed. By conveying arts research as artstext we might aim to create an expanded and inclusive field for critical knowledge of practice, drawing the experiential as document with the analytical, a 'making-to-understand' that can afford novel opportunities for 'co-reflection,' creating a collective communication that might become what Belenky (1997) has called a 'connected knowing.'

[573] (Latour 2008, 39)
[574] (ibid., 39)

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Appendix I *Variable 4*

I.01 *Commentaries*

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I.02 *Acknowledgements*

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Snape Maltings

Dave Charlesworth (Site Manager), Louis Mustill (Technical Manager), Giles Henry Stogdon (Field Recordist), Ableton Max For Live, Havva Basto, John Backhouse and Orford School Campbell Scientific, Franco Casule, Goldsmiths Annual Fund, Joseph James Hales, IdeasTap Ideas Fund, James Hannam, Julia Hodgson, KEF, Mike Knowlden, Ron Locke, Faye McNulty, RSPB Snape, Bella Scarr, Joana Seguro (curator), Ian Stonehouse, Tom Taylor, Iain Thornton, Nick Thorpe, Cecilia Wee, Alex Eichenberger (Cello), Sami El-Enany (Pianoforte, Keyboards), Milo Fitzpatrick (Double Bass), Mikey Kirkpatrick (Flute), Lally Pollen (Voice), Charly Richardson (Clarinet, Soprano Saxophone), Joe Thorp (Acoustic Guitar), Keir Vine (Pianoforte, Keyboards), Alistair Zaldua (Violin).

Elizabeth Castle

Branchage Festival, The Quietus, BBC Radio Jersey, Dave Charlesworth (Site Manager), Louis Mustill (Technical Manager), Giles Henry Stogdon (Field Recordist), Ableton Max For Live, Havva Basto, Campbell Scientific, Franco Casule, Joseph James Hales, KEF, Ron Locke, Faye McNulty, Tom Taylor, Iain Thornton, Alex Eichenberger (Cello), Milo Fitzpatrick (Double Bass), Mikey Kirkpatrick (Flute), Lally Pollen (Voice), Charly Richardson (Clarinet, Soprano Saxophone), Joe Thorp (Acoustic Guitar), Keir Vine (Pianoforte, Keyboards), Alistair Zaldua (Violin).

Portland Bill

B-Side Festival, The Quietus, BBC South West, Dave Charlesworth (Site Manager), Ableton Max For Live, Havva Bulley, Campbell Scientific, Franco Casule, KEF, Faye McNulty, Alex Eichenberger (Cello), Milo Fitzpatrick (Double Bass), Charly Richardson (Clarinet, Soprano Saxophone), Joe Thorp (Acoustic Guitar), Keir Vine (Pianoforte, Keyboards), Alistair Zaldua (Violin).

Appendix II *Living Symphonies*

II.01 *Commentaries*

2014/10/20
Richards, Dan. "Pontillist and Shifting – thoughts of *Living Symphonies"* October 20, 2014
livingsymphonies.com/news/2014/10/1530/

Brown, Christopher. "A Personal Reflection by Chris Brown." *Living Symphonies*, October 14, 2014
livingsymphonies.com/news/2014/10/a-personal-reflection-by-christopher-brown/

2014/08/31
Paul-Choudhury, Sumit (New Scientist). "stately and evolving." August 31, 2014
twitter.com/sumit/status/506092368542838784

2014/08/28
Ellis-Petersen, Hannah. "Living Symphonies: when an ecosystem becomes an orchestra." *Guardian*, August 28, 2014
theguardian.com/music/2014/aug/28/living-symphonies-james-bulley-daniel-jones-forest-orchestra

2014/08/23
Television interview on BBC South East Today

2014/08/22
Sillito, David (BBC News). "Listening to the sounds of the woods." *BBC News*, August 22, 2014
bbc.co.uk/news/entertainment-arts-28900342

2014/08/22
Radio interview on BBC Radio 4's 'Today Programme'

2014/07/30
Radio interview on BBC World Service.

2014/07/28
Mason, Shonagh. "beautifully intricate & special." July 7, 2014
twitter.com/shonaghm/status/493757216110174208

2014/07/17
Venkataramanan, Madhumita. "Turning Britain's wildlife into a living symphony." *Wired Magazine*, July 17, 2014
wired.co.uk/article/field-music

2014/06/04
Nature documentary on Living Symphonies (directed by Noah Baker). June 4, 2014
doi:10.1038/nature.2014.15354

2014/05/23
Gibb, Rory. "A World of Interactions: The Evolving Sound of Living Symphonies." *The Quietus*, May 23, 2014
thequietus.com/articles/15343-living-symphonies-daniel-jones-james-bulley-interview

2014/04/09
Hoffman, Jascha. "Science Events: Unusual Vision." *New York Times*, April 28, 2014.
nytimes.com/2014/04/29/science/science-events-unusual-vision-and-diy-neuroscience.html

II.02 *Acknowledgements*

Dave Charlesworth (site manager), Bella Scarr (production manager), Hayley Skipper (FCE), Antony Mottershead (FCE), Angharad Cooper (SaM), Richard Whitelaw (SaM), Nick Sherrard (SaM), Kealy Cozens (SaM), Patrick Fry (graphic design), Katie Scott (illustration), Giles Stogdon (field recording), Edward Scott-Clarke (film), Louis Mustill (film), Arron Smith (film), Keir Vine (Percussion, Editing, Hang, Pianoforte, Prepared Pianoforte, Harmonium, Rhodes Organ), David Aird (Tuba), Havva Basto (Voice), Teleri Dyer (Harp), Alex Eichenberger (Cello), Katie English (Bass Flute, Concert Flute), Milo Fitzpatrick (Double Bass, Voice), Peter Gregson (Cello), Simon Hewitt Jones (Violin), Daniel Jones (Synthesis), Hywel Jones (Trombone, Euphonium), Theo Lampert-Crook (Ukulele, Percussion, Autoharp), Martyn Potter (Electric Guitar), Nila Raja (Viola, Voice), Charly Richardson (Soprano Saxophone, Tenor Saxophone, Clarinet, Voice), Laurel Sills (Voice), Michael Goodger (installation), Imogen Lloyd (installation), Joanna Roy (installation), Seb Scarr (installation), Bill Thompson (installation), Rob Pell-Walpole (studio work), Simon Wheeler (studio work), Sophia Lee (studio work), Seb Scarr (assistant).

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Appendix III *Tactus*

III.01 *Acknowledgements*

Havva Basto (project management), Arron Smith and Artists and Engineers (engineering), Daniel Jones (software development), Faye McNulty and James Bosley (textile printing and development), Keir Vine (percussion, piano), Simon Hewitt-Jones (violin), Alex Eichenberger (cello).

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Appendix IV *Work and activities (2010—2017)*

Analysing Daphne Oram's 'Still Point' (1948)
Bulley, James and Feshareki, Shiva. 2018. *Analysing Daphne Oram's 'Still Point' (1948)*. In: Laurel Parson and Brenda Ravenscroft, eds. *Analytical Essays on Music by Women composers, 1900–1960*. Oxford: Oxford University Press. [Book Section] (Forthcoming)
research.gold.ac.uk/18943

The Talking Drum
Bulley, James and Price, Astra. 2018. The Talking Drum. *Leonardo Electronic Almanac*, 22(1), ISSN 1071-4391 [Article] (Forthcoming)
research.gold.ac.uk/18942

Still Point at Selector Responder
8 December 2017
British Library, London, UK
Talk on Daphne Oram's 1948 work for double orchestra and turntables 'Still Point.'
bl.uk/events/selector-responder-sounding-out-the-archives

Black Rock
10–11 November 2017
by David Shearing
Stage, Leeds, UK
Sound score and sound design
jamesbulley.com/black-rock/

Island
October 2017
directed by Steven Eastwood
BFI London Film Festival world premiere, London, UK
Sound score, sound design and location recording
jamesbulley.com/island/

The Interval and the Instant
7 October–26 November 2017
by Steven Eastwood
Fabrica, Brighton, UK
Installation score and sound design
fabrica.org.uk/the-interval-and-the-instant

Longplayer Day 2017
21 June 2017
Various venues – Goldsmiths, University of London to Trinity Buoy Wharf, London, UK
Performances, talks and screenings, co-curated with Helen Frosi, assistant curation by Philip Serfaty
longplayer.org/events/longplayer-day-2017/

Progress Music
November 2016
BRICKS FROM THE KILN #2
edited by Andrew Lister & Matthew Stuart. 978-0-9956835-0-1.
Text-sound archive work inspired by the work of Daphne Oram and Geoffrey Jones on the 1964 film 'Trinidad and Tobago.'
b-f-t-k.info

Tactus No.1
10 November 2016
Crafts Council Make:Shift Conference, Museum of Science and Industry, Manchester, UK
Conference presentation
craftscouncil.org.uk/what-we-do/ms-2016

Living Symphonies
as Jones/Bulley
1 November 2016
Free Exchange, Fermynwoods, Northamptonshire, UK
Talk and panel discussion
fermynwoods.co.uk/archive/workshopstalksevents/freeexchangediscussions/

Living Symphonies
as Jones/Bulley
Tuesday 27 September 2016
Forest Artworks Conference, Bristol, UK
Conference presentation
forestry.gov.uk/forestartworks

Then Must You Speak
19 March–18 September 2016
Paccar Gallery, Royal Shakespeare Theatre, Stratford-upon-Avon, UK
Sound installation and score

Still Point (by Daphne Oram)
24 June 2016
St. John Smith's Square, London, UK
Realisation of Daphne Oram's 1948 work for double orchestra and turntables 'Still Point,' in collaboration with Shiva Feshareki and the London Contemporary Orchestra.
jamesbulley.com/still-point/

The Weather Café
by David Shearing
1–20 March 2016
Unit 1, 133-141 The Headrow, Leeds, UK
Sound composition and locative sound design for installation
theweathercafe.co.uk

Tactus No.1
18 September–1 January 2016
Kaunas Biennial, Mykolas Žilinskas Art Gallery, Lithuania
Touch-sound installation
bienale.lt/2015/en/10th-kaunas-biennial

The Talking Drum & Hornpipes (by Bill Viola)
13 October–7 November 2015
Vinyl Factory, Brewer Street car park, London, UK
Spatialisation design and installation assistant for Bill Viola studio
blainsouthern.com/exhibitions/the-talking-drum

Vespers
as Jones/Bulley
28 May–14 September 2015
Royal Festival Hall, Southbank Centre, London, UK
Sound installation
jones-bulley.com/vespers

A Thing Worth Keeping
by Non Zero One
July–August 2015
New Vic, Stoke on Trent, UK
Sound composition for theatre
nonzeroone.com/projects/a-thing-worth-keeping/

Oramics to Electronica
July 2011–12 July 2015
Science Museum, London, UK
Co-curator on public project
group.sciencemuseum.org.uk/our-work/research-public-history/research-projects/past-research-projects/oramics-to-electronica

The Panic Office
by Stanley Donwood
21 May–6 June 2015
Carriageworks, Sydney, Australia
'Holloway' composition, remixed as part of Thom Yorke's 18-day 'Subterranea' soundtrack for Stanley Donwood's solo exhibition, 'The Panic Office.'
jamesbulley.com/holloway

Convergence
14 March 2015
Institut Français, London, UK
Panel discussion: The New Digital Wave, chaired by Cecilia Wee

Bjork Biophilia Live Discussion
6 March 2015
Genesis Cinema, London, UK
Chair of panel discussion: Technology & Electronic Music

Mountaineering
by Non Zero One
3–15 February 2015
Roundhouse, London, UK
Score and sound design for theatre
roundhouse.org.uk/whats-on/2015/mountaineering/

The Weather Machine
by David Shearing
5–7 February 2015
Stage, Leeds, UK
Score and locative sound design for theatre
jamesbulley.com/the-weather-machine

Radio Reconstructions
As Jones/Bulley
9 October 2014
Concertzender, Netherlands
Radio broadcast
jones-bulley.com/radio-reconstructions

Progress Music
4–25 October 2014
South Kiosk, London, UK
Film-sound installation
jamesbulley.com/progress-music

Variable 4
as Jones/Bulley
5–14 September 2014
b-side Festival, Portland Bill, Dorset, UK
Weather-driven sound installation
variable4.org.uk

Living Symphonies

as Jones/Bulley
26 August–7 September 2014
Bedgebury Pinetum, Kent, UK
Forest-based sound installation
livingsymphonies.com

20 Years of Archive Fever
12 July 2014
Freud Museum, London, UK
Sound installation with Anthony Stadlen and Guy Atkins
research.gold.ac.uk/10843/

Living Symphonies
as Jones/Bulley
26 July–1 August 2014
Cannock Chase, Staffordshire, UK
Forest-based sound installation
livingsymphonies.com

Living Symphonies
as Jones/Bulley
21–26 June 2014
Fineshade Woods, Northamptonshire, UK
Forest-based sound installation
livingsymphonies.com

Living Symphonies
as Jones/Bulley
24–30 May 2014
Thetford Forest, Norfolk, UK
Forest-based sound installation
livingsymphonies.com

Histories, Theories and Practices of Sound Art
15–17 May 2014
Goldsmiths, University of London and the Courtauld Institute of Art, UK
Conference co-director
research.gold.ac.uk/10983

Paul Smith App
1 November 2013
Sound design for iPad application
itunes.apple.com/gb/app/paul-smith/id755441887?mt=8

Radio Reconstructions
as Jones/Bulley
24 October 2013
South Kiosk *Vestige*, Design Museum, London, UK
Radio installation
jones-bulley.com/radio-reconstructions

Holloway
14–31 May 2013
Rough Trade East, London, UK
Soundscape installation as part of Stanley Donwood's exhibition
jamesbulley.com/holloway

Goldsmiths E.M.S - Sound Arts
18:30–21:30, 9 May 2013
Queen Elizabeth Hall, London, UK
Curator
jamesbulley.com/a-concert-of-sound-arts

Radio Reconstructions
as Jones/Bulley
18:30–21:30, 9 May 2013
Queen Elizabeth Hall, London, UK
Performance

Radio Reconstructions
as Jones/Bulley
6 March–15 April 2013
LimeWharf, London, UK
Radio installation
jones-bulley.com/radio-reconstructions

Pilgrimage
by Matthew Lloyd
16–24 November 2012
Wilton's Music Hall, London, UK
Composition and sound installation for verbatim theatre
jamesbulley.com/pilgrimage

51°32'36, -0°3'25
as Jones/Bulley
6—29 September 2012
Galerie8, London, UK
For Ella Finer's *Where We Meet, Volumes 1 and 2*
jones-bulley.com/where-we-meet/

SHO-ZYG
20–27 September 2012
St.James's Hatcham, London, UK
Sound art exhibition and events programme, co-curated with Kathrine Sandys
sho-zyg.com

You'll See Me (Sailing In Antarctica)
by Non Zero One
6–20 July 2012
National Theatre, London, UK
Composition and sound design for theatre
nonzeroone.com/projects/youll-see-me-sailing-in-antarctica

Maelstrom
as Jones/Bulley
16 May–10 June 2012
Museum of Science and Industry, Manchester, UK
Sound installation
jones-bulley.com/maelstrom

Consciousness
by Marcus du Sautoy
2 March 2012
Barbican Centre, London, UK
Sound design and operation for performance lecture by Marcus Du Sautoy with James Holden
jamesbulley.com/consciousness

xtet
as Jones/Bulley
2–3 March 2012
Barbican, London, UK
Sound installation
jones-bulley.com/xtet

Variable 4: A Dynamical Composition for Weather Systems
Bulley, James and Jones, Daniel. 2011. 'Variable 4: A Dynamical Composition for Weather Systems'. In: *Proceedings of the International Computer Music Conference*. Huddersfield, United Kingdom. [Conference or Workshop Item]
research.gold.ac.uk/6506

Maelstrom
as Jones/Bulley
24 November 2011
Barbican Gallery, London, UK
Sound installation
jones-bulley.com/maelstrom

This Is Where We Got To When We Came In
by Non Zero One
15–30 September 2011
Bush Theatre, Shepherd's Bush, London, UK
Composition and sound design for performance piece
nonzeroone.com/projects/this-is-where-we-got-to-when-you-came-in

Variable 4
as Jones/Bulley
22–25 September 2011
Elizabeth Castle, Jersey, UK
Weather-driven sound installation
variable4.org.uk

Variable 4
as Jones/Bulley
28–29 May 2011
Snape Maltings, Suffolk, UK
Weather-driven sound installation
variable4.org.uk

Variable 4
as Jones/Bulley
22–23 May 2010
Dungeness, Kent, UK
Weather-driven sound installation
variable4.org.uk