

SOUND SCULPTURES, DYNAMICAL SYSTEMS AND NATURAL ENVIRONMENTS:

A PORTFOLIO OF COMPOSITIONS WITH CRITICAL COMMENTARY

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WITH CRITICAL COMMENTARY

SIMON KNIGHTON

A thesis submitted in partial fulfilment of the
requirements of the Royal Northern College of Music and
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Abstract

In today's contemporary music landscape, the integration of electronics with live acoustic instruments is increasingly widespread. Nevertheless, navigating the aesthetic and technical artistic challenges of combining these two sound worlds offers continuing provocation for many in the field. In response, this research presents a portfolio of works that explore how acoustic, electronic, and automated sounds can be combined, fused, and worked with in a variety of creative ways.

Developed through an iterative, creative-critical process, this project employs notions of *sound sculpture* as a multi-textural metaphor to guide and inspire creative decisions, whilst also providing a conceptual lens through which to analyse my artistic practice. This commentary traces the evolution of this metaphor as it developed with each new piece of my portfolio: from live, spatialised performances that apply acoustic and psychoacoustic phenomena to fuse acoustic and electronic sound; to the use of electronic production techniques that facilitate collaborative work with classically trained performers; to hybrid installation-concert pieces that creatively explore notions of musical linearity and sonic environment in live performance. As such, this project offers a variety of insights for composers and sound artists working in the field of *composing for instruments and electronics*.

Reflecting on the highly collaborative creative processes that emerged, this commentary draws on themes of *distributed creativity* and *material agency* to challenge the traditional notion of composition as a solitary act. Instead, it positions the composer as an agent within a dynamic network of instruments and performers, tools and technologies, environments and cultures. In this model, a key part of the composer's role becomes to guide (or perhaps navigate) these relationships. My research suggests techniques for engaging in this role that, whilst particular to me as an artist, will nonetheless provide insights into the complex interrelationships that exist between the composer and the networks they operate within.

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Documentation

All recordings, scores and other relevant documentation can be found here:

<https://drive.google.com/drive/folders/1FagVLjutSpYtIO8J63-O2m7B3aoK5doN?usp=sharing>

Links to online recordings of each piece are also provided for convenience and can be accessed by clicking the title of each piece.

Please note – some of the figures are linked to videos, which are available in the ‘Video Figures’ folder and can also be accessed online through the hyperlinks provided.

Acknowledgements

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Portfolio

[Étude for Saxophone, Electronics and Sound Movement](#)

Performed by Lennart Baerts on 6th July 2019 at Soundmine, Bilzen, Belgium. Approx duration: 5'

[Sound Sculpture No.1 for Five Clarinets, Eight Speakers and Sixteen Soundscapes](#)

Performed by Melissa Demarjian, Sebastian Marshall, Bethany Nichol, Benjamin Pinto and Matthew Walker on 14th February 2020 at the RNCM. Approx duration: 23'

Second performance (two clarinet version) at St Margaret's Church, Whalley Range Manchester, 30th July 2022.

[Sound Sculpture No.2 for Two French Horns](#)

Performed by Erin Bathgate and Jack Sindall. Recorded at the Royal Northern College of Music Concert Hall, summer 2021. Approx duration: 13'

[Sound Sculpture No.3 for Trombone](#)

Performed by Weston Olencki. Audio samples recorded at Weston's house. Approx duration: 13'

[Sound Sculptures, Dynamical Systems, Natural Environments](#)

Album released through Nonclassical on 26th July 2024.

1. [Sound Sculpture No.4 Part One](#)
2. [Sound Sculpture No.4 Part Two](#)
3. [Sound Sculpture No.4 Part Three](#)
4. [Dynamical Systems One](#)
5. [Dynamical Systems Two](#)
6. [Dynamical Systems Three](#)
7. [Natural Environments One](#)
8. [Natural Environments Two](#)
9. [Natural Environments Three](#)

All tracks produced by Simon Knighton. Recorded at various locations.

Album artwork by Fiona Brehony.

Mastered by Joe Shrimpton.

Performed by Gemma Bass (Violin), Amy Gray (Percussion), Simon Knighton (Percussion), Peggy Nolan (Cello), Chihiro Ono (Violin), Carl Raven (Saxophones), Stephanie Tress (Cello), Kathryn Williams (Flutes).
Approx duration: 45'

[Sound Sculpture No.5 for Spatialised Quartet, Electronics and Installation](#)

Commissioned by Nonclassical.

Performed by Gemma Bass, Peggy Nolan, Amy Grey, and Carl Raven on 22nd September 2022 at St John's Church, Waterloo, London. Composed for the concert [Simon Knighton curates: Dynamical Systems and Natural Environments](#). Approx duration: 20'

Sound Sculpture No.6 for the House of Bedlam

Performed by Carl Raven, Stephanie Tress and Kathryn Williams on 27th October 2022 at the Royal Northern College of Music Concert Hall. Approx duration: 27'

Sound Sculpture No.7 for Orchestra

Commissioned by Southbank Sinfonia and Nonclassical.

Conducted by Toby Thatcher.

Performed by Southbank Sinfonia on 23rd February 2023 at St John's Smith Square, London. Approx duration: 14'

Sound Sculpture No.8 for String Trio, Electronics and Installation

Commissioned by Nonclassical.

Performed by Gemma Bass, Simon Knighton, Chihiro Ono and Peggy Nolan on 4th May 2024 at the Southbank Centre. Approx duration: 26'

Second performance on 11th June 2025 at the International Anthony Burgess Foundation, Manchester.

Pendula

Commissioned as part of the 8-cubed project by RNCM Centre for Practice & Research in Science & Music (PRiSM) and the University of Liverpool. Recorded by Riot Ensemble on 13th August 2021 at Kings Place, London, with funding from the Cultural Recovery Fund. Approx duration: 6'

Second performance by Sono Ensemble on 14th April 2023 at the International Anthony Burgess Foundation, Manchester.

Always Look for the Flowers

Commissioned as part of the Music and Parkinson's research project, led by Dr Michelle Phillips (RNCM) and Professor Ellen Poliakoff (University of Manchester).

Performed by Yuanfan Yang on the 30th January 2025 in the Carole Nash recital room at the Royal Northern College of Music. Manchester. Approx duration: 6'.

Second performance on 20th May 2025 at the NHS-Universities conference, Royal Northern College of Music. Manchester.

Research Dissemination and Knowledge Exchange

Artist Talks

2025, January 9th. [Simon Knighton. Royal Music Association Tippet Medal Winner Presentation/Conversation](#). [On stage, one one-hour interview] BFE/RMA Research Students' 2025 Conference.

2023, October 19th. *Two-hour lecture on my work and research*. Trinity Laban Conservatoire London, UK.

Awards

Sound Sculpture No.5: winner of the 2023 [Royal Music Association Tippet Medal](#).

Sound Sculpture No.7: nominated for best orchestral piece at the [2023 Ivors Awards](#).

Broadcasts

Natural Environments One: broadcast on [BBC Radio 3's Late Junction](#) on August 23rd, 2024.

Dynamical Systems Two: broadcast on [BBC Radio 6's Freak Zone](#) on November 30th, 2023.

Sound Sculpture No.7: broadcast on [BBC Radio 3's New Music Show](#) on November 18th, 2023.

Sound Sculpture No.6: broadcast on [BBC Radio 3's New Music Show](#) on January 28th, 2023.

Conference Presentations

2025, May 20th. ["Always Look for the Flowers": an exploration of using music composition to navigate Parkinson's disease with Dr Simon Knighton, Chris Jones & Yuanfan Yang \(piano\)](#) [Presentation and performance]. Greater Manchester Universities Student Mental Health Partnership Conference 2025. Royal Northern College of Music, Manchester, UK.

2024, November 10th. [Sculpting Sound: Exploring the Creative Affordances of Material Agency in the Generation of Novel Tuning Systems](#) [Paper Presentation]. SOUND/IMAGE 2024 Festival at Greenwich University, London, UK.

2024, July 2nd. [An evening of music and mathematics](#) [Presentation and performance]. Classical Function Theory in Modern Mathematics Conference at the International Centre for Mathematical Sciences, Edinburgh, UK.

2022, June 18th. [Capturing Indeterminacy: Exploring the Spectral Potential of the Clarinet](#) [Paper Presentation]. Music Since 1900 at Birmingham Conservatoire, UK.

Workshops

2024, October 3rd. *Sound Sculpture Workshop*. With students of the [Compose It!](#) learning and participation programme by Huddersfield Contemporary Music Festival and Riot Ensemble.

2023, September 23rd. *Sound Sculpture Workshop*. [Allendale Folk Festival](#).

2023, June 3rd and 24th. [What to Play and How to Play It](#). Improvisation/Composition workshops with students at the Junior RNCM.

2023, March 28th. [An Introduction to Sound Sculptures and Autonomous Musical Systems](#). Lecture and workshop at Leeds Conservatoire.

Writing

2023, November 11th. [Simon Knighton, Composer](#). Meet the Artist.

2022, November 3rd. [A Dynamical Systems Playlist](#). Van Magazine.

2021, January 8th. [Capturing Indeterminacy to Explore the Spectral Potential of the Clarinet](#). The Garden of Forking Paths.

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Introduction

My PhD portfolio centres around eight works that I refer to as *sound sculptures* – a collection of concert performances, studio recordings, and installations that investigate compositional methods of combining acoustic, electronic, and semi-autonomously generated sounds.

The integration of electronics with live acoustic instruments has become increasingly widespread in contemporary music, to the point of near ubiquity. Nevertheless, many of the artistic challenges inherent to *mixed music*¹ remain persistent. These range from the “stark, unrelenting contrast between the acoustic and electronic sound sources that characterised the early works of the 1950s” (Vandenbogaerde, 1972, as cited in Sallis et al., 2018, p. 5); to technical difficulties of timing, synchronisation, and dynamic balancing that persevere across new technologies (Han, 2025); to key debates around issues of *liveness and physical presence*, in which the disembodied nature of electronically produced sound can uneasily contrast the embodied, tactile qualities of acoustic performance. As composer John Croft observes:

Once one tries to create a continuous, intimate relation between the two [acoustic and electronic sound], so that one is dealing with an extension of the instrument rather than an emulated ‘other’ or environmental context, one is confronted with a fundamental difference between a sounding body whose physical properties transparently determine its sonic possibilities, and the loudspeaker, which can produce practically any sound at all (Croft, 2007, p. 59).

In relation to this focus on physicality, composer Simon Emmerson emphasises the role of the performer as an agent in shaping acoustic sound, stating: “an agent is an entity... which may execute an action (a change in something, usually involving a transfer) which results in sound” (2007, p. 3). By contrast, electronically produced sound lacks the causal relationship that defines acoustic instruments/performers, leading Emmerson to ask, “Do we want or

¹ Mixed music or *musique-mixte* is a common term for music that combines live acoustic instruments and electronics. See the literature review (page 22).

need to know *what causes the sound we hear?*” (2007, p. 5). This question highlights fundamental issues of liveness, presence, gesture, and causality in mixed music.

These aesthetic tensions are further compounded by timbral differences, which emerge not only from compositional decisions but also from the material qualities of the technologies employed. Loudspeakers and electronic devices inevitably imprint their own timbral, dynamic, and spatial characteristics on any sound they reproduce. Emerson refers to these colourations as the “grain” of loudspeakers (2007, p. 132) (drawing an analogy to the unique grains of wood). The loudspeaker is never fully transparent or neutral. Even where high-quality systems minimise such effects, a recording and a live performance of the same sound will never be entirely identical, and a synthesised tone will vary across different playback systems. Thus, the *grain* of acoustic and electronic sound, combined with their embodied and disembodied qualities, underpins the perceptual, technical, and aesthetic challenges of composing with both in combination.

For me personally as an artist, the disembodied and spatially ambiguous qualities of electronic sound were a central concern in my early mixed music works, becoming a catalyst for this research enquiry. This project began as an investigation into compositional and performative approaches that might resolve (or perhaps reframe) these challenges. Developed through an iterative process (producing a musical work around a set of ideas, critically evaluating the process and outcomes alongside relevant contextual reading, and then re-entering the practice with new knowledge to build on emergent themes), these methods are *creative-critical* and rooted in practice-as-research.² My compositional methods and points of enquiry evolve directly from my compositional practice: as my compositions develop, so do my methods of research. The term *sound sculpture* is used throughout the portfolio as a narrative device to map the evolution of this research enquiry – a multi-textural metaphor that guides and inspires creative decisions whilst also providing a conceptual lens through which to analyse and understand my practice. Notions of *sound*

² Practice-as-research as defined by Robin Nelson, who writes: “[Practice-as-research] may be undertaken through a practice (praxis) and that the processes or products might constitute the primary evidence of the research” (2022, p. 22).

sculpture function as an ever-evolving framework of ideas, inspiring each new piece in response to the last, whilst simultaneously generating boundaries and constraints for aesthetic and technical choices. *Sound sculpture* serves both as a provocation through which to understand the creative process and as a framework for contextualising the key compositional concerns of this project in relation to the many fields of music with which it intersects.

The project's evolution

And so, this project began with a simple question: *How might acoustic and electronic sound be entwined perceptually in concert performance?* Discussed in chapter one, the first two pieces of my portfolio explore this question by applying acoustic and psychoacoustic theory to compositions for spatialised clarinets, saxophone, and surround sound electronics. The term *sound sculpture*, in this instance, came to refer to the fusion and spatialisation of sound in performance settings, where music becomes something to be ‘sculpted’ around a listener in time and space, on fundamental levels of perception.

Following the evaluation of these pieces (and shaped in part by the constraints imposed by COVID), the middle works in the portfolio consist of home/studio recordings that explore how graphic scores, improvisation, and electronic production techniques can facilitate creative collaboration with performers. In this phase, the focus shifted from combining acoustic and electronic sound in live performance to investigating the intersection of electronic production methods and acoustic performance practices. Here, *sound sculpture* refers to methods of developing the ‘raw materials’ of a piece with performers, before selecting and sampling key moments to build, *sculpt*, and compose with.

Finally, as discussed in chapters three and four, the collaborative techniques for generating and developing material introduced in chapter two are applied in the live domain in the final works of the portfolio. These works explore a variety of approaches to creative notions of *sound sculpture*, with physical sound art installations that morph into spatialised concert

performances being the cumulative realisation of my practice. Notions of *sound sculpture* as physical, automated sound-making systems are particularly prominent in these sections.

Aims

This commentary aims to illustrate the process of creating my portfolio and to provide a space for discussing the key insights that arose from the following research aims (each of which emerged sequentially through the course of the study):

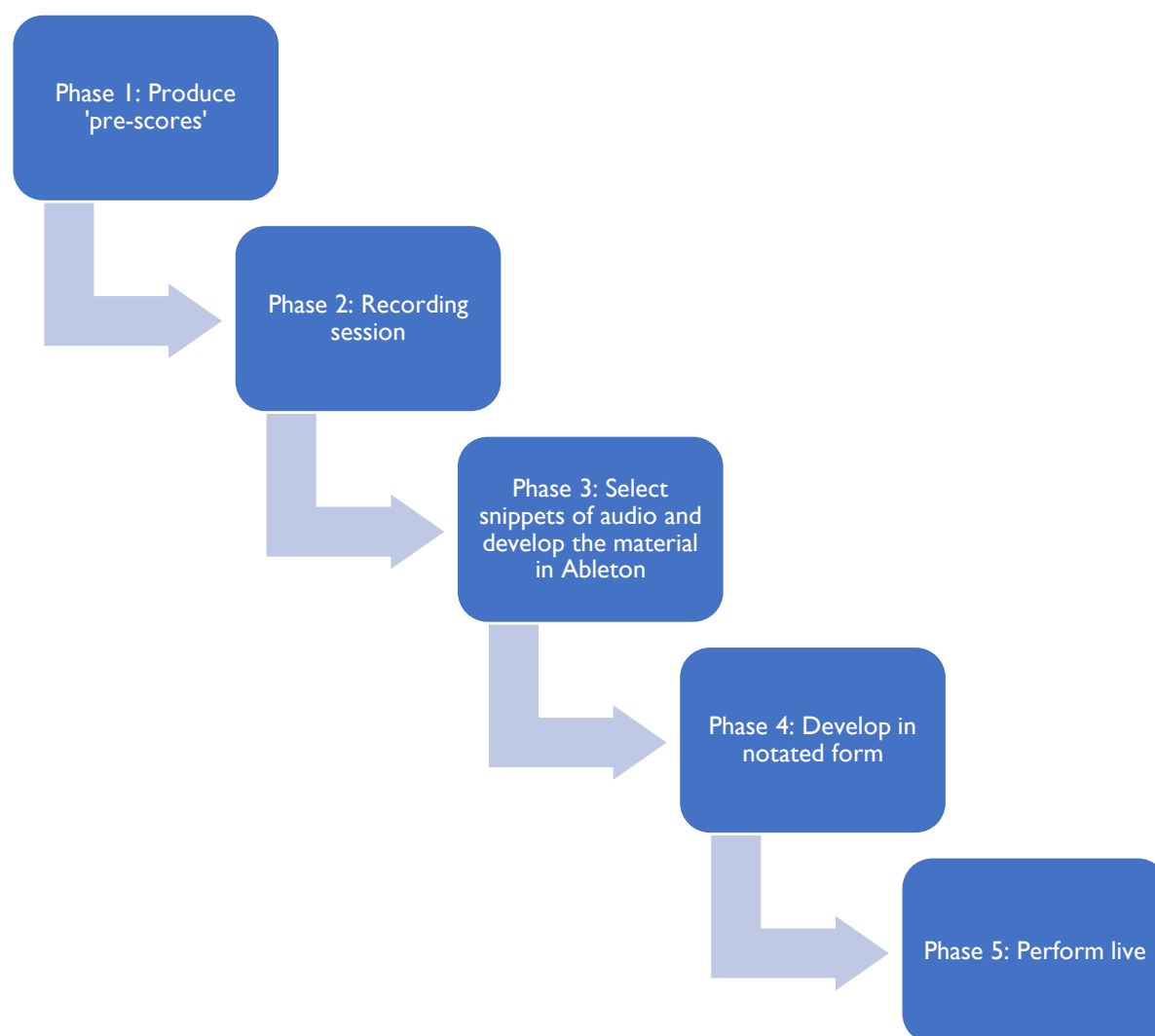
1. To engage with and examine how fundamental acoustic and psychoacoustic properties can be used compositionally to entwine acoustic instruments and electronic sound in live performance (see [chapter one](#)).
2. To challenge the traditional composer-performer relationship through the merging of acoustic and electronic composition techniques; to interrogate the traditional relationship between performers and their instruments for the creative affordances that might be offered to the compositional process (see [chapter two](#)).
3. To creatively explore how the temporally linear nature of performance can be fused with the environmental and system-based qualities of installation (see chapters [three](#) and [four](#)).
4. To integrate the creative affordances of material agencies and dynamical system behaviours into hybrid installation-performance pieces (see chapters [three](#) and [four](#)).

Composition methods

Initially conceived as a series of live, spatialised mixed music concerts centred on acoustic and psychoacoustic theory-informed composition, the project evolved to explore the broader complexities of music-making. The portfolio contains a wide variety of musical forms – live performances, studio recordings, installation/performance hybrids – underpinned by many varied compositional processes. The key phases of composition for *Sound Sculptures No.1* through 7 are outlined below in Figure 1. Not every piece uses all

phases, and different works emphasise different phases. For example, *Sound Sculpture No.3* relies mainly on the first three phases, *No.7* emphasises phase 4, whilst 2, 5, and 6 use a fairly even distribution of all phases. *Sound Sculpture No.8* is an outlier discussed in chapter four.

Figure 1 *Phases of the composition process*



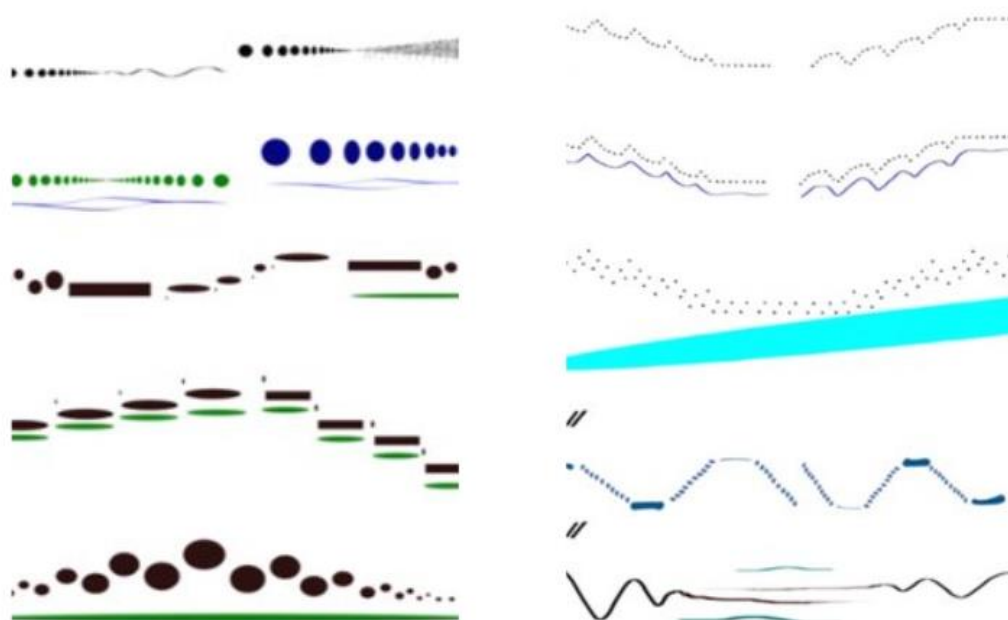
- **Phase one: Produce pre-scores (see 'pre-scores' folder)**

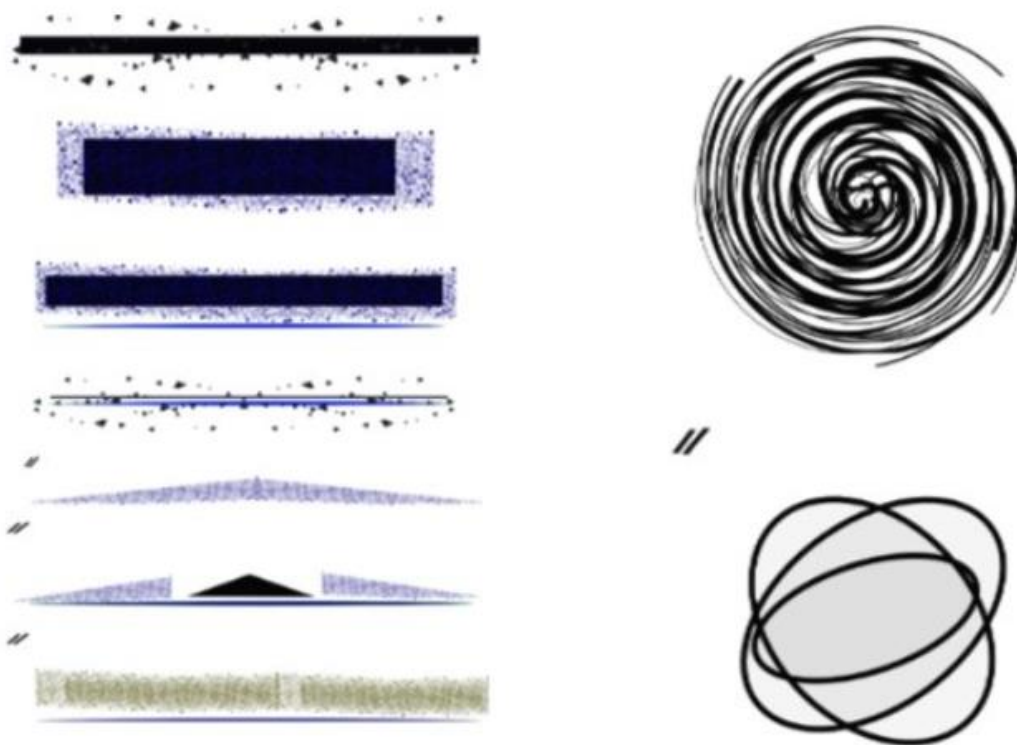
Each piece begins with a workshop/recording session, during which improvised material is gathered from the performers of each piece. These improvisations were originally intended

to serve as a source of ‘sample material’ (see literature review, page 22) from which to create electronic parts for live performance.

To facilitate sessions, I prepared ‘pre-scores’ that provided performers with a starting point to explore their instruments for sounds, gestures, and materials of potential compositional interest. The first pre-score, used for *Sound Sculpture No.1*, employs traditional notation to guide the recording with a pre-composed harmonic language, and with text instructions for specific instrumental techniques to explore. For the first two pieces in the portfolio, these sessions were conducted in person, with verbal direction provided when interesting ideas or sounds emerged, allowing us to ‘lean into’ these moments and develop them further. These initial workshops proved to be a fruitful way to begin the composition process, with performers engaging enthusiastically in a more active role than they were used to when working with composers. However, when the pandemic made in-person sessions impossible, I began to design graphic scores that could be sent to performers and help facilitate improvisation sessions remotely. This approach opened new possibilities, encouraging more open and wide-ranging material and giving performers greater agency to explore their own instincts and musical voices.

Figure 2 *Graphic score example*





The design of these graphic scores involved a thorough examination of the musical literature. I searched through audio recordings, scores, and extended technique demonstration videos on YouTube, looking for interesting techniques to inform my graphic score designs. Each *sound sculpture*, therefore, exposed me to a wide range of contemporary music and performance practices relevant to the instrumental forces of each piece. For example, Rădulescu's use of graphic scores and bowing techniques in *Das Andere* (as outlined in detail in a fantastic lecture by Martin Suckling, 2019a), Saariaho's cello techniques developed in collaboration with cellist Anssi Karttunen, as demonstrated via the Carnegie Hall (2012) YouTube channel, and Carola Bauckholt's imitation of birdsong in *Doppelbelichtung* (Bauckholt, 2017) were all key influences (see the pre-score for more examples).

The graphic scores were created with specific instrumental techniques in mind. When designing these scores, I aimed to strike a balance between guidance and suggestion, providing enough structure to inspire without being reductive or overly constraining. For example, I could have asked performers to improvise entirely 'freely' or I could have insisted

that certain symbols mean certain things. But as psychologist Philip Johnson-Laird notes in *Freedom and constraint in creativity*, “What gives us freedom of will is the ability to reflect about *how* we shall make a decision, and thus to choose at a meta-level a method of choice” (1988, p. 206). In this spirit, suggested techniques are offered not as prescriptions, but as frameworks performers can use to make informed decisions, avoiding the risk of arbitrary rather than truly ‘free’ choices.

For *Sound Sculpture No.4*, I was able to attend the sessions again in-person, and I decided to use a combination of graphic scores, text scores, and verbal instructions to facilitate sessions. I had begun to see these improvisations as a process of exploring the nuanced feedback loop between sensory-motor processes, expressive intention, embodied instrumental technique, and the material agency of the instruments themselves (see chapters one and two). I aimed to bring out these qualities through both the graphic score design and my verbal guidance during the sessions.

Sound Sculpture No.7 involved adapting these workshop methods for orchestra. In this case, the pre-scores reverted to conventional notation, as asking 30+ players to improvise to graphics would be impractical. Instead, I offered short gestures for the players to perform, and during the workshops, asked them to ‘semi-improvise’ around these gestures as a group to create layered soundscapes. These were then sampled and used as the basis for the initial demo of the piece.

Figure 3 Example of orchestral workshop ‘pre-score’

Violin I

molto sul tasto

p

f

slowly move from molto sul tasto to molto sul pont - reach sul pont just before changing to next gesture

Loop gesture until conductor passes back directly in front of you (after next mark) and switch to next gesture

ad lib dynamics with each repeat.

move to different strings ab lib with each repeat

- **Phase Two: Recording session**

These recording sessions took place in a variety of locations, under different circumstances, and with a variety of recording equipment.

- Erin Bathgate and Jack Sindall (*Sound Sculpture No.2*) recorded their improvisations at home onto their phones due to COVID restrictions.
- Weston Olencki (*Sound Sculpture No.3*) recorded his samples in a very high-quality home studio.
- Gemma Bass and Peggy Nolan (*Sound Sculpture No.4*) were recorded in a professional-grade studio at the RNCM by myself. I was able to give in-person feedback and prompts throughout the session, whilst also using the graphic scores.
- *Sound Sculpture No.5* contains a mixture of sources, including samples from the *Sound Sculpture No.4* sessions, samples from an improvisation recorded by Carl Raven at home on high-quality equipment, and audio recorded onto my phone in a rehearsal room by the percussionist Amy Gray.
- *Sound Sculpture No.6* uses Carl's improvisation from the previous piece, as well as new improvisations recorded at home by Kathryn Williams and Stephanie Tress.
- *Sound Sculpture No.7's* samples were recorded by myself at the Purcell School in London, where the orchestra rehearsals took place.

I encouraged these sessions to be approached in a light, playful manner. I asked the players not to overthink, to be spontaneous, and not to worry about mistakes. I wanted to keep the sessions rolling, not to get stuck overthinking, and certainly not to get stuck trying to get things 'right'. In this spirit, the likelihood of novel, interesting and unexpected creative ideas, or what Sawyer and DeZutter call "collaborative emergence" (2009, p. 82),³ is more

³ Sawyer and DeZutter write, "Collaborative emergence is a defining characteristic of social encounters that are improvisational because only when the outcome is not scripted can there be unpredictability and contingency... Collaborative emergence is more likely to be found as a group becomes more aligned with the following four characteristics: • The activity has an unpredictable outcome, rather than a scripted, known endpoint; • There is moment-to-moment contingency: each person's action depends on the one just before; • The interactional effect of any given action can be changed by the subsequent actions of other participants; and • The process is collaborative, with each participant contributing equally" (2009, p. 82).

likely to occur. Such approaches can be challenging for performers who have been trained within an education system that prioritises perfection. All of the performers in this project were, in this respect, fantastic collaborators, allowing themselves to be vulnerable and to give their ‘mistakes’ free rein in the name of creativity.

- ***Phase Three: Select snippets of audio to develop in Ableton Live***

Following each session, I would listen through the recorded improvisation and look for moments of ‘spark’ to compose with. But how do I select which snippets of audio to use? This is very hard to define, and when things are going well, I am tempted to say things like “the samples select themselves” – if in a flow state, I may be quite unaware of why decisions are being made. But I will here attempt to discuss possibilities.

A section of the recording may have *something* about it – some unusual or compelling quality that makes it stand out. This might be understood as my perceiving, on some creative level, an affordance in the material for its creative use. As psychologists Linson and Clarke state,

Perception, action and meaning in music can be productively understood in terms of affordances, revealing how, in the everyday activities of listening and playing, sound may be differently perceived and thus afforded different actions depending on its context and on individuals’ interests and capacities (2017, p. 57).

Alternatively, I may look for interesting interactions and ‘emergences’ (see chapter three) that occur between two or more snippets of audio when combined on top of one another. Sometimes, when one snippet of audio is placed against another, something ‘clicks’. This can also happen when a snippet of audio is placed against a copy of itself (a copy which may or may not be processed in some way, through methods such as pitch-shifting, reversing, time-stretching, etc). The possibilities are endless as the potential number of interactions is effectively infinite here (and this is why this part of the process can take months). This idea of combinational creativity is popular in the culture nowadays, arguably due to Steve Jobs famously saying, “Creativity is just connecting things. When you ask creative people how

they did something, they feel a little guilty because they didn't really *do* it, they just *saw* something" (Wolf, 1996). And though this conception of creativity does not tell the whole story, it serves here to illustrate the process of layering samples to find interesting combinations.

After selecting or building the core materials of a piece, I begin the process of developing and composing in Ableton, using a variety of techniques from electronic and electro-acoustic music to craft intricate collages. These collages are constructed from audio snippets drawn from across the improvisation, which are then shaped and processed into forms that may comprise tens of thousands of edits, as will be discussed in chapter two.

- ***Phase Four: Develop in notated form***

At a certain point in the creative process, I feel that I have exhausted the possibilities of the available audio material. Some pieces, such as *Sound Sculptures No.3* and *Natural Environments One, Two, and Three*, are effectively finished at this stage. In other works, including *Sound Sculptures Nos. 2, 4, 5, and 6*, further composition occurs by transcribing the Ableton draft into Sibelius and continuing to develop the material in notated form. This additional drafting phase, using different tools, imparts new qualities to the music. Beyond the practical necessity of making the material technically playable, this stage allows for creative reworking in ways that are abstracted from sound itself. On notation, John Croft writes:

Notation is variously fetishized or dismissed in the contemporary music world, but I think its real importance is that, far from being a means to an end (the 'sound'), it is a medium of thought and is productive precisely because it exists in the space between sound and abstraction – the very space of music itself (music is, after all, not sound, but what is heard in sound) (2017, p. 203).

In chapter two, I will provide examples throughout that demonstrate how notation and DAWs⁴ were instrumental in shaping the material being composed, and how this influenced certain aspects of the music.

- **Phase Five: Perform live**

Finally, the piece is performed live. Electronic parts are made primarily from the original improvisation to create surround sound experiences in which the performers interact in real-time with samples of themselves.

Contribution to knowledge

My compositional practice draws on a wide range of techniques spanning multiple genres and sub-disciplines within contemporary music. This diversity reflects and responds to the plural and multifaceted nature of contemporary music practice. The central focus of this enquiry, however, is the fusion of electronic and acoustic sound in live settings, alongside the use of electronic production methods for collaborative work with performers. As such, this commentary offers insights for composers engaging with live acoustic performers and electronics, regardless of style or genre, in the following areas:

- Approaches to applying acoustic and psychoacoustic theory (or *spectral thinking* – see page 26) to blend sounds in live performance.
- The use of pre-recorded soundscapes in spatialised contexts that integrate acoustic instruments with samples of those same instruments.
- The application of electronic production techniques as core compositional tools.
- The development of creative strategies that challenge and redefine the traditional composer-performer relationship within contemporary classical music culture.

⁴ DAW: Digital Audio Workstation, such as Ableton Live, Pro Tools, Cubase, Logic etc.

- Methods of integrating the linear qualities of live performance with the environmental characteristics of installation art.

Wider insights into the creative process

Whilst primarily belonging to the field of composition, this project also belongs to the broader field of practice-as-research. It therefore aims to provide insights for scholars of academic creative practice. According to Professor Hart Cohen from the University of Western Sydney, a key aim of practice-as-research and practice-based research is to:

Create new knowledge and contribute to new ways of thinking. The practitioner constructs theories of ‘artistic knowing’ and in this manner can develop theories about art, about learning and teaching art and about the cultural worlds to which art is frequently linked (Cohen, 2016).

To this end, this commentary contextualises my creative process with insights from the fields of creative psychology and material philosophy. In doing so, it contributes to an ongoing conversation about the creative act of music-making as something that emerges from a network of dynamic, interrelated systems, tools, technologies, and psychological processes.

Literature Review

“Historically, each era had a defining sound or cultural movement - like swing in the '30s and '40s, rock 'n' roll in the '50s and '60s, or even the MTV-driven pop music of the '80s... This was because mass media (meaning radio, TV, MTV, and print media) was all coordinated with major labels, which controlled the distribution channels of music to create dominant narratives... things like Napster, the iTunes Store, Spotify, and YouTube changed the way people discovered and consumed music. Today, there's really no unifying broadcast platform that forces a collective experience for listeners... now we're in what I would call a post-genre world, where there's no particular dominant sound – just a galaxy of possibilities.”

– Rick Beato (2025)

As Alex Ross documents in *The Rest Is Noise* (2007), by the end of the 20th century, the contemporary musical landscape had fractured into an almost countless number of streams. This is further iterated in *Music After the Fall* (2017), where, due to “globalisation, digitization, and new media”, Tim Rutherford-Johnson expands the definition of Western art music to include forms of composition, experimental music, sound art, and crossover work from across the spectrum, inside and beyond the concert hall (2017). This multiplicity and diversity of approaches is reflected in the output of labels like Nonclassical⁵ (with whom I have regularly worked throughout this project), as well as with ensembles such as Bang on a Can, where serialism, minimalism, electronic music, and (almost) everything in between are juxtaposed and programmed alongside one another with equal precedence – leading to a “new kind of audience that doesn’t concern itself with boundaries” (Smith, 2007). As an artist, I operate and exist within this framework of thinking: a largely genre-blind paradigm situated broadly within the contemporary classical space, though heavily influenced by many other genres aside. However, the wide range of pre-digital and post-digital tools, techniques, and compositional approaches that I employ sit broadly within the field of *composing for instruments and electronics*. As such, this chapter outlines key works from this field before examining other key fields that became connected to my compositional enquiry as it developed through the project.

⁵ www.nonclassical.co.uk

Music that blends acoustic and electronic elements in live performance

The integration of electronics into acoustic performance has taken place since the invention of electronic music technologies. From the theremin (invented in 1928), which found its way into many orchestral and avant-garde pieces; to the early live electronic music of *Kraftwerk* which combines live synthesisers with flutes, vibraphone and drums (PhineasFreakers, 2015); to the wealth of digital music-making technology that features in many a contemporary concert today, electronically generated sound has always had a place next to live, acoustic instruments.

A central figure of early research into this area was Karlheinz Stockhausen, the German experimentalist who worked primarily at the WDR Studio for Electronic Music in Germany, founded in 1951. He became a leading figure in the development of instrumental and electronic music, experimenting throughout the 1950s, '60s, and beyond with *musique concrète*, synthesised electronic sound, and hybrid works combining live instruments with electronics in a variety of diverse ways. One of his early and influential works, *Gesang der Jünglinge* (Stockhausen, 1956), is an acousmatic⁶ tape piece (no live instruments are used in performance) that blends recordings of a boy soprano with electronically generated sine tones, pulses, and filtered white noise. In *Gesang*, Stockhausen sought to blur the boundaries between vocal and electronic timbres by carefully shaping the envelope of synthesised sounds to match the complexity of the human voice (Decroupet, Ungeheuer, and Kohl, 1998), demonstrating an early attempt to reconcile some of the technical and aesthetic differences between synthesised and acoustic sound. The piece was also an early exploration of spatialisation, originally presented using five loudspeakers positioned around the audience.

Stockhausen went on to mix electronically synthesised tones with live acoustic instruments in pieces such as *Kontakte* (1960) for electronic sound, piano, and percussion and in *Mixtur for orchestra, featuring four sine-wave generators and four ring modulators* (1965), which is one of the first examples of live, synthesised elements being integrated with orchestral music.

⁶ Compositions designed to be experienced over loudspeakers without visible sound sources.

Another key work, *Mikrophonie I* (1964), is an example of early live electronic music, where acoustic sounds are processed in real-time with various effects.

These formative stages of inquiry outline several foundational approaches to mixed music that continue to underpin the field to this day. And despite the technological advancements of recent decades, the core elements that constitute these approaches have remained relatively stable:

- **Synthesised Electronics:** Sounds generated through either analogue or digital synthesis.
- **Audio Manipulation:** The practice of taking audio recordings and manipulating or processing them in some way. For example, one might take a sample or snippet of audio and loop, reverse or time-stretch it; one may apply effects such as reverb or EQ; one may make collages of audio recorded to tape (through physically cutting and splicing) or via a DAW. Or one may also apply granular synthesis technique to cut tiny sections of audio which are then re-arranged electronically, or other such algorithmic processors.
- **Live Electronics:** Live acoustic instruments processed in real-time through electronic effects and processes that respond dynamically to the live performance.⁷

Using these elements, a huge variety of textural relationships between performer, instrument, and electronic sound can be created. In his *Thesis on Liveness* (2007, p. 62). John Croft outlines several potential paradigms:

- **Backdrop:** The electronic elements create a passive sonic background with no causal link to the performer.
- **Accompanimental:** The electronic sounds function like a traditional accompaniment.

⁷ We may also add acoustic instruments that are played using motorised or automated mechanisms to this list.

- **Responsorial/Proliferating:** The electronic sound has a responsive, antiphonal relationship to the acoustic sound.
- **Environmental:** The electronics simulate acoustic spaces using reverberation, resonance, filtering and other such processes.
- **Instrumental:** Aiming to form a composite instrument, this paradigm merges performer, acoustic instrument, and electronics into a single expressive entity.

Of course, the boundaries between these categories are flexible, allowing for endless variation in how these musical elements and relationships may be realised in practice.⁸

Today, countless composers freely integrate acoustic instruments, synthesis, audio manipulation, sampling, field recording and algorithmically generated music with an abundant, aesthetically genre-blind pluralism.

For example, Alex Paxton's *Candyfolk Space-Drum* (London Sinfonietta, 2023) uses live synthesisers in ensemble works, whilst Richard Ayres' *The Garden* (London Sinfonietta, 2020) incorporates pre-recorded sounds and entire tape pieces interspersed between entirely acoustic sections. Both composers use electronic elements to create almost childlike, Monty Python/Frank Zappa-esque musical collages of wildly juxtaposed material. Larry Goves' *Hollow Yellow Willow* (2017) and Hollie Harding's *Melting, Shifting, Liquid World* (2019) continue the trend of using acoustic and electronic sounds to foreground spatialisation in innovative ways. Goves splits the orchestra into left and right sections, aligning material with stereo reproduction of electronic sound. In contrast, Harding allows the audience to move freely in and around the piece as it unfolds. In *The Endless Mobility of Listening* (McLaughlin, Kanga, & Benjamin, 2021), Scott McLaughlin extends the tradition of live processing acoustic instruments by employing live looping to capture the unpredictable emergence of string partials during extended violin drone bowing. In this technique, the precise timing and identity of the partials cannot be predetermined – they 'pop out'

⁸ See the introduction to *Live-Electronic Music: Composition, Performance* (Sallis et al., 2007) for many examples of the complexities that arose within the development of electroacoustic research.

spontaneously and sometimes chaotically. When this occurs, the performer uses a foot pedal to loop these sonic events, gradually constructing a layered, spectral collage in real-time. The piece exemplifies a contemporary approach to *spectral thinking*, incorporating modern live-electronic tools such as Max/MSP to explore the unstable and evolving nature of timbre.

Spectral thinking

According to Croft, forming a composite instrument of acoustic and electronic sound is the most difficult textural relationship to achieve successfully in mixed music composition (Croft, 2007, p. 62). In the first two pieces of my portfolio (as discussed in chapter one), it was precisely this issue that I sought to address through the use of acoustic and psychoacoustic principles and “spectral thinking” (Donin & Féron, 2019, p. 3).

The principles that dictate how sounds are perceived and interpreted in the mind are a key component of composition. From the prohibition of parallel fifths in early counterpoint;⁹ to classic works such as *On the Sensation of Tone As a Physiological Basis for the Theory of Music*¹⁰ (Helmholtz, 1875/1954); to the technological advancements of the 1970s that led to the Spectralism, acoustic and psychoacoustic principles have underpinned approaches to composition for centuries. The IRCAM-based musicologists Donin and Féron describe such approaches as “spectral thinking... music that takes account of the acoustic structure of sounds and the mechanisms of auditory perception in order to produce forms, timbres, temporalities and new modes of expression” (2019, p. 3).

A key factor in the development of Spectralism was the technological ability to analyse waveforms in fine detail through the use of computer-based sonographic tools. An early piece to exploit this, Gerard Grisey’s *Partials* (1975), uses a spectral analysis of a low

⁹ Parallel fifths were prohibited to avoid losing the sense of independent musical voices due to the effects of harmonicity (see footnotes, page 27).

¹⁰ This text attempts to develop music theory in tandem with a scientific understanding of sound and perception.

trombone note (resulting in precise information on the overtones present in the waveform) as the starting point of its composition. The piece is then built by orchestrating the overtones for a small ensemble, using quartertones to approximate the microtonal tunings of the partials as naturally found in the acoustic sound complex. This piece plays with “perceptual grouping mechanisms” (Deutsch, 2013, p. 185) and factors relating to pitch and timbre that affect how the human brain fuses certain types of sound/musical events in the listener’s perception. If the pitches used in *Partial*s were sine waves (and precisely tuned), the sound complex would coalesce into a single sonic entity in the listener’s perception due to the effects of harmonicity,¹¹ but as the individual instruments of the ensemble themselves are producing notes made of complex tones (with their own set of partials), this absolute perceptual homogenisation doesn’t occur. Instead, a dense and unconventional sonority is created, which sits somewhere ambiguously between harmony and timbre (Anderson, 2000, p. 11).

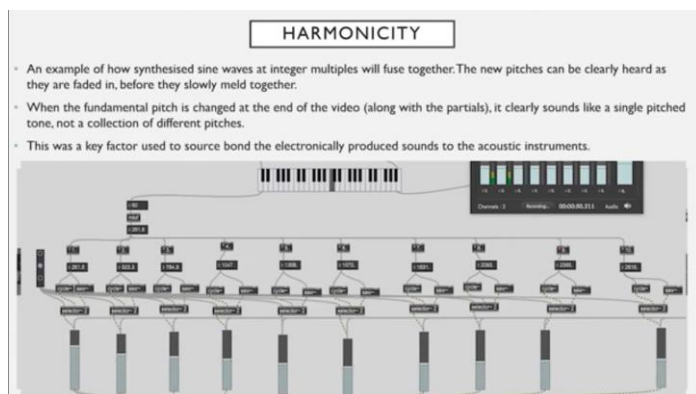
Georg Friedrich Haas’ *String Quartet No.2* (1998) is a more recent example of a piece that creates sonorities using pitches derived from the harmonic series. A key feature of this work is the use of onset synchronicity.¹² This effect is brought into play by the time delays in the ‘overtones’ which add to the sense of perceptual separation between the notes and the ‘fundamental’. An interesting experiment can easily be set up in a DAW to test the effects of onset synchronicity using sine waves – it is interesting to hear your own perception ‘switch’ a few moments after tones are introduced and each pitch becomes

¹¹ According to prominent music psychologist Diana Deutsch, when considering “the relationships between the components of a sound spectrum that lead us to fuse them into a unitary sound image and those that lead us to separate them into multiple sound images” (2013, p. 185), the *perceptual grouping mechanism* known as *harmonicity*⁴ is a primary factor. Deutsch describes harmonicity thus: “Natural sustained sounds, such as those produced by musical instruments and the human voice, are made up of components that stand in harmonic, or near-harmonic, relation; that is, their frequencies are integer, or near-integer multiples of the fundamental frequency. It is reasonable to expect, therefore, that the auditory system would exploit this feature to combine a set of harmonically related components into a single sound image” (Deutsch, p. 185). This is in opposition to inharmonic spectra, which “have a tendency to disperse into streams” (Smalley, 1997, p. 14).

¹² Onset/offset synchronicity is an important factor in determining the closeness of perceptual grouping between harmonics and partials. In nature, a sound complex of partials will always sound simultaneously, therefore, if tones of the harmonic series are introduced at different times, they will more likely be heard as separate tones (Deutsch, 2013, p. 187-189).

psychoacoustically assimilated into the whole (this idea forms the basis of *Sound Sculpture No.1, Part One* – see page 48). Pitch becomes timbre as the brain fuses the sounds together, as demonstrated in Video Figure 4:

Figure 4 [Harmonicity / synchronicity demonstration](#)



Current composers employing spectral features in their work include Julian Anderson, who presented a paper at the 2019 IRCAM Spectralisms Conference introducing new formal harmonic structures based on developments in spectral composition and psychoacoustics (Anderson, 2019). His approach includes a variety of innovative techniques, notably the use of sum and difference tones to produce psychoacoustic effects and generate pitches that extend beyond the standard frequency range of the string quartet. Another current composer is Martin Suckling, whose work *This Departing Landscape* (2019b) makes extensive use of microtones to create harmonic structures related to just intonation. In *Nocturne* (2013), he uses microtones to craft melodic material reminiscent of birdsong's microtonal qualities in a similar manner to Carola Bauckholt's *Doppelbelichtung* (Bauckholt, 2017) as discussed below.

Spectral thinking and acoustic/electronic sounds

As pioneered in Stockhausen's *Gesung*, many composers have sought to blend acoustic and electronic sounds spectrally. A key work in this respect is *Désintégrations* by Tristan Murail

(1982). According to Julian Anderson's introductory notes on the piece, the computer-generated spectra in the piece are “directly modelled on real instrumental sounds” (Murail, 1982); however, the goal for Murail is not to imitate those instruments. Instead, he uses these spectra as “structural analogies” to shape the pitch content and form. This ensures, according to Anderson, that the computer/tape sounds have an “audible organic unity... indeed, the extent to which taped and instrumental sounds fuse and blend throughout the work is unusually consistent, not least given the technology of the time” (Murail, 1982). Another key work that uses spectral analysis to guide harmonic choices and subsequently fuse electronic and acoustic sound is *Lichtbogen* by Kaija Saariaho, who writes:

The harmonic material is created by analysing short transitions played with a violoncello, starting from artificial harmonic sound and ending to complex 'multiphonic' sounds. The analyses have been made by selecting many small windows in the different parts of the sound. From the results of the analyses I have reconstructed the transitions and made harmonic processes, which are often combined to the original playing manners of the analysed sound, so that harmony and timbral thinking stem from the same source (1986).

Whilst the above piece uses spectral analysis to inform compositional choices, Alvin Lucier is a key figure among composers who explore acoustic and psychoacoustic principles in of themselves, stating: “I’m always cutting things down to their simplest form so that the phenomena is exposed” (Lucier, 2005, p. 232). His work features numerous examples of fascinating acoustic/electronic sonic interaction, a prime example being *I Am Sitting in a Room*, in which the room resonance of the performance space serves as both the chief compositional method and aesthetic feature of the work. Lucier uses “a feedback process that activates the resonant frequencies of the performance space, [and] the room becomes the instrument” (Fox, 2016). The acoustic elements of the piece (in this case, the room resonance) increasingly intermingle with the electronic element (the voice recording). It is a fine example of a compositional technique which creates a synchronisation of timbre and form which develop in tandem with one another, blending acoustic sound sources (the voice) with electronically produced sound in an incredibly unique and idiosyncratic way.

A second key work by Lucier that creates a unique interaction between acoustic and electronic sound through acoustic phenomena is *947 for flute with pure wave oscillators* (2001). In this piece, the performer plays notes which create beating patterns against sine waves. Flautist Harriet Richardson writes, “Lucier... employs two roles in the realisation of a piece: a live performer against the use of electronics/technology. This juxtaposition of two autonomous roles allows the convergence of separate systems causing phenomena to be unveiled.” (2015, p.32).

A final example, which employs a spatialised combination of acoustic and electronic sounds, is *Doppelbelichtung* for violin and electronics (2016). The work positions twelve loudspeakers around the audience to create an immersive environment that evokes the ‘surround sound’ qualities of sounds in nature. It projects audio samples of time-stretched and pitch-shifted birdsong, which the acoustic violin mirrors melodically through imitation, and timbrally through the use of “violin loudspeakers”. Composer and researcher Cathy van Eck states:

By placing tactile transducers on violins and hanging them in the concert hall, sounds are transmitted through the corpus of violins. In this piece every sound seems to be a sonic double exposure of a violin and a bird: the violin imitates the bird sounds, which are in turn modified to resemble the violin. By transmitting these sounds through tactile transducers attached to violin corpuses hanging in the air, every bird recording acquires the spectral characteristics of a violin (van Eck, 2017).

Manipulating audio recordings: audio sampling and electro-acoustic methods

Bauckholt’s *Doppelbelichtung* incorporates snippets of field recordings that are projected into the concert space, positioning it as a work in which audio manipulation forms an integral part of both composition and performance. Many key genres and styles of music are rooted in the manipulation of recorded sound, most notably the tradition of *musique concrète* (pioneered by Pierre Schaeffer and the Groupe de Recherches Musicales in France) and, in a more commercially oriented context, the electronic music production techniques

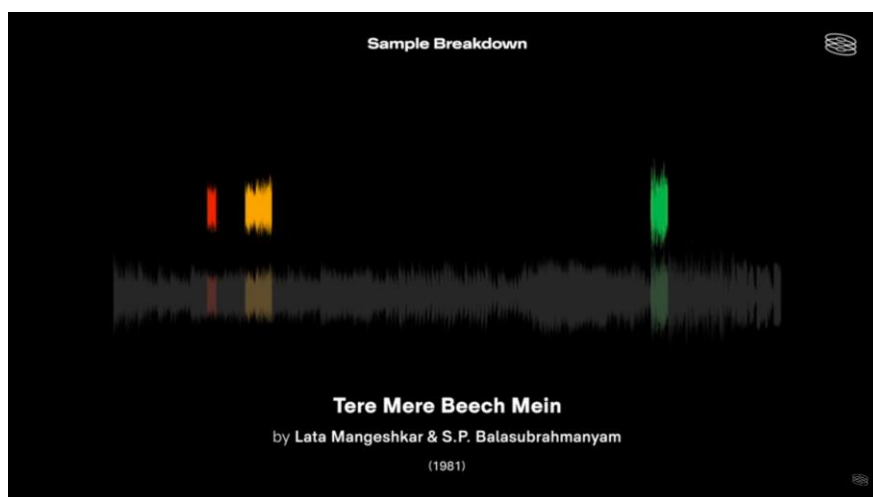
that emerged from the audio sampling culture of the 1970s and 80s hip hop and dance music scenes. Audio sampling, as producer Jason O'Bryan defines it, is...

In essence... when you include an element of a pre-existing recording by someone else in your composition. The sample can be anything that you've 'sampled' from another track; a rhythm, a melody, a beat, vocals or speech, which you then manipulate, edit, chop up or loop to fit creatively within your work (hannah, 2020).

Today, sampling is arguably the dominant compositional method in mainstream pop and electronic music, which incorporates any combination of sample material derived from existing records and commercially produced sample packs.

Whilst the cultural context of early sampling remains integral to its historical and aesthetic significance, many of its core technical processes converge with those of *musique concrète*, such as looping, reversing, and stretching fragments of audio to rework them into entirely new forms. The fact that both commercial producers and avant-garde composers now generally rely on the same core technology (the digital audio workstation), makes this convergence both logical and emblematic of the genre-fluid nature of contemporary music. I will here present contrasting examples that illustrate this connection and have inspired the collaborative strategies explored throughout this project (as discussed in chapter two).

Figure 5 [Sample breakdown: Britney Spears - Toxic](#)



(Tracklib, 2020)

The above video clearly demonstrates the sampling process when using existing commercial recordings as source material. Three samples are extracted from *Tere Mere Beech Mein*, a song from the 1981 Bollywood film *Ek Duuje Ke Liye*, composed by Laxmikant Shantaram Kudalkar and Pyarelal Ramprasad (Tracklib, 2020). These samples are then stretched, reversed, and edited, before electronic drums, bass, and other sounds are added to create the instrumental track of Britney Spears' hit *Toxic* (2003). This example illustrates how simple yet creative alterations and reworkings of existing sounds can generate new musical forms.

A second, contrasting example of audio manipulation is Steve Reich's 1965 work *It's Gonna Rain* (Boosey & Hawkes, 2023). The piece is constructed from a short recording of a preacher speaking about Noah's flood in relation to the impending Cuban missile crisis (Huizenga, 2015). Reich's initial interest lay in the melodic qualities of the preacher's vocal inflections, intended to notate them for instruments (in a process that would have in some ways anticipated Diana Deutsch's *speech-to-song illusion* (see page 102). Ultimately, he came across the idea of looping a small selection of the recording before making a duplicate loop that played simultaneously at a slightly different speed, pioneering the technique of *phase music* (Reich, 2002) as will be discussed further in chapter three.

A contemporary artist working with natural field recordings today is Toshiya Tsunoda, who, in *Landscape and Voice* (2022), captures recordings of nature and then, at select moments, extracts small slices of audio and repeats them with varying degrees of silence in between. This creates an interesting effect, whereby the sound is altered and entirely removed from its context. The sound becomes detached from its source in the mind of the listener (see *source bonding* on page 46), who then hears these sounds from a variety of fresh, new perspectives.

A final example is Manchester Jazz artist Alabaster DePlume, who produced his album *Gold* (2022) thus:

He invited a different set of musicians each day, who would record the same tunes at the same speed so that Alabaster – who produced the record – could cut them

together later, like ingredients. “They didn’t have enough preparation to be able to hide behind this piece of material or skill,” [Alabaster DePlume] says. “They had to look up and respond to each other, and that’s what we’ve recorded” (Warren, 2022).

Here, the spontaneity, energy, and unpredictability of improvisation are what the artist sought to capture, after which appropriate audio editing techniques were applied to weave the album together.

Sound installation and notions of sound sculpture

The final category I will discuss relates to installation and sound art practices that engage with autonomous and spatialised pieces installed for extended durations. Such pieces invite visitors to walk into the piece, encountering it mid-flow, with no clear start or conclusion. Many installations rely on physical sound production typically incorporate materials that are free to vibrate and resonate, with some form of energy provided to excite them. This energy could be a natural force, such as wind or magnetism, or alternatively it could be from a mechanical source, such as an electric motors. The installation piece *Singing Ringing Tree* by Mike Tonkin and Anna Liu (2007) is an example of a wind-powered installation composed of a collection of steel tubes pointing in various directions. The tubes are activated by the wind, allowing the piece to generate sound autonomously. The resulting sonic output includes elements of chance and unpredictability, as the direction and quality of the sound vary depending on the wind’s strength and direction at any given moment.

Figure 6 *The Singing Ringing Tree*



(Tonkin Liu, 2007)

Another key artist working in this domain is Zimoun, who uses simple raw materials (wood, cardboard, metal, etc) and small motors to create white noise-like soundscapes.

Figure 7 *Zimoun's installations*



(Zimoun, 2024)

Other types of sound installation use electronically generated sound, often spatialised around a space. Works of this nature tend to foreground the perceptual qualities of sound phenomena, creating what sound artist Michael Brewster defines as,

An expanded sculptural experience... a full bodied bunch of sensations "around" being here, in the realm of the actual, the physical, in this multi-dimensional world... Sculpture should be a category of Experience, not a just a category of physical objects for us to "stand back and behold" (1998).

In this vein, Michael Brewster's *Acoustic Sculptures* (1979) project minimal electronic tones with fast beating effects into a bare acoustic space that suitably reflect echoes of the sound. With this, he intends to "physicalise" the room and cause physical reactions within the listener. Such an example has no vibrating physical element that produces sound (besides the speaker cone) and is entirely electronic/acousmatic.

A piece that projects recorded audio in installation form is *Forty Part Motet* (2016) by Janet Cardiff. This work presents the choral music of Thomas Tallis (his *Spem in Alium*, composed in 1573) in 'surround'. Each speaker contains a multitracked individual voice of the 40-part harmony. In an interview for TateShots (Tate, 2017), Cardiff uses the word 'sculptural' in a metaphorical sense to describe the formal shape of the music – how it ebbs and flows structurally, as she hears it. Cardiff then seeks to accentuate this for the listener through the use of DAW-based spatialisation techniques.

Figure 8 Janet Cardiff's surround sound work



(Tate, 2017)

A work to combine both electronic and physical elements is *Music on a Long Thin Wire* by Alvin Lucier (1977). This piece is set up by stretching a piano string wire across a large room. The wire's vibrations (triggered by a magnet) are then amplified using a power amplifier and contact mics. A sine wave oscillator is also connected to the amplifier; by adjusting the oscillator's frequency and volume, a wide range of sonic effects such as slides, frequency shifts, and beats can be generated. This results in an unpredictable and self-evolving sound piece. After re-creating the installation, filmmakers Viola Rusche and Hauke Harder stated:

Only because of Lucier's choice to take a long wire at rather low tension and to use a strong magnet and amplifier, does the wire – if carefully tuned – show various acoustical phenomena and behave in an unpredictable way. In this state, the wire changes by itself without any alterations to the system. It seems to possess a life of its own... constantly [altering] between long, sometimes even very long, nearly silent moments and active periods, during which the wire burst into complex harmonies. It upheld this behavior during the entire, more than three-month course of the exhibition (2012).

The piece therefore displays unpredictable, emergent and chaotic behaviour, which will be discussed further in chapters three and four.

Sound sculpture as multi-textural metaphor

Whilst Janet Cardiff uses the term ‘sculpture’ in relation to form, I employ it more broadly within this project as a metaphorical and creative means of assimilating the above fields into a single conceptual framework. *Sound sculpture* is a vague term (Landy, 2007, p. 183) and, because of this, is open to interpretation – the term can become a source of inspiration by prompting creative ways that it might be reused from one piece to the next. *Sound sculpture* can describe physical, kinetic installations that autonomously produce sound. *Sound Sculpture* can also describe pieces that consider electronic sound as a material or object to be sculpted around a listener. *Sound sculpture* can be used metaphorically (or perhaps as a kind of adverb) to describe qualities of other musical parameters such as form and harmony. The term can be used to think of the creative process of working with audio recordings, in which existing sounds are reworked, reshaped, and ‘sculpted’ into new forms. Or, as discussed in the next chapter, it can be used to consider the qualities of sound from spectral perspectives, where the inner workings of timbre are used compositionally to create perceptual connections across time and space.

Chapter One. Fusing Sounds with Acoustic and Psychoacoustic Principles

“It is merely a convention to conceive of an instrumental sound source as a point in space. Actually, different timbres can suggest different spatial positions. The reflections from various directions give a sound its spatial qualities, producing a kind of acoustic sculpture...”

– Robert Platz and Frances Wharton (1995, p. 23-28).

I began this PhD research with a central question: *How can acoustic instruments be blended and merged with electronic sound in live settings, with absolute perceptual coherence, so that listeners cannot tell where the acoustic sounds end and the electronic sounds begin?* This approach to mixed music engages directly with John Croft’s depiction of an “instrumental relationship” (Croft, 2007, p. 62), in which the acoustic instrument and electronics merge into a single expressive entity. As Croft writes, “It is the most difficult relation to achieve and maintain, and for this reason the most interesting to discuss. I would also argue that it is rarely convincingly achieved, because of the many difficulties associated with the very idea” (Croft, 2007, p. 62). The first two pieces in my portfolio engage most directly with this idea and address my first research aim.

ÉTUDE FOR SAXOPHONE, ELECTRONICS AND SOUND

MOVEMENT

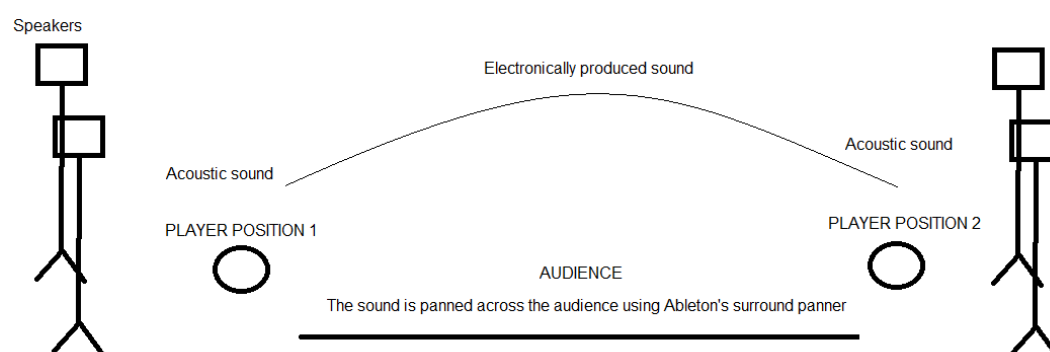
This piece became the seed of my portfolio and was sown in the summer of 2019 with a small, rather off-the-cuff idea that emerged during a five-day intensive composition course called SoundMine.¹³ This is a yearly composition course established by the late composer Wim Henderickx, which takes place annually in a huge castle in Bilzen, Belgium. At the end of the week, each of the 25 or so participants would present a three-minute sketch to a public audience of some new approach, technique or idea that they had dreamt up during the course. I recall Wim telling us at the start... “if you don't fail, you've failed!” (personal communication, 2019). Of course, what Wim meant by this was that if your ideas work

¹³ <https://www.musica.be/en/projects/soundmine/>

perfectly during the concert, you haven't pushed yourself far enough out of your comfort zone, and you've failed to make full use of the exploratory, experimental nature of the course. This approach caused me to drop the idea I had in mind (a very safe piece of semi-romantic notated music) and instead push forward with a much fresher idea that emerged from a conversation with Jorrit Tamminga (the electronics tutor at SoundMine).

The idea was to seamlessly blend a live acoustic instrument with electronically processed recordings of the same instrument in a way that the audience could not distinguish where the live acoustic instrument ended and the electronic sound began. Having placed four speakers around the audience, the electronic sound would then be panned 'around' the audience as the player walks around the hall before 'catching' the sound on the other side of the room. Complete perceptual fusion between the acoustic and electronic sounds was the aim: a seamless transition from acoustic to electronic sound, and back again. A thoroughly open and curious saxophonist called Lennert Baerts happened to overhear this idea and, interested to hear the results, offered to be the performer. The next day, we did a short recording session in which we explored the saxophone for interesting sounds to make electronic soundscapes with. The beginning and end of the soundscapes were designed so that they would blend with and appear to be sonically 'source-bonded'¹⁴ to the live instrument during performance.

Figure 9 *Étude for Saxophone, Electronics and Sound Movement diagram*



¹⁴ 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" (Smalley, 1997, p. 110).

The study unexpectedly led to several important realisations about acoustics and psychoacoustics. It laid the foundation for my portfolio, not only by blending acoustic and electronic sounds in spatialised, ‘sculptural’ ways, but also in fostering collaboration with performers from the outset of the creative process.

* Please see the portfolio video for text commentary on the techniques applied.

SOUND SCULPTURE NO.1 – PART TWO

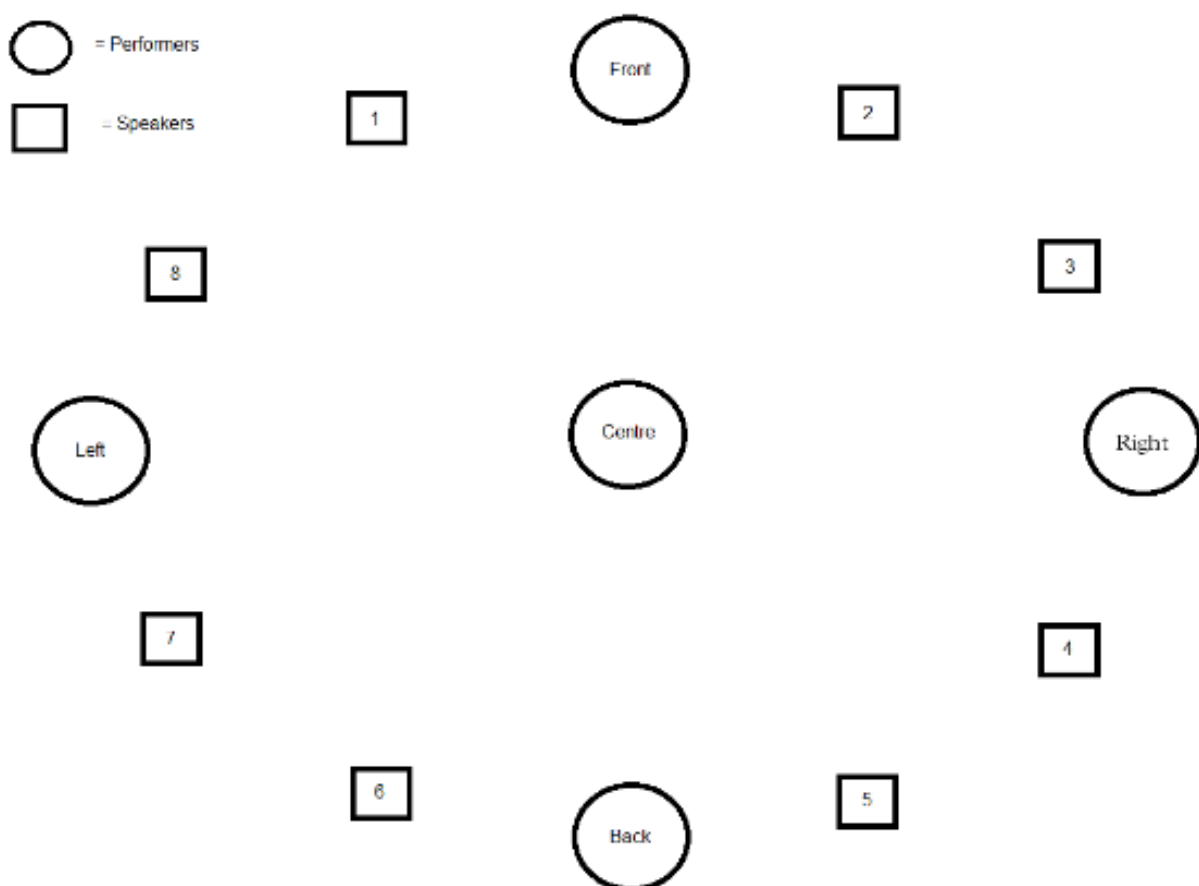
Sound Sculpture No.1 was composed for a research project entitled The Garden of Forking Paths,¹⁵ through which I was introduced to ideas of instability and indeterminacy in clarinet playing technique. It became clear how much flexibility the clarinet has in producing an almost full range of simple to complex spectra, which makes it an ideal instrument with which to explore the perceptual qualities of sonic spectra in a musical context. However, some of the more esoteric inharmonic sounds are products of momentary instability which arise in entirely contextual and uncontrollable circumstances. The Garden of Forking Paths project aims to find solutions to some of the compositional and performance issues which commonly arise when dealing with these kinds of sounds and playing techniques. My contribution to this project was to use audio sampling and time stretching to ‘capture’ these unpredictable and indeterminate sounds so that they can be used with equal precedence alongside the more easily accessible and reproducible ‘ordinary’ clarinet sounds, which are more commonly associated with the clarinet.

Taking the methods used in the *Étude* as a starting point, the second half of *Sound Sculpture No.1* (part one is discussed below) is a piece for five clarinets, eight loudspeakers, and sixteen electronic soundscapes that explores how the perceptual qualities of sonic spectra can be used to source-bond electronically produced sound with acoustic instrumentation. Live performers (positioned around the edges of the space, with audience members in the

¹⁵ A research project led by composer Scott McLaughlin at Leeds University: www.forkingpaths.leeds.ac.uk

middle) play tones, sounds and extended techniques which are mixed with pre-recorded clarinet samples. These sounds are panned around the room, creating the 'illusion' of connected, singular tones that begin with a clarinet on one side of the room, which then appears to seamlessly move across the audience (whilst being electronically processed along the way), before joining with an adjacent clarinet. For this 'illusion' to be successful, the live instruments must blend with the electronic parts entirely, and this establishes the need to develop composition methods which integrate an understanding of specific phenomena relating to acoustic and psychoacoustic theory and *perceptual grouping mechanisms* (see the footnotes, page 27).

Figure 10 *Sound Sculpture No.1 layout*



The recording process

The composition process of *Sound Sculpture No.1* broadens the scope of the *Étude* by starting with a three-hour recording session with four performers to gather a considerable amount of sample material. I also prepared the first of my ‘pre-scores’ for this session, to give the sessions a more considered structure around planned pitch collections (relating to the harmonic series) and instrumental techniques:

Figure 11 *Sound Sculpture No.1* ‘pre-score’ example

The musical score is divided into two systems, each with four measures. The instruments are Clarinet in E♭, Clarinet in B♭, and Bass Clarinet in B♭. The notation includes dynamic markings (ppp, mf, f), articulation (accents), and performance instructions in italics.

System 1:

- Measure 1:** Clarinet in E♭: *Clean, natural swell*, *QUESTION*, *o-mf-o*. Clarinet in B♭: *o-mf-p*. Bass Clarinet in B♭: *o-mf-p*.
- Measure 2:** Clarinet in E♭: *Clean, natural swell*, *o-f-o*. Clarinet in B♭: *o-f-o*. Bass Clarinet in B♭: *o-f-o*.
- Measure 3:** Clarinet in E♭: *Clean, natural swell*, *ppp-mf-ppp*. Clarinet in B♭: *ppp-mf-ppp*. Bass Clarinet in B♭: *ppp-mf-ppp*.
- Measure 4:** Clarinet in E♭: *Introduce artefacts subtly (a little breath noise for example)*, *ppp-mp-ppp*. Clarinet in B♭: *ppp-mp-ppp*. Bass Clarinet in B♭: *ppp-mp-ppp*.

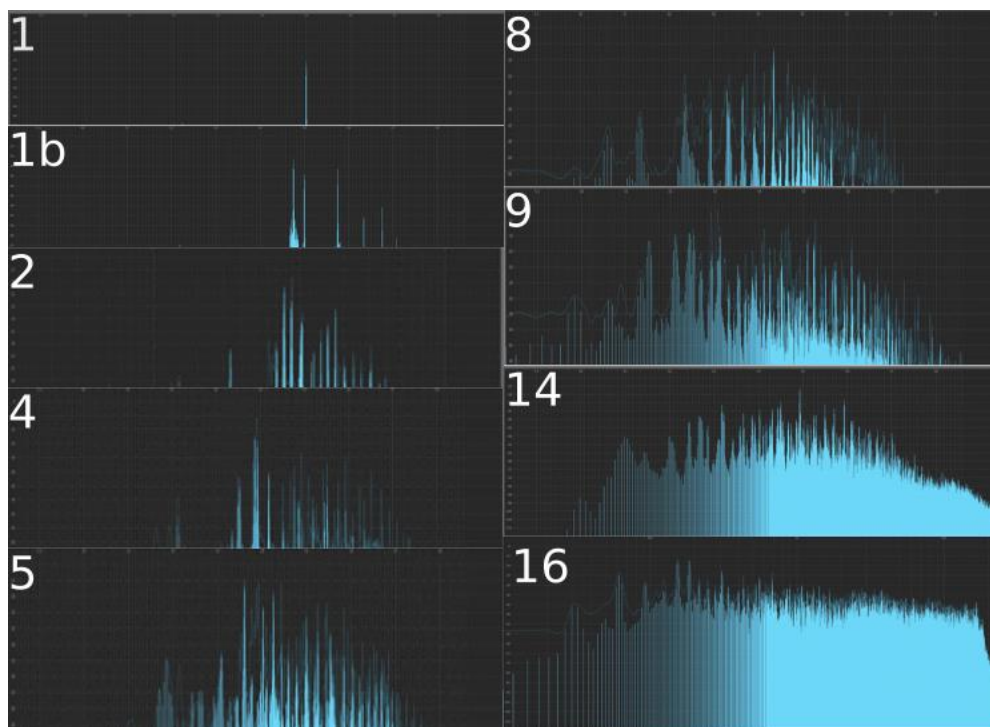
System 2:

- Measure 5:** Clarinet in E♭: *Introduce artefacts subtly (breath noise for example)*, *QUESTION*, *ppp-p-ppp*. Clarinet in B♭: *Introduce artefacts subtly (breath noise for example)*, *ppp-p-ppp*. Bass Clarinet in B♭: *Introduce artefacts subtly (breath noise for example)*, *ppp-p-ppp*.
- Measure 6:** Clarinet in E♭: *Gentle, Very soft swell, no vibrato, clean*, *ppp-mf-ppp*. Clarinet in B♭: *Gentle, Very soft swell, no vibrato, clean*, *ppp-mf-ppp*. Bass Clarinet in B♭: *Gentle, Very soft swell, no vibrato, clean*, *ppp-mf-ppp*.
- Measure 7:** Clarinet in E♭: *poco vib - molto vib*, *ppp-f-ppp*. Clarinet in B♭: *poco vib - molto vib*, *ppp-f-ppp*. Bass Clarinet in B♭: *poco vib - molto vib*, *ppp-f-ppp*.
- Measure 8:** Clarinet in E♭: *poco vib - molto vib - poco vib*, *ppp-ff-ppp*. Clarinet in B♭: *poco vib - molto vib - poco vib*, *ppp-ff-ppp*. Bass Clarinet in B♭: *poco vib - molto vib - poco vib*, *ppp-ff-ppp*.

During the session, we recorded an extensive collection of samples. I directed the session verbally to prompt players to explore particular ideas as they emerged. However, for this piece, we generally adhered to relatively simple, expressionless sounds, albeit ones that explore extended techniques with the express intent of using the sample material later in ways that blend seamlessly with the live instruments.

These samples were then used to create sixteen ‘soundscapes’ or sections in the music production software Ableton (which correspond to each mark in the score). Inspired by Kaija Saariaho’s use of the “sound/noise axis” (Saariaho, 1987), in which “the complete range of timbres from the purest to the noisiest are deployed, in direct correspondence to the degree of consonance or dissonance of the music's harmony” (Anderson & Saariaho, 1992, p. 617), the form of *Sound Sculpture No.1* follows a trajectory from sine waves; to harmonicity; to inharmonicity; to white noise, through sixteen evolving sections/soundscapes. The form is designed so that each section becomes increasingly spectrally dense (through the number of notes and the spectral complexity of the sounds used) and increasingly deep (the pitch range floor gets gradually lower). Soundscapes 9-16, on the other hand, are freer and more exploratory: these sections are less interested in maintaining a homogenised relationship between acoustic and electronic sound, instead focusing on creatively exploring the unique possibilities of this surround sound setup. The following spectral analysis goes some way to visualising the formal development:

Figure 12 *Spectral analysis of Sound Sculpture No.1's form*



Acoustic and psychoacoustics in performance

In live performance, each soundscape is triggered after each clarinet plays an acoustic note. In the following Ableton screenshot, the dark grey parts represent the clarinet sound in the room and are not part of the electronic soundscape. The blue tile is a pre-recorded note or sound that is identical to the dark grey part. The green parts are different samples of clarinets, whose pitches become increasingly less related to the fundamental as the soundscape progresses.

Figure 13 Ableton soundscape screenshot



With the greater degree of control of indeterminate sounds that the use of sampling afforded, it became possible to explore the potential of sonic spectra in a variety of interesting ways (most noticeably to fuse acoustically produced sound to electronically produced sound). This phenomenon of harmonicity (see footnotes, page 27) is used throughout the piece to perceptually connect the live clarinets with the electronic parts by having pitches enter that are harmonically related, and micro-tuned (down to 1 cent accuracy within Ableton), to just intonation. Other examples of acoustic and psychoacoustic principles applied within the composition are:

[Soundscape 1: Sine waves and localisation. \(00m02s in video, page 8 in score\)](#)

An electronic sine wave starts the piece and is accompanied by the front clarinet, which plays a harmonic note a minor third lower. Humans cannot perceive the location and directionality of harmonics and sine wave-like tones with as much ease as complex

waveforms, hence reducing (and in the case of reverberant spaces, eliminating entirely), the perceived localisation of instrument and sound when performers use harmonics. According to Platz and Wharton:

It is merely a convention to conceive of an instrumental sound source as a point in space. Actually, different timbres can suggest different spatial positions. The reflections from various directions give a sound its spatial qualities, producing a kind of acoustic sculpture... Certain fingerings on the clarinet enable the player, at low volumes, to produce a note almost free of overtones, and these, being the nearest possible [acoustical] approximation of a sine-wave tones, are perceived as directionless (1995, pp. 23-28).

A recorded version of this clarinet harmonic then enters and pans across the room, joining with the centre and back clarinets. The perceptual qualities of both sine waves and instrumental harmonics result in a spatially ambiguous, somewhat directionless sound, which creates a sense of localised fusion between acoustic and electronically produced sound.

[Soundscape 1: Beating patterns. \(00.02, score page 8\)](#)

Beats are an acoustic (not psychoacoustic) phenomenon that occurs when two sounds of slightly different frequencies create tremolo-like modulations in amplitude. The interaction of near-unison pitches between instrument and electronics (the electronics are slightly detuned a few cents) creates beating patterns, adding another 'layer' of interaction between acoustic and electronic sound.

[Soundscape 9: Synchronicity and harmonicity. \(07:14, score page 16\)](#)

Soundscape 9 begins to incorporate a deeper (electronically produced) spectral range, far beyond the capabilities of an acoustic clarinet quintet. Lack of onset synchronicity (see footnotes, page 29) is used to create an acute awareness of the clarinet locations within the room by staggering the accented clarinet starting points.

[Soundscape 14: Bell-like Inharmonicity \(12:00, score page 21\)](#)

Soundscape 14 consists entirely of multiphonics tones, with an electronic part composed entirely of multiphonics samples. This creates a complex, highly inharmonic soundscape with spikey, angular, dissonant harmony. Many streams of sound should be heard in the space rather than the homogenised mass of earlier, more ‘harmonicity-based’ soundscapes.

[Soundscape 15: White Noise-like Inharmonicity \(13:15, score page 22\)](#)

By soundscape 15, the piece has transformed entirely into inharmonic spectra, in the form of breath noise, rattles, etc. Notice this only uses acoustically produced inharmonic spectra, hence the lack of low-end bass information and the overall low amplitude of the soundscape.

[Soundscape 16: Coda \(13:55, score page 23\)](#)

The final soundscape acts as a kind of coda, summarising the whole piece through a gradual transition from harmonicity to inharmonicity, whilst simultaneously shifting from entirely acoustic to entirely electronic sound. The piece employs combination tones (Adam Neely, 2017) and the missing fundamental effect by asking the performer to play an ordinary note whilst simultaneously humming a perfect fifth higher. Combination tones (also known as sum and difference tones) are a kind of auditory illusion that is created when the sum or difference of two tones creates a third ‘ghost’ tone. This ghost tone is then overlapped with a synthesised bass tone of the same frequency, meaning this portion of the piece also blends psychoacoustic tones with electronic tones in the listener’s mind.

Source-bonding

A key element of acousmatic music is the lack of perceived sound source – this is what Pierre Schaeffer has termed ‘reduced listening’, in which:

The *source* of a sound is deliberately ignored in order to focus on the sonic properties and characteristics inherent to the sound. We forget about what agent, object, or action made the sound or what the sound signifies; we focus only on the musical properties of the sound – its internal rhythms, its timbres and textures, possibly some melodic elements (Andean, 2014).

And as Dennis Smalley describes, before reduced listening, music was inevitably married to gesture:

Sound-making gesture is concerned with human physical activity which has spectral morphological consequences, a chain of activity links a cause to a source... A gesture is therefore an energy-motion trajectory which excites the sounding body, creating spectromorphological life (Smalley, 1997, p. 111).

In my first two pieces, the composition techniques used led to an illusory form of source-bonding, whereby electronic sounds appear to be spectro-morphologically¹⁶ bound to an acoustic instrument. Source-bonding refers to identifying potential sources of a sound in perception, such as when one hears a recording of a train and subsequently imagines a train. In this work, I source-bond electronic sounds to the clarinet both as a mental conception and in terms of physical locations in the space; an argument could be made that by attempting to ascribe to the clarinet a stream of sounds which it has not actually created (effectively ‘source bonding’ electronic sounds to a ‘false’ source), *Sound Sculpture No. 1* addresses an issue inherent to acousmatic music: composer James Andean suggests that the notion of divorcing sound from source was always doomed to fail. He writes, “Over time it became increasingly clear that it is nearly impossible for the human mind not to ascribe, even if only unconsciously, a string of causes and sources to the sounds we hear” (Andean, 2014). I hope that by creating the false impression that the electroacoustic soundscapes of *Sound Sculpture No. 1* emanate from the clarinets during ‘live’ performance, the qualities of

¹⁶ Of spectromorphology, the electro-acoustic composer Dennis Smalley writes, “the two parts of the term refer to the interaction between sound spectra (spectro-) and the ways they change and are shaped through time (-morphology)” (1997, p. 107).

the acousmatic musical experience can become more focused, concentrated and coherent – albeit in an uncanny, illusory and unreal way.

However, does this method truly result in a single, cohesive instrument as defined by Croft? Whilst the *Étude* and the early sections of *Sound Sculpture No.1* certainly approach this description successfully from a listener's perspective, the later stages of the piece (in which the electronics become more prominent and heavily processed) are better characterised as a relationship of accompaniment rather than integration with the instrument. Furthermore, a genuine expansion of an instrument would also need to consider performability from the performer's perspective. As Emmerson states:

The technology extends what we already know, furnishing the composer with increased control over timbre and space, rather than extending the performer's instrument and its capabilities and possibilities in performance (Emmerson, 2007, p. 108).

This is precisely how the electronics function within the piece: they expand its timbral and spatial qualities, but not in a way that creates a feedback loop with the performers or the instruments' capabilities. Therefore, on a technical level, the piece was only partially successful in creating a composite instrument. However, the wider artistic provocations of the piece were highly compelling, prompting experimentation with the boundaries of textural relationships that I explore further in subsequent pieces.

Sound Sculpture No.1 – Part One

A key element of my work became to blend open-ended installations with performance. This idea was established in the first movement of *Sound Sculpture No.1* – an acousmatic surround sound installation in which multiple clarinet samples are tuned precisely to the harmonic series. The attack and decay portions of the samples are removed before the sample is looped indefinitely, creating an everlasting drone. Each sample is micro-tuned within Ableton to integer multiples of the frequency of the lowest note, thereby creating a harmonic series and sense of timbral homogenisation. As the piece progresses, clarinet

multiphonic samples are introduced, which are tuned to increasingly higher partials of the harmonic series. These integrate into the overall sound complex with noticeably less homogeneity, which creates interesting dissonances whilst disrupting the sense of timbral unity. During performance, each loop is projected from a separate speaker, which, after panning, creates sixteen localised perceived electronic sound sources. Audience members then move around the space and are able to alter the timbre of the chord by moving closer or farther away from different speakers, exploring in real time the nature of phenomena such as harmonicity and synchronicity. This piece is inspired by harmonic series Max/MSP patches such as those seen in Figure 4 (page 28), which demonstrate the psychoacoustic effects of harmonicity and synchronicity quite clearly.

The audience enters the installation, and after fifteen minutes or so, *Part Two* begins. The initial title for this piece was *Being and Becoming*, representing the almost static nature of the piece's first movement and the more directional, narrative, and linear (albeit slow) time-based treatment of the second.

Material agency

It was through *The Garden of Forking Paths* that I was first introduced to ideas of material agency. An 'agent' is something that functions as a force within a cause-and-effect relationship. In contrast to the traditional view that agency is exclusive to sentient humans acting through conscious decision-making, a broader understanding allows physical materials themselves to possess agency – as entities that bring about change and influence on some other entity. *Material agency*, therefore, denotes that “objects have an effect on the course of action that is irreducible to direct human intervention” (Van Oyen, 2018). Embracing such ideas has led to a trend in contemporary music in which physical materials themselves become indeterminate and unpredictable “quasi-agents in music-making” (Sergeant, van Elferen, & Wilson, 2020, p. 518).

Musical instruments, too, by this definition, have forms of agency. Essentially, an instrument is a system of physical materials, some of which vibrate and create sound waves, and some

of which hold the resonant materials in place. Culture has trained us to think that a violin string (for example) is ‘meant’ to vibrate evenly across its whole length and thus produce what we perceive as the fundamental tone – a musical note. However, it is a misconception in many ways to think of the fundamental as the natural state of a vibrating string. Generally speaking, performer technique aims for this state, and instrument design aims for this state – hundreds of years of development have gone into making this state the norm. Wind and brass, on the other hand, are far harder to control as these instruments do not ‘want’ to vibrate across their whole fundamental frequency so easily (and students must learn to control the instrument to do this at will). Lack of control in playing technique can cause the air column vibrations to vary unintentionally, which results in unintended partials and pitches being ‘released’. McLaughlin calls this “indeterminacy”: the likelihood that a string or column of air will move from one state of vibration to another:

Materiality is a focus on how the specific physical material of a sounding object behaves in performance. Often this is in relation with a human performer, so we can speak of both the human agency of the performer playing the instrument (making conscious choices about how to direct energy into the instrument), but also the material agency of the instrument responding to that input. Material is not neutral (2017).

By this definition, material agency results in the unpredictable and indeterminate sounds that emerge from vibrating objects and instruments, which are usually under ‘control’ by human actors.

These definitions uncover a lack of nuance in my thinking around conceptions of ‘acoustic sound’ as a definitional category. Prior to this piece, I was, in effect, attempting to treat a clarinet as an entity in and of itself, somehow divorced from the performer who plays it – I was trying to blend *acoustic* sound, not *performed* and *embodied* sound). And to try and enact this misunderstanding in reality, I would ask performers to play simple sounds: long, straight notes with as little expression as possible. These kinds of techniques mimic what a clarinet divorced from performer practice might sound like, attempting to boil the

instrument down to its core basic units of sound by ‘removing’ anything associated with personal expression or culture (such as scales, melodies and articulations). However, even the most basic, expressionless note will have some tiny element of ‘humanness’ embodied in it. The slight wavering of pitch as the breath begins to force air through, or the slightly uneven dynamic changes that occur as a note ends. These giveaways, no matter how small, are picked up by listeners and used to consciously distinguish between acoustic instruments and electronically produced sounds.

Closing thoughts on chapter one

So, the key insight I took from these pieces was something that now feels obvious (but like many a good insight, it is not obvious until you realise it). Instruments and performers are not separate entities; the sound of an instrument is not something that can so easily be divorced from the performer and performance practice – they are ontologically entwined on fundamental levels of conception. A clarinet does not sound without a performer, and a performer needs their instrument to be a performer. They exist not in isolation but as a dynamically related network. A collaboration between a composer and a saxophonist is actually a collaboration between the saxophonist and their instrument, the composer and their tools: all in relation to both the immediate acoustic environment and the wider culture they function within. And all of these factors interact with each other in an infinitely complex, dynamically interconnected web. Realising this, in my subsequent pieces, I sought to actively engage the performer in the creative process, and my works became inherently collaborative in nature.

Chapter Two. The Composer is Part of a Dynamic Network

“Expectations for art to be inventive (original, new, unique) require that art, like improvisation, cannot be fully planned or follow externally prescribed rules. The inventive quality of the artwork or performance, as much as its coherence, hence must emerge in the process of its creation (or performance). This leads to a decentering of the artist... [and] infringes on cherished Enlightenment ideals of agency, autonomy, and of conscious and rational control of one’s doings”
 – Edgar Landgraf, 2018, p. 214).

Sound Sculpture No.1 was performed in February 2020, approximately a month before the COVID-19 pandemic and subsequent lockdowns began. This, of course, posed a significant challenge for a practical project like this, in which the live integration of acoustic instruments and electronics was the original central focus of exploration. As a result, a change in direction became inevitable, and – inspired by my analysis of *Sound Sculpture No.1* from the previous chapter – I transitioned from investigating methods of blending acoustic and electronic sound to exploring electronic production techniques and acoustic performance practices. In this chapter, I will discuss the collaborative methods I came to use in relation to my second research aim, with commentary on how the project evolved into a broader artistic endeavour within the context of current contemporary music practice.

Classical cultures and fixed roles

In classical music culture, there is a long-established expectation that the composer writes a score, which the performer then interprets. These roles are fixed by tradition, culture, and logistics, and even with the best of intentions, breaking out of these roles can be extremely difficult for many reasons. Constraints such as limited rehearsal time, lack of funding, and the challenges of entrenched expectations all contribute to making this relationship the norm. As Clarke et al. observe:

Despite indications from academic writing and the statements of practitioners that this division of creative labour is increasingly regarded as highly porous... in the creative economy of contemporary western musical production, the defined roles of composer and performer remain powerfully embedded (2017, p. 116).

These conditions create particular challenges for a project like mine that aims to engage performers collaboratively (and were compounded by COVID-related restrictions, which occurred 6 months into my project). However, when possible, such collaborative approaches can yield exciting results, as performers become “agents in the process of creating the work” (Fraser, 2019, p. 11) rather than simply interpreters of the composer's intentions and/or score.¹⁷

Distributed creativity

Psychology professor Vlad Petre Glăveanu describes distributed creativity as a framework that “challenges the standard view that creativity comes only from within an individual by arguing that creativity also exists ‘outside’ of the mind or more precisely, that the human mind extends through the means of action into the world” (2024). Therefore, we can start to think of creativity as something that emerges from the interactions of people, objects and environment; from interactions of cognitive, motor, and perceptual abilities: through the physical constraints of the body and instrument; and through the social and cultural practices in which a performer is embedded (Linson & Clarke, 2017). This view understands music production as “a cultural process rather than a heroic act” (Toynbee, 2003, p. 169) and sits in opposition to the cultural image of the composer-genius: the Beethoven archetype, perhaps, who does not even need to hear music to write masterpieces – he ‘simply’ imagines the music in his head and commits it to paper.

Considering notions of *distributed creativity* specifically in relation to classically trained musicians, each performer of an instrument is connected by culture, education, and history to a rich performance practice that contributes to embodied and received instincts

¹⁷ A notable example of such a collaboration is the work between vocalist Juliet Fraser and composer Cassandra Miller. In *The Tracey Project* (2017), they developed “automatic singing,” where Fraser combined meditation with vocal responses in order to generate musical material, placing the performer’s voice at the centre of the creative process. Miller later applied a similar method in *I cannot love without trembling* (2022), developing material by repeatedly singing along to recordings of Greek violinist Alexis Zoumbas, who, after immigrating to New York in the 1930s, recorded improvisations that reflected his pain at being displaced from home. In doing so, she explored collaboration not only with performers but also with histories and traditions, using her own body as a compositional tool.

expected of them and taught through their education; we can then begin to think of collaboration as something that occurs between musician and culture, both past and present (Born, 2005). And, if we take notions of material agency to their logical extreme, when someone works with a tool, instrument or technology (that itself possesses a form of agency), we may think of collaboration as something that can also occur between human and nonhuman agents (Sergeant, 2018).

A key part of the collaborative methods within this project became to explore, compositionally, the creative affordances of these interactions. In the psychology literature, an *affordance* is a resource that the surrounding environment offers humans and the subsequent relationship that might develop between human and environment as a consequence of this exchange. It is suggested that the fundamental tenets of perception itself might be wrapped up in this relationship (Gibson, 1979). Humans, it is argued, have evolved to perceive, on various levels of pre-conscious, subconscious and conscious levels, the affordances of their environment (and subsequently ignore anything that cannot be conceived as an affordance). “An affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used” (Norman, 2013, p. 11). This then leads us into a creative realm in which various musical ‘uses’ for objects and instruments might be explored. All music which is based on the performance of acoustic instruments (or indeed any vibrating objects that resonate and create sound) contains such a relationship. As performers interact with their instruments, they see affordances in the potential for musical expression. However, they also see constraints in the things which are not possible to play. Music philosophy and cognition researchers Menin and Schiavio state:

A skilled guitarist might be unable to say where to put her/his finger to perform a solo, but s/he can use the motor knowledge of the fingers to reconstruct the actual set of notes played, by just putting the hand on the strings. We believe that this sensory-motor process not only represents the basis of musical understanding, but it can also shed light on the notion of musical affordance, relying on a sub-cognitive, pre-linguistic, intrinsically motor form of intentionality (2012, p. 210).

We then might think of instruments in terms of their *intended* affordances, by using them in ways intended by their instrument design (and of course, there is a body of conventional performance techniques that have been developed over centuries relating to every common instrument). Or we might think of instruments in terms of their *unintended* affordances, as many composers throughout the 20th century have done with “extended techniques” (Samuel Andreyev, 2024). Extended techniques are now arguably as common in new music as conventional techniques, it often seems.

However, within this project, the aim was not to explore conventional or extended instrumental techniques in and of themselves. Within the many collaborations of this project, I was searching for something more nuanced than ‘just’ a technique – something that can be difficult to articulate. I’m looking for the cracks between the techniques, the instrument, and the performer as they interact in a moment of improvisation. That *something* that sounds like *music*, or at least a potential seed of music. In *Musical Cognition: A Science of Listening* (2014), Henkjan Honing begins to lay the technical ground for why these things can be so challenging to explain, stating:

Philosophers like... Diana Raffman were convinced music can only partially be put into words. According to Raffman, the ineffability of music, especially of the listening experience, comprises at least two elements: that which cannot be remembered and that which cannot be said... Some nuances in music, like a singer’s specific timing or intonation, resist allowing themselves to be stored in memory. You may remember experiencing them in a certain way (the emotion is traceable), but the whole musical experience, the performance in all its details, doesn’t last. Nuances in the performance can be heard and experienced, but – again according to Raffman – not precisely recalled, distinguished or named. We simply don’t have the categories and concepts that allow us to put these sensorial experiences into words (Honing, 2014, p. 42).

This is where the method of recording the spontaneity of improvisation became an essential collaborative method. This method uses electronic production techniques to capture and

preserve fleeting musical moments, which can then be ‘sampled’ later and used in the creative process. When listening back to an improvisation, I search for fragments of sound that can be cut, reversed, stretched, pitch-shifted, and reworked. Certain sounds naturally lend themselves to certain kinds of transformation, and my ‘job’ became to match the sound/process and explore how it might be developed. The interest often lies in the details. For example, there may be nothing inherently compelling about a flying spiccato bow technique on its own; however, if a violinist performs this gesture twenty times, there may be something unique in one of those repetitions. Perhaps a muted or unexpected note, a slight shift in tempo, or a subtle variation in timbre that depends on how the bow contacts the strings in that specific moment. These are the qualities I listen for before asking myself questions such as:

- *How can this feature or quality be used compositionally?*
- *How can it be expanded or contrasted with a sound from another instrument that highlights its character?*
- *Where might it fit within the structure of the piece as a whole?*

Often, snippets from an improvisation are layered and recontextualised. For instance, a chord played at the ten-minute mark of an improvisation might be extracted and placed next to one from twenty minutes, and another from thirty, to form a new harmonic sequence (this sequence can then serve as the foundation for a new section of the piece, which I may ‘flesh out’ and develop in both DAW and notated form).

The sounds I seek often exhibit qualities associated with ‘*demoitis*’. This is a phenomenon familiar to many recording artists and listeners, where the raw demo version of a track is preferred over the polished, final recording. As Gryner (2010) notes, despite technical imperfections, there is often something about the demo that simply *feels* better – feels, in fact, like *music*. I would argue that many of the finer nuances of performance lie beyond the reach of conventional notation, and so do the unpredictable and indeterminate interactions between performer, material, and instrument. It is for these reasons that I begin each of my compositions by sampling audio from improvisations: to capture the unrepeatable, nuanced

moments of interaction between performer and instrument, and place them at the heart of the compositional process.

SOUND SCULPTURE No.2

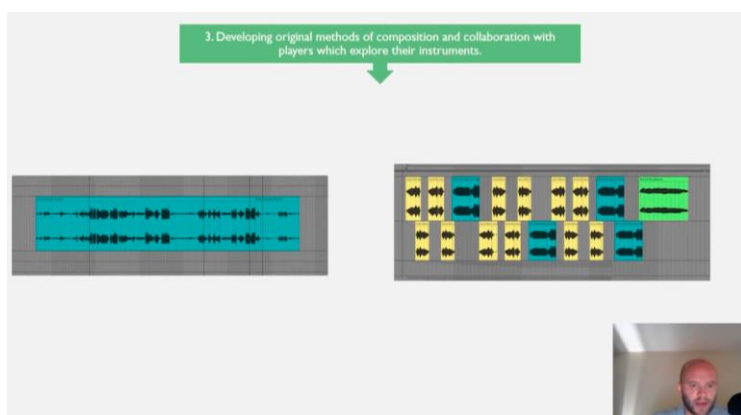
This piece was commissioned by *Horn Fusion*, a collaborative project involving audio and visual artists from diverse backgrounds, aimed at raising awareness and funds for a social enterprise called Invisible (Manchester). The work was composed during lockdown, which challenged me to find new ways of collaborating with performers remotely. This led to my use of graphic scores as a key part of my method. Erin Bathgate and Jack Sindall were wonderfully open and imaginative collaborators, making the process playful, fun and creative.

* Please note, the recording of the piece was pieced together in the editing process to look like a live performance but was very much a studio piece.

Entangled agencies

When I first listened through Erin's improvisation, there was one moment in particular that 'spoke' to me in the recording. It occurred several minutes into a ten-minute improvisation and is demonstrated in the following video:

Figure 14 [Sound Sculpture No.2 composition process](#)



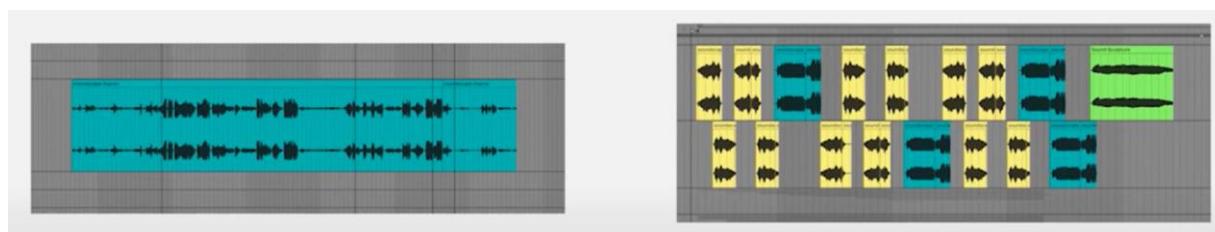
What I love and find compelling about this example is that Erin is clearly, and quite consciously, focused on producing a particular type of sound that she interprets from the graphic score. She repeatedly explores the same kind of multiphonic 'growl' sound, seemingly intent on getting it 'right', concentrating on a technique she has instinctively linked to the graphic in question. Yet, in the midst of this focused exploration, she suddenly plays an unexpected upward arpeggio melody. This brief moment has a delicacy and playfulness absent from the surrounding material. The tempo quickens, the multiphonic technique drops away, and for just an instant, it feels as if the conscious part of her brain has let go. It seems almost unintentional, as though she doesn't even register that she's played it. If she were consciously trying to introduce a playful, agile gesture that draws on the harmonic series, she might have repeated or shaped it further. Instead, it appears as an afterthought. And yet, in this fleeting moment, Erin naturally weaves together her embodied skill as a trained performer with the natural resonances of her instrument by running up the harmonic series of the French Horn, with a little skip in rhythm that gives it more character than a straight upward arpeggio.

Erin's brief lapse from deliberate effort gives rise to a quasi-subconscious gesture that points toward a creative flow state, highlighting the value of not overreaching from a purely conscious or intentional place, of allowing oneself to connect intuitively with tools and materials, enabling the emergence of expressions that feel effortless and organic rather than forced. It is a playful, natural and unselfconscious moment in which performer and instrument 'speak together', in what Professor of Sociology and Philosophy Andrew Pickering may refer to as a "dance of agency":

A temporally extended back-and-forth *dance of human and non-human agency* in which activity and passivity on both sides are reciprocally intertwined... (2012, p. 195)... Dances of agency have a decentred quality – they are the zones of intersection where the non-human world enters constitutively into the becoming of the human world and vice versa. They cannot be accounted for by focusing either on the human or the non-human alone (2012, p. 196).

In this way, creativity in the moment appears distributed across several elements: Erin as a performer and her embodied knowledge, the 'agency' of the French horn itself, whose physical properties subtly shape the outcome, and the act of letting go, allowing the instrument to 'speak' with a kind of intention equal to that of the performer. And then, my role as composer/producer becomes to notice this moment, to sample and develop it musically. In this instance, I copy the chosen sample, reverse it, and then edit in another moment from a different part of Erin's improvisation to make, what feels to me, like a complete musical phrase. This phrase is then repeated several times with variations to build a complete sounding section of music.

Figure 15 *Editing the sample into a phrase (Ableton screenshot)*



As an electronic accompaniment, I then built a layer of resonance from a time-stretched loop of the fundamental note, using an EQ to filter the partials and create a kind of spectral soundscape that unfolds behind the repeated phrase. The EQ is then automated over time to open gradually. My intention here was to create the effect of the room resonance growing and 'swallowing' the music, effectively source-bonding the room resonance of the concert hall to the electronic part. I then creatively transcribed the Ableton demo into notated form, focusing on both the technical logistics of performance and refining the structure of the piece. I chose to pass the above phrase across the two players, as seen in this score excerpt:

Figure 16 *Sound Sculpture No.2* score excerpt

The figure displays three systems of a musical score for two performers, Erin H. and Jack H. The notation is in treble clef with a key signature of one flat (B-flat).

- System 1 (Measures 311-314):**
 - Erin H.:** Starts at measure 311 with a **R** (Repeat) sign. The melody features eighth-note triplets and sixteenth-note runs. Dynamics range from *mp* (measures 311-312) to *ff* (measures 313-314). A performance instruction above the staff reads: "add bits of fluttertongue here and there to add expressiveness".
 - Jack H.:** Remains silent in measures 311-312. In measure 313, he plays a half-note chord. In measure 314, he plays a triplet of eighth notes. Dynamics include *ff*.
- System 2 (Measures 315-318):**
 - Erin H.:** Silent in measure 315. In measure 316, she plays a triplet of eighth notes (*mp*). In measure 317, she plays a half-note chord (*ff*). In measure 318, she plays a half-note chord (*ff*).
 - Jack H.:** Plays a triplet of eighth notes in measure 315 (*mp*). In measure 316, he plays a half-note chord. In measure 317, he plays a half-note chord. In measure 318, he plays a half-note chord.
- System 3 (Measures 319-322):**
 - Erin H.:** Silent in measures 319-320. In measure 321, she plays a half-note chord (*f*). In measure 322, she plays a half-note chord (*f*).
 - Jack H.:** Plays a triplet of eighth notes in measure 319 (*ff*). In measure 320, he plays a triplet of eighth notes (*ff*). In measure 321, he plays a triplet of eighth notes (*ff*). In measure 322, he plays a half-note chord (*mp*).

Developing material in notated form

The next step was to build several sections to make a complete draft of the piece in Ableton demo form. A short sample of fast, improvised scalic material by Jack formed the basis of the middle section ([beginning around 3:50](#) or at bar 15 in the score). However, developing this material required a different compositional approach. Unlike Erin's arpeggios, which were mainly developed using tools in Ableton, Jack's rapid phrases felt constrained by the limitations of DAW methods. I sensed that the material had more potential than Ableton alone could unlock, and to explore this further, I developed the passage almost entirely in notated form.

Figure 17 Jack's quick harmonic passages

The musical score for Figure 17 consists of two systems of staves for Erin H. and Jack H. The first system begins at measure 116, indicated by a box with the letter 'H'. Both parts feature a 'pinched harmonic series on Bb'. Erin H.'s part includes a triplet of eighth notes and a dynamic marking of *mf*. Jack H.'s part also includes a triplet and a dynamic marking of *mf*. The second system begins at measure 119. Erin H.'s part continues with a triplet. Jack H.'s part features a 'harmonic series on C' and includes a quintuplet of sixteenth notes. The notation includes treble clefs, key signatures with two flats, and various musical notations such as triplets, slurs, and dynamic markings like *mf*.

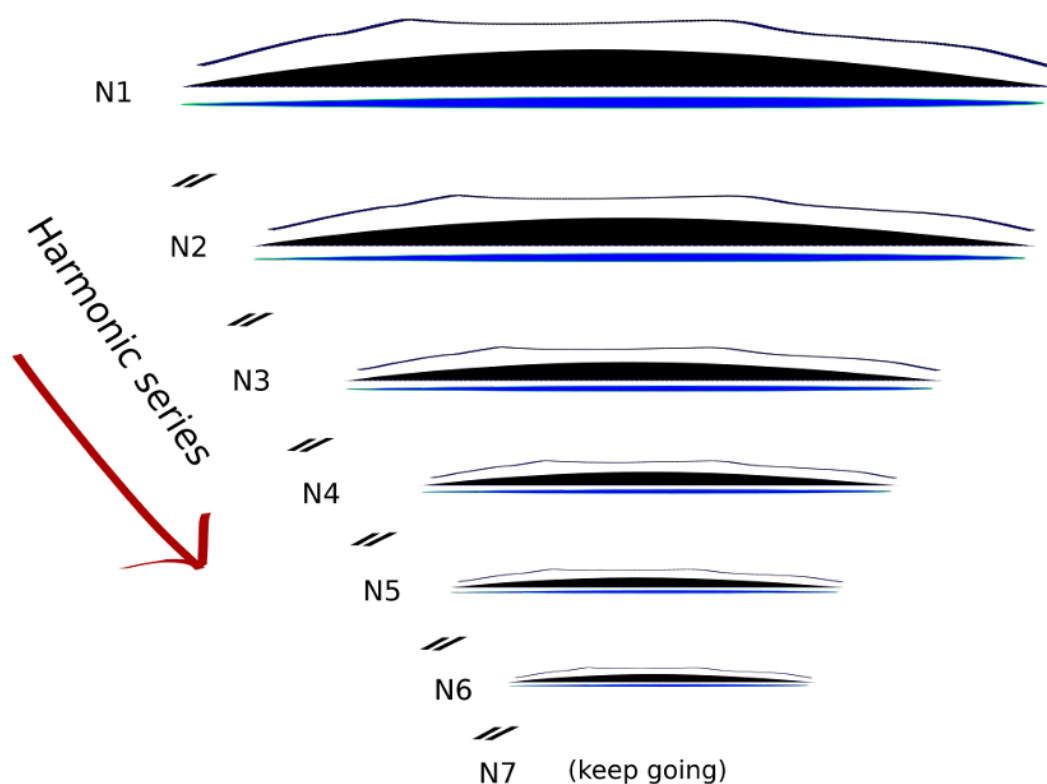
A particularly memorable moment occurred during rehearsals when Erin assumed the notated version of Jack's material was unplayable. Jack then demonstrated that by using rapid, shallow bursts of air from the mouth rather than the diaphragm, higher pitches were more achievable than Erin had expected. This discovery, made possible through the improvisation and sampling process, highlighted the kind of performative insight that emerges only through hands-on experimentation and collaboration.

SOUND SCULPTURE NO.3

I sent the same graphic score from *Sound Sculpture No.2* to Trombonist Weston Olencki, and it was immediately fascinating to hear the differences in the 'improvisation'. First, Weston's recording was far more structured. Whereas Jack and Erin's recording was a single, unedited 10-12 minute WAV file, Weston split his improvisation into sections as per each page of the graphic score, each one around 1-2 minutes long. These improvisations were far more neat and 'professional', one might say. However, after listening to all of this material for weeks on end, I couldn't find any 'seeds'... any moments that spoke to me and

suggested starting points for a piece. There was just no ‘music’ inherent in these raw sounds; in some respects, it was like a commercial sample library (albeit a very esoteric one in which the trombone is explored for extended techniques in fine detail) in which individual sounds were recorded and had to be built into something. After wondering whether I had made a mistake and that this process wouldn’t work at all, I began layering different sounds on top of one another, searching for a combination that might generate something usable. Eventually, after much experimentation, I settled on a combination of five notes which, when rhythmically aligned with slightly staggered entry points, created what sounded and felt to me like a promising foundation to develop the piece from.

Figure 18 Samples which were inspired by this graphic, when arranged in a certain way, became a seed



Once the initial chord was ‘found’, the rest of the piece emerged quite effortlessly. The opening 3-minute section of the piece is built around this repeated chord [\(0:22 in the](#)

[recording](#)). I used other sounds from Weston's improvisation to create variation, a sense of development and rising tension. Sections two [\(3:00-8:00\)](#) and three [\(8:00-end\)](#) followed quite naturally through the use of similar methods and some really interesting key changes emerged in the second section based on the natural harmonics of the instrument; my role here became to shape the gestures offered by Weston into structures whereby the key changes became audible, rather than separate events in a sample library. The final track has thousands of edits and hundreds of tracks layered on top of one another to this end, and this method of capturing samples really opened the instrument to uses and affordances that I wouldn't have been aware of when working in notated form.

However, due to COVID restrictions, an opportunity to perform this piece live never emerged, and so the notation phase was never employed. In July 2002, I presented a surround sound version in Studio 8 at the RNCM, in which hundreds of tracks were grouped into 16 channels and then dispersed around the space, creating a sense of spaciousness in the arrangement that is not heard in the stereo mix.

SOUND SCULPTURE NO. 4

Sound Sculpture No.4 was created in collaboration with Gemma Bass (violin) and Peggy Nolan (cello). For this piece, I was once again able to attend the session in person with the performers, following the lifting of COVID restrictions. The session took place in November 2021 at Studio 8, located within the RNCM.

To begin, I adapted the graphic score (see pre-scores folder) to suit string techniques, drawing on an exhaustive survey of string repertoire to gather techniques and inspiration around which to design the score. For example, the graphics shown below are quite clearly influenced by flying spiccato style bowing techniques, which are specific to string instruments (though the performers were of course free to interpret the graphics in any way they felt was appropriate).

Figure 19 String sculpture graphic with suggested symbol interpretation

Sound Sculpture No. 4 - Graphic Improvisation Score for Strings

Suggested Guidelines

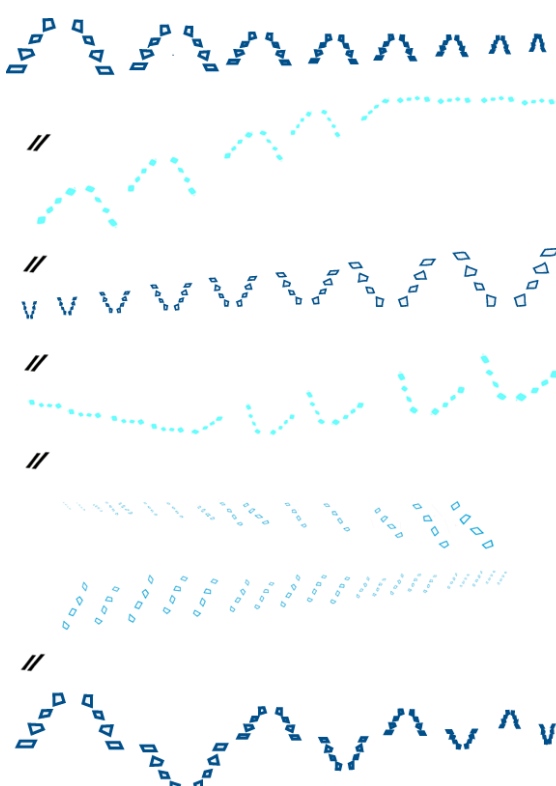
Page 2
Tapping noises such as pizz, col legno battuto and Fast, jumbly finger picking etc. Also plucking behind bridge and other unusual places.

Page 3
All natural harmonics. Create little motifs and fragments of melodies etc.
<https://vimeo.com/437978846>

Page 4
Quick bowing across all 4 strings. Create chords from natural harmonics. Sometimes place fingers as if harmonics exist where they do not.
 (Sciarrino Caprices)
https://www.youtube.com/watch?v=poAylr4TSnc&list=RDMM&start_radio=1

Page 5
Oscillating harmonics – harmonic trills, use two harmonics at once. Be gentle and birdsong-like.
 (Sciarrino Caprices)
 (Spiraz Mazis)
<https://www.youtube.com/watch?v=7Wl-ow4HnRU&t=19s>

Page 6
Staccato, spiccato, bouncing bow, ricochet etc type material.
More ordinary notes though, and recognisable fragment of melody.



We then had a very open and creative two-hour recording session, during which we quickly established a routine whereby, one page at a time from the graphic score, one of the performers would perform a solo improvisation. Then the other player would follow with their own solo improvisation, which instinctively became not only a response to the graphic scores but also to the first improvisation. Both players would then improvise together. This resulted in a wonderfully creative, open, and reactive session, during which we recorded over two hours of improvised material. I spent months working with this material, and it essentially became the backbone of tracks 1, 2, 3, 5, 8, and 9 of the album in my portfolio.

However, a key difference in the process of recording this piece and the previous *Sound Sculptures* was that we had a second recording session, which I used to record variations of key materials selected and developed from the first session. For example, the following

material was edited from Gemma and Peggy's first session, notated, and then recorded as a series of semi-improvised variations. This led to fragments of recordings that I then edited again into the piece's final form (again, this took months).

Figure 20 *Sound Sculpture No.4 session two workshop score example*

$\text{♩} = 72$ slight sul tasto.
attack = jete or throw bow then
allow string to rest quick and swell each note

1

Vln. 1 *p*

Vc. 1 *p*

Vln. 2 pizz. *p*

Vc. 2 pizz. *p*

5

slow unmeasured tremolo
speeding up/down

Vln. 1

Vc. 1

Vln. 2 percussive tapping sounds
slow unmeasured tremolo speeding up/down

Vc. 2 percussive tapping sounds
slow unmeasured tremolo speeding up/down

For example, in *Sound Sculpture No.4 Part One*, the first two minutes of the track feature five different variations of the above melody, each edited one after the other with various production techniques applied. To be clear, these variations were not recorded in the order you hear them; we actually recorded many takes of this material, with breaks in between. And then, when listening through, I decided that a good formal structure might be to present five variations of that theme (and this decision emerged through the process of recording and listening to the material). The remainder of *Sound Sculpture No. 4* contains tens of thousands of edits, as samples were meticulously shaped into a collage designed not to be perceived as a collage.

Notes on the vocabulary of computer music

One additional note that I will discuss here is about my treatment of the ‘grid’ in Ableton when producing these tracks. Within DAWs such as Ableton, the default setting is for audio and MIDI clips/notes/events to ‘snap’ in line with some pre-decided time signature and tempo (known as quantisation). This inevitably leads to certain kinds of music being favoured; to the composer’s hand being led by the tools they use – music that tends towards fixed tempos, loop-based structures, slight rhythmic variations and such. This linearity is one of the reasons why electronic musicians such as Mark Fell prefer Max/MSP, which does not lay its materials out on a linear timeline in the same way (Fell, 2013, p. 66). In the podcast *Hanging Out With Audiophiles*, on electronic music and computers, the composer Matthew Herbert says:

So much of it is the death of freedom and the illusion of choice... there’s a grid... and it even asks you when you open it up: “Do you want to make a bit of electronic music”... and it pulls up some naff synth sound... and I love Logic, it’s got some extraordinary things in it... but it takes you away from that risk, and it takes you away from the vulnerability and it takes you away from the spontaneity (Lidell, 2024).

In *Sound Sculpture No.4* (and my work generally), I attempt to remedy this by turning the quantisation grid off and producing freely into the program. This can be very niggly and time-consuming, but it means that materials are no longer temporally fixed to the DAW. However, the lack of a grid can then lead the producer towards drone or ambient music, which I again try to consciously counteract with variation, rhythm and phrasing choices that are not simply led by the quirks of the technology. In *Sound Sculpture No.4*, I tried wherever possible to avoid copy and pasting. This was made possible by having a wide range of material variations available from the second recording session. Where copy and pasting is used, variations are created in a variety of ways, by slightly time-stretching the sample, or by accompanying the sample with other sounds in subtle ways.¹⁸ However, in *Sound Sculpture No.4 Part 3*, I didn't have many variations of the main pizzicato chord sequence. Hence, looping became unavoidable and is quite apparent. In the second half of the piece, I reactivated the grid snap function and looped the rhythmic material, resulting in the grid-based style of music featured in tracks 4, 5, and 6 of the album.

Upon reflection of Herbert's above quote, I also note that the methods I employ here inherently welcome risk and spontaneity into the composition process, further avoiding the safety (and predictability) of pre-programmed sounds and commercial sample libraries. I am essentially building my own esoteric sample libraries in collaboration with the performers of each piece, from momentary occurrences, and this certainly feels like a vulnerable place to begin things, as I essentially have no idea if what will emerge will be any 'good'. It becomes about trusting and accepting the process, of welcoming spontaneity as an essential element of the practice, of giving over the piece to the process that I curate, before developing the results over months and months of refinement.

¹⁸ This can quite obviously be heard in the main chord of *Natural Environments One*, which repeats throughout the piece but is never an identical copy of itself.

DYNAMICAL SYSTEMS TWO

DYNAMICAL SYSTEMS THREE

After the completion of *Sound Sculpture No.4*, I decided to make some tracks that consciously stuck to the grid of Ableton and had a strong sense of looping/rhythm in deliberate contrast to *Sound Sculpture No.4*. These tracks were loosely inspired by notions of dynamical systems as discussed in chapter three.

Dynamical Systems Two was a particularly interesting track in terms of distributed creativity, as I have no memory at all of making the first half of the piece. I had COVID at this time and lay on my sofa, moving samples around in a semi-conscious daze. The track is created by layering several string samples and then processing them through various effects, including a phased amplitude chopper with randomised granulation of the samples, which causes the left and right channels to move in different patterns. And a few weeks later, I found the file on my computer, and I really liked it. It is an interesting question to ponder: Where did this material emerge from? If the players who created the original samples were improvising, the producer who assembled the samples was delirious, and the computer that generated the rhythms was randomised, where is the creative agency here?

Dynamical Systems Three was the final track I made for the album using samples of my DIY chime bells (discussed in chapter four). This track served to divide the middle section of the album into three parts, making the album conceptually cohesive.

NATURAL ENVIRONMENTS ONE

In September 2022, I produced *Sound Sculpture No.6* with the House of Bedlam and received improvisations over the internet from Carl Raven (saxophone), Stephanie Tress (cello), and Kathryn Williams (flutes). *Natural Environments One* is effectively a demo of the main section of *Sound Sculpture No.6*. *Natural Environments One* and *Two* employ very similar techniques, with similar intentions: to create musical metaphors of natural soundscapes. However, as

each piece uses different samples as source material taken from different players, interesting similarities and differences emerged in the various pieces. I found it interesting to place these two tracks next to each other in the album's running order, so as to hear the contrast in collages created with similar techniques and intentions, but different samples.

Figure 21 *Natural Environments One* stacked samples, micro-tuned and slightly time-stretched.

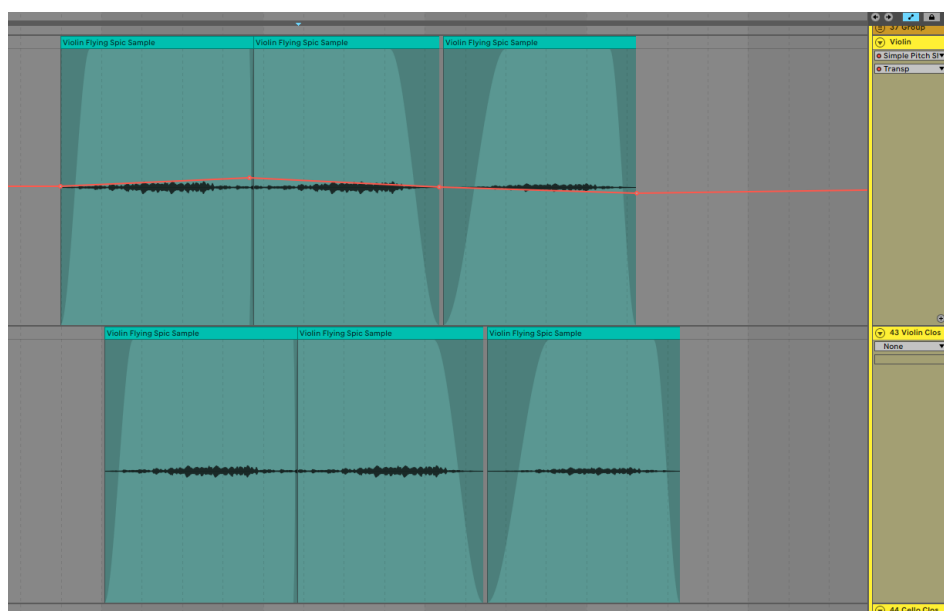


NATURAL ENVIRONMENTS TWO

In *Natural Environments Two*, several instances of flying spiccato bowing techniques sampled from Gemma's improvisation form the basis of the piece. The resulting sound of this technique could be argued to be quite a generic one: once mastered, the sound of this technique is inherently linked to the violin and offers little space for individualism, as it is so ubiquitous to violin culture. I would listen to countless examples of this technique from improvisation, and then select specific instances that I thought had a certain character. This

might be a slight mistake, such as one note in the gesture not sounding as clearly as the others, or perhaps an interesting quirk of rhythm in which the flying spiccato tempo wavered slightly in a way unintended by the performer. I then created several tracks containing variations of this technique and placed them against each other, before applying small amounts of electronic glissando, automated to pitch shift the track up/down by less than one semitone over 30 seconds to a minute. This creates gradually shifting layers of microtones within the layers of flying spiccato. Around two minutes into the recording, I start to create wave-like patterns which mimic the sound of water by layering more than 20 instances of this technique, with a wide range of pitch shift and time-stretching applied to create constant variation and avoid delay-like effects (which sounds like an echo). This consciously mimics the nature of water droplets and the ‘plink’ sounds they make in close spectral and temporal proximity to one another (see chapter four):

Figure 22 *Natural Environments* Two electronic glissando curves.

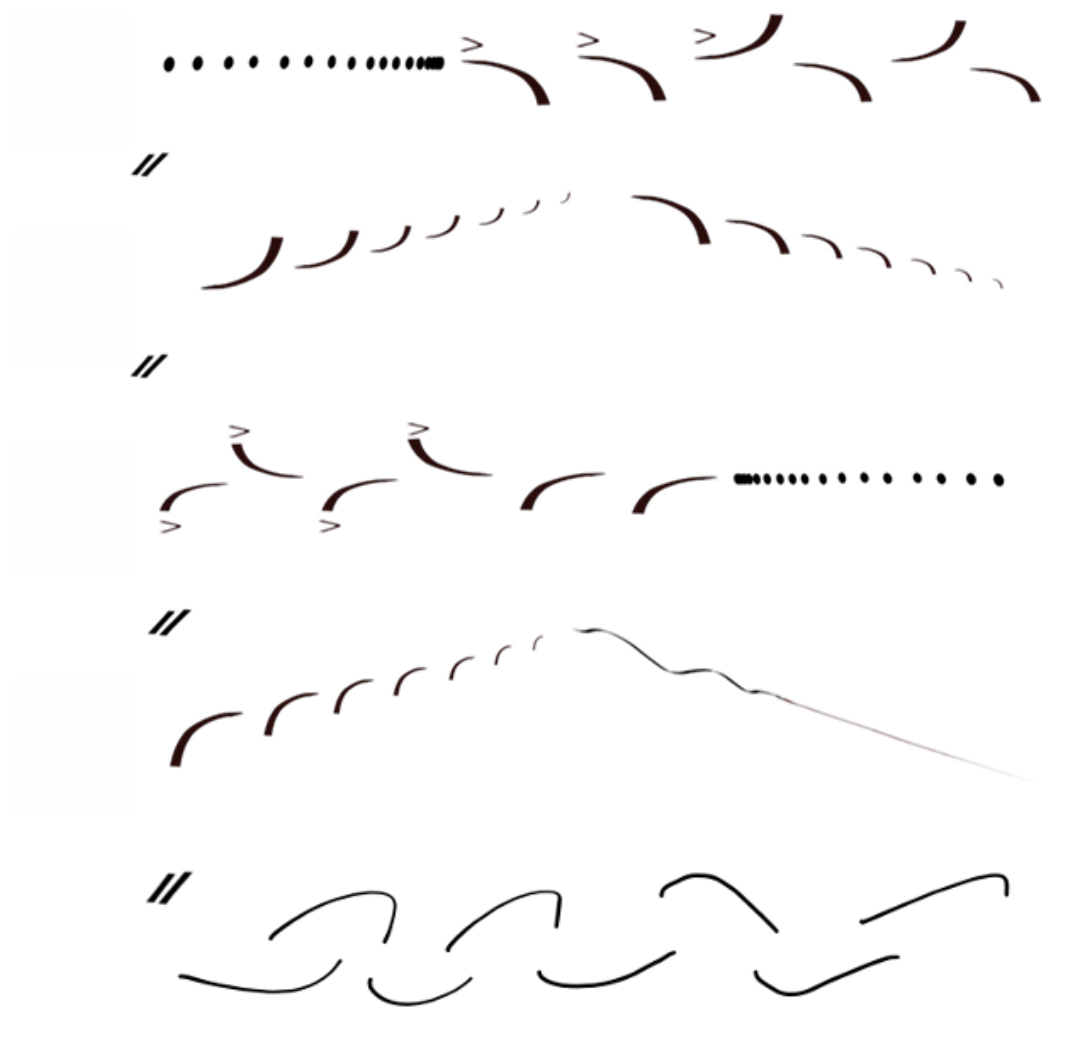


The top track pitch shifts over 45 seconds from concert pitch to 80 cents sharp and back again, whilst a copy of the track underneath remains at concert pitch.

NATURAL ENVIRONMENTS THREE

The final album track is built around two improvisations from Gemma and Peggy. The first half uses material that emerged from this graphic score image:

Figure 23 *Natural Environments Three* graphic score



I then layer and stitch the pitch-shifted multiple versions and variations of each material to create an engulfing texture of string glissandos.

The final section of this piece is based on a melody that Peggy came up with during the improvisation. I rewrote it a little, giving it more shape by reworking it in notated form, but it more or less came out as you hear it. I then built up several instances of it to create an engaging melodic texture again.

ALWAYS LOOK FOR THE FLOWERS

The final piece I created during my time at the RNCM was *Always Look for the Flowers*, a piece that perhaps best exemplifies the techniques that I developed based on collaborative thinking. This composition was part of the [Music for Parkinson's](#) research project, in which seven composers were paired with seven individuals living with Parkinson's disease to create a piece of music that, in some way, addresses issues of Parkinson's, music, wellbeing and health. I was paired with Chris Jones, and the pianist was Yuanfan Yang. The concept of distributed creativity inspired my approach and prompted the question:

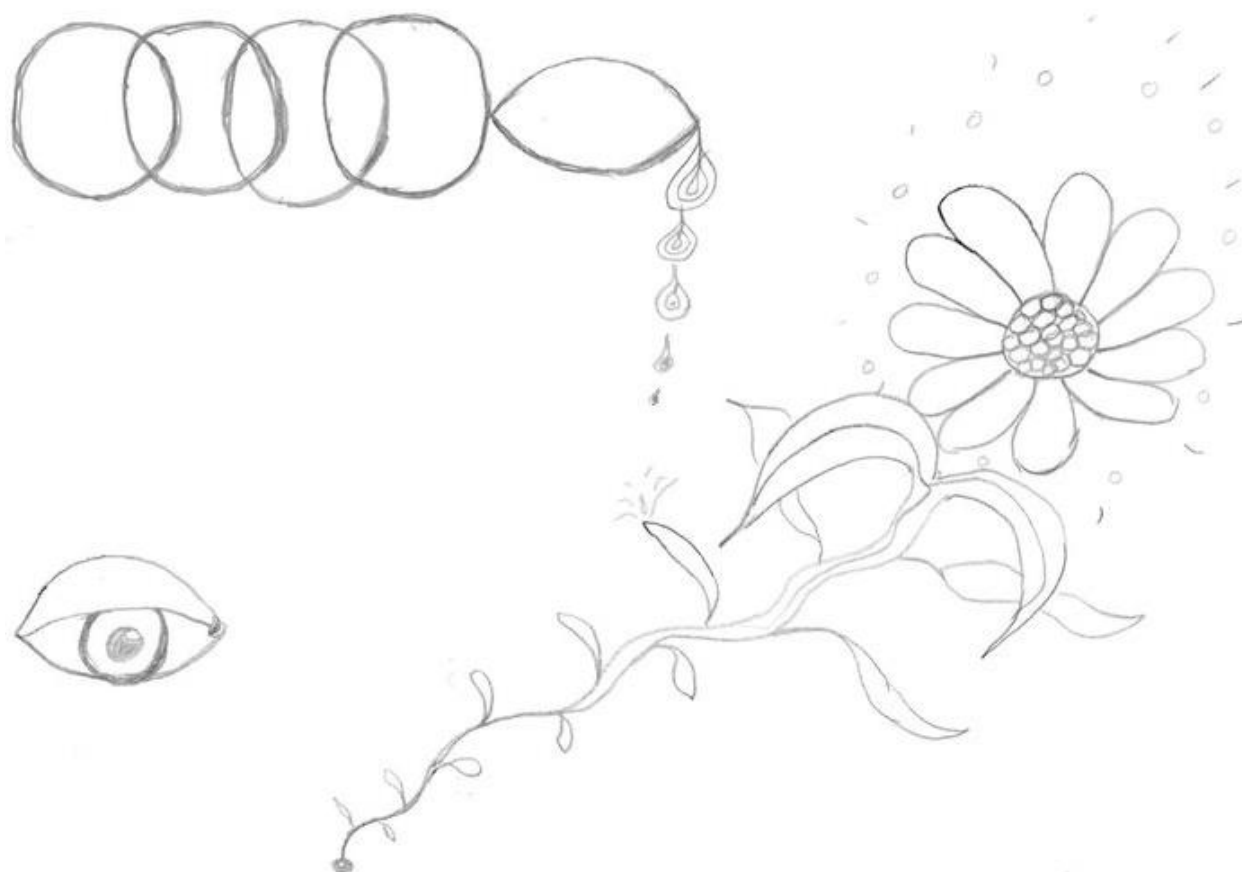
- *How might engaging in the creative process of distributed creativity enhance wellbeing?*

To this end (and drawing on the processes developed in this chapter), I invited Chris to design a graphic score from which Yuanfan could improvise, beginning to develop material for a piece that embodied her experiences of living with Parkinson's. Chris designed a beautiful score (see Figure 24 below) based on the quote, "In a world full of sorrow, always look for the flowers," which she first heard on the news in relation to the Paris bombing attacks some years ago. The words deeply resonated with her experience of being diagnosed with Parkinson's.

During the improv workshop session, Yuanfan Yang offered various improvised responses to this, and we talked at length about Chris's experience of Parkinson's. By this point, I had developed a clear approach to how I wanted to conduct these sessions, generating emergent material from the network of distributed creativity, as I saw it, consisting of myself, Chris, Yuanfan, the piano, musical style, culture and various other elements to be explored openly. I directed the sessions to consciously and deliberately develop contrasting

ideas in ways that fostered and generated unexpected collaborative emergences, rather than pre-planned products.

Figure 24 *Chris Jones' graphic score*



For example, before Yuanfan began his first improvisation, he asked me whether I wrote tonal or atonal music so he would have some idea of where to start harmonically. However, this question, as far as I was concerned, did not address what I wanted and showed that Yuanfan needed further guidance on the nature of the session as I intended it. I did not want Yuanfan to come up with material 'for me' in a style I would prefer; I wanted to see what emerged from the session spontaneously. So when Yuanfan asked, 'tonal or atonal', my response was to say, 'Let's do one minute of tonal improvisation responding to Chris's score and then one minute of atonal improvisation.' Then, as the session went on, each

improvisation was prompted to respond to the last. For example, Yuanfan used a lot of fast arpeggios in an early improvisation, so for the following one, I prompted him to use lots of space. And in the next improv, he played lots of quiet material, so I prompted a loud take following that. This way, the ideas and material that emerged were contingent more on responses to the moment rather than what I, as a composer, might ‘like.’

After the session, I started composing the piece by constructing two chord sequences from chords sampled throughout the improvisation. These chords were transcribed to Sibelius, where the piece was further developed. A melody was added, and the piece expanded to have three sections, which mirror the form of the picture that Chris created. The first section creates a sombre mood (*“a world full of sorrow”*). In the middle section, the material becomes energetic and searching (*“always look for...”*). The final section ends the piece with strong chords that are rooted, defiant, and characterised by a sense of renewal (*“the flowers”*). This piece represents a co-created work that I am very proud to have been a part of.

Figure 25 [Chris, Yuanfan, and myself presenting at the Greater Manchester NHS-Universities Conference](#)



Closing thoughts on chapter two

It was not until I was thirty years old that I first worked with classically trained musicians, although I had by this point accumulated fifteen years of experience playing in and recording bands. During my first sessions with classical musicians, I was struck by one thing in particular: just how *directed* the players expected to be. In the folk/rock world, it might be considered condescending for the band songwriter to prescribe to another group member exactly what they should play and how they should play it. However, in the classical world, it is more likely to be seen as unprofessional or naive not to dictate almost every aspect of a piece to performers – it is part of the composer’s role and the expected norm. There was a steep learning curve to this, which I had to adapt to quickly. And perhaps, through the methods discussed in the chapter, I have unlearned this, though crucially, in ways that are acceptable within the conventions of classical music. My methods aim to reshape the relationship between performer and composer in ways that respect the expectations inherent in these roles, whilst also considering the logistical constraints of contemporary music.

Performers are usually offered a degree of creative agency at the end of the writing process to interpret the elements of a score that are left open in traditional notation (such as dynamics or tempo in early music works). In my process, however, performers are also invited into the creative process at the beginning. I then take control during the middle stages of composition, before the performers return at the end to perform the piece. These kinds of collaborations share similarities with other art forms, such as dance or drama, whereby choreographers work closely with performers in the initial stages of a process known as “devised theatre” (Munk et al., 2024). This naturally leads to some reflections on the question of ownership within these pieces.

In the Romantic model of creativity (where music is seen as emerging solely from the mind of the composer), ownership appears relatively straightforward. However, in a distributed understanding of creativity, the origins of a piece can be much more diffuse. A musical work might arise from the quirks of a particular instrument, or from a technological constraint, or

a commercial sample, or from an accidental mistake in a moment of improvisation that the performers can't even remember. The resulting piece then evolves from this initial spark through a network of influences, inputs, agencies and collaborative contributions. So, in such a context, where does ownership reside?

Consider the Beatles as a key example of this complex dynamic. Officially, most of their songs were credited to Lennon/McCartney, even when the two of them wrote separately. However, as seen in *The Beatles: Get Back* documentary (Jackson, 2021), the creation of a Beatles song often involved creative input from all members, with the structure, production, vibe, and instrumental parts of a track shaped collectively in the studio. Yet George Harrison and Ringo Starr were not credited as songwriters, despite their obvious contribution to the Beatles' artistic voice. This raises questions not just about ownership but also about the nature of creativity and how people understand what parts of a recording (melody, lyrics, production, etc) actually constitute 'the song'.¹⁹

And so, to what extent do performers own the music they perform, especially when they have a large, essential part in the creative process? Should the performers of my pieces also be credited as co-composers? I certainly feel a sense of ownership over the works in my portfolio that the performers do not (as evidenced through anecdotal conversations with them). Perhaps this is because I ultimately make the key artistic and logistical decisions, and the responsibility for these decisions lies solely with me. It is therefore my musical 'voice' that speaks through these choices. However, from this position, I always try (wherever possible) to give as much credit as I can to the performers, who are far more than 'just' interpreters. They are active agents in the creative process. Personally, I prefer to refer to these works as *co-created*, whilst still preserving the distinction between the roles of performer and composer. I then, wherever possible, describe in qualitative terms how the

¹⁹ This question of legal copyright ownership gets even muddier in Bob Dylan's music, which is now legally owned by Sony Music Entertainment after he sold it for huge sums (Snapes, 2022). Yet Dylan's music is itself derived in large part from the folk tradition, which it can be argued, is 'owned' collectively by the cultures and traditions from which it emerged.

expected boundaries between these roles are broadened and stretched through our collaborative process. In my experience, performers have always responded well to these methods – they enjoy feeling more creatively involved than with most projects and certainly do not feel as though they are being used in any way. One analogy might be filmmaking: if an actor improvises or alters the script on set, they are not suddenly credited as the screenwriter. It is accepted as part of a porous boundary between creative roles.

Chapter Three. Sound Sculptures and Dynamical Systems

“What is important in the arts is not the scientific part, the analysable part of music, but something that emerges from it – but [then] transcends it – which cannot be analysed because it is not in it, but of it. It is the quality which cannot be acquired by simply the exercise of a technique or a system. It has something to do with personality, with gift, with spirit. I quite simply call it magic”

– Benjamin Britten (*Britten Pears Arts*, 2003).

In the previous two chapters, I discussed the compositional techniques, procedures, and methods that emerged from my research between 2019 and the end of the COVID lockdowns, resulting in the first half of my portfolio being primarily studio-based recordings. This chapter begins after COVID restrictions were lifted and live performances once again became possible. The following pieces build on the spatialised, half-installation/half-performance format first experimented with in *Sound Sculpture No.1*, blending this approach with the collaborative compositional techniques developed in *Sound Sculptures 2, 3, and 4*. These works became less focused on creating a composite instrument between acoustics/electronics and more interested in creating shifting, immersive, semi-acoustic, semi-electronic, semi-autonomous soundscapes, in which the relationship between live performers and instruments playfully switches between “backdrop, accompanimental, responsorial/antiphonal, and environmental” (Croft, 2007, p. 62) as discussed on page 24. These pieces primarily aim to fuse the temporally linear nature of performance with the environmental and automated qualities of installation, as per research aim three. I will here discuss what I mean by this, before demonstrating how these ideas manifest in my portfolio.

The environmental and temporal qualities of sound installation

Defining sound installation remains challenging precisely because of its porous and boundary-breaking nature. Works may “merge many interdisciplinary elements such as sculptural forms, video, photography, radio and performance as well as sound, while others may appear almost invisible” (Bandt, 2006, p. 353). Nevertheless, space and time are often

cited as central qualities that installation works tend to fundamentally explore in one way or another. Australian composer Ros Bandt conceptualises sound installation as:

A place, which has been articulated spatially with sounding elements for the purpose of listening over a long time span. It defines the exhibiting place as an acoustic space where sound, space and time converge in interesting and challenging ways for the listener/perceiver... It is a sonic intermedia practice, which blurs the boundaries of the visual and aural and includes the spatial, the temporal and the haptic (2006, p. 353).

Unlike conventional concert performances, sound installations tend to situate the audience within a physical environment that constitutes a sonic event, often automated or self-generating, with no fixed beginning and no defined end. Listeners move through this environment, experiencing the work from multiple perspectives at their own pace. In comparison to a traditional concert, this way of experiencing work deconstructs the shared temporality of live performance and instead establishes an individualised, intimate relationship between perceiver and work. As curator Claudio Tittel observes,

Sound installations break down the traditional concert hall situation. The common reception of [installation becomes] a contemplative observation because visitors [can] choose their own timeframe. But, of course, this reception differs from the reception of sculptures or pictures. The static character of sculptures is dissolved; the artwork is audible, therefore immaterial and ephemeral... changing the once distant relationship between work and recipient and making it transitory (2009, p. 60).

Within such personalised environments, the concepts of temporality and spatiality acquire heightened significance. I will here discuss the mechanisms by which humans perceive time in order to explore this further.

Time, linearity, and narrative

The term *spatio-temporal* describes how sounds cannot exist independently of time. The human perception of time has been described as “a philosophical puzzle” with no agreed solution (Connor & Smith, 2022, p. 69).²⁰ However, one suggested model is to consider listener perception of time as consisting of three elements: the perpetual present, the short-term past, and the anticipated future. This aligns with philosopher Edmund Husserl’s view that “each momentary experience has a tripartite structure: a past-directed retention, a present-directed primal impression, and a future-directed protention” (Connor & Smith, 2022, p. 69). Music, therefore, generates its own sense of linearity and movement through this perception, and this has particular relevance for musicians and composers on many levels; many characteristics within music play directly with this perception. Take harmony, for example. When we hear the notes of a chord played simultaneously, we experience them within the perceptual present, but we also perceive harmony when notes are spread over time (as the short-term memory remembers relative relations between pitches). Without this psychological function, melody would not be possible, nor would chord sequences or relationships between musical phrases. Without this psychological function, music would be a very different phenomenon.

Tonal harmony works on a similar principle in order to create a sense of trajectory through chord progressions that generate tension and then resolve in creative ways. This can create musical ‘narratives’ and propel the music forward moment by moment, whilst also shaping larger formal structures. Much of contemporary electronic dance music functions as it does because of this principle, where ‘drops’ are created by temporarily removing the beat and bass whilst other elements build tension, priming the audience to anticipate their return. When executed well, this return produces a powerful sense of release. The most effective drops balance fulfilment and surprise, delivering what the audience expects but not exactly in the way they expect it. For example, in Four Tet’s live performance of *Looking at Your Pager* (BBC Music, 2022) at Glastonbury 2022, the piece builds toward a conventional drop

²⁰ See *Music and Time* (2022) by Michelle Phillips and Matthew Sergeant for a thorough accounting of this issue.

but reintroduces the bass one beat earlier than anticipated (at 2:30), a playful subversion that both honours and tweaks formal expectations, amplifying the audience's enjoyment as evidenced by their reaction.

Due to their generative nature, environmental sound installation pieces, on the other hand, tend to oppose narrative, drama, and linear musical momentum, instead creating musical states that feel fixed in the present. Curator Mark Rosenthal writes,

The viewer is asked to investigate the work of art much as he or she might explore some phenomenon in life, making one's way through actual space and time in order to gain knowledge. Just as life consists of one perception followed by another, each a fleeting, non-linear moment, an installation courts the same dense, ephemeral experience... The viewer is in the present, experiencing temporal flow and spatial awareness. The time and space of the viewer coincide with the art, with no separation or dichotomy between the perceiver and the object (2003, p. 27).

In my experience, sound installation can induce meditative states not dissimilar to the flickering of fire or the movement of water. When performing the installation part of *Sound Sculpture No.8* (as will be discussed in the next chapter), I watched young families become quite mesmerised by the visual and sonic qualities of a motor bouncing back and forth across two xylophone bars, sitting for half an hour, content simply to watch the repetition that never quite exactly repeats – the chaotic behaviour inherent in physical materials. These states perhaps have resonances with Mark Fell's description of Tibetan music:

The singing bowl and the prolonged tonal frequencies of chanting and the thigh bone trumpet offered a sonic diagram of the world quite unlike the one promoted in Western musics... there was no place for narrative, emotion or the communication of meaning, but sheer physicality and presence of sound (Fell, 2014, pp. 79–80).

I will now discuss automated systems common to many installation works and the behaviours they exhibit.

Physical sound installations produce sound with some degree of autonomy; therefore, they must be some form of system

And so, in installation work, the spatial environment must be populated with sound. This is often achieved through automated sound-making systems, as exemplified in the motorised works of Zimoun, the wind-driven *Singing Ringing Tree*, or Alvin Lucier's magnetically activated *Music on a Long Thin Wire*, as discussed in the literature review (page 33).

Alternatively, installations may generate sound electronically with computer-based generative systems, as is common in programs such as Max/MSP.

Such pieces, therefore, consist of and contain systems: networks of interconnected, interacting components, through which sound installations can become a playground for various kinds of linear, chaotic, resultant, and emergent behaviours common to the natural world. Such behaviours are studied within various disciplines: I was introduced to them within the mathematical discipline of dynamical systems by Professor Lasse Rempe, with whom I collaborated as part of the PRISM research project *8-Cubed* (resulting in the piece *Pendula*, discussed on page 85). Such behaviours include:

- **Linear behaviour**

A dynamical system changes and evolves according to a fixed set of rules (Rempe, 2022). For example, planets in a solar system or a pendulum swinging back and forth until it runs out of energy – these are examples of regular, simple systems which show stable behaviour and cycle through a predictable set of states. In relation to sound installation works, we might think of Zimoun's works as globally predictable but locally unpredictable mechanical systems within this context. If the energy never died, you could come back in a hundred years, and it would still be doing the same things (although the precise relative positions of each component would not be repeated).

- **Nonlinearity/chaos**

In the 1960s, Edward Lorenz (a well-known meteorologist) discovered mathematical chaos in the unpredictable, non-linear nature of weather systems (Lorenz, 1963). He summarises chaos as “when the present determines the future, but the approximate present does not

approximately determine the future” (Ramadhan, 2021). Some dynamical systems can become chaotic easily because of their “sensitivity to initial conditions.” All you need to do to make a pendulum act chaotically is add a joint to create a double pendulum: the trajectory of the second pendulum will be different every time and therefore entirely unpredictable because the exact position that the pendulum is dropped from can never be exactly replicated, and however small the change of angle is, it will permeate through the system. Alvin Lucier’s *Music on a Long Thin Wire* (1977) could be considered an unpredictable, chaotic system with behaviour and sound that emerges differently every time.

- **Synchronisation**

The phenomenon of synchronisation was first observed in physical systems by the Dutch scientist Christiaan Huygens in the 17th century, when he noticed that oscillating pendulums would synchronise their frequencies due to sympathetic resonance transmitted through a shared coupling structure; in this case, the wooden beam from which the pendulums were suspended (Ramirez, 2020). Synchronisation is a widespread phenomenon across the natural world. For example, plucked violin strings quickly align their harmonics after being triggered (Han, 2017); planets synchronise their orbital patterns within a solar system to avoid being flung into space; metronomes placed on a (suspended) wooden surface will fall in sync due to shared vibrations carried through the structure (Veritasium, 2021); and fireflies will synchronise their flashing with LED’s, as clearly demonstrated in the installation *Synchronicity* by Robin Meier and Andre Gwerder (2015).

- **Emergence**

Notions of emergence span multiple disciplines and provide a means to understand the properties of complex systems (physical and otherwise) that cannot be reduced to the individual parts of the system in question (Silva, 2024). Theoretical physicist Maxi San Miguel states:

When we say that a system has emergent properties, we mean that an effective theory of the system at some scale or level of organisation is qualitatively different from the lower-level scale... Society is more than a collection of individuals, in the

same way that the brain and mind are more than a collection of neurons, or traffic a collection of cars (2023, p. 1).

A commonly cited example of this comes from the world of physics and notions of ‘wetness’: When two hydrogen atoms are joined with an oxygen atom, they form a water molecule; when multiple molecules interact they create bodies of water – out of which the quality of ‘wetness’ emerges (Brooks, 2023). Take these molecules apart, and the property of wetness ceases to exist. Emergence such as this occurs within musical contexts at fundamental levels of acoustic and psychoacoustic perception. Take, for example, the emergence of timbre in human perception when multiple frequencies combine. The sensation of timbre here is emergent; just as ‘wetness’ disappears if water molecules are disconnected, so does the specific timbre of a sound if the constituent parts of a wave complex are removed (as demonstrated in Figure 4, page 28).

This idea of emergence applies not only at the most basic levels of sound perception, such as timbre, but also to the human conception of music at higher levels of psychological abstraction. As Carvalho observes, “There is something that emerges in a piece of music, especially in the skilled act of making music. What emerges is the music in that piece of music” (2019, p. 77). Similarly, Honing notes that music is much more than “organised sound” (2014, p. 46); music is a cognitive phenomenon; music exists in our minds. And Clarke argues that to perceive sound as *music*, we must attribute meaning to the sounds we hear:

To hear a sound and recognise what it is (for example, the sound of the mail being delivered through the letterbox) is to understand its perceptual meaning, which will result in *corresponding actions* (2005, p. 7).

In this case, such a corresponding action is likely to physically stand up and collect the mail. A corresponding action in response to a sound installation might be something else – to enter a meditative state, perhaps?

And so, music emerges not only from the sonic components of a piece but also through the listener’s psychological processes, collected experiences and cultural training. This sense of

emergence is central to sound installation, where generative sound-making systems create more than just ‘interesting sounds’ – they also interact with the spatial environment and the listener themselves. This leads me to consider: could a meditative state induced by an installation be considered an emergent property of a system that includes not just the sound making apparatus, but the listener as well? Is a meditative state the *ideal* emergent property of installation work?

Many of the system behaviours discussed above become cornerstones of compelling sound installations. I will now outline my attempts to understand and creatively manifest such system behaviours musically in my own practice, alongside explorations of temporal and spatial considerations.

PENDULA

My initial attempts to integrate notions of dynamical systems manifested as a kind of musical metaphor, echoing Tristan Murail’s *Attracteurs étranges* (1992), which musically embodies the butterfly effect and strange attractors (as visualised by the Lorenz Attractor, see Figure 26 below). In such systems, trajectories never repeat exactly, revolving instead around fixed points called attractors. Murail writes, “The melodic contours trace spirals with trajectories that always seem to return toward one or several of the same points, but often follow varied, distorted or twisted paths... we sometimes seem to reach a point of equilibrium: but the equilibrium is unstable and projects the music into a new cycle of oscillations” (1992). Whilst *Pendula* was a satisfying piece in its own right, it ultimately became a springboard for exploring how composition and installation could engage with dynamical systems more literally, moving from metaphor into the physical and chaotic realms explored by Zimoun and Lucier.

Figure 26 *Lorenz attractor image*



Lorenz Attractor (n.d). In Wikimedia Commons. Retrieved November 23rd, 2024, from

https://upload.wikimedia.org/wikipedia/commons/5/5b/Lorenz_attractor_yb.svg

SOUND SCULPTURE NO.5

This piece was composed for [Simon Knighton Curates: Dynamical Systems and Natural Environments](#), a concert curation project commissioned by Nonclassical that took place in September 2022 at St John's Church, Waterloo, London. For this project, my aim was to compose new works on the theme of 'Dynamical Systems and Natural Environments' whilst also programming other pieces that complemented this concept.

At that time, two fellow RNCM students, Sam Longbottom and Tanguy Pocquet, had recently completed their installation, *threaded | spinning | abrading | possibly breaking* (Longbottom & Pocquet, 2022), which I felt fitted the brief perfectly. The work employs turntables, fishing wire, and string instruments to generate drones and other sounds. Its design offers a wide range of sonic possibilities that can be explored by altering the system's parameters; for example, applying bow resin to the fishing wire can create strikingly different timbral results. I opened the concert with *threaded | spinning | abrading | possibly breaking* so that the audience entered directly into an installation environment.

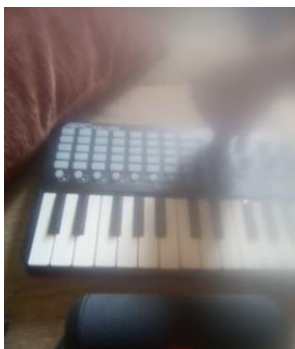
Figure 27 [threaded | spinning | abrading | possibly breaking by Longbottom and Pocquet \(2022\)](#)



(Longbottom & Pocquet, 2022)

I then composed my *Sound Sculpture No.5 (and No.6)* to blend seamlessly with the installation, furthering my attempts to fuse installation and performance as first experimented with in *Sound Sculpture No.1*. I achieved this crossover by using the same pitches that Sam and Tanguy tuned their installation to, gradually layering notes over time from across the ensemble and employing the technique of blending live legato tones with samples of those same tones, first developed in *Sound Sculpture No.1*. The piece then transitions into a spatialised work for acoustic instruments and electronics through an electronic glissando. In this section, all the tones of the chord are MIDI mapped to a single pan pot, which, when turned fully, creates a unison chord. Each pitch has a different transition value programmed to multiple pitch shifters, producing a dynamic and evolving spatial effect.

Figure 28 [Electronic glissando](#)



The core materials and compositional processes of this piece then build upon my methods of blending samples of instrumentalists with live performers from *Sound Sculpture No.1*, but are expanded significantly through the use of samples of gestures in line with the pandemic-related work of *Sound Sculptures 2, 3, and 4*. *Sound Sculpture No.5* is in many ways a live re-working of material from *Sound Sculpture No.4 Part Two* and *Natural Environments Two and Three*, albeit with extra samples offered by Carl Raven (saxophones) and Amy Gray (percussion). This represents people who have never met, having samples of improvisation mixed. Considerations of how to perform the material live became paramount here and had to be worked into the composition process. Essentially, each part in the score is a notated version of a selected sample with a corresponding electronic part that is made from the same sample but with electronic processing of some form applied. For example, subtle micro-tuned pitch shifts (see *Natural Environments Two* in the previous chapter) are applied electronically to Gemma's flying spiccato gestures (see score, page 10), which are copied and repeated at random time intervals. Gemma is then asked to improvise variations of the same gesture, in response to the electronics in real-time (and likewise, the other players use gestures sampled from their respective improvisations). After a certain amount of time, I give a signal, and the piece moves on to the next section. This means that the overall form of the piece is fixed, but the details of how the piece unfolds within these boundaries have a degree of flexibility and freedom.

Figure 29 *Sound Sculpture No.5* score example (score page 9)

The image shows a musical score for 'PART THREE' of 'Sound Sculpture No.5'. The score is written for four staves: Violin (Vln.), Viola (Vc.), Percussion (Perc.), and Baritone (Bari.).

- Violin (Vln.):** The staff is mostly empty, with a box labeled 'K' at the beginning and a box labeled 'L' further along.
- Viola (Vc.):** The staff is mostly empty.
- Percussion (Perc.):**
 - At the beginning, there is a box labeled '5 Metal objects'.
 - Below the staff, there is a long horizontal line with 'x' marks, indicating a sequence of sounds. Below this line is the instruction 'Improvise for approx. 1 minute 30 seconds'.
 - At measure 27, there is a box labeled '27'.
 - Below the staff, there is a wavy line with the instruction 'keep going until mark O'.
- Baritone (Bari.):**
 - At measure 28, there is a box labeled '28'.
 - Below the staff, there is a wavy line with the instruction 'keep going until mark O'.
 - Below the staff, there is a box labeled 'p' (piano) and the instruction 'Improvise for approx. 1 minute 30 seconds'.
 - Below the staff, there is a box labeled 'Alto Saxophone' and the instruction 'Create clean, simple sine wave like sounds using these tones. Vary the octave, rhythm, dynamic, duration etc but keep it calm.'.

There are also time markers: 'Approx 10 seconds' with a dashed line and an arrow, and 'Approx 10 seconds' with a dashed line and an arrow.

Because listeners may find themselves physically closer to one instrument than another, depending on their position in the room, the piece's texture had to reflect this spatial dynamic. The goal was to avoid placing any single musical part, such as a melody over a chord sequence, at the top of a hierarchy. This presented an intriguing compositional challenge in terms of texture and in terms of making a piece of music where no one part is the focal point. where each part can be layered on top of the other and still work musically.

The piece (and indeed all my pieces) employs a post-tonal harmonic style in which pitch choices and harmonic structures arise from intuition, instrumental resonance, and considerations of acoustic and psychoacoustic phenomena. My harmonic style centres loosely around spectral-type harmonies with strong consonances, drawing on triadic pitch relationships without using their directional qualities explicitly in a classically tonal sense. It is this quality that situates my harmonic language within a post-tonal framework. As Jason Noble observes, “The temporalities of triadic post-tonality often replace closure-based syntax with open-ended potential for boundless extension” (2022, p. 139). This approach lends itself to harmony that sits ambiguously between direction-driven and static, making it well-suited to a wider music aesthetic that explores the environmental/temporal dimensions of installation and performance.²¹

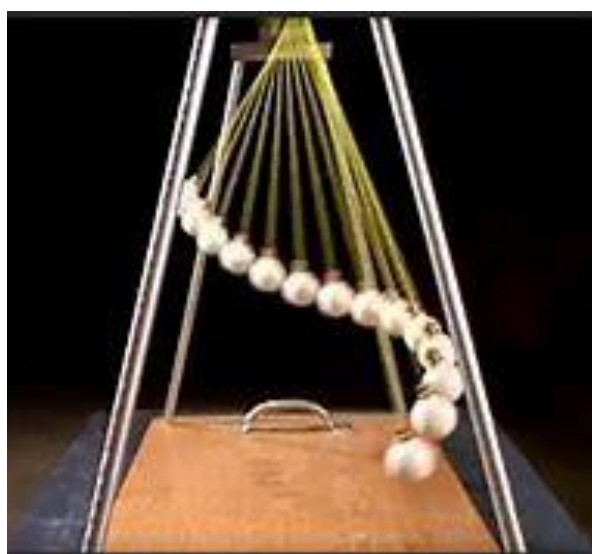
DYNAMICAL SYSTEMS ONE

As discussed in chapter two, my album tracks *Dynamical System Two* and *Three* use looping, chopping, and granulation to mimic dynamical systems. *Dynamical System One* explores more emergent behaviours through phase music. Composed for my 2022 concert *Dynamical Systems and Natural Environments*, the piece is an algorithmic electronic response to

²¹ A notable feature of the chord progression in *Sound Sculpture No.1*, I came to realise upon reflection of post-tonal harmony, is the slow rate of change of each soundscape. Each soundscape has a chord or harmonic field designed to create an infrequent sense of tension, producing subtle harmonic movement. Because the piece unfolds so slowly, at roughly one chord per minute, it is uncertain how readily the audience will perceive these changes. As Noble notes, “The sheer pace of change alters the perceptual identities of the harmonic units, erasing the functionality that may accompany them in a more normative timescale” (2022, p. 138).

threaded, spinning, and abrading processes, using the same precise tuning as Sam and Tanguy's work, transposed across octaves. It opened the second half of the concert as an electronic installation counterpart to the acoustic installation of the first half and also appears as track 4 on my album and the final section of *Sound Sculpture No. 6*. The work is inspired by pendulum waves: independent oscillators with varying lengths and speeds that fall out of sync to produce travelling waves, standing waves, and other emergent visual patterns (MEL Science n.d.; Harvard Natural Sciences Lecture Demonstrations, 2010).

Figure 30 [Pendulum waves demonstration](#)

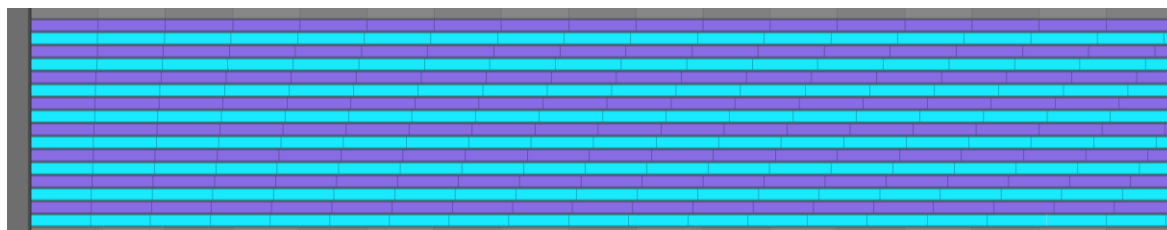


(Harvard Natural Sciences Lecture Demonstrations, 2010)

The core materials of this piece are generated by a musical system inspired by pendulum waves. Loops at different tempos feature percussive hits on the first and fifth beats of a 7-beat bar, creating spatio-temporal patterns where pitches from a single chord sound at different times and spatialised locations (achieving through panning) around the room. Odd time signatures and irregular hits produce evolving wave-like textures, with timbres drawn from synthesiser blips, guitar plucks, glockenspiel strikes, music box plinks, and a church bell recorded in Aegina, Greece. Post-production shapes the sound further, highlighting certain Escheresque patterns and adding surprise. Techniques include automating volume levels of

instrument subgroups to create phantom tempo shifts, looping sections of the wave, applying tempo shifts to nested subgroups, and using granular processing to warp selected sounds and accentuate harmonic elements.

Figure 31 Ableton screenshot of *Dynamical Systems One*



The opening seconds of the piece illustrate how over 40 overlapping parts, each at slightly different speeds, fade in and out to form the arrangement, in contrast to Steve Reich's phase pieces, which typically layer fewer parts (Étude, 2022). *Dynamical Systems One* demonstrates a musical system in which the composer actively manipulates the output, as the system alone did not produce enough variation or interest. The piece is thus semi-autonomous, providing raw materials for compositional shaping. It marks a step forward from *Pendula*, incorporating more literal systems and positioning the composer as both system designer and performer controlling its parameters.

Figure 32 *Dynamical Systems One* surround sound version, St John's Church, Waterloo, September 2022



SOUND SCULPTURE NO.6

In *Sound Sculpture No.6* for the House of Bedlam, I attempted to portray various types of musical dynamical systems, as discussed above, in one piece of music. To this end, *Sound Sculpture No.6* has three parts inspired by notions of physical, poetic, and electronic dynamical systems. The piece begins again with Sam and Tanguy's installation with the instruments slowing entering as per *Sound Sculpture No.5*. At mark F in the score (page 53), new material (in which samples of the instruments taken in rehearsal are pitch shifted by small degrees as they sound with the live instruments (who play the same chords) creates a shifting timbral soundscape. In Part Two (page 12 of the score), a live reworking of *Natural Environments One* begins and represents a poetic dynamical system. Visualised in a short film by artist Fiona Brehony, part three features *Dynamical Systems One* in stereo form. Our intention with the film was to make visual and sonic connections between nature and dynamical systems.

Figure 33 [*Sound Sculpture No.6* final section accompanying film by Fiona Brehony](#)



Image/film by Fiona Brehony. <https://fbrehonyphotography.com/>

SOUND SCULPTURE No.7

The final piece I will discuss in this chapter is *Sound Sculpture No.7* for orchestra. There was no installation part for *Sound Sculpture No.7*, and I returned to some of the ideas of *Sound Sculpture No.1* (around the spatial movement of sounds and panning), combined with ideas around dynamical systems in music, which in this case, sit somewhere between poetic analogy and real emergent systems. My previous sound sculptures were designed for two to five players, so this orchestral commission presented a very exciting opportunity to explore the spatial width of numerous acoustic instruments spread across a stage, in contrast to the stereo width of speakers placed around the hall. To this end, *Sound Sculpture No.7* essentially features two types of material, each with a distinct approach to ensemble conduct. One approach is conventional, and the other is not: both explore different types of mirroring, symmetry, and parallelism in the physical and musical geometry of the orchestra and the concert hall. Many different approaches to time are presented throughout this piece, with the highly directional chord structure of the opening and closing sections contrasted by the intervening *walking sections*, in which musical time is governed not by the narrative consequences of harmony, but by the physical, spatial position of the conductor in relation to the orchestra itself.

Walking sections

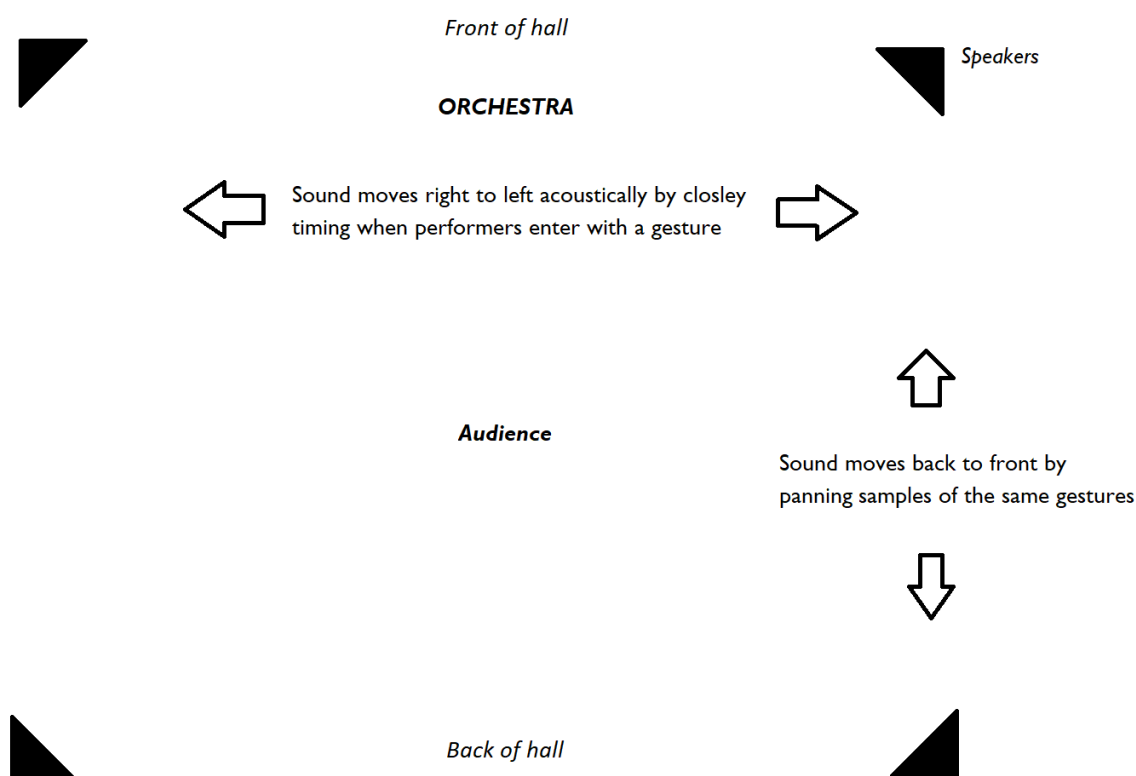
I attempted to design composition methods that consider performers as individual components within a larger system that “evolves over time according to fixed rules” (Rempe, 2022). Taking my understanding of ‘raw materials’ in this instance to mean a performer with a specific gesture, my goal with this piece was to treat the individuals of the orchestra as components which, when acting together, create emergent musical outputs. As individual parts, the components might not mean much, but as higher levels of organisation, emergent musical properties occur and interestingly, autonomous human behaviours were observed during rehearsals.

The walking conducting sections (see score, page 8) employ an interpretation of musical dynamical systems, applied across a large group of instruments. The conductor walks from left to right and back again in front of the orchestra, thereby physically/visually representing the dimensions of the space. The score directs players to begin new semi-improvised gestures as the conductor passes in front of them. Here, the performers act as individual components connected by the movements of the conductor, who functions as a kind of coupling system found in synchronous systems (see below). When each gesture is triggered in close succession, an emergent musical/spatial wave ‘moves’ across the concert space, creating an effect reminiscent of pendulum waves, Mexican waves and swarm intelligence in bird/fish flocks. Simultaneously, pre-recorded samples of these gestures (taken in rehearsals) are panned from front-to-back across the audience, re-using the source-bonding techniques from *Sound Sculpture No.1*. This creates various aural movements around the listeners’ field of spatial perception.

Such spatial treatments are inspired by Denis Smalley's conceptions of *perspectival* and *spectral space*. Perspectival space concerns the positioning of sound sources within an acoustic environment, both physically and perceptually. Smalley describes perspectival space as:

The flux in relations among three views – prospective space, panoramic space and circumspace. Prospective space is the frontal image, which extends laterally to create a panoramic space within the range of vision; circumspace – space around the listener – extends panoramic space to encompass the listener, with the possibility of approaching or passing over egocentric space from all directions (2007, p. 48).

Spectral space, by contrast, refers to the frequency content of sound. Sounds with dense harmonic layering occupy more spectral space, whereas those with fewer harmonics occupy less spectral space (white noise fills the full broadband of spectral space). As Smalley observes, “The concept of spectral space is analogical: higher pitches can be thought of as spatially higher, and lower pitches as lower, but in terms of actual spatial location, they are not normally ‘physically’ higher and lower” (1997, p. 122).

Figure 34 *Orchestra sound movements diagram*

I developed an unconventional form of notation to integrate this method of conducting. The score for these sections no longer reads linearly; instead, each gesture is lined up with an instruction to the players to 'begin playing when the conductor passes in front of you'. Some of the gestures are instructed to be looped, whilst others are played only once. The conductor must then attempt to walk across the space in ever-decreasing amounts of specified time. Again, this is a creative response to the spatiotemporal nature of time and performance in a four-dimensional concert hall environment, aiming to create a semi-automated system of human interaction. It is no coincidence that the development of the musical materials took place primarily during the notation phase of this piece, far more so than in other works in my portfolio. The nonlinear nature of these materials made creating an Ableton demo virtually impossible; the system had to be designed on paper and realised directly in performance.

Figure 35 *Sound Sculpture No.7* score example (score page 23)²²

WALKING CONDUCTING PART THREE

*All players should begin each gesture as the conductor passes in front of them.
Players should choose their own tempo and should not synchronize with other players.
Players are encouraged to improvise variations based on the given gestures.*

Left to Right, 10 Secs.

The score is written for a large ensemble. The top section includes staves for Flute (Fl.), Clarinet (Cl.), Bassoon (Bsn.), Trumpet (Tpt.), and Trombone (Tbn.). Below these are staves for Violin I (Vln. I), Violin II (Vln. II), Viola (Vla.), Cello (Cb.), and Double Bass (Bass). The score features a variety of musical gestures, including long, sustained notes with dynamic markings like *ppp* and *f*, and more complex, rhythmic patterns. A vertical dashed line indicates a 10-second duration. A 'To Tempo' marking is present on the Trombone staff. A 'Back to front of zone' instruction is located near the bottom right of the score.

²² Where the sound palette used in *Sound Sculpture No.1* was kept to basic, simple gestures (mostly long legato tones, for example), *Sound Sculpture No.7* uses a broad range of increasingly complex musical gestures which relate to instrumental technique and performance practice discussed in chapter two.

Synchronisation and coupling structures

Interestingly, synchronisation can be demonstrated and observed in groups of people with decision-making agency. The motor function of the human body is, in many cases, subservient to the behaviours of complex systems. This is supported by psychologists Alexander Demos, Roger Chaffin, and Vivek Kant, who write of a simple experiment that most humans can easily test to experience this in their physical bodies:

Point the tips of your two index fingers toward each other. Slowly move your fingers up and down in opposite directions (anti-phase). Slowly speed up to go as fast as you can. As you speed up, you will notice that your fingers spontaneously start moving in the same direction... In contrast, if you start out fast and in-phase and slow down, there is no automatic transition to anti-phase movement. This simple exercise illustrates the self-organizing nature of a complex system (Demos et al, 2014, p. 2).

As such, two insights into this kind of behaviour were gleaned in relation to orchestral performance involving large groups of individual performers. The flying spiccato musical gesture, in particular, provided fascinating insights into the nature of human synchrony, as no matter how many times I asked in rehearsals, I could not get the players to play their independent gestures at noticeably different speeds from one another. Additionally, players could be heard to ‘lock-in’ musically at certain points in ways not directed in the score (score page 24, for example), or by the conductor or myself. The group therefore displayed behaviours consistent with bottom-up, self-organising systems, whereby musical structures emerge from a simple set of rules. I would therefore argue that this piece is not an analogy of a dynamical system, but a kind of actual dynamical system in its own right. In future pieces, I hope to explore further methods of creating the conditions for these types of emergent musical patterns and to investigate human synchronisation and self-organising behaviours across large groups of musicians in relation to theories such as swarm intelligence and complex coupling configurations (Shahal et al., 2020).

The conventionally conducted sections

In between the *walking sections* are conventionally conducted and notated sections in which chords and phrases from the orchestra are juxtaposed with various electronic parts projected from the back of the hall. This creates another form of dynamic interplay between orchestra and electronics and makes further use of creative use of perspectival and spectral dimensions.

In the conventionally conducted sections 1 and 4, synthesised chords tuned to just intonation resonate against equal-tempered versions of the same chords from the orchestra. As the electronic tones have slightly different micro-tunings to the acoustic tones, they occupy slightly different spectral space within the arrangement. There is a clear and intended juxtaposition of timbres created by using acoustic instruments and synthesised tones in this manner. Perspectival space is played with by having the synthesised tones projected from behind the audience, creating a perspectival space for the listener within the musical arrangement, where much spectral information is spread across and around the concert hall. This provided a much more transparent sound in live performance when compared to the stereo recording, in which everything is quite ‘mushed’ together. The chords descend in the opening section and rise in the closing sections, providing a kind of musical symmetry to the form of the piece.

In the conventionally conducted sections 2 and 3, reversed recordings of entire musical phrases (recorded rather hastily during rehearsals) are projected between live orchestra phrases. This plays with notions of perspectival space in combination with time-based musical linearity in a fun and playful way, by literally reversing the material just heard from the orchestra. And whilst the audience’s perception of time is still moving forward, the music itself is moving backwards, whilst being projected from the back of the hall.

Closing thoughts on chapter three

The works discussed in this chapter close out the core of the portfolio. As outlined earlier, my approach to combining acoustic and electronic sound evolved significantly over the

course of this research. What began as a preoccupation with perceptual fusion developed into a multifaceted exploration of the textural relationships between acoustic and electronically sound, situated within the broader context of *sound sculpture* and notions of spatiality, temporality, and ideas of installation-performance crossover.

One recurring concern I had with some of these pieces was the ‘weight’ of the electronic element. Whilst not dominant to the point of overpowering, the music often leaned heavily on the electronics, and the disembodied nature of such use became increasingly apparent, particularly in *Sound Sculptures 5 and 6*. In my final piece, I sought to address this by using electronics with greater subtlety, placing the responsibility for the created sonic world primarily on the acoustic instrument, whilst employing the electronic element as a supportive backdrop that still fuses and blends with the live performance in creative, but more restrained, ways. Additionally, I felt there was one further type of work I needed to create for the portfolio to feel truly complete. Collaborating with Sam and Tanguy on *Sound Sculpture No.5* and *No.6* was invaluable in exploring the intersection of installation and performance. My next step, however, was to create a physical installation of my own, one that embodies ideas of dynamical systems, material agency and the other ideas expressed in this chapter, whilst also incorporating an acoustic performance integrated within the installation itself.

Chapter Four. Natural Environments

“Working with stone is different to say painting, in that the grain of the stone decides to a large degree how a sculpture will be made... to the point that some artists [feel] that the sculpture [is] already there in the stone, and the artists job [is] just to find it, to see it and to bring it out”

– Blindboy (2023).

In this final chapter, I will discuss the final piece of my portfolio, *Sound Sculpture No. 8*, in which I attempted to encapsulate and assimilate the techniques, methods, and thinking of the previous seven sculptures into a single, coherent 30-minute work for string trio, electronics, and installation. This piece most concisely tackles my fourth stated research aim: to integrate the affordances of material agency into installation/performance pieces. This piece extends my thinking on spectral thinking and material agency to create a piece in which physical materials themselves become indeterminate and unpredictable “quasi-agents in music-making” (Sergeant, van Elferen, & Wilson, 2020) in multiple direct ways. It is worth noting that this is the only portfolio piece that does not start with a recording session with performers; instead, it starts with a recording session with nature.

A ROOM THAT SINGS – FIELD RECORDINGS

In October 2023, I was invited by visual and sculptural artist Nayan Kulkarni to visit Dalby Forest in North Yorkshire and make field recordings of a protected beaver dam for his project *A Room that Sings*,²³ in which he is building an audio installation commissioned by Forestry England. This project served as an effective study of dynamical systems in nature, which I then attempted to embody in *Sound Sculpture No.8*.

²³ <https://www.emanuelhendry.co.uk/projects-services/item/143/a-room-that-sings-yorkshire>

Figure 36 *Photo of the beaver dam*



Photo by Fiona Brehony

Clocks and clouds

I recorded multiple locations along the banks of the dam, where there were hundreds of small trickles around the edge of where the beavers had built the dam wall. I placed two microphones at close distance to two separate trickles of water, and another stereo pair further back to capture the general ambience of the space. The close microphones capture a very high-resolution sonic image of the ‘rhythm’ of the drips. In contrast, the distant microphones capture a more atmospheric, ambient scene – a distant sonic image of the many streams around the space as they converge to become a kind of ‘cloud-like’ soundscape. In the recordings, I gradually adjust the mix of the different microphones to transition smoothly from one image to another.

The ‘plink’ sound that one hears when a water drip hits a larger body of water is a complex phenomenon that has been a source of scientific curiosity for over a hundred years (Phillips et al., 2018, p. 1). Recent research describes the ‘plink’ as having several stages:

The initial impact, capillary waves on the surface, a cavity due to the inertia of the drop, a recoil of the cavity due to surface tension, an entrapped air bubble, the

recoiling surface forming a jet that disintegrates into a liquid drop above the air surface (Phillips et al, 2018, p. 11).

Furthermore, different volumes, shapes and sizes of droplets will resonate at different frequencies, producing different pitches (Beacham, Tilger, & Oehlschlaeger, 2020). An interesting observation I have made when studying the frequency content of these audio recordings is how certain frequencies seem to pair with one another within a single trickle. These tend to be close in the frequency spectrum. So, for example, a 'plink' at 1000 Hz will not pair with another at 6000 Hz. However, if two 'plinks' are nearby, at say 8000 and 8200 Hz, they will tend to become grouped in the perception as a kind of counterpoint rhythm. And there seems to be a kind of critical mass; when too many frequencies occur, they become impossible to assimilate perpetually and become the cloud-like sound texture mentioned above.²⁴

The speech-to-song illusion

A final observation I made from the field recordings: it is easy to hear that a trickle of water does not repeat its 'rhythm' and that there are constant variations (the trickle is non-linear). A psychoacoustic trick to make this obvious is to loop a short section of recorded water, as I have done with a field recording (taken by artist Fiona Brehony) in the final moments of *Natural Environments Two*. This water loop illustrates an interesting psychoacoustic phenomenon known as the "speech-to-song illusion" – an auditory illusion discovered by Diana Deutsch (n.d.) in which spoken passages will transform in the perception of the listener from speech to melody when looped. There are several purported reasons for this as discussed by music psychologists Hymers et al (2014), such as that different parts of the brain are activated when hearing speech vs song, or that the melodic pitch information of the spoken words is of secondary importance until it is looped; the brain first looks for meaning in the words before the looping tells the brain that it is actually music, and the

²⁴ Does this have links to the four voices of counterpoint and the human capacity to perceive a limited number of voices? This question could lead to further research beyond the scope of this project.

brain then instead searches for meaning in the pitches of the sounds. However, the fact that this effect occurs in water loops, as well as speech, eliminates this theory and, I would argue, highlights the importance of rhythm as a key factor of melody.

The speech-to-song illusion has led some researchers to discuss the importance of repetition in music from psychoacoustic perspectives, arguing that the listener's ability to “[move] down and up through an event’s temporal structure across repeated hearings... [is a] fundamental component of what it means to attend musically to a stimulus” (Margulis, 2013, p. 159). However, I would argue that this is an inaccurate claim. Many types of music do not contain repetition, and in any case, exactly what is considered as ‘music’ is very much a cultural and cognitive phenomenon relative to particular schools of people, cultures, etc. Indeed, the cultural boundaries of what constitutes ‘music’ are always evolving. Perhaps one of the most famous pieces to challenge conventional notions of formally structured music is John Cage’s 4’33, in which a pianist sits at a piano and plays nothing for 4 minutes and 33 seconds. The exact meaning of this piece is still debated to this day (for example in a recent article by the BBC’s *Classical Music* magazine (Classical Music, 2024)), but many believe that 4’33 encourages audiences to take a more active role in listening and deciding what sounds to focus on during a performance and therefore include in what they understand to be ‘music’. This kind of listening has keen ties with field recording and installation artists alike.

SOUND SCULPTURE NO.8 INSTALLATION

In my *Sound Sculpture No. 8*, I created an installation inspired by the aforementioned study of water. The piece then goes on to investigate how unique, esoteric tuning systems can be derived from the non-human creative affordances of a specific set of physical materials – in this case a set of self-designed and self-built chime bells. During performance, these chime bells are automated using motors (and are accompanied by xylophone bars and a randomised synth patch) to generate a constantly shifting timbral and harmonic soundscape.

These percussion instruments are designed so that the motor can naturally bounce between two different surfaces and therefore create micro-rhythms consisting of the contrapuntal interaction of two related pitches, as inspired by the movement and sound of water. During the premiere, the installation was spread out over the foyer of the Southbank Centre, before being moved into the concert hall for the performance.

(A video of the installation building process can be viewed by clicking the title above.)

Chime bells

I began the composition process of this piece by building a set of chime bells out of sheets of brass. The chime bells are cut and molded to specific ratios of one another, inspired by the harmonic series and how it emerges from frequencies which are integer multiples of the longest frequency in a pitch complex. However, in chime bell design, the density of the brass is also an essential element of pitch, and the annealing process (where the brass is heated to become malleable before being shaped) changes the density of the brass. After annealing, the bells are hammered into shape, during which the brass hardens and becomes denser. However, this does not happen uniformly across the entire piece of material, so different parts of the chimes have noticeably different pitches, which can clearly be heard when struck at different points across their materials (this is demonstrated in Video Figures 41, 42, and 43 below). The uneven curvature of the chimes also creates unpredictable harmonic content. An additional design feature, added to provide extra harmonic interest, was to cut extra shapes out of the chime bells to make multiple lengths and widths of material, resulting in a complex of sometimes expected consonances and sometimes unexpected dissonances. These factors lead to compelling and rich harmonic relationships between the inner harmonics of individual chimes and the chimes as a set, and I built seven chime bells to the following specifications:

Figure 37 Chime bell design 'type 1' measurements

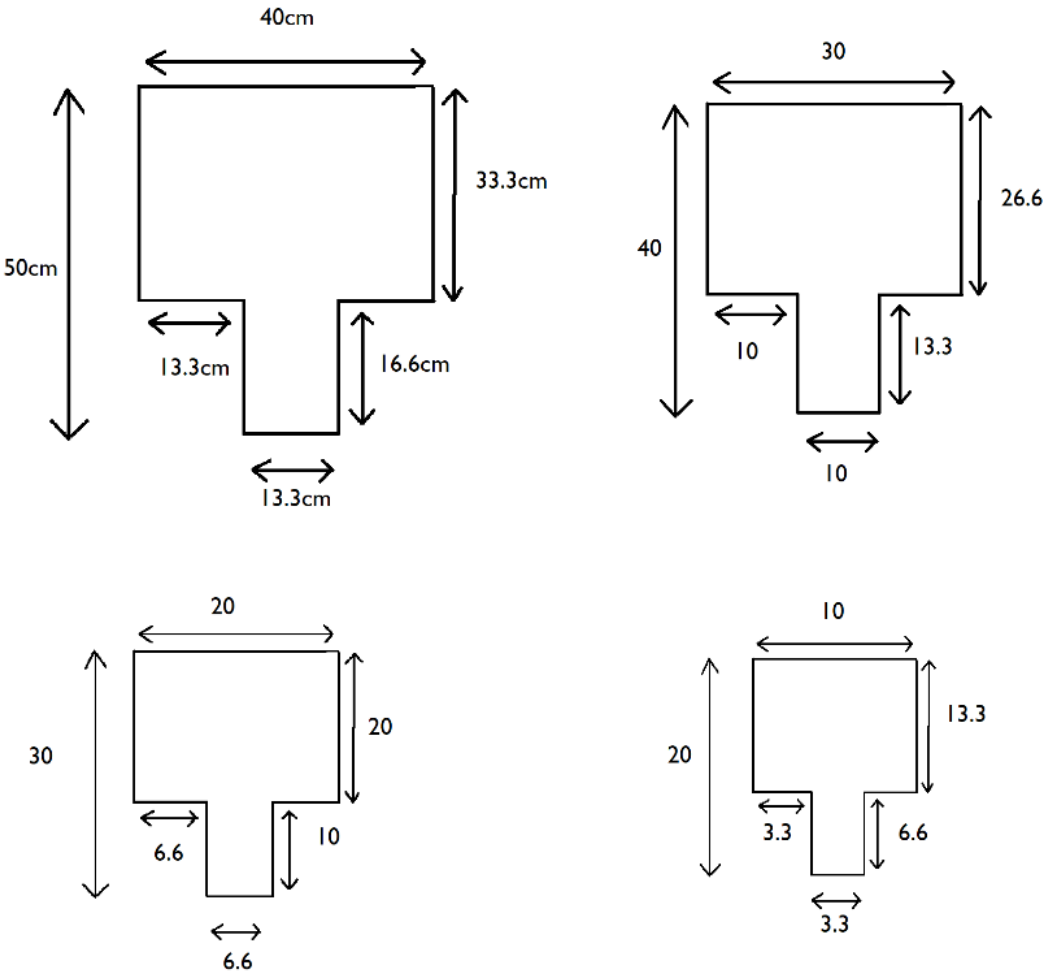


Figure 38 Chime bell design 'type 2' measurements

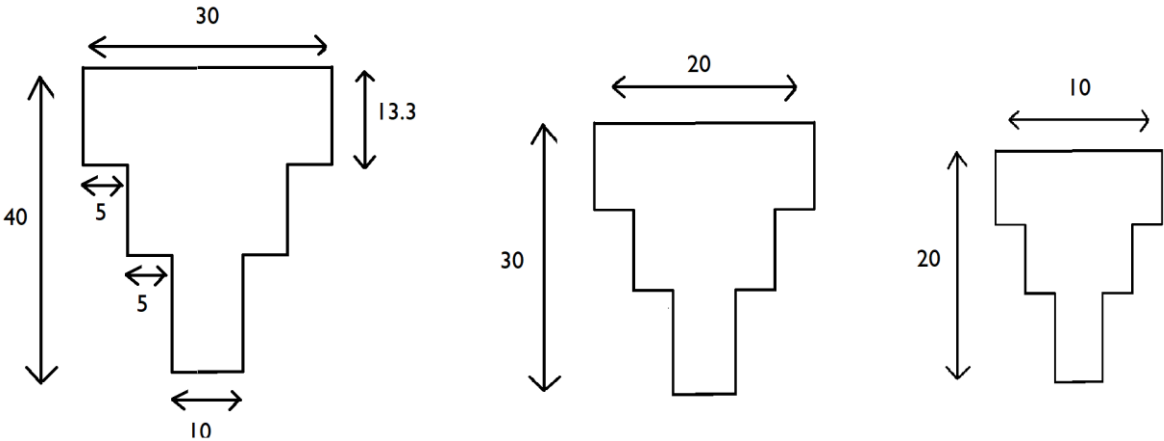


Figure 39 [Chime bell set demonstration](#)



Figure 40 [Chime bell set demonstration 2](#)



Figure 41 [Type 1 and type 2 chimes 20cm](#)



Figure 42 [Type 1 and type 2 chimes 30cm](#)

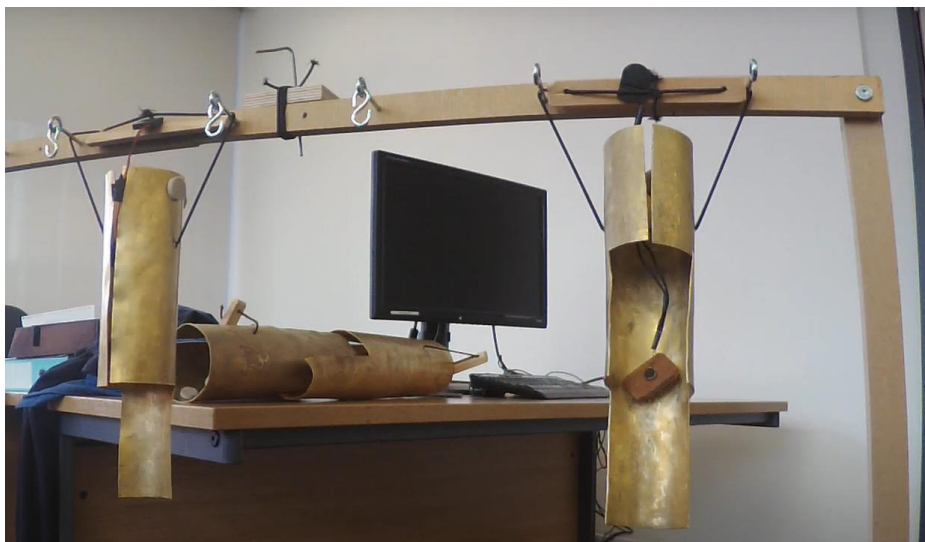


Figure 43 [Type 1 and type 2 chimes 40cm](#)



Synthesised tones

I then analysed the frequency content of the chimes and noted the most prominent harmonics, as shown in Figure 44 below. I then built a micro-tuned synthesiser in Ableton with these exact pitches.

Figure 44 *Chime bell harmonics*

20cm (type1)	30cm (type1)	40cm (type1)
E5 +38 G#5 -33 A#5 +47 D6 +00 E6 -18 F#6 +1 B6 -21 D7 +08 D#7 +25 G7 _40 A7 -39	C5 +47 D5 +39 G#5 +00 C6 +33 F6 +43 G#6 +36 C7 +19 D#7 +38 F#7 45	D#4 -09 B4 -19 D5 -25 F5 +32 G#5 -39 D6 +37 F#6 -06 G6 +36 B6 -34 E7 -49 F7 +4 A7 +29 D8 -04
(type2)	(type2)	(type2)
C#6 -16 D#6 -25 F#6 +45 A6 +38 C#7 -43 D#7 -39 F7 -09 G#7 +10	C6 -31 C#6 +10 E6 +41 F#6 +07 G#6 +49 D7 -15 E7 +21 G7 -05 B7 +16	D#5 -36 G#5 +25 B5 -20 C6 -43 F#6 -06 C#7 -43 F7 -09 A7 +50 D8 +34

Xylophone bars

Using an electronic tuning device (and the synthesiser as an aural guide), I then built xylophone bars which are also micro-tuned to the harmonics of the chimes. I eventually made over 50 xylophone bars:

Figure 45 [Xylophone bars tuned to 20cm chime type 1](#)



Figure 46 [Xylophone bars tuned to 30cm chime type 2](#)



Motors

During performance, these chimes and xylophone bars have multiple vibration motors attached, which are controlled via pre-programmed Arduino circuit boards,²⁵ allowing them to turn on and off at regular intervals automatically. The motors sonically activate different pitches within the materials in a chaotic, nonlinear fashion, and the instruments are purposefully designed to have surfaces that facilitate a kind of ‘material agency’ in this respect. For example, the chime bells have a slit cut into them, allowing the motor to be placed at the lip of the slit, where it is most likely to bounce back in chaotic ways. Each side of the chime bell has slightly different pitch content due to density differences in the brass, which creates a kind of sonic mimicry of water droplets. The following example displays the ideal positioning of a motor.

Figure 47 [*Chime bell slit*](#)



Similarly, many of the xylophone bars are designed to sit side by side with one another at just the right height and angle for a motor to naturally ‘want’ to bounce between the two bars.

²⁵ Special thanks to Chris Ball at www.chrisballprojects.co.uk for technical help with the Arduino side of things,

Figure 48 [Xylophone bars close](#)



I then began to experiment with different chord combinations using the synthesiser patch. These synthesised tones/chords are precisely tuned to the harmonics of the chimes and then triggered around the space. This draws the listener's attention to specific harmonics within the sound complex, creating a subtle yet dense, ever-evolving sound world. Much like a steady stream of water, the sound is always the same, yet always moving. The listener can decide on the level of detail they hear in each individually automated percussion instrument by moving closer or further from the sound source. Standing closer will reveal individual rhythms, whilst standing further away will reveal 'cloud-like' soundscapes similar to the beaver dam field recordings discussed in the opening of this chapter.

Figure 49 [Installation test run](#)

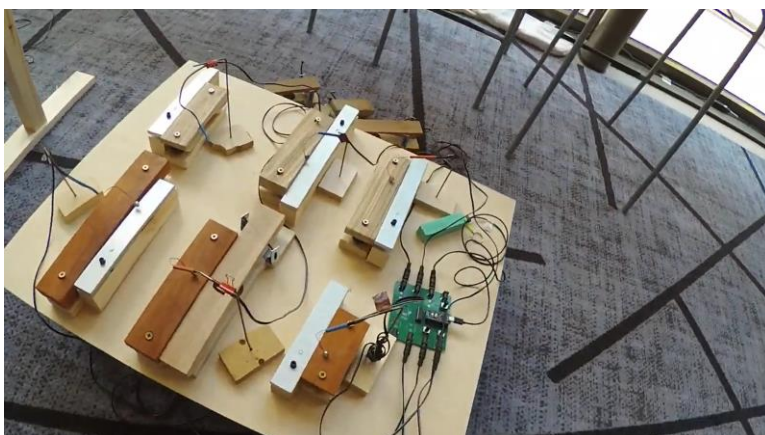


Figure 50 [*Installation test run with synth tones*](#)



Material agency

Throughout this commentary, I have discussed multiple meanings of agency. Are the unpredictable harmonics that arise from the materials (the curvature, density and other factors) a form of material agency? Is the motor bouncing across different parts of the instruments another form of material agency? Whilst I do not feel it is necessary to attempt to definitively answer these questions, if we take Andrew Pickering's discussion of "dancers of agency" again as a reference, then we do see clear points of agreement:

- Dancers of agency are themselves performative, not linguistic, cognitive, or whatever. They have to do with actions, human and non-human, in the material world and the interplay of those (2012, p. 195).
- Agency is emergent in the brute sense of being unknowable in advance of specific performances (2012, p. 195).

For me, the point within my practice is not whether my work falls into certain definitions, but rather how these sorts of concepts can inspire and become entwined in the creative process.

SOUND SCULPTURE NO.8

In line with one of the key emergent aims of this research, *Sound Sculpture No. 8* is a final exploration of how elements of installation and performance can be merged in various creative ways. The piece was first performed at the Southbank Centre in May 2024. During the day, the installation was set up in the foyer before being moved to the concert hall in the evening where the performance part with the strings happened. The piece was performed for a second time in June 2025 at the Anthony Burgess Foundation, Manchester.

Figure 51 Side view of trio and installation on stage at the Southbank Centre



The piece is divided into four parts:

- ***Part One. A spatial sonic environment***

The piece begins with the installation sounding on its own. One by one, the performers enter the performance space and begin to accompany the installation with gestures indicated in their scores (see Figure 51 below). Performers are encouraged to improvise variations of these gestures. The boxes are not intended to be synchronised across performers, hence the use of unconventional, open notation. After a suitable amount of time has passed (as agreed upon during rehearsals) the ensemble transitions into the next section.

Figure 52 *Sound Sculpture No.8 Part One* score extract

Violin enters

Very Slow

○ Slow, irregular circular bowing.

IV III II

Vln. *p* aim to blend with the dynamics of the installation (sometimes dipping under and sometimes sticking out).

Vln. *f* *mp*

Viola enters

Very Slow

○ Slow, irregular circular bowing.

IV III II

Vla. *p* aim to blend with the dynamics of the installation (sometimes dipping under and sometimes sticking out).

Vla. *f* *mp*

- **Part Two. Emergent musical linearity**

From this point on, the notation becomes conventional as the ensemble perform chords and tones derived from the chime harmonics (as shown in Figure 44). I attempted to compose the string material to increasingly suggest a sense of musical linearity, narrative, and direction, through shortening the spacing of the chords temporally, through accumulating texture density, and through the use of stronger pitch choices in terms of tonal 'pull'.

Surrounding these chords are synthesiser tones, micro-tuned to the chimes, creating a shimmering, electronically resonant layer behind the conventionally tuned string instruments. The string trio plays in standard tuning, whilst the synthesiser, micro-tuned to the precise harmonics of the chimes, mirrors the chords. Any sense of harmonic function within the chord sequences is composed intuitively and, due to the temporal spacing of the

chords, the result is a kind of slow-moving, post-tonal harmonic language that continually and subtly shifts between the chromatically tuned instruments and their micro-tuned synthesised counterparts. The installation soundscape functions as a connective element between the two tuning systems whilst also providing a distinct temporal layer, so that the static, 'cloud-like' installation acts in counterpoint to the slowly evolving, yet subtly directional harmonic strings/synthesisers. My intention is for the listener (conditioned by culturally ingrained expectations of equal temperament) to be pulled between the two tuning systems, having their sense of pitch and harmony continually destabilised and refreshed throughout. An apt metaphor might be to think of the string material as signposts in a forest, suggesting a path through the installation.

Figure 53 *Sound Sculpture No.8 Part Two score extract*

The image shows a musical score extract for three instruments: Violin I (Vln.), Viola (Vla.), and Clarinet (Cl.). The score is divided into four measures. Each measure contains a staff for each instrument. The first measure is marked with a '1' and includes the instruction 'Non vib. Molto sul pont.' and a forte dynamic 'fff'. The second measure is marked 'c. 8 secs' and features a forte dynamic 'fff'. The third measure is marked 'c. 7 secs' and features a forte dynamic 'ff'. The fourth measure is marked 'Sul pont.' and features a forte dynamic 'ff'. The score also includes a 'Sample 1' box at the bottom left and a 'B' box at the bottom right.

- **Part Three. Coda to the sonic environment qualities of the piece**

The piece concludes with two brief recaps. The first revisits the environmental and spatial material from Part One, but in a reimagined form. This time, the ensemble performs without the installation, and instead, the soundscape is constructed from processed samples recorded during rehearsals, combined with newly composed synthesiser chords. These

samples have been chopped, edited, and arranged to create a shimmering, spatially modulating texture.

For this section, I also returned to the collaborative techniques discussed in chapter two. During rehearsal, I recorded a quasi-improvised gesture that I was interested in exploring further: circular bowing combined with harmonic glissando. I later integrated this recording into the performance, blending it with the live players and applying a granular panning effect. The result is a dense, spatialised sound world that merges live performance with manipulated rehearsal material in a fluid and immersive way.

Figure 54 *Sound Sculpture No.8 Part Three score extract*

Slow

○ Slow circular bowing. Create mostly air noise with small flickers of pitch. No need to synchronise with other players - reconvene at next pause.

175 Vln. *p* IV ○

Vla. ○ II

Cl. ○ IV

Slow irregular circular bowing. Create mostly air noise with small flickers of pitch. No need to synchronise with other players - reconvene at next pause.

Search for random harmonics on any string.

p III

○ III

○ II

Sample 37 - Chopped up samples of the above gestures

E/I

- **Part Four. Coda to the musical linearity qualities of the piece.**

The piece concludes with a recap of the chord sequence from Part Two, reworked into a coda for acoustic instruments alone. This allowed me to focus more explicitly on traditional harmonic features, composing around the tension and release of dissonance and consonance in a very direct way. My intention is for this more directional music to feel as though it grew out of the initial, more static textures. Notions of ‘being and becoming’ (which was in fact

the original title of *Sound Sculpture No.1*) come to mind. Gestures and chords that serve as the foundation of Part Four were intentionally ‘seeded’ throughout the piece, functioning similarly to foreshadowing in a story. By planting these elements, I aimed to create formal associations across the work, aligning with the following concept by music psychologist Bob Snyder:

Associations between similar pitch and rhythmic patterns allow us to jump and make associations across different parts of a piece of music, outside its linear time order.

In this way, we can find ourselves at a place similar to somewhere we have previously been in a piece. It is even possible for musical material to refer backwards across a piece and change the significance of something we have heard earlier...

Much of the syntactical connections between different but related patterns in a piece of music are associative (Snyder, 2001, pp. 224–225).

In many ways, this final section rolls back to a compositional approach I might have used before the more experimental techniques explored in my PhD took root. In chapter one, I referred to a piece I abandoned during the SoundMine sessions in Belgium, encouraged by Wim Henderickx’s statement, “If you don’t fail, you’ve failed!” That earlier piece would have shared some surface similarities with this ending to *Sound Sculpture No.8*. However, the approach I now take is deeply influenced by the depth and breadth of experience gained through this research. I now write for established collaborators whose playing I know well, and I compose with a broader technical vocabulary and a more nuanced understanding of physical gesture and instrumental interaction. My harmonic language has also evolved, shaped by explorations in material agency and instrument-building. Even when I am not explicitly applying techniques developed during my PhD, the research continues to inform and enrich my broader creative practice. In this sense, it feels like a kind of personal revolution, where earlier methods are revitalised within a new and expanded artistic context.

Closing thoughts on chapter four

A key theme of this entire project has been to explore the network of tools, technologies, materials, instruments, and collaborations that exist around the composer, offering creative affordances by handing parts of the creative process over to forces outside the composer's mind and imagination. This is more than just finding inspiration; it is discovering the actual materials of music in external places and spaces. It is creating processes and situations where the materials of music might emerge from dynamic relationships at play. In *Sound Sculpture No.1*, these materials were found in the acoustic and psychoacoustic properties of acoustic instruments; in *Sound Sculpture No.2,3,4,5,6* these materials were found in the improvised instrumental explorations of performers; in *Sound Sculpture No.8* these musical materials were found in the physical material properties of DIY built instruments and the subsequent material agencies that emerged. This process, therefore, applies the decision to engage with the network of possibilities available to me as a composer – to consciously embrace distributed creativity by developing the network from which creativity emerges.

It is fascinating that this creative process emerged from a simple curiosity in the fusion of acoustic and electronic sound; it illustrates how the project grew to encompass the creative process of making music in the broadest sense, albeit one that places combining acoustic and electronic music-making techniques at its heart. It is a compelling example of iterative practice-as-research that begins with a focused investigation into a singular topic and then evolves into a deep exploration of artistic practice as a whole.

Conclusions

“We live in a world that has been spectacularly failed by reductive tendencies. Music is an extraordinarily complex phenomenon that so readily evades human agency”

– Christopher Fox (2024, p. 95).

In the popular history and anthropology book *Sapiens* (2015), Yuval Noah Harari puts forward a provocative idea. Twelve thousand years ago, before farming became common across the globe, humans lived nomadic lifestyles, moving from place to place ‘in tune’ with the land and with nature. However, over many generations, they began to settle in one place to cultivate the wheat crops on which they became increasingly dependent. More plentiful food stocks led to population growth, which in turn led to larger settlements and increased demands for food. Over thousands of years, this resulted in an irreversible entrenchment in agricultural life. From an evolutionary perspective, wheat succeeded spectacularly from the new arrangement between humans and sustenance: it is now one of the world’s most prominent grasses, evolving from a small, localised grass species in the Middle East to become one of the most widespread crops on Earth. Harari suggests that wheat ‘manipulated’ humans to spread its DNA, forcing us to abandon the ‘natural’ state of the nomadic lifestyle, diminishing our quality of life in the process. We did not master wheat; wheat mastered us, or so Harari argues.

Accusations of “paleo-romanticism” aside (Etherington, 2015), Harari’s idea showcases the emergence into popular culture of ways of thinking relating to post-humanism and material agency that “challenge traditional human-centred views by emphasising interconnectedness among organisms and complex systems, aiming to disrupt hierarchies and boundaries between humans and other entities”.²⁶ I use Harari’s example of wheat to illustrate a fundamental paradigm shift in my thinking over the five years of my PhD. Far from the romantic notion of the composer as solitary, solipsistic genius, with autonomy of mind and

²⁶ Quite suitably and ironically, this definition is an AI generated quote generated at sciencedirect.com, though the AI has based its definition on the work of education theorist’s Theresa Rogers and Caroline Hamilton-McKenna (2023).

autonomy of creative output (Stern, 2021), I now no longer see the musical composer as the central figure in the creative composition process, but rather as one element of an infinitely complex, dynamic relationship between human and non-human agents enveloped in the tapestry of environment and culture, both past and present.

If wheat guided the decision-making processes across multiple generations of humans, then there are countless examples of how musical ‘raw materials’ (and instruments) guide the hand of the composer over similar timespans. What many composers consider to be composition ‘materials’ usually begins with reference to the parameters of music as understood by theory textbooks: scales, chords, key signatures, pitches, tones, rhythms, forms and structures. However, from a broader perspective, music psychologists Clarke et al write:

The ‘raw materials’ for any creative process in principle range across an unlimited spectrum of structural, social, physical and conceptual opportunities, so the ‘raw materials’ for music can be many kinds of things: a set of social relationships, a pitch system, some preexisting music to be manipulated, a structural trajectory, a procedure. Commonly, a specific instrument or collection of instruments forms a significant element of the ‘raw material’, and the particular way those are set up can constitute an important factor (2017, p. 119).

And all of these things will bring their own histories, traditions, cultures, and perhaps even *agencies*, which will guide the hand of the composer.

Take, for example, the 12-tone tuning system and the harmonic vocabularies that emerged from it. Before it became ubiquitous (in Western culture at least), this tuning system was not ‘universal’, and many tuning systems were in use simultaneously within the culture. And when, in the 1700s, chromatic tuning became generally adopted, it involved a compromise. Yes, equal-tempered tuning facilitated modulation and the harmonic revolution that emerged from this, but it also degrades the sound quality of many intervals, particularly the major third and seventh, which are quite strikingly ‘out-of-tune’ and have noticeable beating patterns within them (clearly demonstrated in this YouTube video by [Blue Mango Software](#),

2018). It was by no means unanimous amongst composers of the time that the equal-tempered tuning system should have become ubiquitous in Western culture (Jorgensen, 1991). Yet, the 12-tone harmonic system became standardised and now millions of musicians use this tuning system every day, without thought, recognition or understanding that it is a compromise between physical materials and the affordances these materials offer humans (George Collier, 2021). Material instruments do not simply reflect the wishes and intentions of the composer: they bring to bear centuries of history imbued in them before any individual human plays their first note. And instruments must be learnt to be played: must indeed be ‘mastered’. If wheat domesticated humans, do instruments perform people? Seeing the process of composition as a network of interactions between composer, performer, instruments, tools, acoustic spaces and cultures, through my creative process I have sought to disrupt the implied use of many of these relationships. Whether by placing an audience in the middle of a room, or by attaching motors to DIY made instruments, or by beginning a recording session with no written material, I have attempted to destabilise and question the status quo of the received hand of circumstance. However, I am not a deconstructionist for deconstruction’s sake: these deconstructions are applied in search of the creative affordances that might be offered. The beginning of my composition process is open and messy; the closing stages are meticulous and rigorous. And with these ideas in mind I discover a new interpretation of the term *sound sculpture*: to ‘mine’ the raw materials of music from wherever I can, to find what already exists somewhere in the depths of the culture, the technologies, the tools and the performers, and then sculpt these raw materials into musical forms in which acoustic, electronic and autonomously produced sound interactions might envelop audiences in the three-dimensional physicality of sound itself.

Conscious and subconscious mental processes

Whilst this commentary has veered away from this point of view in favour of more recent conceptions of creativity as a distributed phenomenon, I will close with some thoughts on

the mental processes behind the composition process, the importance of which should not be forgotten.

Within the creative act, numerous agents, systems and processes are at play, including the various conscious and subconscious processes within an individual's mind. Neuroscientist David Eagleman states,

When an idea is served up from behind the scenes, the neural circuitry has been working on the problem for hours or days or years, consolidating information and trying out new combinations. But you merely take credit without further wonderment at the vast, hidden political machinery behind the scenes (Eagleman, 2016, p. 7).

A famous, easily demonstrable example of this is the 1965 Beatles' song *Yesterday* (McIntyre, 2024), the melody of which 'came to' Paul McCartney in a dream. At the risk of expressing a slightly silly idea: if unconscious Paul McCartney dreamt the melody to which conscious Paul McCartney then added words, chords, structure, etc, then did two parts of Paul McCartney's brain collaborate to produce this song? A kind of distributed network of creativity across different parts of the human brain?

There is a cultural trend (of songwriters in particular) stating that they feel like some kind of antenna when they write their best work, that they receive what already somehow floats in the air somewhere, acting as some kind of conduit for naturally occurring phenomena. One such example is Tom Waits, who in a recent *New York Times* interview said:

I like the idea that there are things coming in through the window and through you and then down to the piano and out the window on the other side... If you want to catch songs you gotta start thinking like one, and making yourself an interesting place for them to land like birds or insects. Once you get two or three tunes together, wherever three or more are gathered, then others come... It's like a line for a hot dog place, you know? And when there's four people lined up on the sidewalk, some people will stop and get in line just 'cause there's a line' (Mason, 2017).

But of course, the description of the songwriting process that Waits offers here could be a rather compelling, metaphorical description of the distributed network of creativity, where the emergence of ideas comes through the fingers, the piano, and the embodied cognitive processes²⁷ of playing an instrument, which entwines with the cultural and historical knowledge Waits' has accumulated throughout his life, and now sits in various levels of his conscious and subconscious mental processes, waiting to be whisked into new forms. And then perhaps this combines with whatever emotions or personal/societal concerns that happen to inspire the content of a song in that particular moment. Therefore, "it came through the window" is an apt metaphor to describe the complexities of these internally and externally entwined processes.

One key task of the artist then becomes not to let the conscious agent part of the brain interfere with this network. A common cause of 'writer's block' is overthinking and worrying about whether something is 'good' or not (Bechara, 2022). If there is one thing that is certain about music, it is that the conscious part of the brain, unfortunately, cannot just decide to write a great piece of music whenever it feels like it. The best creative works often feel like they 'flow' out of the artist, that they somehow emerge *through* the artist, quite effortlessly, in which sensory-motor and cognitive practices are carefully balanced (Robson, 2024). Many artists describe the flow state as the ideal state in which to create, in which you are not thinking of the past or future and aren't worried about whatever you make being 'good' or 'bad' – you are simply in the moment with your creativity. And when this balance is achieved, the artist inevitably feels that whatever 'flowed' was in some ways outside of them, that it "came through the window".

I have found myself saying in conversation on many occasions, something to the effect of: "I often feel that my best music happens when 'I' get out of the way and allow the music to be what it wants to be". And so, the creative process might feel like unravelling the inevitable consequences of the material from which the piece is derived. However, it is also an

²⁷ Embodied cognition emphasizes the role "neural systems controlling the body" play in cognitive processing (Gallese, V. & Cuccio, V. 2018, p. 216).

obvious fact that two contrasting composers will produce radically different works when using similar materials, even if they both feel like they are 'letting the materials speak for themselves'. Indeed, I do not feel satisfied until my works *feel* like they are inevitable, and will go to great conscious lengths to make them feel as effortless as possible. And when I make my music, I feel like I have control, but contradictorily, I also feel like I let the 'inevitable' flow through me. And perhaps these inherent contradictions are what make music-making so endlessly fascinating and endlessly mysterious.

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