Sentient Spaces: Composition as Instrument-Making

Nicholas Moroz

St Hilda's College

University of Oxford

Submitted for the degree of

Doctor of Philosophy

Acknowledgements

This thesis would not have happened without a great number of people and organisations whose support I have been privileged and fortunate to receive over the past years. I am grateful for the support of the Arts and Humanities Research Council's Doctoral Training Partnership, and to the Faculty of Music and St Hilda's College for supporting my research with additional grants; Professor Martin Harry and Professor Jonathan Cross for their constant support, guidance, wisdom, and patience, especially through periods of disruption during and after the pandemic; Dr Jonathan Packham for his friendship, inspiration, and humour, both throughout the degree, and during our short but sweet EXPO series, and beyond; Dan Hulme for his technical support, enthusiasm, and culture-building at the Faculty of Music's Studios, the Electronic Music Practice Research Group, and the Art of Noises series at the Modern Art Oxford; Joel Baldwin for his support and friendship during the early years running events and experiments at the Jacqueline du Pré Music Building; my once flatmate and fellow doctoral student, Dr Landon Peck for all the Zucchini cake and bean talk; all the musicians of Explore Ensemble for their inspiration while keeping me rooted in the reality of practice; Sebastiaan Kemner for daring to commission me twice after the first project saw him spin around barefoot while moving sound 'like a Jedi', and for all his musical support in those projects; George Barton and Siwan Rhys AKA the GBSR Duo for commissioning *Intralatent* and taking time with me to develop what became a demanding yet rewarding work; all my friends from Oxford, school, RCM, and beyond who continue to make life fun, exciting, and delicious; most of all, my wife, Phoebe, whose infinite kindness, patience, perspective, and humour helped get me through the most difficult corners, unexpectedly losing my Dad in 2019 and more recently my Grandmother in 2023; finally, my family, especially my Mum, Grandmother, Grandad for supporting me no matter what with their love, and with that first bass guitar many years ago.

This work is dedicated to the memory of Maria Moroz (1936-2023)

Sentient Spaces: Composition as Instrument-Making

Nicholas Moroz


The Zone is a very complex
maze of traps.

A Note

The following submission comprises both a portfolio of original musical compositions with accompanying research prefaces (included in this document), and a dissertation of critical writing entitled 'Entanglements of Creation: Luigi Nono and the Experimentalstudio Freiburg'. While both share common themes, they are intended to be read as two separate though related entities. Further explanations behind the choice of this format, initially based on the possibilities of the degree specification at the start of the research, are given in the introductory chapter below.

Thesis Format

The submission is structured as follows:

1. Composition Portfolio:
   Sentient Spaces: Composition as Instrument-Making
   Abstract, Introduction, Research Prefaces, Bibliography

   1.1 *Her still singing Limbs*
   Score, recording, Max patch, 'readme' file

   1.2 *Unfurl*
   Recording, Max patch, 'readme' file

   1.3 *bot.radio*
   Recording, Max patch, 'readme' file

   1.4 *Intralatent*
   Recording, Max patch, 'readme' file

   1.5 *The Holy Fool*
   Score, recording, Max patch, 'readme' file

2. Dissertation
   Entanglements of Creation: Luigi Nono and the Experimentalstudio Freiburg

Part 1 of the above is included in this document over the following pages.

Composition Portfolio Research Preface: Table of Contents

List of Figures

List of Tables

Abstract

This composition portfolio presents five original works composed between 2018 and 2021 which are interrelated by underlying methods and concepts that I describe as a circulation of instrument-making and speculative worldbuilding. The core research narrative explores the creation of hybrid acoustic and live electronic instruments that blur the boundaries between a musician's physical body, their physical instrument, a digital instrument, the performance space, and the experience of the audience. Live electronics form the core of the portfolio's compositional methodology, with the exception of the final work, The Holy Fool, which extends these ideas from electronics into an acoustic ensemble domain. Concepts and methods such as interactivity, mapping, proprioception, and homuncular flexibility help to explain the functioning of such systems, all built using Cycling 74's Max. The type of instrumentality that I develop forms a continuum between an integrated performer–instrument–space unit and a more heterogeneous agent–environment paradigm, where human and electronic performers stand as distinct entities in a larger imaginary environment. The four electronic works in this portfolio explore different instances along this unified/heterogeneous spectrum. Of the latter category, I describe the instrument-space as a sentient space, which provides an aesthetic and technical framework throughout the portfolio and supports a broader objective that positions music as a means of disalienation from contemporary life through re-sensitising the listener to sound, space, and musical bodies. Throughout the portfolio, I return to core references that underline the speculative worldbuilding potential of music in relation to critical spatial and technological practices in art and academia, namely: the films of Andrei Tarkovsky, Mark Z. Danielewski's novel House of Leaves, Hito Steyerl's essays on technology in the arts, and the Situationists' practices of psychogeography. Furthermore, the portfolio draws on concepts and methods explored in a partner musicological dissertation, which elucidates Luigi Nono's live electronic turn and the Experimentalstudio Freiburg in the 1980s with regard to recent literature in organology, anthropology, and electronic music practices.

Sentient Spaces: Composition as Instrument-making

Nicholas Moroz

Introduction

This composition portfolio presents works composed between 2018 and 2021 which are interrelated by underlying methods and concepts that I describe as the circulation of instrument-making and speculative worldbuilding, the latter being a generalised term often used in literature, game design, film and TV, particularly in sci-fi and fantasy genres (Heussner et all 2015; Zaidi 2019; Fischer & Mehnert 2021; Wang et al 2022; Howard 2023). This introductory text presents the contexts and overarching research narratives of the portfolio, and is further complemented by individual research preface for each work. The table below outlines the contents of the portfolio by chronological order of composition, work title, date, instrumentation, and duration.

Table 1: Outline of portfolio

1	*Her still singing limbs*	2018	Trombone and live electronics	14 minutes
2	*Unfurl*	2018	Bass guitar and live electronics	15 minutes
3	*bot.radio*	2019	Interactive installation	10 minutes / variable
4	*Intralatent*	2019	Piano, percussion, and live electronics	20 minutes
5	*The Holy Fool*	2021	Trombone, strings, voices	14 minutes
Approximate Total Duration				1 hour 13 minutes

With two exceptions of purely acoustic or electronic instrumentations (works 3 and 5), the portfolio sets out to create hybrid acoustic and live electronic instruments that blur the boundaries between a musician's physical body, their physical instrument, a digital instrument, the performance space, and the experience of the audience. This goal emerged out of my previous work with live electronics, most notably *Semantron* (2016) for electric guitar and spatial live electronics, which prompted further explorations of certain aesthetic and technical features. The portfolio's core agenda entails several question: how can the aforementioned barriers, boundaries, and differences be dissolved in a

compositional context; how does technology afford such a proposition; how can instruments help to create fictional worlds; and, can an instrument itself be a world? Furthermore, how can an audience actually perceive and experience such an instrument and its world, whether actual, virtual, implied, or subjective; what is the phenomenology of the type of live electronics capable of such ventures, and how does it relate to existing lineages of music history and the arts today?

These questions will be addressed in relation to each work in the following preface notes. One entry point to help begin unpicking these question is introducing what I call a *sentient space*: a realisation of musical instruments' capacities to reconfigure the sonic and imaginary dimensions of space, temporality, and agency, by suggesting single or multiple musical entities that engulf both audience and performers alike. The purely metaphorical 'sentient' aspect of the concept is supported by interactive technology built in Max, which establishes a field of causal relationships between performer and electronics. The modes of interaction that I engineer using Max set up a continuum spanning musician-instrument as singular and coherent unit, to the musician-instrument as an oppositional musical duo, or subject-environment binary. Underlining this continuum, I identify *proprioception* — an ability to perceive and map the performer's body and musical motion to live electronic sound — as a condition for the musician's and audiences' actual perception of the causal links between performer, instrument, and space. Establishing a sense of proprioception in sound and space through interactive live electronics is, therefore, a precondition of creating a sentient space in my work. Important concepts and references that run throughout this portfolio include liveness and live electronics (Auslander 2023; Croft 2007), space and spatialisation (Born 2013), instrument design and instrumentality (Bates 2019 & 2021; Browning 2017; Donnarumma 2017), interactivity via questions of human and non-human agency and collaboration (Snape & Born 2022; Lewis 1999 & 2000), and a wider field of composition with technology (Fell 2021).

All of the works were composed with (and some are performed using) Max, and a suite of bespoke live electronic and interactive Max modules, as well as devices made by third parties, which are all detailed in the prefaces to the individual works. In addition to Max, I used Dorico to notate the scores, and

Ableton to create certain fixed audio components of the works, or to test certain DSP effects. Through the accounts of individual works presented in this document, I outline my compositional methodology as one that shifts between workshop sessions with musicians experimenting with acoustic and live electronic materials, to working alone in the studio while assembling sonic materials, fine tuning a live electronic instrument system, and generating symbolic i.e. notated material. The interactions and circulations of these materials and processes have come to define the specifics of my practice over the period in question, whether taking place socially, between me and another musician, technologically between me and a device (physical or digital), or imaginatively through speculation and musical thinking about space, time, harmony, and rhythm. A generalised summary of my composition process, bracketed within larger acts of collaboration, is that of material generation, filtering, and editing into a final fixed form; one which still allows for certain contingencies and expressivity in performance. While on the one hand, leaving space for contingent and emergent features of my musical systems is a vital principle, on the other hand, technology will be shown throughout this portfolio to be equally important in the creation of more fixed elements, in the form of both symbolic/notated and live electronic materials.

All works in the portfolio engage in acts of speculative worldbuilding, mostly through sound, and to a lesser extent the theatrical and situational aspects of live performance. Acts of speculation is activated by the implicit suggestions of certain forms and plays of space, materiality, corporeality, and other more subjective poetic associations, which all form immanent dimensions of the compositions, and which the individual listener can access to varying degrees. Despite an aesthetic and philosophical interest with Sci-fi in literature, film/TV, and games, I have no interest in projecting certain futuristic stylistic markers in my work. In its proclivity for mostly instrumental music, without texts of explicit semantic meanings, this portfolio primarily envisions a phenomenology of live electronics as a site for non-verbal experiences of sound, space, and agency which provoke excitement and a feeling of awe in their sonic richness and spatial immersiveness.

Depending on the particularities of the piece, the works generate either calm and contemplative or exciting and volatile emotional and imaginative possibilities for the listener. I am interested in the continuum that these ostensibly antithetical modes of listening open up, and — particularly by using musical patterns, elastic rhythms, and repetition — how they can warp and transform our sense of musical space and time, prompting a certain kind of embodied or empathetic experience of feeling sound as though a body sensing and moving through space, which makes us feel both more present in the moment, while also dissolving the boundaries between our imagination and the physical world. This direction reflects a broader interest in psychedelic, ecstatic, and religious experiences, as well as critical writings on art, film, and contemporary culture, all of which, in my view, offer vital alternatives to the ever shrinking monoculture of contemporary society and its techno-feudal imperatives of cultural conformity.

I am concerned and disturbed by the rapidly shrinking breadth of human experience — via digital technology — to a few narrow commodified and politically-censored zones, especially as mediated by social media. Recent development in AI tools such as ChatGPT, surveillance technologies, and image and music generation platforms, also point to AI being yet another inscrutable and ungraspable force in the mechanisation of human life within the global capitalist machine. While aware of the histories of failed utopias and promises among the early internet pioneers, I am still interested in the liberatory capacities of technology, as a means to expand our perception of the world, create new work, relationships, and open up social possibilities. Therefore, in a modest way, with the tools available to me and in my limited and privileged social context, I want to explore how my musical expressions of composition and performance might outline a methodology that flouts and transcends the monotonous and predictable experience of the everyday in contemporary capitalist society. I hold self-evident that I am not creating overtly political work. It lacks a socio-political specificity compared to, as an emphatic example, contemporary artist such as Ai Wei Wei or Banksy, or even historical examples in music such as Nono and Henze, who dealt with topical social or concrete historical issues. Nonetheless, in my

work, musical cultures of space, instruments, composition, and performance bear, at the least, the scuff marks from my reflections on music making in twenty-first century in the UK.

In both the act of composition and the experience of my music, I am interested in what Jameson describes as disalienation through cognitive mapping; an aesthetic strategy that combats the alienation of the fathomless postmodern capitalist city, where people are 'unable to map (in their minds) either their own positions or the urban totality in which they find themselves.' He continues: 'Disalienation in the traditional city, then, involves the practical reconquest of a sense of place and the construction or reconstruction of an articulated ensemble which can be retained in memory and which the individual subject can map and remap along the moments of mobile, alternative trajectories.' (Jameson 1991. 50). Transplanted into a musical context, the works of this portfolio will show a variety of methods and concepts wherein humans, acoustic/electronic instruments, and spaces all cohere as 'articulated ensembles' that remap or reconstruct the affective capacities of sound and space. As such, I imagine worldbuilding as an act that not only provides self-discoverable symbolic, poetic, and thematic contexts, in the conventional sense of the term, but in a more physical sense, as though re-writing the laws of physics and our attendant perceptual mappings thereof in the fictional musical worlds that I create; a re-sensitisation or Jamesonian 'reconquest' of our own earthly sensibilities, that help us see and hear the everyday anew.

In creating new instrument systems that hybridise existing acoustic and novel live electronic instruments, I have sought to explore the 'magical' qualities often ascribed to musical instruments and technology, as examined in critical organology scholarship (Qureshi, 2000; Sonevytsky, 2008), as well as art and anthropological studies (Gell, 1988, 1992; Stahl, 1995). The power of instruments as transformative and mediatory socio-culturally situated objects is the basis for their disalienating potential. I do not specify how to listen to these instruments or my work in general, rather, via instrument-making and worldbuilding, I seek to create an experience that is open to individual experience and interpretation by the audience, though where themes of technology, sound, and space,

figure heavily as subtexts. Moreover, the performance contexts of the works already bring their own implicit forms of listening, i.e. self-evidently part of the western concert format, although, as some works will show, I seek to extend this format, using electronics to create a more immersive experience than the traditionally-staged concert, and to expand the sense of instrumentality to include the entire performance space. As such, themes of dwelling, inhabiting, labyrinths, ecology, and metaphors of the natural world, as well as concepts of technological or virtual spaces are prominent in my work, though rarely made explicit or held necessary for a 'correct' interpretation of my music.

Since the 1970s, numerous composers and sound artists have explored the affective capacities of music, sound, and space through the domains of architecture, psychoacoustics, electronics, and the natural world, and often without recourse to either conventional acoustic or electronics instruments, musical notation, or even a notion of performance per se. For example, many of the works by Alvin Lucier, Maryanne Amacher, Annea Lockwood, Eliane Radigue, José Maceda, Chris Watson, and Jana Winderen all exist as either installations of variable duration, or phonographically as records. Nonetheless, in the practice presented in this portfolio, conventional western orchestral instruments and their attendant cultures of concert performance and listening formats still feature as prominent centres of investigation, since they are part of my own musical identify, and they carry their own musical histories, personalities, and materialities, which I find compelling and productive. Furthermore, my use of conventionally notated scores reflects my fascination with highly specific yet reproducible instrumental timbres, gestures, rhythms and harmonies. Of notated music, the late works of Morton Feldman, Gérard Grisey, Luigi Nono, and other 'post-spectral' composers such as Mauro Lanza and Enno Poppe, among others like Catherine Lamb, Rebecca Saunders, and James Dillon, all form important musical and aesthetic contacts with whom I feel a certain affinity. Notation affords a reproducibility of certain sounds, which is a critical precondition for my live electronic instruments to be able to function accurately in programmatically responding to certain sound inputs, for example, certain combinations of pitch, dynamics, and timbres. This topic is discussed further in relation to specific works in the portfolio.

In addition to this wider field of compositional and sound art references, numerous forms of electronic, experimental, improvised, rock-derived, club-adjacent, and other genres of music inform my practice in terms of its material bent towards highly rhythmic, layered, and/or energetic material. Key artists include Oren Ambarchi, Angharad Davies, Autechre, John Butcher, Demidike Stare, Taylor Deupree, Beatrice Dillon, Mark Fell, Okkyung Lee, Flying Lotus, goat (jp), Jon Hassall, Hyperdawn, LCY, Meshuggah, The Necks, Oval, SND, Squarepusher, Andy Stott, Thundercat, Rian Treanor, among many others.

Throughout the course of this research, I have been active as the artistic director of Explore Ensemble, a chamber music group based in London which is dedicated to contemporary music. I have had the privilege to programme existing modernist and contemporary repertoire while commissioning new works by UK-based composers. I have drawn enormous inspiration and practical knowledge from my relationships and projects with my ensemble colleagues. Many of the composers whose works the ensemble has performed have become important references for my own work. Indeed, my focus on smaller scale works and the fine details of instruments and their musicians is most likely a consequence of my immersion in this chamber music practice. As such, the ensemble and its networks of performers, composers, artists, and promoters altogether form an invaluable hinterland if not a foundation that has undoubtably guided the course of my research and artistic growth.

My activities as a curator reflect my values as a composer, and vice versa. While I have not sought to create a unified style with the ensemble's programming, whenever I have had the curatorial freedom, I have deliberately tried to platform composers both alive and dead whom create high quality and original work with an intense relationship to sound, space, and the imagination, and who do not compromise to the mainstream conservative or tokenistic trends in classical music programming (BBC Proms being symptomatic, in my view), nor those among the more central European *Neue Musik* milieu

(Darmstadt, Donaueschingen, Eclat, Wien Modern, MaerzMusik), nor those of the experimental electronic festival circuit (Rewire, Unsound, Sonár).

The artists who have worked with or who (if dead) have been programmed by Explore Ensemble over the past few years include Lara Agar, Angharad Davies, Joanna Bailie, Beatrice Dillon, John Croft, Pascale Criton, Lawrence Dunn, Mark Fell, Gérard Grisey, Edwin Hillier, Clara Iannotta, Lisa Illean, Nakul Krishnamurthy, Catherine Lamb, Mauro Lanza, Klaus Lang, Oliver Leith, Neil Luck, Cassandra Miller, Jonathan Packham, Alex Paxton, Horațiu Rădulescu, Fausto Romitelli, Rebecca Salvadori, Rebecca Saunders, Salvatore Sciarrino, Jack Sheen, and James Weeks.

Finally, this portfolio resonates with and draws direct inspiration from numerous aspects of my accompanying dissertation on the live electronic music of Luigi Nono and the Experimentalstudio Freiburg. In the dissertation, I have deliberately made no reference to my own compositional work so that it reads as a standalone piece of musicology. Nonetheless, the compositional research prefaces below make clear the relevant connections between my musical thinking and the concepts and critical framework developed in the dissertation, particularly on issues of instrumentality, space, and live electronics.

The bibliography at the end of this document covers this introductory text and all of the individual preface texts. The dissertation has a separate bibliography.

1: ‘Her still singing limbs’

2018, trombone solo and live electronics, ca. 12 minutes

In this work, a solo trombonist performs at the centre of a ring of speakers (at least eight), and the audience ideally sit or stand inside the ring between the trombonist and the speakers. The trombone has an iPhone attached to it which runs the GyrOSC app and transmits live compass heading data via OSC and a Wifi connection to a laptop running Max. In the Max patch, the compass data is read as a direct analogue of the trombonist’s orientation as they turn on the centre point, facing out around the perimeter of the loudspeaker ring.[1]

Using IRCAM’s Spat library for Max, the live compass data connection grants the trombonist live control over the spatialisation of their amplified and processed sounds in a number of ways. Firstly, their amplified unprocessed sound is fixed to come from directly behind them, so that the directivity of the acoustic and amplified trombone sound sound work in congruence, thereby clarifying the trombonist’s live presence in the context of a spatially dense soundfield populated with other live electronics and pre-recorded elements. Secondly, the processed live electronic sounds of the trombone are positioned at numerous fixed and mobile locations in relation to the trombonist’s orientation. Some are fixed to always face the trombone i.e. wherever the live compass data node is located on the speaker perimeter, while others are perpendicular to the trombonist, and others move in rotational movements around the speaker ring, the speed of which are determined by the speed of the trombonist’s movements, taken as a running average over several seconds. Overall, all sounds are in constant motion, and the only time when a sound remains static is whenever the trombonist is still, which even then is only temporary.

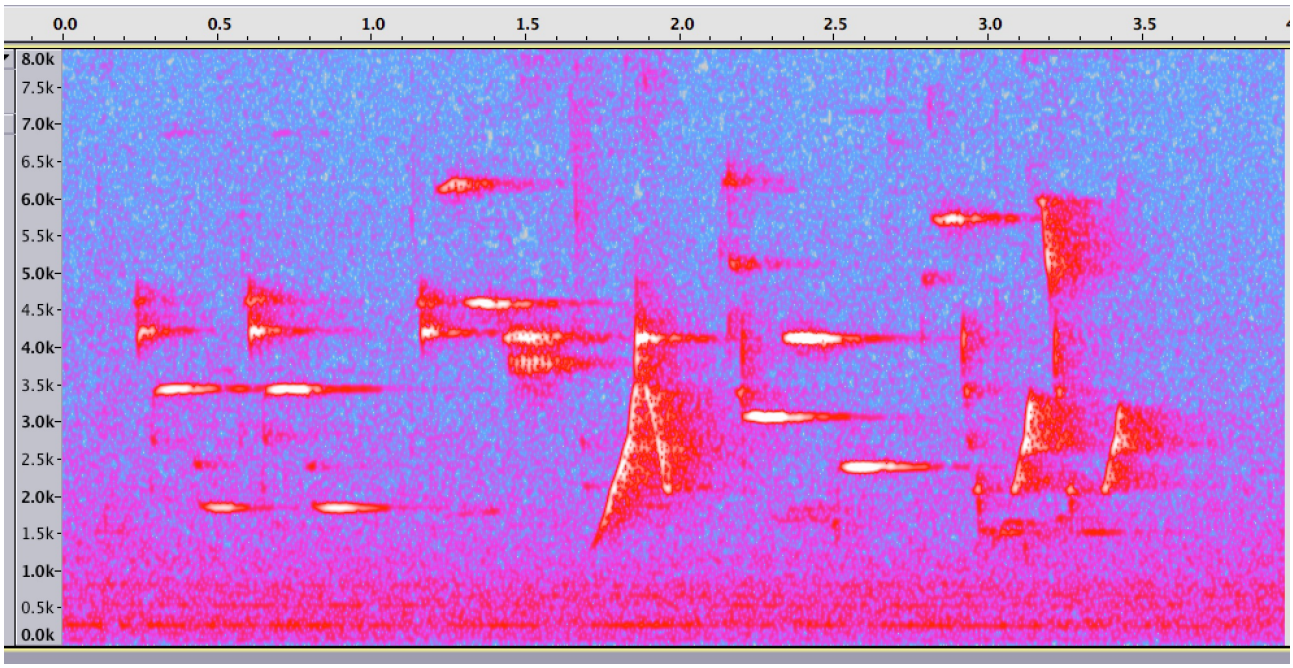
[1] NB this note is particularly long because it introduces concepts that recur throughout the other works of the portfolio.

In addition to the trombone, the other main sonic material of the work incorporates recordings of birdsong, specifically the Slate-coloured Solitaire native to tropical Latin America. I downloaded several free samples from the website Xeno Canto.[2] The site features a search engine of user-uploaded recordings of birdsongs which users can filter according to several criteria such as species and geographical location. The search results can also display each recording with a spectrograph, meaning that rather than listening to each recording one by one, I can quickly explore large selections and visually select which birdsongs look more interesting, from a melodic or morphological point of view.

Fig. 1 shows a spectrogram of the recording I used the most for this piece (recording XC235263). I started listening to the birdsongs at a half, a quarter, an eighth, and a sixteenth of the original speed, and therefore also 1, 2, 3, and 4 octaves lower, respectively. At these low speeds, they begin to resemble whale song, but with much more striking melodic and harmonic content. I began thinking about how I might incorporate them into a musical context at the start of the DPhil degree in autumn 2017, and in early 2018 the opportunity to write for leading Dutch trombonist Sebastiaan Kemner came as part of the Art of Noises series in at Modern Art Oxford. Serendipitously, the trombone seemed to offer an excellent partner to the slowed-down birdsongs, since it can move on the harmonic series, as many birdsongs do, but also because it can slide and easily play microtonal harmonies, and perform multiphonics, which many birds do with their double larynx, the syrinx.

[2] https://www.xeno-canto.org/

Figure 1: Spectrogram of Slate-Coloured Solitaire Birdsong



In spring 2018 Sebastiaan and I conducted several workshops at the Jacqueline du Pré Music Building at St Hilda's College trying out trombone material, live electronics, and the interactive spatialisation element of the iPhone compass tracker. I learned of Sebastiaan's interests in certain sounds and registers of the trombone, and particularly for melodic material in the higher register. We also tried out ways to mimic the birdsong trills, slides, and multiphonics. With these recordings I began to sketch out melodic material for the trombone, imitating the slowed-down birdsong. Meanwhile, a formal idea emerged around an imaginary dialogue between trombone and artificial or warped birdsong, where the latter encircle the former and the audience via a loudspeaker ring. From this simple premise, a structural and somewhat theatrical idea emerged for the birdsong samples to begin the piece, and the trombonist to enter the speaker ring and performance space from offstage.

The form and pacing of the work progresses slowly, emphasising the sense of warped and extended time, from initial dialogues to more excited and dynamic interplays. The last third of the work see the birdsong samples increase in intensity, density, and spatial velocity. I use delay-line granulators on the birdsong samples to create a granulator effect, chopping them up into microscopic bits, sprayed across

the space using the mobile spatialisation, which further emphasise the tension between natural and artificial materials; a core component in building the worldliness of the work. The use of octave pitch-shifting on the granulator, and feedback on this signal chain, results in a surreal halo though digital sounding effect which further denatures the birdsong.

The trombone's live electronics include several bespoke modules I created with the intention of warping the sense of space-time of both the performance space, and the trombone itself, and which thereby creates a continuum that bridges the trombone with the warped birdsong material. These two custom objects are used in all of the other works of my portfolio, except the acoustic piece *The Holy Fool*. As such, the below explains their function in detail.

1.2: [nm.timewarp]

The process of this object is fairly simple. It records a live input into a buffer, and then immediately plays back the recorded sound at half the speed, resulting in the same sound one octave lower. At the same time, this output is fed back into the input, meaning that the source sound is heard at increasingly lower and slower rates, related at the octave and doublings of the speed. The object needs to be triggered live immediately before the subject sound. I found in performance that I had to trigger the effect as if it were a grace note to the trombone's entry, otherwise, if I left too long a gap between triggering the unit and the trombone, the initial time interval (usually a silence) would multiply exponentially due to the feedback aspect, and disrupt the rhythmic cohesion and live quality of the intended effect. To demonstrate the importance of this performance practice aspect, fig. 2 shows two sonograms for two recordings of the effect and the original input sound where I say 'one two three'. In the top sonogram I trigger the sound just before speaking (100ms before), as in my performance practice, and in the lower sonogram the effect is triggered too early (600ms before the sound), resulting in the longer echo times evident in the sonograms.

Figure 2: Spectrograms comparing different [nm.timewarp] uses

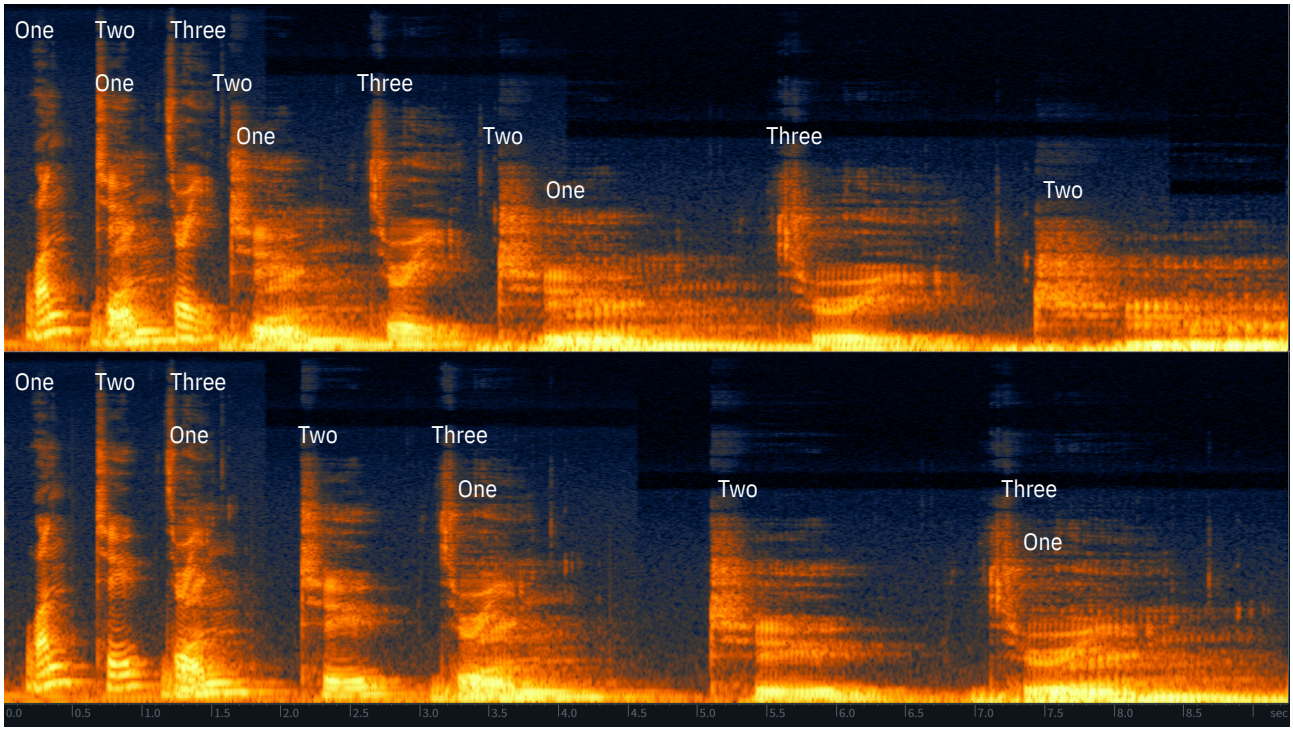
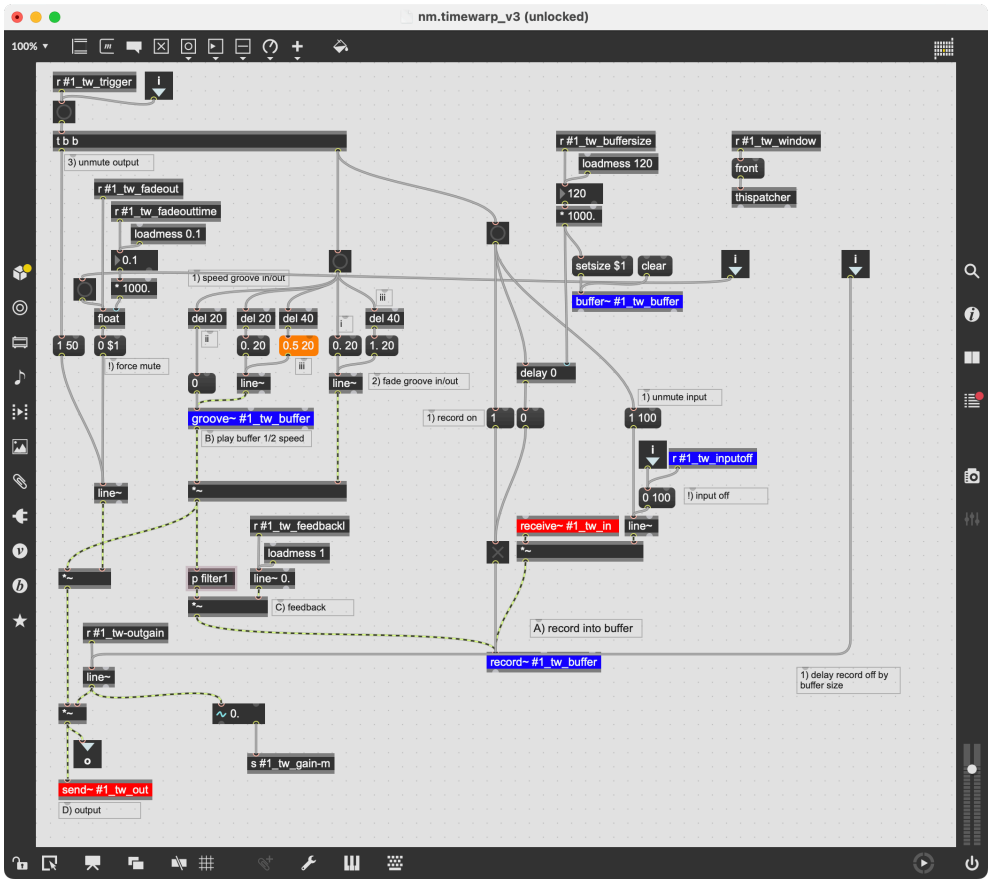


Fig. 3 shows the [nm.timewarp] Max patch, revealing the controller inputs and settings: buffer size, to determine the max sample duration; trigger, to trigger the effect; 'input off', to mute the input once the effect is filled enough. This effect can be heard most clearly at the very start of the piece, where the birdsong is stretched and slowed down from its original time and pitch, into a virtually unrecognisably slow and low ambient rumble.

Figure 3: [nm.timewarp] Max patch



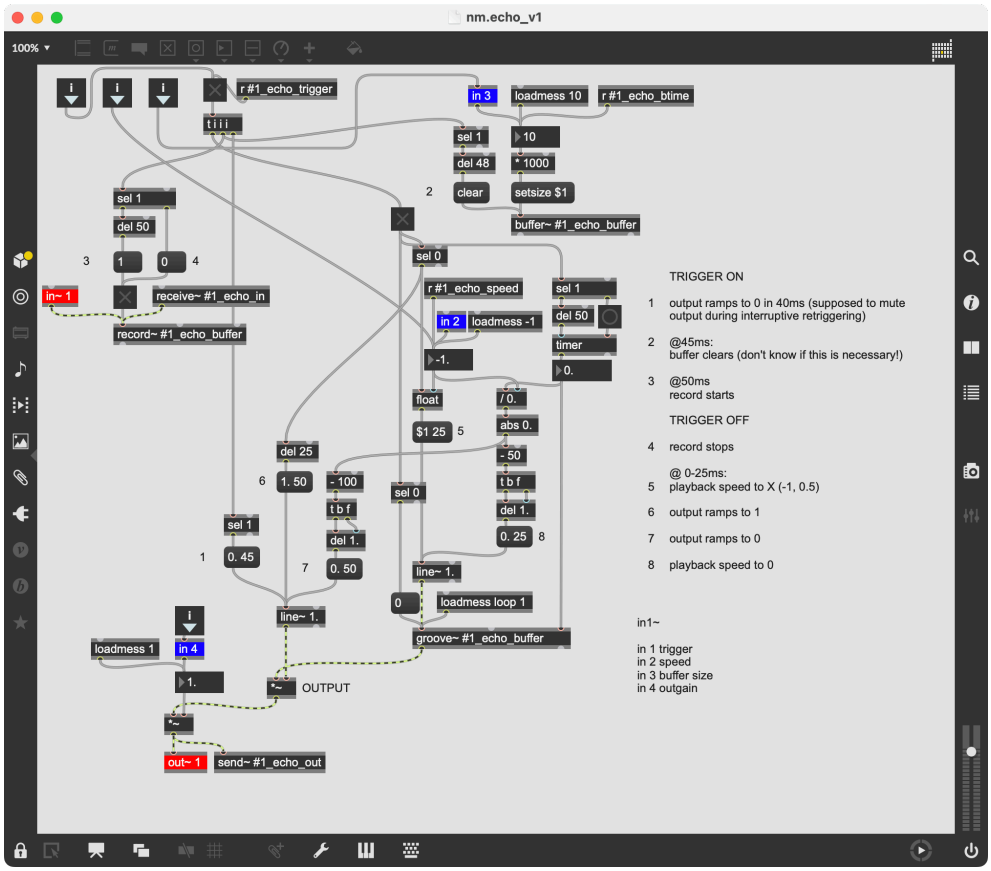
1.3: [nm.echo]

The echo effect is imagined as a kind of warped mirror reflection of a chosen or realtime-captured subject. Like the timewarp, the echo is triggered live for certain material. Fig. 4 shows the subpatch. An *on* or *record* trigger is first sent, the material enters the patch, and then you trigger an *off* signal, which stops the patch recording the live input, and then triggers the immediate play back of the recorded sample in either forward or reverse, and at different playback speeds (0.125, 0.25, 0.5, 1, 2).

The most obvious use of this effect in the piece is at figure G in the score. In this section, until K, the birdsong is spectrally frozen using the live granulator, providing a textural background for the trombone to antiphonally exchange passages with its own warped electronic reflections, at half and

quarter speeds. I use two echo units to superimpose two reflections running at different speeds. The lower speed playback reveals striking details of the trombone's timbre with the harmon mute; previously inaudible overtones and formants at normal pitch/speed become more prominent metallic colours and resonances that characterise the sound at slower speeds, as though revealing the trombone's materiality under some kind of spatial-temporal microscope. This aspect of revealing and instrumentalising natural though perceptually latent qualities of instruments through live electronics has become a core guiding phenomenological and technical principle of my work, and is taken further in *Unfurl* and *Intraltent* in particular.

Figure 4: [nm.echo] Max patch



In addition to these two effects and the spatialisation aspects of the trombone and birdsong, the granulator I initially used was the 'KT Granulator' plugin which I previously used in my 2016 work 'Semantron'. Due to incompatibility over the 64-bit Mac upgrade, I replaced this with the [munger] object from the PeRColate Max package by Dan Trueman and Luke Dubois.[3]

The forward-facing spat source routes the echo and time warp units' output, imagined as if the space is directly responding to the trombonist face-to-face. The source behind the player projects their live 'clean' sound with added reverb, as well as the treated sound that uses a bitcrusher effect. The bitcrusher further heightens the digital artificiality of the live electronics, and helps the trombone and birdsong coalesce as if living musical entities in a common imaginary environment, or world, as both succumb to gradually more intense digital pixellation and distortion.

The live sound of the trombonist always projects in the same direction that the player faces, whereas the electronics either encircle the space or face opposite the player. Furthermore, I wanted to map specific effects to the specific parts of the performance space to engender some performative interactivity between the player, the electronics, and the space; dissolving the boundaries between these different corporeal and material objects.

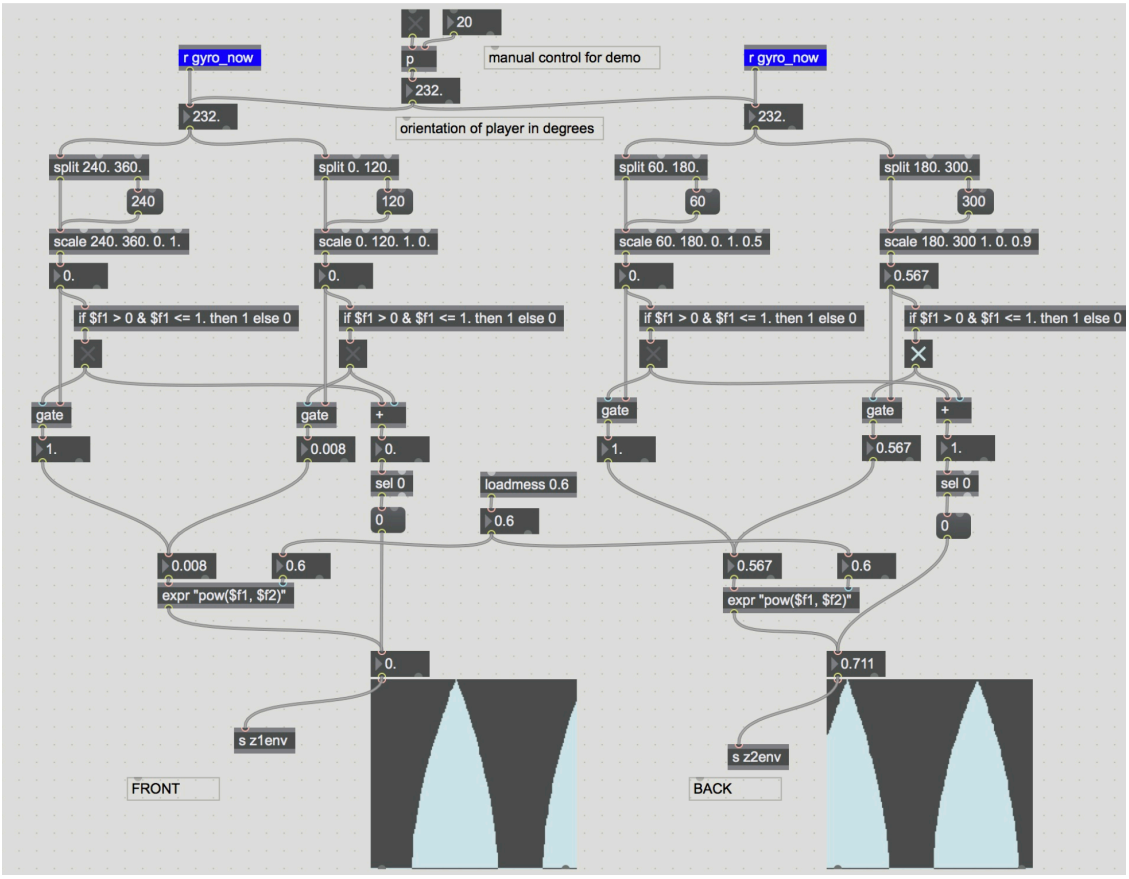
Fig. 5 shows a subpatch within the performance Max patch in which I convert the orientation of the player into an amplitude value for the bitcrusher effect. In essence, the closer the player faces the 'front' of the array (the 'front' can be chosen situationally depending on the venue), the louder the bitcrusher will be mixed into their live sound (coming from the behind-source). In detail, fig. 5 shows that the value of 232° in the upper central number box representing to trombonist's live orientation value. While envelope 1 favours the front orientation of the player, envelope 2 does the opposite. As fig. 5 shows, the 232° value generates 0.711 gain level (later converted to dB) in the low-right hand side number box. Since the trombonist was mostly facing the front in the performances we made in

[3] https://github.com/Cycling74/percolate

conventional concert venues, I mapped the bitcrusher level to envelope 2, so that whenever the trombonist turned towards the back the bitcrusher would gradually fade out.

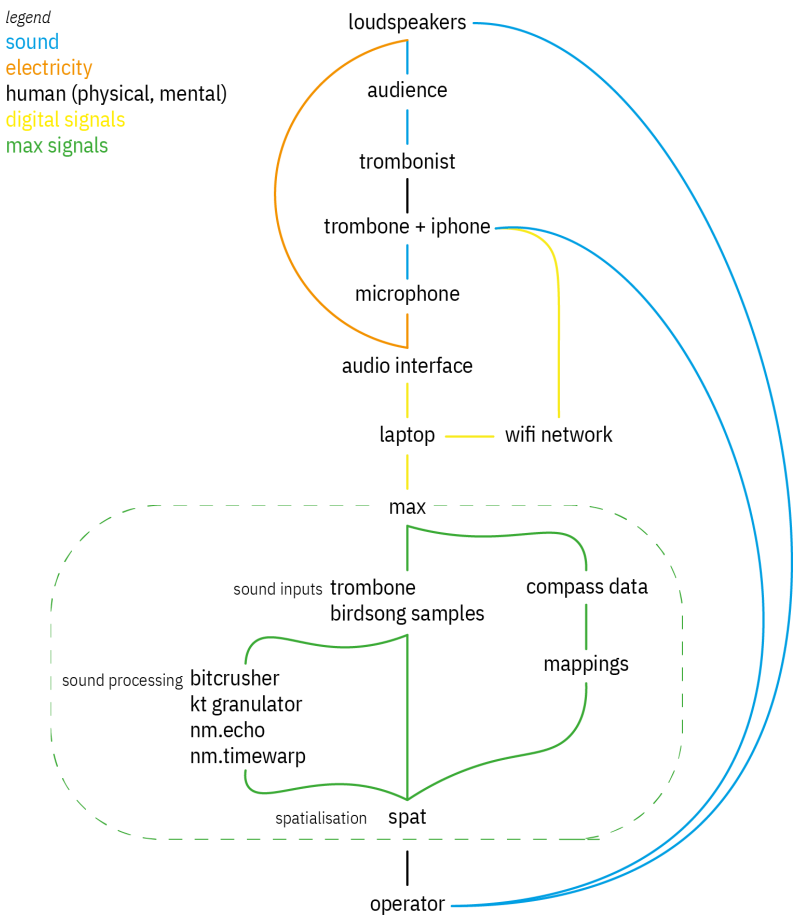
Throughout the piece, the trombonist is entirely free to both rotate as they perform, and to make gestures for the deliberate control of the spatialisation. With Sebastiaan, we agreed a framework where he would remain either still or move very slowly when performing slower material, while with more active live electronic moments using the [nm.echo] object, he would turn more and make more gestures to rapidly sweep the sound around the speaker ring. We compared these movements to pseudo-religious or ritual acts and gesticulations, thereby adding to the sense of the lore of the work's aesthetic, whereby the trombonist becomes an unknowable medium figure in performance.

Figure 5: Compass subpatch



This component of the live electronics shows in concrete terms how I instumentalise space, and in doing so, begin to dissolve the boundaries between the physicality of the musician, and the intangible sonic entities of the electronics, elaborated in the following subsections. Fig. 6 shows a generalised schematic for the entire instrumentality of the work, including the components of the max patch. This notation intends to represent the basic operations of the technology so that the piece could potentially be reproduced using different software and hardware, a practice that the critical edition Nono scores have followed, as well as other composers like John Croft.[4]

Figure 6: Instrumental Schematic of 'Her still singing limbs'



[4] See the prefaces to the scores of Crofts works such as *Intermedio* (2011).

This work was an important first test in demonstrating the successful convergence of novel compositional, aesthetic, technical, and performative aspects. It thereby created the foundation for the subsequent works presented in this portfolio. The restrictive use of trombone and birdsong materials, augmented by live electronics, and presented in an immersive and interactive spatial setting, all realise an ideal of worldbuilding in the sense of establishing a sense of a pre-existing universe or lore for a fictional world, in particular, with the use of warped birdsong suggested a preexisting, even ancient, environment into which the trombonist transgresses.

1.4: Homuncular Flexibility

The interactive spatial component of the iPhone compass tracker was my first step in exploring the idea of *homuncular flexibility* as proposed by Jaron Lanier (Lanier 2006). In Lanier's pioneering work in virtual reality (VR) between 1989-1999, he noticed that when, by some coding accident, a user's avatar's virtual limb was made unrealistically huge (e.g. a 100 metre arm), people could, with some practice, learn to use this entirely unnatural limb with the available controllers. Taking this further, Lanier showed how users could control entirely non-humanoid bodies, such as an eight-armed lobster, by creating fine-detailed mappings between wrist movements and the lobster's legs. More recently, Won et al (2015) have shown that while embodiment in the physical world is flexible, 'avatars are even more flexible', and continues to evidence this principle through two experiments. In a musical context, I find this conceptual framework highly rewarding, both for its potential explanatory power in terms of actual physical, bodily, and mental processes of flexible embodiment and instrumentality, but also as a poetic and artistic act that provokes critical reflection among audiences through the implicit challenging of the conventional notions that hold performers, electronics, and spaces, as mutually exclusive bodies. *Her still singing limbs* is a modest step researching the potential of this framework.

Compared to a VR system, the lack of a visual representations of electronic sound for the performer and audience alike make the connection between performer and electronics harder to grasp. Nonetheless, this *telekinetic* aspect of the technology—a trombonist moving sound around as they point

their instrument—attracts me from the point of view of a kind of magic or transgressive performative quality.[5] The tension between the 'natural' and 'artificial' in general poetic terms, became a core aesthetic subtext for the entire portfolio, and has driven me to explore different phenomenological aspects of acoustic and electronic sound as symbols and drivers of these ideals.

1.5: A Sentient Space

The work's title comes from Mark Z. Danielewski's experimental novel *House of Leaves*. In the book, chapter five presents a faux-academic text on the importance of echoes in the labyrinth, and begins with the myth of Echo, in which the quote 'Adonta ta melê' appears translated in the footnotes as 'Her still singing limbs' (Danielewski 2000, 41). As such, I began the idea for a new work, where the trombonist uses increasingly digitised and corroded echoes of themself and birdsong to navigate a virtual musical space. The presence of an unseen though distantly heard monster in a shifting labyrinth at the heart of *House of Leaves* prompted the idea of imagining the electronic sounds in my work as though a similar unseen though heard entity. This lead to the idea of a *sentient space*, wherein the sound and space fuse to form a perceptible musical entity that complements and responds to the live musician. In both *House of Leaves* and another touchstone for my work, Andrei Tarkovsky's film *Stalker*, both fictional labyrinths are speculated to respond to the inherent morality and psychological disposition of those who walk within them. In this sense, they demonstrate an—apparently supernatural—agency, sentience and intelligence.

While there is no obvious moral dimension to my work, I set out to create a similar sense of phantom entities, constituted in sound, and made perceptible through interactivity. In *Her still singing limbs*, the birdsong assumes the role of a sonic *other*, which the trombone duets with in its augmented live electronic form. The birdsong remains a separate sonic body throughout the work, though through the gradual digital corrosion of the original birdsong sample and the trombone's live electronics, both

[5] The initial idea was in fact to be able to magically move electronic sound around a space 'like a Jedi'.

succumb to the effects of a greater virtual environment suggested by the work. In the beginning, the effects remain relatively transparent, however as the work progresses, the effects become more aggressive and distorting, as though both trombone and birdsong are descending into the abyss of a labyrinth which dematerialises them into noise with every step. Another image that came to mind during rehearsals, and based on the instrumentalised spatial aspect, is imagining the trombone's sound and electronic projection as though a torchlight beaming out into the pitch-black of an unknown space; as they turn around, it is as though a light peers into the darkness. The *sentient space* idea will be further discussed in relation to the other works in the portfolio.

The work owes a great deal to Sebastiaan Kemner's initial input on the trombone writing and sounds, and so, naturally, the piece is dedicated to him. He has performed it several times, and its success lead to the larger work *The Holy Fool*, which concludes this portfolio. This project also helped to prove that such collaborations, when successful, were a viable vehicle for the development of my work in the context of the research degree.

1.6: Performance History

1. 3 May 2018: Modern Art Oxford
2. 30 May 2018: Jacqueline du Pré Music Building, Oxford
3. 26 June 2018: Holywell Music Room, Oxford
4. 5 February 2019: Uilenburgersjoel, Amsterdam
5. 23 April 2022: Noorderkerk, Amsterdam

2: ‘Unfurl’

2018, bass guitar and live electronics, ca. 15 minutes

This work expands the technical and aesthetic paradigm initiated in *Her still singing limbs*. Like the preceding work, a solo performer, a bass guitarist, stands at the centre of a loudspeaker ring, with the audience sitting or standing freely between them and the speakers, ideally in large and low-lit space. The bass guitar is fitted with an iPhone that transmits a live compass heading to a Max patch. In this case, I created the work for myself to perform, as I wanted to take further the idea of the patch and space as an instrument, and the *instrument as the composition*. As such, it made sense to write for my own instrument so that I could make use of its idiosyncrasies without the need for an extra collaborator performer.

From around the start of 2018 I listened to more records of various types of improvised and non-notated music, acoustic and electronic, from British artists such as John Butcher, Angharad Davies, and Mark Fell, to other acoustic and electronic artists such as Okkyung Lee, Oren Ambarchi, and Jon Hassell, among others. In my initial discussions with Mark Fell as part of a project with Explore Ensemble, he presented the idea of composition, performance, and improvisation as all being divisions of a more fundamental notion of ‘a work.’ In his 2013 PhD thesis and his 2021 book ‘Structure and Synthesis’ Fell has written about this critique of western music’s hierarchical partitioning of such activities, contrasting it with other cultures such as South Indian Carnatic Music. He also advances a critique of the western avant-garde in relation to electronic music and experimental music. He identifies a ‘Cartesian’ or ‘Metaphysical’ model which emphasises numerous dichotomies between thought and reality that he sees as a false reflection of musical creation as it actually happens in the world (Fell, 2013, 8-46). Fell roots the attitude of many modernist as well as contemporary electronic artists to Edgard Varése’s dream, of ‘instruments obedient to my thought’ (Varèse, 1917, 1), and then elucidates a number of binaries that reinforce the primacy of the mental over the physical in this historical regime, including: thought and instrument, dominant and obedient, essential and expendable,

source and vehicle, active and passive, genuine and suspect, isolated and shared (Fell, 2013, 13). In Fell's subsequent examples in electronic music history, as well as his own work, he offers an alternative view of musical creation as rooted in practice, and refutes the Cartesian-Metaphysical model: an 'absorbed embodied exploration of how the machine behaves under certain conditions, contexts and uses' (p. 31), wherein 'being, action and thinking are not considered to be distinct from technical environments but, by contrast, are fundamentally constituted within them.' (p. 43). More recently, Fell has developed these ideas in relation to his Max-centered practice, speaking of a 'material-attunement where making is an empathic process of understanding and sensate focus—touching, holding, and sensing—that enables physically-embedded curiosity' (Fell 2021, 16). Fell's music, writings, and my later personal interactions with him over the course of the Explore Ensemble project[6] served as stimuli for centring the tool, technology, instrument and its attendant modes of engagement i.e play and performance as the work or composition itself.

The result of this and other encounters around 2018-19 is *Unfurl*, a work that lacks a conventional score, but instead develops an elaborate hybrid instrument in the form a bass guitar with spectral scordatura, augmented with interactive spatial live electronics. In exploring the inherent instrumentality of the system, and refining it through multiple iterations of experimentation and performance, I created several types of materials based on different rhythmic and melodic materials, and other gestures based on particular playing techniques. In this sense, the system and my own compositional intentions formed a mutually interdependent whole, wherein my initial musical criteria prompted an initial design, and that first design created a variety of successful, unsuccessful, and unexpected but interesting results. The unexpected results prompted a redesign of the system, which further changed the initial successful results, and produced yet more unexpected and desirable results. I repeated this process several times until I felt the work had reached a mature state, both in the sense of the material I developed to play on the bass guitar, and the material of the Max patch instrument.

[6] From 2020 to 2022, resulting in the Italian and British performances of the ensemble work *Every non-empty ultra-connected compact space has a largest proper open subset*. https://markfell.com/web/work?id=839

Through this circulatory development process, I created several material types, and these form the basis for a structured improvisation that seeks to explore the full expressive potential of the live electronics system, while granting more agency to the performer to discover hard-to-notate and unexpected emergent properties of the instrument-system. This responded to my findings in *Her still singing limbs* and other experiments in the studio, that conventionally notated scores had limitations in exploring the full scale of possibilities that such live electronic systems contain, especially considering the extent of the contingencies that they entail, and which a score arguably cannot account for in an elegant way.[7] Such contingencies include variations in microphone techniques and pickup or input signal processing, variations in the performance space (acoustics of both the space and the audience), and variations in the feedback effects of the patch itself, and how these ramify further with the other contingencies of the work. As such, the instrumentality of *Unfurl* ostensibly favours a corporeal and intrapersonal practice that emerges between the human performer/composer, the bass guitar, the max patch or spatial live electronics, and to a lesser degree, the live audience.

In creating the work, I did not make a score as such, but made notes to remind myself of different materials and patterns that I would weave together while improvising live. Throughout several rehearsals and in the two performances, I explored different paths with the material to test the range of possible combinations. The goal of the work, beyond the other technical and aesthetic dimensions described below, was to create a personal performance practice for improvisation on my primary instrument, extended with live electronics to render the entire space part of that instrument.

I had already developed my own performance practice and guitar techniques in my 2016 work *Semantron,* which uses space-time notation to unfold melodic patterns based purely on natural harmonics of the strings, retuned to a spectral scordatura. In *Unfurl*, I used a six-string bass guitar with a particular microtonal scordatura that enabled a range of melodic possibilities using natural

[7] I am interested in prescriptive rather than descriptive notation.

harmonics. At the same time, I gathered a number of materials based on other playing techniques, such as playing finger style, slap, double-thumb slap, and a number of less well codified gestures such as scraping my nails across the length of the strings, and 'ghost' note arpeggiated plucks made by rapidly raking the fingers across the strings while muting the strings or touching unstable harmonic nodes with the left hand.

As in *Semantron*, I use a microtonal scordatura derived from a single harmonic spectrum, though which avoids emphasising the obvious harmonies of the fundamental itself. The soundworld of *Semantron* and by extension *Unfurl* was initially inspired by Clarence Barlow's piece *...Until... Version 7* (1981) for classical guitar and sine tone, which utilities only the natural harmonics of the guitar in a microtonal scordatura. I later discovered Catherine Lamb's *Point/Wave* (2015) for guitar and electronics tuned to just intonation i.e. the harmonic series, which suggested that my own exploration of this material is part of a wider practice of exploring the melodic potential of scordatura guitar tuning, a point evident today with guitarist/artists such as Julia Reidy and Chris Rainer.

In *Unfurl*. The strings are tuned to the harmonics of a sub-audio A (13.75 hz) which itself is not present in the work, nor any obvious "harmonic-series-in-A" character, since I am not interested in the now hackneyed stylisations of spectralism that rely on blatant and tonal centres, which are a cliché rife in contemporary classical music. The tuning of the strings is as follows, with corresponding partial ranks and frequencies shown in hertz:

Fundamental	1°	13.75
String 6	5°	68.75
String 5	6°	82.5
String 4	33°/4	113.4375
String 3	11°	151.25
String 2	27°/2	185.625
String 1	9°	247.5

The pitches of strings 2 and 4 are upper harmonics transposed down by one or two octaves to suit the particular string register, hence the above indication of dividing them by 2 or 4. The choice of this exact scordatura is neither purely theoretical nor numerological, but rather, a result of practical experimentation and trial and error, wherein the primary criteria include firstly the minimal retuning of the string from its usual pitch to avoid poor tone and playability (e.g. the fret buzzing or a too-loose feeling if tuned too low, or a risk of snapping if too high), and secondly, the maximising of harmonic and melodic possibilities via the available natural string harmonics, with a particular interest in finding a number of smaller microtones that beat against one another due to sub-audio differences in frequency (e.g. 1-20 hz).

Fig. 7 shows all of the possible pitches available from harmonics 2-8 for strings VI to I. Some higher harmonics are possible on the higher strings e.g. up to 11 or 12, and are used in the piece, either deliberately or accidentally as artefacts of certain playing techniques, but these pitches are not shown in fig. 1 for brevity's sake. Fig. 8 shows the same 42 pitches in another view as a single ascending form, with colour-coded slurs to show which pitches belong to the same string.

Figure 7: harmonics for 'Unfurl' tuning per string

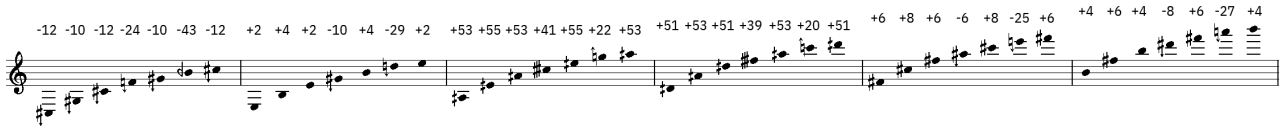
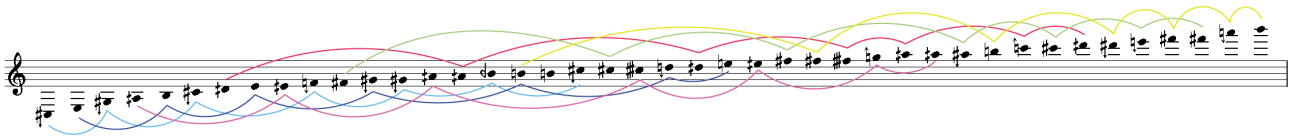


Figure 8: harmonics for 'Unfurl' tuning as a single scale



I did not write or sketch out the pitches when producing the piece as shown above, rather, I explored the material initially by ear and by hand, guided by certain idiomatic, and eventually less idiomatic left-

hand patterns, to produce different melodic patterns and variations thereof. As with finding the scordatura, I also had certain criteria in developing this initial overtone-melody-pattern material: firstly, the patterns have to sit fairly easily under the left hand given the difficulty of playing higher-order harmonics on the bass guitar's thick strings (and while moving while playing in the dark); secondly, the patterns as a collection have to explore a mixture of different intervalic characters, for example, ranging from the gnarly sounds of microtonally-clashing aggregates, to bell-like patterns arranged in triadic combinations, the yet brighter sounds combining of pure fifths, and the less stable harmonics, especially the seventh, which also have a particular timbral quality owing to the frequent prominence of the fundamental open string, especially on strings V and VI. A good example of the use of the seventh harmonic on the sixth string (B natural ca. -31 cents) is at 4:13 - 4:41 in the recording, when it beats against the sixth harmonic of the fifth string (a B natural +4 cents).

The material shown in the above figures, all demonstrate, in Fell's words, a 'material-attunement', and a 'physically-embedded curiosity' to sound, and to the instrument, before any live electronic processes are added. Indeed, I believe a distinctive feature of my music is its harmonic character, in which I try to find a range of seemingly familiar harmonic entities via spectral tunings that incorporate higher-order overtones i.e. where the fundamental tonality of a given spectrum is not necessarily articulated transparently. Instead of riffing on the harmonic series, I etch out melodic fragments that themselves bear spectral stylistic hallmarks, but without pointing to an obvious fundamental. Better still, I try to make the fragments point to multiple and shifting tonal centres, the perception of which becomes part of the listening process of the piece; continuously modulating or deferred harmonic resolutions or horizons. I do not plan these structures or their emergent effects such as the multiple harmonic zones, but rather, I build and elaborate them according to the above described processes and personal criteria, and discover their latent potential through a process of experimentation and refinement.

My preoccupation with a certain kind of microtonal or non-tempered music also reflects my interest in the music of composers including Catherine Lamb, Enno Poppe, James Dillon (especially the works

from the 1980s-1990s), Horațiu Rădulescu, Mauro Lanza, Fausto Romitelli, the later works of Gérard Grisey, and Tristan Murail's works from the 1980s-1990s, all of whom work with either spectrally-derived material or just intonation. As such, establishing and then exploring the instrumentality of the bass guitar's tuning was a critical foundation phase in developing the material and aesthetic underpinnings of *Unfurl* as part of a wider compositional practice that started before the DPhil and continues to occupy me today.

2.1 Freefall

Following *Her still singing limbs*, *Unfurl* presents a more mature paradigm for my solo instrument with live electronics work. On an aesthetic and conceptual level, it responded to key references from Hito Steyerl, Mark Z. Danielewski, Andrei Tarkovsky, and a few others, explained below.

Hito Steyerl's essay 'Free Fall: A Thought Experiment on Vertical Perspective' from 2011 formed a n important conceptual reference point in the development of my spatial imagination, and in particular, the Burkean notion of the sublime in relation to contemporary society; a radically transformational yet paradoxical experience of terror, awe, fascination, and even ecstasy. Developing her notion of groundlessness, Steyerl writes about free falling into oblivion: 'imagine you are falling […] but there is no ground'. In tracing the history of mapping, orienteering, and navigational instruments, Steyerl elucidates how such free falls cause disorientation,, while also leading to new ways of seeing, 'a new representational freedom', as the loss of a stable horizon or a 'stable paradigm of orientation,' questions the historically encultured position and othering gaze of the western viewer.' Steyerl argues that the root of this system lies in the Renaissance and the emergence of linear perspective, and that this has given way to the contemporary 'God's-eye view' of aerial and satellite views and maps engendered by new technologies of surveillance, tracking, and targeting. In thinking about free fall, Steyerl identifies ways to reconfigure illusory space, figures, and objects, to destabilise the primacy of the viewer's

perspective. Groundlessness prompts a rethinking of social dynamics and the breakdown of traditional, hierarchical ways of seeing. As such, falling gains a sublime meaning, as the rejection of stability, and the venturing into the unknown and unsettling. Despite the disquiet that this process might provoke, it holds potential to create radical and previously unimagined forms of freedom.

I draw parallels between Steyerl's liberating Groundlessness and Luigi Nono's *Suono mobile*, a continuously fluctuating multidimensional field of imaginary, sonic, poetic, and sociopolitical potential. Both seek to destabilise the privileged and totalising perspective of the western paradigm's rationalised and monetised forms of seeing and listening. Situationists such as Guy Debord, provided yet another important reference point, where wandering, or the *dérive*, became central to their wider methodology of psychogeography, which sought to discover and transform the social, political, and architectural affordances of urban space (Debord 1956; O'Rourke 2016).

A final important point of reference in Steyerl's essay is her description of the perceptual, proprioceptive, and corporeal confusion that pilot can experience when in free fall (emphasis added):

> Pilots have even reported that free fall can trigger a feeling of confusion between the self and the aircraft. *While falling, people may sense themselves as being things, while things may sense that they are people*. Traditional modes of seeing and feeling are shattered. Any sense of balance is disrupted. Perspectives are twisted and multiplied. New types of visuality arise.[8]

In *Unfurl*, I have pursued a type of spatiality that encourages such confusion between bodies, objects, and space, as part of my desire to extend the instrumentality of the work by combining human, acoustic, and electronic objects, as well as the performance venue. My methods in realising this effect range from simple staging aspects such as using large spaces and low lighting, to blur audience's perception of the physicality of the performance space and its contents, to the more bespoke aspects of the interactive live electronic and spatialisation components at the core of the Max patch, whereby the

[8] Steyerl (2011)

performer's gestures are mirrored by electronic spatial sound to suggest a much larger hologram-like entity which surrounds the audience.

2.2: Infinite Staircase

As with *Her still singing limbs*, Danielewski's *House of Leaves* provided yet more conceptual and poetic impetus for *Unfurl*. Towards the end of the novel, the central character descends a vast spiral staircase inside the labyrinth at the heart of the book. The staircase changes depth every time the characters return to it. On his final return, alone, the central character falls down the staircase as it spontaneously drops beneath him, and he continues to drop into — or begin floating within — an infinite black abyss. Fig. 9 shows a page from the section after the main character desOn a simple formal level, *Unfurl* reflects this journey from light steps in an observable interior space, to a free fall within an existential abyss, activating many of the ideas attendant to Steyerl's essay. As the performer completes 25 rotations, the electronics become loud, intense, and highly distorted. The existential black abyss of *House of Leaves* becomes a whited-out noise abyss in *Unfurl*, where the corporeality of the performer and the bass guitar are dissolved into the whirling vortex of pixelated spatialised sound, using the granulator with high octave and feedback settings.

A related reference point for labyrinthine aspect of *Unfurl* is Tarkovsky's 1979 film *Stalker*, where a group of three men journey into a forbidden zone subject to supernatural phenomena. In seeking the centre of the zone, which is said to grant a person's 'innermost wish', the main trio of characters navigate sprawling wastelands, strewn with destroyed military vehicles and ruined buildings, which flora have engulfed over the intervening years. The titular character constantly stops and shouts at the other two for wandering off path, explaining that:

> The Zone is a very complex maze of traps.
> All of them deadly…
> I don't know what happens when people aren't around.
> But as soon as humans appear, everything begins to change.
> Old traps disappear, new ones appear.

> Safe ways become impassable.
> One moment the way might be easy, another moment, it's confused beyond words.
> This is the Zone.
> It might seem capricious.
> But at each moment, it's as if we construct it
> according to our state of mind.[9]

In response to these references, I saw the potential to create an interactive live electronics system that mimicked the shifting mazes of Tarkovsky's zone and Danielewski's labyrinth, i.e. where the labyrinth figured as a being in and of itself, responding to those who wander through it; a sentient space. Even if the technology is obviously nowhere near an AI system or other machine intelligence, my point here is that as both artists and audience, we do not need such systems in order to have a convincing imaginative musical experience that might prompt such feelings, visions, and emotions evoked by impressions of the technological sublime and otherness.

[9] Stalker in Tarkovsky (1979) *Stalker*. Transcription of the translated subtitles.

Figure 9: page 289 from Mark Z. Danielewski's 'House of Leaves'.

2.3: Technical Features

Echoing the spiral staircase in *House of Leaves*, I initially envisioned a work in which, through the iPhone compass tracking module, I could rotate as I perform a structured improvisation on the bass. As I rotate, the live electronics respond on both micro and macro temporal and gestural scales: on the micro-scale, to the speed of my individual gestures; on the macro-scale, the patch tracks the number of full rotations the performer makes. Within each 'turn' the live electronics follow shifting parameters, and over the entire 25 turns of the work, the electronics form a higher-order narrative structure. The rotation counter enabled me to make a digital instrument formed as though a spiral. We begin in its interior with calm and bounded material, and gradually spiral outwards to wilder, 'capricious' territories.

The composition sees a performer make 25 full turns in either clockwise or anticlockwise directions. They are free to move back and forth, and do not need to move constantly. With each new turn of the spiral, the live electronics generate different processes and spatialisations. The initial 'internal' turns of the spiral are calmer, and as the performer turns through to the 'outer' or final few turns of the spiral, the live electronics become much more aggressive and intense in terms of their sonic presence, spatial activity, and warping effects on the live bass guitar sound.

The main DSP techniques used in the patch are delay-line granulation using the [munger] object (for granulation and octave transposition effects), ring modulation using Max's [freqshift] object, and bitcrushing using Max's [degrade] object. The different settings for these modules, including their balanced levels and intensities, are determined in the spatial mappings of the overall spiral form. I use Max's [function] object to create envelopes that correspond to different electronic parameters throughout the piece. Figure 10 shows a schematic of the work's instrumental design.

Figure 11 shows a subpatch for the control of two ring modulation effects sources in the piece. In this case, the ring modulators remain silent for the first half of the piece, and then they gradually become more present from turns 12 to 25. The ring modulator level envelopes outline an alternation effect, so that as the performer rotates, they blend in and out of one another. In the background, when silent, the ring modulation values also change as the performer spirals through the work. The control parameters for the other effects in the work follow a similar scheme.

Figure 10: Instrumental Schematic of 'Her still singing limbs'

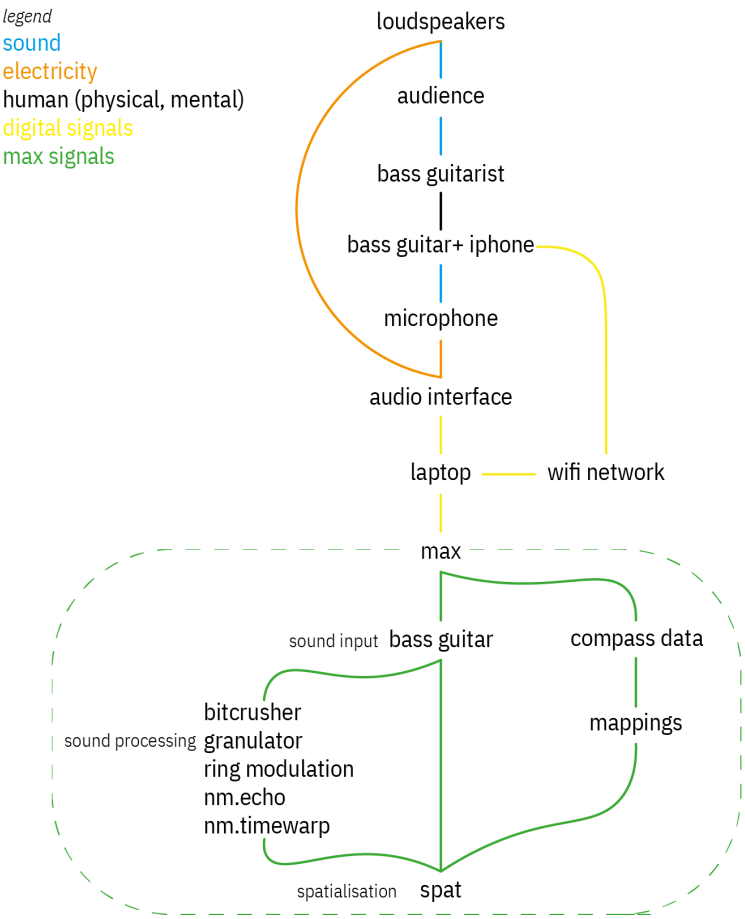
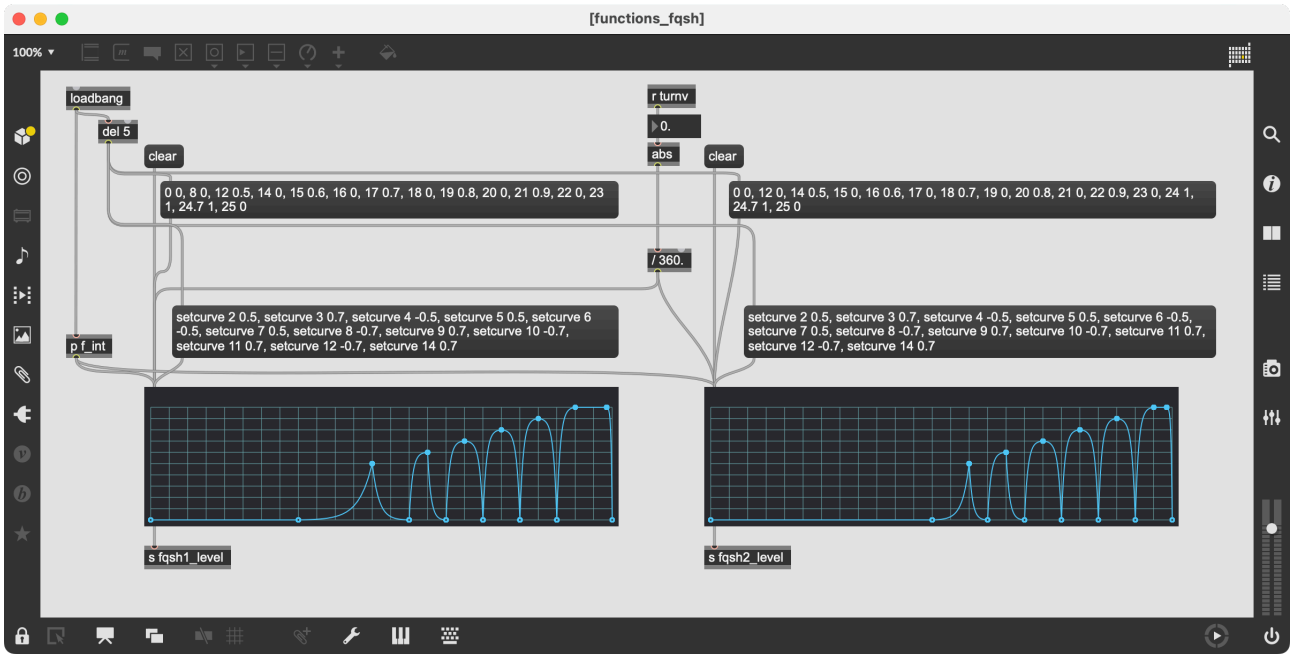


Figure 11: 'functions' subpatch for frequency shift mappings



The patch incorporates a differential analysis subpatch which detects rapid movements of the bass guitar. These sudden movements trigger sudden spatialisation motions, such as fast orbits and disjunct or strobing motions. An internal timing unit tracking a moving average of the 'global intensity level' clocks out after set times, which increase throughout the piece. This unit helps to initially keep the electronics at a calmer level, paced according to my general formal idea of a slow intensification over the course of the work. Towards the end of the work, the possible durations of intensity increase to 60 seconds, as follows:

- Turns 1-6: 10 seconds
- Turns 7-9: 15 seconds
- Turns 10-17: 20 seconds
- Turns 18-22: 26 seconds
- Turns 23-25: 60 seconds

The piece was presented at the JdP Music Building in Oxford as part of the EXPO Oxford series on 10 October 2018, and again at the Modern Art Oxford on 29 November 2018. I presented a paper on the work, its technologies and aesthetics at IRCAM on 29 March 2019 as part of their annual Forum weekend of concerts and presentations. While I believe the piece is a success in terms of the goals it set out to achieve technically, compositionally, and poetically, it suffered in the pandemic. I had planned several more performances, and extending the piece to include other instrumentalists such as flute and violin, but live concerts became impossible during Covid, and I had to move on to other projects. Nonetheless, I see *Unfurl* as a high point of my solo and live electronics works for its use of interactive live electronics, spatialisation, and the aesthetic experience it offers listeners conceptually, sonically, and spatially, where the virtual musical space becomes the instrument through technology. It also proved to me that notation was not a necessity in my compositional practice. In a sense the Max patch is akin to a score, in that it prompts a certain global structure, while leaving the microlevel details entirely open to the performer. Beyond sound and performance, the worldbuilding aspects are also elaborated through the context of Tarkovsky, Danielewski, and Steyerl, provided to the audience in a programme note.

3: ‘bot.radio’

2019, interactive installation, minimum 15 minutes

This work is an interactive installation which takes further the theme of the natural-artificial dichotomy from other works in this portfolio by presenting a putative AI agent as the work’s fictional antagonist. As with *Her still singing* limbs, *Unfurl*, and *Intralatent*, the audience are surrounded by a loudspeaker ring in a large space with low lighting. In this work, the audience are encouraged to move around, and are told as they enter the performance space that their movements trigger responses and changes in the sound. The acoustic instrumentalist that usually sits at the centre of my works is in this instance replaced by a virtual agent that wanders around an imaginary interior; a sentient space, or digital being whom we hear flicking through radio stations, seemingly disturbed by the audience’s presence. The situation I present to the audience is that they are stepping into the mind of a machine being, which is browsing through the sonic clutter of the human world as though they are within its artificial mind, hearing our world through its ears. The actual sound samples used are machine learning (ML) generated emulations of various music and radio recordings including the BBC Shipping Forecast, Bach, Wagner, The Beatles, Beyonce, and Justin Bieber, among many others, detailed below.

bot.radio was presented in Oxford at the JdP Music Building on 14 May 2019 as part of the EXPO series for experimental art and music, which I co-curated with fellow DPhil composition student Jonathan Packham, and in Manchester at RNCM’s *Future Music* festival on 13 June 2019. The recording supplied as part of this submission is an excerpt of the first Oxford performance. The recording is 18 minutes long, however, beside a minimum 15 minute duration, the work has an essentially flexible duration that can be adapted to particular spaces and performance contexts.

3.1: Aesthetic and Technical Background

The playful proposition of *bot.radio* arose while reflecting on the potential uses for SampleRNN, a machine learning (ML) technique that generates novel audio based on large training datasets. The latter half of the 2010s saw a new wave of AI hype explode in the wake of numerous developments with ML techniques and big data. I was interested in interrogating this technology and its contexts in whatever way I could. An early audio generative model called WaveNet, developed at Google DeepMind (Oord et al 2016) demonstrated the potential for creating new audio by training a neural network on hours of existing recordings, including speech and music. The advantage of this technique, working on audio rather in the symbolic or synthesis domain, is that the network can learn to capture fine nuances of sound, such as lip and breath sounds in speech, or timbral details of a musical sound. Nonetheless, these early iterations resulted in very rough sounding results that suffered from high noise content due to their low sample-rate resolution, which was necessary to optimise computation time. Furthermore, the technique was prone to creating garbled version of the original input. It was clear that both music and speech present non-trivial challenges in consolidating different time scales and structural forms in a convincing and natural way.

While more recent iterations of this technology has overcome these challenges, and now produces convincing emulations of the input sound (e.g. RNCM's SampleRNN), I was intrigued by the glitchy nature of the initial WaveNet results. The examples trained on Chopin shared on their webpage had a chaotic and dream-like quality unlike any kind of sampling or DSP technique I had encountered before. Another important reference was the work of Dadabots, the American duo of CJ Carr and Zack Zukowski, who produced several pioneering digital works exploring the potential of generative ML platforms, most notably RELENTLESS DOPPELGANGER, a continuous YouTube livestream of ML-generated death metal, which began in March 2019.[10] Even though I was aware that the output was the result of a highly mechanical and statistical process i.e. training a network, and then using it to generate

[10] Dadabots, RELENTLESS DOPPELGANGER, accessed 03.04.19 https://www.youtube.com/watch?v=JF2p0Hlg_5U

output, I read the entire system as an analogue of machine-like perception of the human world, and therefore, as an index of digital artificiality and cyberspace, what artist Hito Steyerl refers to as a form of 'groundlessness', a sublime unknowability of the hidden virtual and physical infrastructures of contemporary society's digital technologies, and their attendant sociocultural practices.[11]

For *bot.radio*, I partnered with a fellow computer science DPhil student at Oxford, Lewis Smith, who provided the technical expertise and computational resources at the Faculty of Computer Science. Lewis implemented a version of the SampleRNN code available on github, and left me to train several models on multi-hour YouTube videos, tweaking the software to optimise the output for tolerable noise and convincing output. I wanted to cover as many different musical styles as possible, but had limited time to train and generate the content. The final collection of ML-generated sounds derive from the following sources:

- Arriana Grande (multiple albums)
- Beyoncé (multiple albums)
- George Michael's *Careless Whisper* (1 hour YouTube loop video)
- Chicha Libre's *¡Sonido Amazonico!* album
- Justin Bieber (multiple albums)
- Ed Sheeran (multiple albums)
- MIC (multiple songs)
- Several playlists of 'mystery' radio broadcasts and cold war number stations
- Pink Floyd (multiple albums)
- Ravi Shankar (multiple albums)
- Franz Schubert (multiple piano solo compositions)
- BBC Radio Shipping Forecast (several male speakers)
- Richard Wagner's Ring Cycle

The above sources gave me around 100 audio files, lasting just under 1 hour. Additionally, I recorded and sampled some radio scrambling sounds to function as folly in the installation, to occasionally mark whenever a radio station changes.

[11] Hito Steyerl (2010) *In Free Fall: A Thought Experiment on Vertical Perspective*, published online on *e-flux*, accessed 26.10.23: https://www.e-flux.com/journal/24/67860/in-free-fall-a-thought-experiment-on-vertical-perspective/

The nature of this work is unique in my portfolio, not only because of the lack of a staged human performer with a conventional western instrument, but also because its sonic material lacks the conventional characteristics usually afforded by notation and acoustic instruments, namely, harmony and rhythm. Instead, *bot.radio* is primarily about sampling, noise, and the play of symbolism and cultural imagery of each sample. It flits between playful manipulations of a wide range of samples, or random drops and juxtaposition of elements ranging from kitsch to intensely disturbing and aggressive noise. In this vein, I have been able to explore an area of my artistic interests in experimental music and sound art which I usually can not, due to my own self-imposed formal constraints with my instrumental works; constraints that as this portfolio otherwise shows, are constructive and positive forces in forming my artistic identity and practice. Important references in this area include artists such as John Cage, Christian Marclay, Yasunao Tone, Dadabots, Iannis Xenakis, Demdike Stare, Jennifer Walshe, and Russell Haswell, among others.

My use of noise, space, and AI themes in this work also supports my interest in contemporary philosophies of space. Whereas in other works in this portfolio I seek out a more consolatory or revelatory approach to the audience's relation to sound and space, in *bot.radio*, the approach is much more aggressive and unresolved. The intention is one of the deliberate alienation of the audience with the overwhelming and capricious forces of ML-generated sound and interactive spatial instrument. The point is to provoke discussion around the topic of AI in music generation and cultural more widely, while also offering audiences an immersive experience of an intensely noisy and playful work. However, the playfulness is not merely just that, but rather, part of the work's more sinister agenda. On a certain level, I have tried to reproduced the manipulative and deceptive aspects of contemporary digital technologies which encourage an apparent playfulness though underpinned by an ominous, vast, and inscrutable infrastructure, for example, as in the compulsive phenomenon of 'doomscrolling' on social media.[12] In bot.radio, the audience's can be seen as though doomscrolling with their entire bodies through an imaginary landscape of machine-transformed audio detritus towards an uncertain if not

[12] See Jessica Klein, 'The darkly soothing compulsion of 'doomscrolling', BBC, accessed 01.05.22: https://www.bbc.com/worklife/article/20210226-the-darkly-soothing-compulsion-of-doomscrolling

infinitely deferred endpoint. A vision of a dead-end techno-feudal future that endlessly recycles content and past culture to profit off those trapped in its midst.

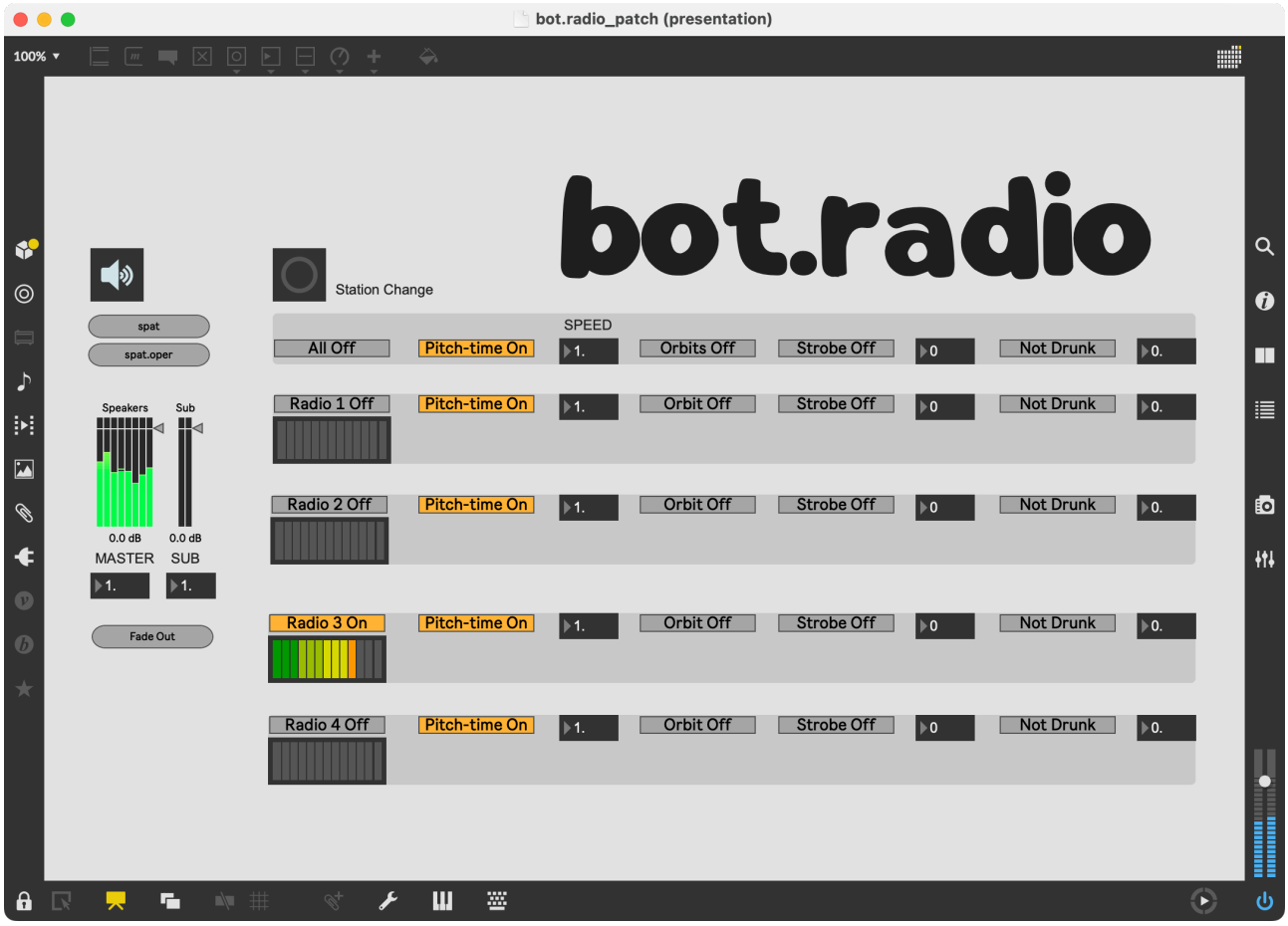
3.2: Max Patch Design

The Max patch is designed to simultaneously play up to four imaginary radio channels. The patch was originally designed to work autonomously, driven by the interactivity afforded by a basic computer vision unit: a webcam fed into a subpatch, which watches and analyses the audience to trigger changes in the sound and activity. The interactive vision aspect is explained below. Nonetheless, in both presentations of the work in Oxford and Manchester in 2019, in addition to the autonomous functions, I also performed the patch live, albeit out of sight of the audience, to maintain the illusion of an entirely artificial agent producing the sound. I decided to contradict my original intentions of an autonomous interactive installation because I was unable to programme into the patch a high enough degree of controlled chaos and responsiveness to the audience, where there is a balance of exciting and calm moments, i.e. a certain structural flow, while also avoiding too many repetitions of a particular sample or set of samples. Rather than see this as a failure of my patching abilities, I have embraced the notion of the patch itself as a live instrument, and one that affords a particular sense of playfulness in support of my aesthetic goals with the work. Figure 12 shows a screenshot of the patch in presentation mode, as I used it in the performances.

Each channel or radio source is a mono signal, and is spatialised around the speaker ring using the Spat library. Spat also includes a reverb, which helps to create a sense of a cohesive space. The recording supplied in this submission uses the [spat5.virtualspeakers] object to make a stereo downmix of the eight channel recording. The spatial movements of the radios range from either smooth orbits around the ring, or jagged 'strobing' motions where the source jumps suddenly from one spot to another. There

is also a 'drunk' function, where the orbits stumble in an irregular motion around the perimeter. Both strobe and drunk settings have variable speeds of motion, operable via the number boxes to the right of their respective on/off switches.

Figure 12: 'bot.radio' patch performance interface



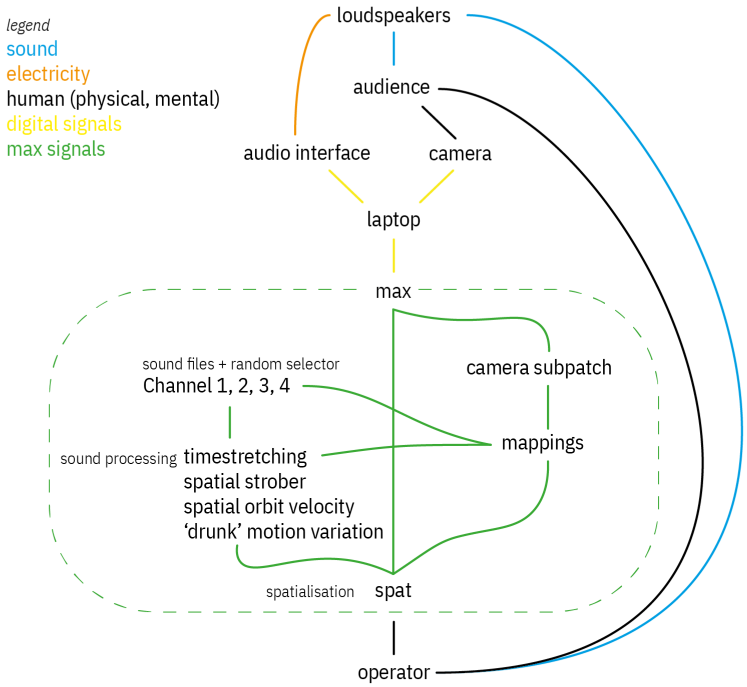
A crucial part of the sound design of the work is the use of timestretching and the variable playback speed of the samples. In the patch shown in fig.11, each channel has a 'Pitch-time' on/off switch. This switches timestretching on and off in the [groove~] objects, which are the playback engines for each sample. When switched off, I controlled the playback speed of the sample using the number boxes to the right of the switch. Without timestretching, the pitch of the sample varied with specified speed. In the performances, I played with very low and slow speeds (e.g. 0.125, 0.25, and 0.5), as in my [timewarp] effect in other works in the portfolio, but I also used high speeds (e.g. 2, 4, 8, 16). The change in speed of

the samples had a strong transformational effect on the sonic characteristic of each sample, and afforded me the ability to use samples in different ways. For examples, when low and slow, samples became an ambient background texture, whereas I used high speeds for more exciting and high energy moments. Examples of slowed-down samples in the recording are at 2:07 (slow piano sample and vocal/sung sample) or 13:26 (slowed piano ambience and radio folley), and of the sped-up samples at 8:50 (vocal samples) and 16:48 (vocal samples and radio folley). With pitch-time switched on, the [groove~] object enacts timestretching, preserving the original pitch level of the sample, and changing the speed as determined by the number box. I used a range of low and high speeds to bring out the artefacts of the timestretching algorithm used by [groove~], for example at 17:34 with the comb filter like sounds in the final noisy sample. In the version I showed in Oxford and Manchester, In addition to the camera input, I also controlled the spatialisation live, responding to the individual and collective movements of the audience. For example, when someone moved suddenly, I would trigger the strobe function on a particular channel, or change a sample, or switch a channel on or off. In other words, there was a direct correlation between the speed, extent, and duration of audience movements, and changes in the patch, albeit the mappings that I effected in performance were essentially improvised, in addition to some of the fixed mappings I programmed into the patch.

I used the cv.jit package in Max by Jean-Marc Pelletier[13] so that the video feed from a single camera pointing down at the performance space from above (reproducing Steyerl's 'God eye view') could be used to analyse the audience motion and drive the radio controller system. Using two techniques 'blob tracking' and 'colour tracking', the patch crudely calculates the activity of the observed scene in terms of the number of people and the extent of their motion. A simple differential subpatch calculates the rate of change in the data flow, compiling the number and speed of the tracked objects. When this compiled value exceeds a certain threshold, the subpatch sends out a signal to the radio controller module to change a channel, and to switch to a new collection of ML-generated samples. Fig. 13 shows a schematic of the instrumental design of *bot.radio.*

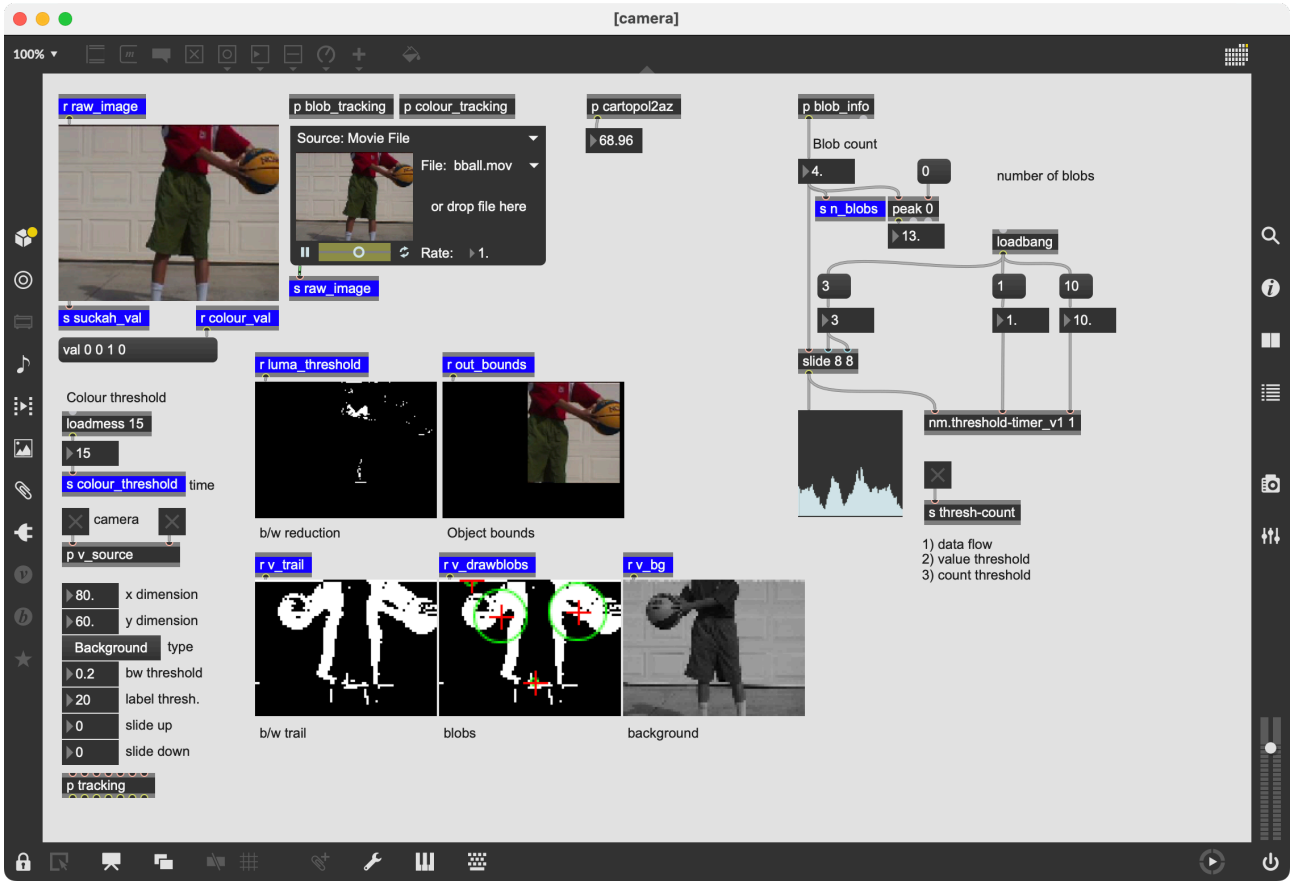
[13] https://jmpelletier.com/cvjit/ accessed 08.08.18

Figure 13: Instrumental Schematic of 'bot.radio'



These parts of the patch can be inspected inside the subpatch 'camera', as shown in figure 14. The patch uses a combination of background comparison and blob tracking to count the number of moving elements in the given scene. I fix the background image on the empty performance space, so that as people enter, the patch can clearly identify people. The blob tracking counts the number of people, but can also pick up individual limbs when people move quickly or spread their arms or legs out. The custom object [nm.threshold-timer] analyses the data stream, creates a differential analysis value, and sends triggers to other parts of the patch according to pre-defined threshold values. The image shown in fig. 14 of a basketball player is from the Max examples, and only for illustrative purposes.

Figure 14: 'bot.radio' camera subpatch



One of the pleasantly surprising results of the work was seeing the variety of positive audience responses and engagements. In Oxford, while people initially walked around slowly, looking somewhat puzzled, one person started to jump and run around, and then a few others joined in, eventually dancing, and this made the interactive element more concrete, but more importantly, brought a sense of play and chaos to the work, which is what I was searching for, as an important experiment for me outside the conventional concert format. As I controlled the spatialisation live, I was also able to increase the intensity of spatial movements in step with the excitability of the audience. For the second showing in Manchester, I encouraged people to move and dance as much as they liked in my introduction, building on the initial experience in Oxford.

3.3: Learnings

Overall, *bot.radio* successfully advanced and demonstrated the convergence of several technical, aesthetic, and conceptual principles in my compositional practice, in particular the sentient space, given that the work is explicitly presented as a sentient agent that the audience interact with. On a technical level, it proved that CV-based systems work within Max in combination with the suite of devices and modules I had developed in my previous works with acoustic instruments and live electronics. The hybrid nature of the patch as both autonomous and live instrument also established the legitimacy of such mixed approaches. Instead of pursing a simplistic valorisation of 'autonomy' and 'interactivity' in my patches this project taught me that such hybrid and pragmatic approaches could ultimately be both more successful in performance, but also more rewarding for me in the development of my technical and creative practice. This finding has had a lasting effect in my work, and is observable in the following two works in this portfolio: *Intralatent* and *The Holy Fool*.

The project also showed that I could, with the support of Lewis Smith, train and create ML-generated audio. Relatedly, the use of said materials showed that I could more explicitly foreground and investigate the topics of technology, interactivity, and AI in my work, going further than my purely acoustic instrumental works were able to. Were I to take this further, I would seek to approach the sourcing of audio in a more explicitly ethical manner. The practice of mass-sweeping web sources, and in particular YouTube, was and continues to be rife in the development of AI/ML systems.[14] The rights of the artists whose music has been sampled are not, per se, recognised in my work, and I justify this to myself in the case of *bot.radio* on the basis of my work being essentially a student effort and work of experimental research, albeit public-facing, but not a commercial initiative that would exploit other peoples' labour for private benefit, as is the norm with the vast majority of other tech companies including Google DeepMind, Meta, and OpenAI. A promising model that reconciles an artists rights,

[14] See media reports: Eric Hal Schwartz, 'Investigation finds companies are training AI models with YouTube content without permission', Tech Radar, 16 July 2024, accessed 3 August 2024: https://www.techradar.com/computing/artificial-intelligence/investigation-finds-companies-are-training-ai-models-with-youtube-content-without-permission

and particularly the identity of their singing voice, style, and identity, with that of a community's creative use of said features, is Holly Herndon's Holly+ system.[15] This 'digital twin' of Herndon uses decentralised autonomous organisation (DAO) that attributes rights and rewards among a network that comprises herself, users, and the DAO itself, as various individuals use the system to create new music.[16] Nonetheless, it would seem that with the foundational models and datasets for training the now leading AI systems such as ChatGPT or music generating systems such as Loudly and udio, these companies have already got away with profiting off the mass-harvesting of data without the consent of the original creators.

While *bot.radio* maintains the conceptual separation of the audience and the imaginary machine entity, it still explores the topic of a disembodied digital and spatial instrument that blurs the boundaries between the physicality and digitality of audience and technology, a theme which runs throughout this portfolio as a central pursuit. The sense of interiority prompted by my explicit suggestion of *going inside* a machine mind further promotes a sense of dwelling within a bounded fictional environment, and therefore, presents another example of spatialised and interactive sound as techniques for worldbuilding in music, and one constituted of noise and digital detritus, while being animated by the audience itself in a dialogue and dance between human and machine.

[15] Accessed 21.03.24: https://holly.plus/

[16] Ars Electronica, 'Holly+: Holly Herndon (UM), Mathew Dryhurst, Herndon Dryhurst Studio'. Accessed 23.12.22: https://ars.electronica.art/planetb/en/holly-plus/

4: ‘Intralatent’

2019, piano, percussion and live electronics, 20 minutes

Intralatent is work for piano, percussion and live electronics, commissioned by the GBSR Duo and premiered by them and the composer at hcmf// on 18 November 2019 at Huddersfield Town Hall. The title makes reference to ideas from Karen Barad (Intra-Action) and AI (latent spaces), pointing to the presence of a third imaginary digital being, viewed as the third presence and performer alongside the duo. As with the other works in this portfolio, I*ntralatent* calls for a non-standard concert layout, where the musicians are located in the middle of the performance space, and a multi-channel loudspeaker system (8.1) surrounds them. The audience sit inside the speaker ring along the perimeter, facing inwards at the duo. *Intralatent* builds on concepts and practices that I developed in earlier works of this portfolio, including the term *sentient spaces* concept to describe the distinct combination of performative, compositional, programming, and aesthetic concerns. *Intralatent* explores this concept further in two contrasting movements.

Each movement represents an experiment in compositional methodology and live electronic performance. Broadly speaking, the first movement explores short/fast time using more strictly notated material and hewn from small patterns, whereas the second movement explores long/slow time using freer notation where the performers are given more agency to effect or musicalise their own live electronic transformations. Thus, the piece presents a binary of compositional techniques, between strictness and looseness, which are further explored in the ramifications of the live electronic processing. The piece also experiments with performance formats with its alternative staging. The motivation is to remove audiences from the conventional front-facing concert format, and to challenge the mannerism of the ‘sweet-spot’ in electronic music concerts. I offer in place a pseudo-ritualistic work that invites listeners to renew their aural relationship to both the performance venue and the musicians. The listeners’ displacement in the space is compensated by the use of the surround system, which attempts to evenly distribute the live amplification and electronics throughout the performance.

This means that, even though a listener might be sat in a single position for the performance, they are not stuck with a single aural perspective, nor missing out on a particular 'sweet spot' listening position.

A central reference point in *Intralatent* and across my entire compositional portfolio is Mark Danielewski's novel *House of Leaves*, which includes a mysterious labyrinth that changes shape and size in response to those who wander within it; a well-suited analogue to interactive live electronics. In Danielewski's labyrinth travellers hear an unseen monster and its ominous sound echoing through the labyrinth's pitch-black corridors. They also encounter a massive spiral staircase that changes size every time the characters return to it; from a few flights high, to seemingly infinitely deep, as described in relation the preceding work, *Unfurl*. As detailed below, in my work with live electronics, and in particular with multichannel surround sound, I have been influenced by such ideas as world-building and labyrinth creation as found in literature and the arts. In musical terms, I want sound to transfigure space, to charge it with an affective energy, or more simply, an emotive mood that lifts people out of everyday experience, whether that be of excitement, danger, or the sublime, and where interactive electronic techniques afford a sense of agency to electronic sound, such that one can frame the electronics as a kind of being, even if an ultimately fictional or artificial one. I see my preoccupations here as an continuation of pre-existing aesthetic and technical discourses in electronic music, for example which George Lewis has described as 'technology-mediated animism',[17] or what John Croft calls 'aesthetic liveness'.[18] Fundamentally, I use technology to explore both acoustic and electronic, space, and 'musicality' at both micro and macro scales, in both composition and performance, while using a somewhat constrained collection of materials and processes.

A YouTube video of the premiere is available on the link below. NB: due to a technical error of a third party, the stereo downmix of the surround electronics was lost, and so the balance of the electronics is, regretfully, very low in the mix, captured only by the instrument mics. Unfortunately, the pandemic and

[17] Lewis (2000), 37

[18] Croft (2007), 60

funding challenges prevented a new recording of the work, since it requires a lot of rehearsal time, a large venue, and an extensive technical setup.

https://youtu.be/v1yauGWwOhw?si=-IxBny2sz00JQNtt

4.1: Collaboration and Experimentation

Intralatent began life when the GBSR Duo was invited to perform at hcmf// 2019. Together we fundraised and planned the project to cover the commission, workshop, and rehearsal costs. With the hcmf// date fixed, we then planned other performances at Oxford, at the JdP Music Building, and in London, at City University. Throughout the summer of 2019 I made two visits to GBSR's home (they are a couple) to workshop material for the piece. I already had ideas of how to use my existing timewarp and echo Max effects on their instruments, but I needed to record samples in order to test and optimise the effects, especially because both piano and percussion have much more aggressive attack transients, and so, my effects needed adapting to avoid clipping while still giving a strong and clear signal.

In the first workshop I recorded George Barton playing various skin drums. This would lead to my decision to eventually focus only on bongos and congas in movement 1. On the same day, I also experimented with the one-cent Euro coin preparation with Siwan Rhys, which I had seen used effectively in Mauro Lanza's music. After having both agreed that the sound was interesting and the preparation was safe to use on a piano, I later recorded a wide range of preparations myself back in Oxford in the JdP Music Building. I used these samples to help compose the piece as well as test the electronics.

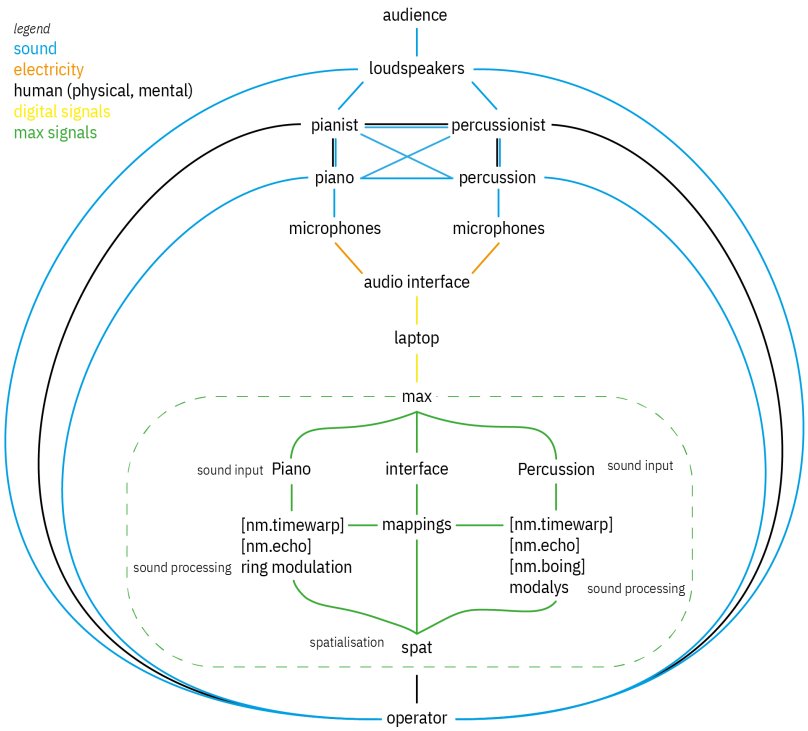
During the second workshop at GBSR's home, we tested various sounds with live electronics, monitoring simply on headphones in their rehearsal room. During this session, I tried the superball

mallet dragged across the bass strings of the piano, together with my timewarp effect. Siwan Rhys and I were pleased with the powerful, dark, and detailed sound. It went on to form a core material of the second movement. On the same day I also brought several transducers and an amplifier, as I originally wanted to add another layer of electronics that would be heard through large bass drums, as in other works such as Alvin Lucier's *Music for a Solo Performer*. However, although we made some sounds work through the bass drum in the workshop, I decided not to use them, and to use only the loudspeaker system, because the transducers on bass drum systems would not be loud enough, or cover a full frequency spectrum, and I already knew that I wanted to create a piece that could be very loud at one extreme. During this second day, and later in the rehearsals, we would develop and refine particular performance techniques for the different materials and live electronics. This varied from communication tactics (e.g. nods from them both to show when I need to pre-emptively trigger certain effects), to microphone techniques, and optimising mallet choice for the different instruments.

The GBSR Duo's time, patience, guidance, and playful creativity during these workshops is a vital part of the entire compositional process. I consider them as collaborators who share agency in co-creating the piece with me. Furthermore, having known them both for some years, I also feel that I have in some way responded to their personalities in composing the piece. There is something particularly poised and focused about them both, in different ways, and which I have always found an impressive part of their musicianship. These aspects seep into the material of *Intralatent*. While vital collaborators, we agreed that in the case of this piece, the duo did not feel like they were co-authors or co-composers, given how the vast majority of the work manifests via the score.

The following describes the relationships between musicians and electronics in each movement, as well as the compositional processes. The live electronics are realised and performed in Max using a combination of standard, custom, and third party objects and libraries. Fig. 14 shows a schematic for the overall instrumental design of the work.

Figure 15: Instrumental Schematic of 'Intralatent'



4.2: Movement 1

Movement 1 draws on a wide field pre-determined rhythmic and harmonic material that undergoes a dialectical process of synthesis throughout the arc of the piece. Materials are limited to either small cell-like motifs, or certain playing techniques, which are augmented by live electronic processing that self-modulates throughout the course of the work according to live inputs of the musicians. The mechanistic processes behind the generation of the notated material contrast with the free manner in which I assembled them. I refer to this as an 'abundance-assembly' method: first, I generate large amounts of 'raw' material (rhythmic, harmonic) without a particular function or form in mind (often stemming from an initial idea or groove I come up with while daydreaming or doing nothing in particular; tapping my fingers, singing etc); second, I assemble and edit together the materials while intuitively sketching-out ideas for the individual parts of the piece. Some materials are never used, while others are used frequently. As I develop and re-draft sketches, an idea for a certain large-scale

form or process for the movement emerges from the inherent sonic, dynamic, and dramaturgical characteristics of the individual parts and their interrelationships. In the case of the first movement, a dialectical weaving of percussion and piano part, where each instrument shifts between two material types that develop at first seemingly in isolation, and later in parallel towards a climactic shattering.

My methodology here reflects years of progress and a struggle with balancing control and freedom, design and spontaneity, idea and sound. In previous years I was preoccupied with uniting large and small-scale structure in my compositional process, reflecting interests in different forms of modernist music, for example, the late works of Feldman, or the 1990s works of Grisey, *Vortex Temporum* being a paradigmatic work. However, I constantly found myself flouting the systems I had created, or, I found that they sounded bad, so I rejected them. I ended up composing with a broadly intuitive approach, though always with the frustration that I could not work strictly within a system; I would use the materials of the system, but not in the prescribed manner the system had defined. This was an unsatisfying process and wasteful. In my exploration of live electronics and other methodologies through the course of this doctoral degree, I have explored various solutions: Instead of trying to create systems that work across all structural levels of a work, only to then flout and ignore such systems, instead, I now embrace and foreground the previously problematic dualism, giving both systemic and intuitive methods equal footing. In a sense, working with live electronic, and the necessary process of experimentation that this entails, has helped to liberate me from the formalist paradigm that I previously found myself cornered in. I have, therefore, found Nono's thoughts on the disruptive and radical transformational potential of technology useful in this domain; embracing contingency, an emergent process, and the discovery or elaboration of material out of small bodies of sound, instead of perching sound and music *a priori.*[19] My method of sifting through material and making multiple iterations of sketches until a piece emerges also reflects Mark Fell's idea of 'material-attunement'.[20]

[19] Nono (1983)

[20] Mark Fell (2022), 16.

The appendix to this preface shows the 'abundant' pre-compositional material made for the percussion part. The cell-like motifs follow from my earlier works such as *Semantron* (2016) and *Unhintergehbar* (2016) which combine rhythmic pattern manipulation with post-spectral harmonic techniques. The rhythmic approach follows from an interest in composers such as Feldman, especially the late works, but also more recent electronic musicians such as Mark Fell. Both artists produce low-level material as brief patterns, and manipulate them elastically in time. While Feldman does this in notation, for example in *Patterns in a Chromatic Field* (1981), Fell creates custom real-time generative systems in Max that exhibit certain temporal and morphological behaviours, for example in his 2013 release *Multistability*. In composing the percussion part, I tried to merge both approaches, at least as a starting point: I created a family of rhythmic patterns according to certain subdivisions of a variety of durational units. This could have been realised algorithmically in Max or OpenMusic, since the procedure behind them is essentially numerical. However, I gathered them in notated form, and revelled in forming what Feldman called 'notational images'[21]: notation that is not necessarily 'conventional' or 'practical' (e.g. beamed to show the beats), but which would elicit a certain performative response from a musician, and also had an aesthetic value to me, and thereby guided the compositional process.

Referencing Fell and Feldman further, in movement 1, I experiment with multi-temporal notational layers for the first time in my practice. The percussionist part floats partially separate to the piano, however, both are interrelated metronomically (the piano is at half the speed of the percussion). In performance, they still have to coordinate joint shifts between key material types and sections, shown by the dotted vertical lines in the score. They can drift apart as long as they synchronise at key moments, such as the beginning of sections. The percussion's short rhythmic patterns are contrasted by the piano's slow melodic arcs, using only piano harmonics, reflecting my guitar writing style. The second material type of the piano includes chords derived from sum and difference tone sonorities. The third material type for the piano links to the percussion: short and rapid cells which flair up and burn

[21] Feldman (2000a), 143.

out. The opening half of the movement evolves as a kind of binary form, with each instrument initially bouncing between its own A and B type materials. Whereas in the first half of the piece, I avoid any kind of rhetorical devices in structuring the parts, eventually the separate temporal layers converge in an overt climax (figure R) before retreating (figure S) with progressively lengthening homorhythmic patterns that flow *attacca* into movement 2.

The percussionist plays bongos and congas with their hands, exploring several different articulations, hits, and sounds, and their live sound is augmented by several custom and existing DSP techniques:

- [nm.boing]: a custom Max object that triggers a fast, sliding, bubble-like sound that glides upwards, imitating the bending tones of the Tabla in Hindustani music. Embedded within a [poly~], 'boings' are triggered by soft to loud attacks in the percussion part (using the [bonk] attack detector). The slide parameters for each 'boing' are randomly varied with each trigger, meaning that each 'boing' will sound slightly different in the speed and frequency range that it covers.
- [modalys]: a physical modelling package distributed by IRCAM. The percussionist's live sound and the boing sounds are passed through a virtual glass plate, where the contact and pickup points in the physical model move around the plate at a constant speed which is proportional to a dynamic level averaged across 5-10 seconds. This effect is spatialised around the entire surround system, so that the entire performance venue becomes a virtual glass resonator.
- [munger]: a delay-line granulator which temporally pixellates the percussion sounds, using both original and transposed grains (-1 and -2 octaves)

To illustrate the above and to compensate for the poor recording quality of the electronics in the premiere performance, I have included a mockup of the bongo, boing, and modalys effect in the submission folder. The sound file is called *1.4.4 glassy bongo boing.aif*. It uses a bongo loop I recorded with George Barton during an early workshop.

The piano alternates between microtonal melodies played via harmonics, and chords made of ring modulation processes. Later in the piece, rapid piano figurations of small patterns attempt to link it to the percussion material. The electronics applied to the piano include:

- [munger]: granulation with -1 and -2 octaves, which emphasise the rich timbre of the harmonics, and add a deeper sense of body to the sound.
- [freqshift]: a conventional ring modulation technique applied to the 'B' material; the chords, and later the figurations.

I kept the piano processing light because I found the results of the munger and freqshift already so rich in their harmonic and timbral augmentation of the piano's original sound, and I wanted to give these sounds space to breathe in the piece. This also accords with other practitioners' experience with live electronics, as John Croft states: 'It is inevitable that aesthetically pertinent 'liveness' involves relatively simple relations between input and output.'[22] The piano is also prepared with four one-cent Euro coins in the middle register, creating a detuned multiphonic timbre. This helps to fuse the piano's acoustic sound with the augmented sounds of the live electronics. For reference, and to compensate for the low electronics in the mix of the recording, I have included a recording of my own experiments with the munger granulation part of my Max patch to illustrate this effect, available in the online folder containing this submission, named: *1.4.5 - Intralatent - piano harmonics.aif*

Regarding spatialisation, I used IRCAM's spat library in Max to create a virtual surround environment, where the acoustic instruments where amplified with very slowly moving sources, and where the live electronic processes used multiple source locations that moved and variable speeds according to high-level analysis of the music's present intensity. This is achieved by mapping spatialisation speeds to envelope followers with slow averaging functions so that the speeds of sources are constantly moving

[22] Croft (2007), 66.

in smooth motions, and not erratically. The lack of erratic motions represents my desire to create a more cohesive *enveloping* electronic sound; an imaginary force-field rather than swarm of insects.

4.3: Movement 2

In the second movement, I explored a completely different compositional approach to the first, guided almost entirely by materials developed in the workshop sessions. The movement proceeds with a simple formal proposal: starting from a quiet and dark mood, and incrementally growing to a loud and bright climax, whereupon the piece finishes as the players leave the performance space, pseudo-ritualistically. The electronics are the engine of this movement's structure, and this reflects my previous work *Semantron* (2016) for guitar and live electronics, where I wanted to move from one extreme to another (quiet to loud), but at such a slow pace that the listener would not notice.

Both instruments are treated by a custom Max object: [nm.timewarp]. As detailed in the preface to *Her still singing* limbs, the principle of the effect is simple: I trigger the effect, which begins to record the input sound. At the same time, it begins to play back this recording at half-speed (and half the pitch), including feedback. The feedback results in the input sound being progressively stretched out in time and pitch, as if a digital shadow of the original sound that falls ever deeper into the bass and the sub-audio register.

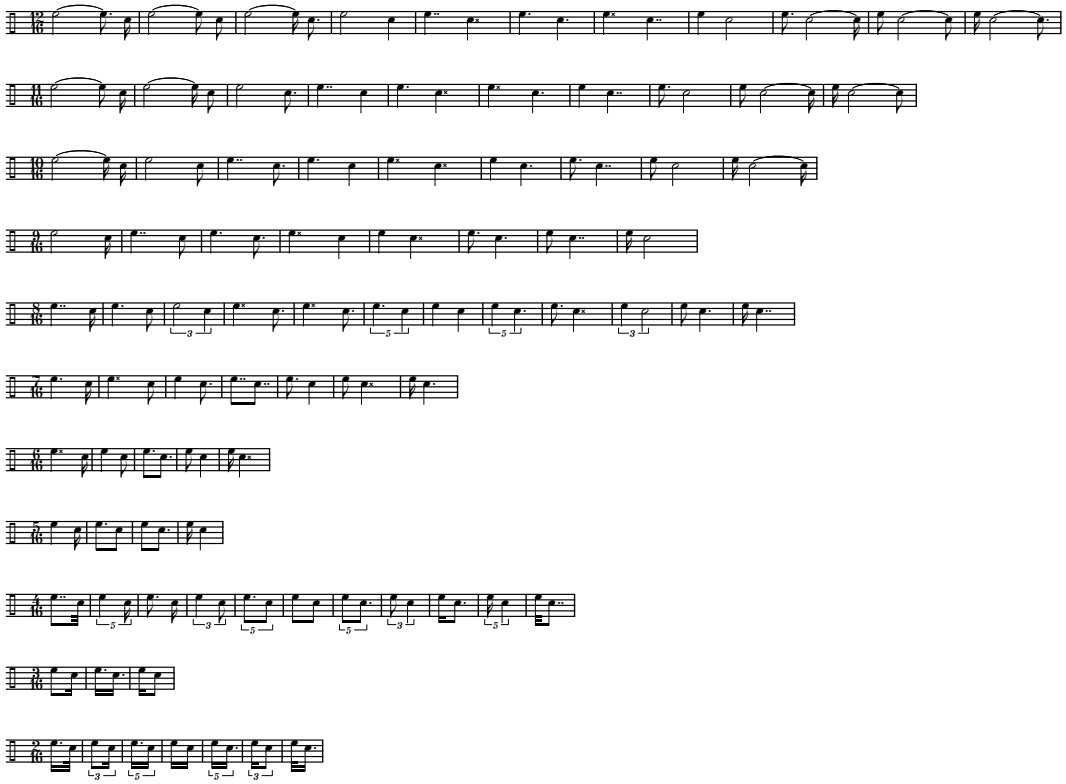
In the submission folder, I include an example of this effect on a piano improvisation I played. By playing quickly in the high register of the piano, you can hear the effect working clearly in the emergence of an underlying bed of slow-motion phantom piano sounds. The file is called: *1.4.6 Timewarp piano.wav*

The movement explores the different timbres of the piano and percussion instruments applied to this process, where I had to manually trigger each unit just before each entrance (not shown in the score). By using multiple timewarp effects, I create an accumulation of temporally disfigured reflections of the original sounds. Half way through the movement, I introduce the [munger] granulation effect with +1 and +2 octave settings, as well as feedback. This means that we have the live electronics expanding the original sounds temporally and warping them into the bass register, while at the same time, temporally compressing them and transposing them into the high register. The use of feedback on the munger results in an accumulation of high frequency noise which acts like a cloud or rays of light that pepper the intensifying textures. The spatialisation procedures use similar settings to the first movement, but at slower speeds of rotation.

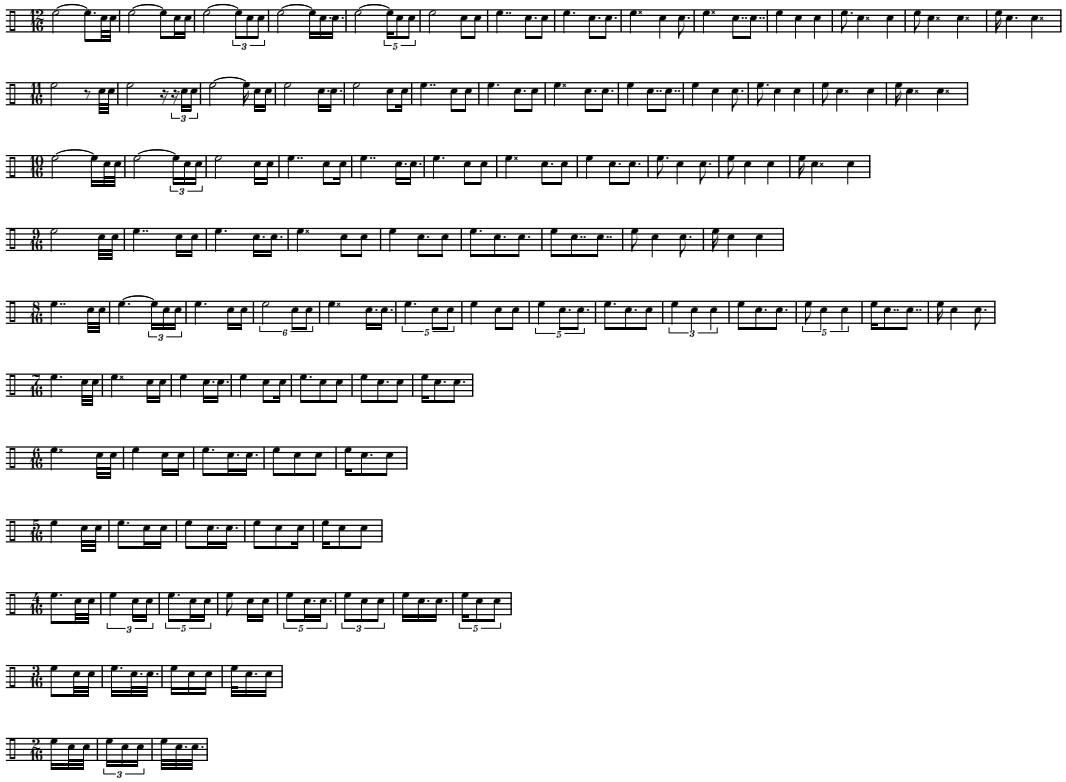
Movement 2 manifests a kind of oneiric quality which I was searching for in reflecting the labyrinth of Danielewski's *House of Leaves'*. The gradual emergence of an overpowering and immersive cloud of electronic sound — a sentient space — mirrors the shifting labyrinth and sense of an unknown presence or otherness, a technologically-mediated sublime — dangerous, vast, and ungraspable — which both transfigures the performance venue, and at the same time, emphasises the bounded corporeality of the musicians. There is also an aesthetic and sonic affinity with the spacious yet dark sound worlds of Nono's late works, and fascination with magnifying microscopic details of sound in time and space, for example, as in Nono's opera *Prometeo* (1984/85) and the section 'Isola seconda: (b) Hölderlin' for two sopranos, bass flute, contrabass clarinet, and electronics.

4.4: Appendix of Rhythmic Material

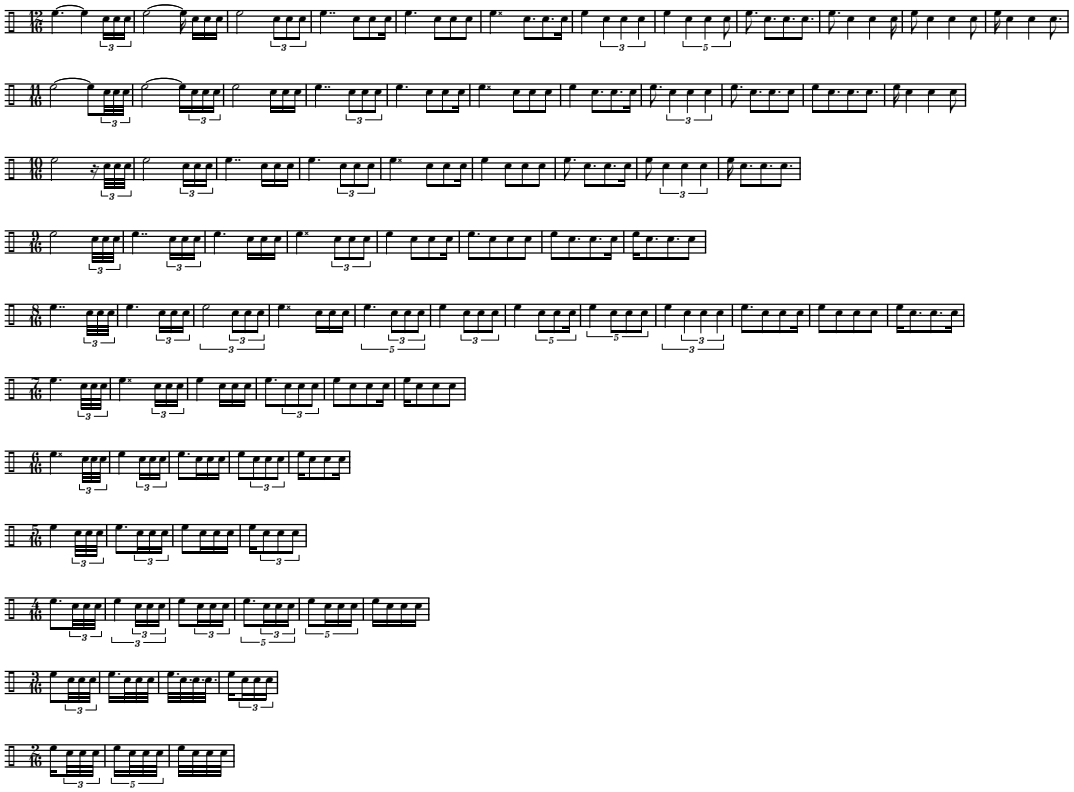
2
1+1



3
1+2

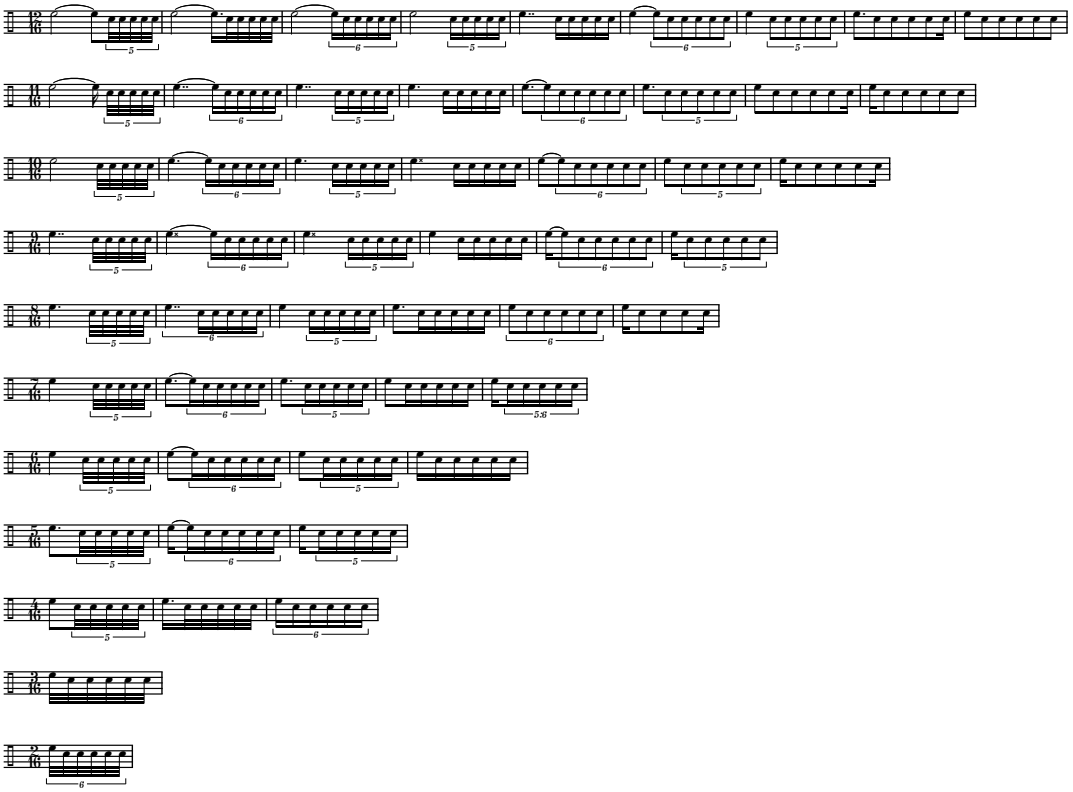


4
1+3

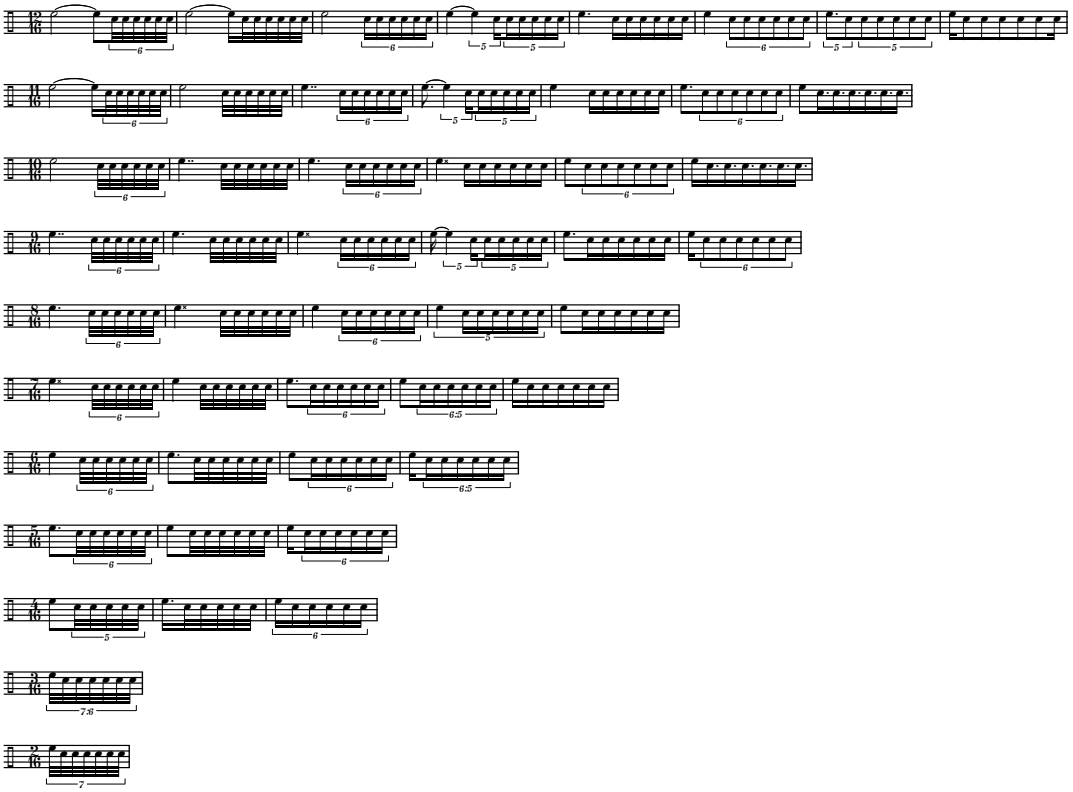


5
1+4

6
1+5



7
1+6



5: ‘The Holy Fool’

2021, trombone, harp, string quartet, and female voices, 14 minutes

The Holy Fool is a work for solo trombone, four female voices, harp, and string quartet, and was commissioned by Fonds Podiumkunsten and Sebastiaan Kemner on the occasion of his award ceremony for the 2020 Nederlandse Muziekprijs. The work was premiered on 12 June 2021 at De Doelen in Rotterdam by Sebastiaan Kemner, Silbersee, and Lonelinoise. A video of the performance is available on YouTube:

https://youtu.be/PQydTH6C9zw?si=z19tuXM3g6nJH9GL

5.1: Poetic and Performance background

As an occasional piece, and given the complex logistics of the premiere event (a national prize, covid, live TV and radio broadcast, a speech by the Dutch culture minister), as well as the different musicians and other ‘stakeholders’ involved, I wanted to create a piece that was fairly direct, and which would sound good in the large concert hall of De Doelen in Rotterdam. I did not want to write a concerto-type work for trombone, but rather, something where the trombone retains a solo presence while being interwoven into a larger musical habitat, continuing with the spatial metaphors that drive my work. I had several poetic references in mind around this time, firstly, the Holy Fool, which I discovered through re-watching several Tarkovsky films in lockdown, and secondly, a meditation on death and transience, albeit in a non-morbid or melancholic fashion, but rather sardonic and Boschian, responding to Sebastiaan’s personality. The Tarkovsky Holy Fool reference combined with the Boschian surreal cynicism form the two predominant poetic backgrounds of the work, against which I then found a third reference in my choice of quotations from Hamlet, explained below.

I composed the piece quickly over a few weeks in March 2021 following several drawn-out but failed attempts at a more spatialised live electronic work in the preceding year. The eventual success of the piece in light of these challenges, as well as other personal difficulties during lockdown, all helped to reassure me that composing with notation was still a valid and rewarding method. This was despite the strong feeling I had at the time for moving

away from notation and towards improvisation and electronics, partly in the wake of *Intralatent*, but also because of my turn to experimental and improvised music records during lockdown, for example, the Another Timbre, Black Truffle, and The Trilogy Tapes labels.

The Holy Fool is, I believe, my most expressively direct, and in some ways, seemingly conventionally 'contemporary classical' piece; It is playful, euphonic, rhythmically-driven; there are big climax moments, and the harmonic language provides an accessible and tonally-suggestive melodic framework. The project was a valuable experience to (re)discover that I am capable of writing notated music of such a style, while still feeling like a genuine part of my own musical imagination, and closely related to the preceding works of this portfolio.

5.2: Compositional Methodology

The Holy Fool holds an unusual position in this portfolio, seeing that it is the only work without electronics. Despite this fundamental disjunction, there are still important connections with my live electronic methodology that justify its place here, and which point to possibilities for new projects with acoustic works. The principal idea connecting both electronic and acoustic methods is that of a kind of *material animism*. In my electronic works, I have tried to use live electronic processes and interactive techniques to suggest the presence of imaginary digital beings, explicitly or implicitly. As referenced in the preceding works of this portfolio, these ideas stem from literature and the arts, but another framing is in so-called new materialist writers, such as Janet Bennett and her notion of Vitalist Materialism.[23] In an acoustic framework, the animism of electronics transfers to the instrumentalists themselves. I achieve this by granting each instrument a particular characterisation and function within a multi-layered texture, akin to niches in a habitat. Besides the solo trombone, both the group of four singers and the group of five string instruments are conceived as their own fixed meta-instruments.

This piece prompted questions surrounding the unusual instrumentation, and in relation to my methodological experiments developed in earlier works like *Intralatent* e.g. the Abundance-Assembly method. My response in taking these ideas into the purely acoustic domain was botanical, metaphorically speaking: take a cutting from

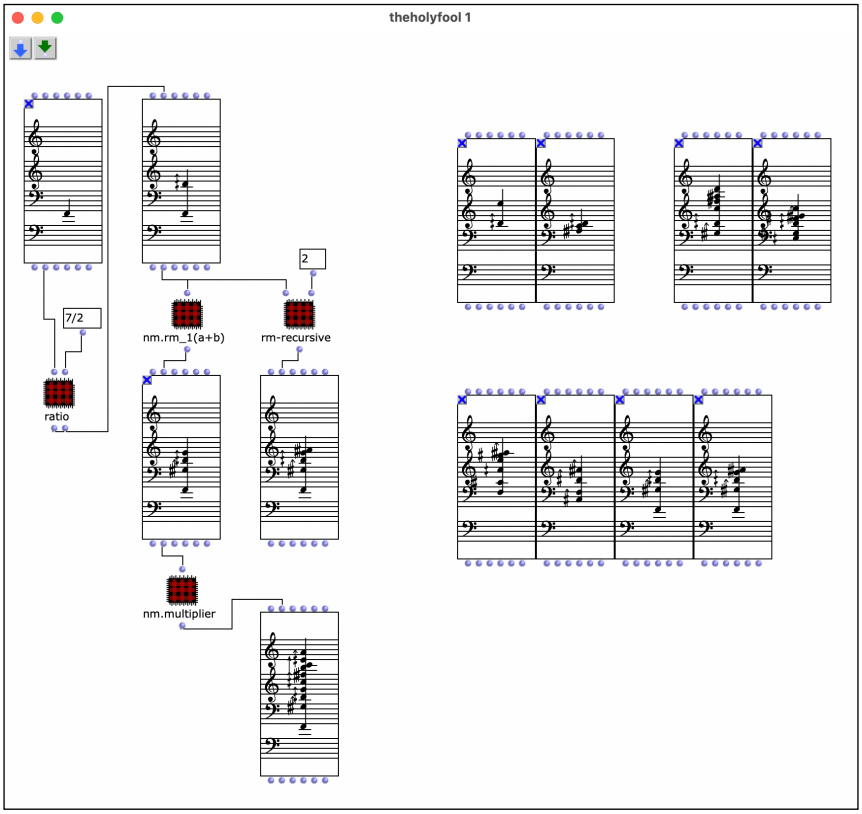
[23] Bennett (2010)

Intralatent and grow it into something entirely new. The harp part takes the opening bongo part from movement 1 of *Intralatent*, which I sketched into a new material type in the necessarily metrically simplified context of this ensemble work (mostly in 4/4). With this initial layer, perhaps referencing a 'clock' archetype not so distant from some Feldman or even Birtwistle works, I then developed a complimentary part for the string quartet that syncopated with the harp. At this point I developed a new harmonic context to the *Intralatent* material. Whereas the earlier works use spectral techniques on the small-scale to create an 'unspectral' harmonic layer i.e. harmonic units without a single common or resolvable fundamental, in *The Holy Fool,* I take a more overtly spectral approach, where the pitch material is restricted to the harmonic series: 13-limit. Each section remains in a particular 'overtone mode', based on a few fundamentals: D, E, F, and A.

The opening section combines both D and E modes before settling in E. Despite this simplistic structure, I try to obscure the overtly 'harmonic series' character of the modes by using chords and harmonies with unusual voicings and inversions, i.e. where the fundamental is not in the bass. This also has an expressive effect rather than purely formal, as I reserve the use of the fundamental in the bass register for key climactic turns in the work such as at Figure P. The harp often spotlights bass notes which emphasise the modal rather than functional or tonal character e.g. at figure E where it alternates between the 5^{th} and 7^{th} overtone.

I used OpenMusic to create a large collection of chord voicings in the different modes, and then assembled these into short chord sequences, later applying them to rhythmic ideas from a separate document of rhythmic patterns, in a similar manner to the process of *Intralatent*, movement 1. The screenshot in fig. 16 below shows a simplified OpenMusic patch. On the left, I have custom-made functions which generate sum and difference tone sonorities within the given overtone modes. On the right, I have a collection of 'chord objects', which amount to my own kind of crude digital sketch pad (not OpenMusic's intended primary functionality); one with which I can hear the microtonal playback of the chords. This playback aspect is a crucial factor in the forming of collections of materials with certain harmonic relationships and voice leading properties, as I do not have another means to audition these materials as quickly, e.g. on a microtonal keyboard, and speed is an important factor when creating and sorting through large quantities of 'raw' material by ear.

Figure 16: OpenMusic patch with harmonic devices



At this point, before considering the trombone and vocal layers, I created a range of harp and string quartet materials that explore different combinations of the focused rhythmic and harmonic material. I sketched these in various ways to form possible under-layers to the expected *hauptsimmen.* During this process, I began exploring linear materials that would emphasise certain pitches that either reinforced or complimented notes in the strings. These eventually became the trombone and vocal parts. Thus, the opening of the piece plays out exactly as I composed it, with each later emerging one by one. The trombone part throughout the piece acts as a counterpoint to the vocal part, alternating between longer, winding lines, and short, fragments of glissandi. The final section contains the only soloistic material of the entire piece, when the trombone skips along in iambic rhythms across a large register, toying with the Holy Fool connotations. Until this moment, the trombone part is relatively constrained, and even austere, the other exception being the climactic section around Figure P.

The table below shows a simple structural analysis of the piece according to sections, the fundamental of the overtone mode, with bar numbers and figures letters.

Table 2: Structural analysis of 'The Holy Fool'

Section	*Fundamental*	*Bars*	*Figure*
A^1	E & D	1-43	-
A^2	E & D	44-63	C
B^1	E	64-86	E
A^3	E	87-110	G
B^2	E	111-155	I
C	F	156-186	L
D		187-203	N
E		204-216	P
F	F - A	217-251	R
G	A	252-307	U

5.3: Text

Regarding the vocal parts and the lyrics, the choice of text setting was partly due to circumstances, and also because I had already collected fragments from Shakespeare's *Hamlet* with some idea to set them one day. While there is no Holy Fool character in Hamlet, morbid black humour is a recurring theme of Hamlet's madness. Thus, I assembled a collage of quotations from Hamlet, uprooted from their original dramaturgical context, and reframed them for my own poetic purposes, ranging from the absurd, to imagist:

Stay illusion

Speak to me

in the womb of earth

— Horatio (act 1, scene 1)

Come, my spade […] *dig without arms*

— First Clown / Gravedigger (act 5, scene 1)

And you, call him! a-down a-down... You must sing

O, how the wheel becomes it!

—Ophelia (act 4, scene 5)

King of infinite space sound me

blow them at the moon

— Hamlet (act 2, scene 2; act 3, scene 4)

My use of voice is deliberately not naturalistic, I treat the voices in a similar manner to the instruments, somewhat mechanical, and fixed to a limited number of materials and behaviour types per section. The voices sing usually in homophony, as if a chorus. In the de-humanisation of the singers, I seek to draw the listener's attention to a kind of mannerism akin to a cartoon or Bosch painting. More practically speaking, I also write non-tempered intervals for the voices within the given harmonic modes e.g. 7^{th} and 11^{th} overtones, and I support the singers' tuning in performance by introducing the pitches somewhere in the immediately preceding parts of the ensemble. The harp also has a few string retuned in order to emphasise this overtone modality.

5.4: Future Directions

In concluding this portfolio, *The Holy Fool* also concludes an arc that began with my collaboration with Sebastiaan Kemner and my first work composed during my DPhil degree, *Her still singing limbs*. While we did not have the opportunity to collaborate in workshop sessions as in our initial project due to the pandemic, I tried to inject this later piece with something that responded to Sebastiaan's character and musicality, as I had come to know it. While the solo part is rather constrained, it maintains an obstinate quality throughout, perhaps even obsessive and beguiling, for example in its recurring fragmented patterns of repeated glissandi and staccato stabs, complemented by moments where it takes on a more leading melodic role at the forefront of ecstatic rupture, for example at bb. 210-216. On reflection, I understand these types of characterisations as an extension of my instrument-building as composition framework. In this instance, a musician's individual personality is intertwined with and inseparable from their instrument.

Throughout this portfolio, I have sought to problematise the boundaries between acoustic and digital instruments, human performers, performance spaces, and to a lesser extent, audiences. The primary motivation here is to try to create a renewed sense of aural and spatial awareness in a world where our ability to orientate ourselves either physically or digitally is becoming increasingly difficult against the backdrop of Neo-liberalism married with the dystopia of social media and other transformational digital technologies. In this light, there is something in the spirit of late Nono present in my work and thinking, in terms of trying to stimulate a sensate and critical 'awareness' of the present day through sound and music. The methodology I have developed has responded to my early experiments with live electronics, and proceeded in a project by project basis: instrumentalising human and non-human actors in order to blur their material and agential divisions. I have drawn on ideas of worldbuilding as a means to explain and further integrate the extra-musical reference points which guided the creation of several works, however, I recognise the limitation of my usage of the term, given the inherent semantic constraints with the instrumental medium I have chosen, compared to, for example, a video game with a plot, characters, and actual places or environments. Even with my use of sung text as in *The Holy Fool*, its setting amounts to an abstract collage of multiple points of view rather than a clear narrative structure, and this is in line with my aesthetic agenda, which privileges abstraction as a way to create a kind of openness. In video games and other media, worldbuilding is a much more comprehensive and necessary act of

creating a convincing fictional world. Thus, the worlds I have created in this portfolio are necessarily constrained by their reliance or embeddedness within an instrumental style that spans late modernist and experimental electronic music genres. *The Holy Fool*, nonetheless, points to possibilities for my methodology to be further expanded in other purely acoustic domains, without relying on digital technology to act as either connector or disruptor of the motley human and nonhuman bodies that populate my fictional worlds. As such, *The Holy Fool*, has laid the foundation for future works and projects in which I plan to develop my compositional framework, and to continue to expand my aesthetic and musical horizons.

Bibliography

Auslander, Philip. 2023. *Liveness: Performance in a Mediatized Culture* (Routledge)

Bates, Eliot. 2012. 'The Social Life of Musical Instruments.' *Ethnomusicology*, 56, No. 3, 363-395

Bates, Eliot. 2021. 'The Interface and Instrumentality of Eurorack Modular Synthesis.' In *Rethinking Music Through Science and Technology Studies*, eds. A. Hennion and C. Levaux (London: Routledge), 170-188

Bates, Eliot. 2012. 'The Social Life of Musical Instruments.' *Ethnomusicology*, 56, No. 3, 363-395.

Bates, Eliot. 2012a. 'What Studios Do.' *Journal on the Art of Record Production*, Issue 7, DOI https://www.arpjournal.com/asarpwp/what-studios-do/

Bates, Eliot. 2019. 'Actor-Network Theory and Organology,' *Journal of the American Musical Instrument Society*, Volume 44, 41-50

Bates, Eliot. 2021. 'The Interface and Instrumentality of Eurorack Modular Synthesis.' In *Rethinking Music Through Science and Technology Studies*, eds. A. Hennion and C. Levaux (London: Routledge), 170-188

Blauert, Jens. 1984. *Spatial Hearing: The Psychophysics of Human Sound Localization* (MIT Press)

Born, Georgina. 1995. Rationalizing Culture: IRCAM, Boulez, and the Institutionalization of the Musical Avant-Garde (University of California Press)

Born, Georgina. 2011. 'Relational Ontologies and Social Forms in Digital Music', in Bodily Expression in Electronic Music, Eds. Deniz Peters, Gerhard Eckel and Andreas Dorschel (New York and London: Routledge) pp. 163-180

Born, Georgina. 2013. 'Introduction', in *Music, Sound and Space: Transformations of Public and Private Experience*, ed. g. Born (Cambridge University Press), 1-69

Born, Georgina and Andrew Barry. 2018. 'Introduction: Music, Mediation Theories and Actor-Network Theory.' *Contemporary Music Review*, 37, Nos. 5–6, 1-45

Browning, Joseph. 2017. 'Mimesis stories: composing new nature music for the shakuhachi', *Ethnomusicology Forum*, 26/2.

Clarke, Eric F. 2013. 'Music, space and subjectivity', in *Music, Sound and Space: Transformations of Public and Private Experience*, ed. Georgina Born (Cambridge University Press), 90-110.

Cipriani, Alessandro & Giri, Maurizio. 2013. *Electronic Music and Sound Design, Vol. 2* (Contemponet)

Croft, John. 2007. 'Thesis on Liveness', *Organised Sound,* Vol. 12(1), 59-66

Croft, John. 2009. 'Fields of Rubble - On the Poetics of Music after the Postmodern', in *The Modernist Legacy: Essays on New Music*, ed. B. Heile (Ashgate), 25-38

Danielewski, Mark Z. 2000. *House of Leaves*, second edition (Pantheon)

Donnarumma, Marco. 2017. 'Beyond the Cyborg: Performance, attunement and autonomous computation,' in *International Journal of Performance Arts and Digital Media*, Vol. 13, No. 2,, 1-15

Fell, Mark. 2018. 'Notes on Pattern Synthesis: 1983 to 2013', in *The Oxford Handbook of Algorithmic Music*, ends. R.T. Dean & A. McLean (Oxford University Press)

Fell, Mark. 2021. *Structure and Synthesis, The Anatomy of Practice* (Urbanomic)

Fischer, Nele & Mehnert, Wenzel (2021), 'Building Possible Worlds: A Speculation Based Framework to Reflect on Images of the Future,' *Journal of Futures Studies*, Vol. 25(3), 25–38

Gell, Alfred. 1988. 'Technology and Magic." *Anthropology Today*, Vol. 4, no. 2: 6-9

Gell, Alfred. 1992. 'The Technology of Enchantment and the Enchantment of Technology,' In *Anthropology, Art and Aesthetics*, eds. Jeremy Coote and Anthony Shelton (Oxford: Clarendon Press), 40-66

Heussner, Tobias; Finley, Toiya Kristen; Hepler, Jennifer Brandes; Lemay, Ann. 2015. 'Worldbuilding', in *The Game Narrative Toolbox* (Focal Press), 48-75

Howard, Kenton Taylor. 2023. *The World of Fallout* (Routledge: New York)

Jameson, Frederic. 1991. *POSTMODERNISM, or, The Cultural Logic of Late Capitalism*, (Duke University Press. Durham, NC, USA)

Lewis, George E. 2017. 'From Network Bands to Ubiquitous Computing - Rich Gold and the Social Aesthetics of Interactivity', in *Improvisation and Social Aesthetics*, eds. G. Born, E. Lewis, and W. Straw (Durham and London: Duke University Press), 91-109.

Nono, Luigi. 1983. 'L'erreur comme nécessité', Scritti e Colloqui, Vol. II (Milan: Casa Ricordi, 2001), 257-259.

Nono, Luigi. 1983b. 'Technology to Discover a Universe of Sounds: Interview with Walter Prati and Roberto Masotti', in *Nostalgia for the Future: Luigi Nono's Selected Writings and Interviews*, eds. De Benedictis and Rizzardi (University of California Press: 2018), 311-317.

Oord et al 2016

Ouzounian, Gascia. 2008. *Sound Art and Spatial Practices: Situating Sound Installation Art Since 1958*, PhD dissertation, University of California, San Diego.

Piekut, Benjamin. 2014. 'Actor-Networks in Music History: Clarifications and Critiques', in *Twentieth-century Music*, 11(2), 191-215.

Snape, Joe and Born, Georgina. 2021. 'Max, music software, and the mutual mediation of aesthetics and digital technologies', in G. Born (ed.), *Music and Digital Media: A Planetary Anthropology* (Duke University Press), 220-266.

Stahl, William A. 1995. 'Venerating the Black Box: Magic in Media Discourse on Technology,' *Science, Technology, and Human Values*, Vol. 20, No. 2, 234-58.

Steyerl, Hito. 2011. 'In Free Fall: Thought Experiment on Vertical Perspective', in *e-flux journal*, Issue 24, accessed 23.11.17. https://www.e-flux.com/journal/24/67860/in-free-fall-a-thought-experiment-on-vertical-perspective

Steyerl, Hito. 2023. 'Mean Images', in *New Left Review*, Issue 140. Accessed 03.10.23. https://newleftreview.org/issues/ii140/articles/hito-steyerl-mean-images

Tarkovsky, Andrei. 1989. *Sculpting Time: Reflections on the Cinema* (University of Texas Press)

Valiquet, Patrick. 2012. 'The Spatialisation of Stereophony: Taking Positions in Post-War Electroacoustic Music', *International Review of the Aesthetics and Sociology of Music*, 43(2), 403-421.

Wang, Jiaren; Wang, Regina Kanyu, Storycom; Qi, Guo, John. 2022. *"Worldbuilding": Creating the Blueprint for a World*, in *The Making of The Wandering Earth* (Routledge India), 93-100

Zaidi, Leah. 2019. 'Worldbuilding in Science Fiction, Foresight and Design,' *Journal of Futures Studies*, Vol. 23(4) 15–26

Filmography

Tarkovsky, Andrei. 1972. *Stalker* (Mosfilm)

— 1979. *Stalker* (Mosfilm)

Websites

Jean-Marc Pelletier, 'cv.jit | Computer Vision for Jitter', accessed 08.08.18: https://jmpelletier.com/cvjit/