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Integrating Sensor Technology into Artistic Practice: A critical examination of the role of the performer

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ABSTRACT

This research questions how interactive music technology might enable creativity in performers. The format is a semi-autoethnographic narrative that follows the performer's artistic process of preparing nine compositions for performance; these works are for bass clarinet or clarinet and live processing (created with Ableton Live, Max for Live, and the SABRe multi-sensor and remote).

In order to conduct this research, I remixed two existing bass clarinet works, collaborated with two composers on six new works, and composed my own piece. I maintained a reflective journal for four and a half years that documented the process of preparing these compositions for performance. Excerpts from this journal are interwoven throughout the main text of this thesis and provide insight into the activities of music practice and performance, programming, collaboration, improvisation, remixing, and composition.

The findings from this research highlight the human aspect of using technology in performance and demonstrate that technology can expand the practice of performers. As both the programmer and performer, I found that my performance practice informed how I programmed the sensors, and programming in turn affected how I practiced. The sensors required me to make decisions on how physical movements would affect the live electronics, thus causing me to reconsider the connection between my mind and body in performance. Additionally, the process of deciding how to integrate the sensors in performance compelled me to look inward at my own practice and question preconceived ideas of creativity. Ultimately, this research provides an in-depth look into contemporary performance practice, while also offering several new approaches to using interactive music technology in performance.

DECLARATION PAGE

I certify that this thesis which I now submit for examination for the award of Doctor of Music, is entirely my own work and has not been taken from the work of others, save and to the extent that such work has been cited and acknowledged within the text of my work.

This thesis was prepared according to the regulations for graduate study by research of the Technological University Dublin and has not been submitted in whole or in part for another award in any other third level institution.

The work reported on in this thesis conforms to the principles and requirements of the TU Dublin's guidelines for ethics in research.

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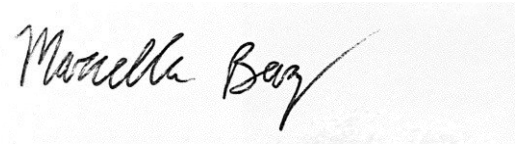

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Special thanks to composers Yue Song and Frank Lyons for our collaborative partnerships and for writing new compositions that I could include as part of my research. Song, in particular, dedicated a huge amount of time to our collaboration and contributed enormously to my research.

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TABLE OF CONTENTS

LIST OF EXAMPLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Explanation
3D	Three Dimensional
ALS	Ableton Live Set File
CNMAT	Center for New Music and Audio Technologies
COVID-19	Coronavirus Disease 2019
DAW	Digital Audio Workstation
dB	Decibel
DJ	Disc Jockey
MSP (as in Max/MSP)	Max Signal Processing or Miller Smith Puckette
MIDI	Musical Instrument Digital Interface
MP3	Moving Picture Experts Group Layer-3 Audio
OSC	Open Sound Control
PA System	Public Address System
SABRe	Sensor Augmented Bass Clarinet Research (https://www.sabre-mt.com/)
SHARE	Step-Change for Higher Arts Research and Education
TU Dublin	Technological University Dublin
USB	Universal Serial Bus
VUCA	Volatility, Uncertainty, Complexity, Ambiguity

GLOSSARY

Term	Definition
Ableton Live	A digital audio workstation produced by Ableton. Sometimes referred to as Live.
argument	Defines and changes Max objects.
Audio Effect Rack	A tool for working with audio effects in Live. These Racks can hold multiple chains of audio effects.
bang	When a Max **button** object is pressed, it emits a bang, triggering events (such as sending messages).
chain	A chain of Live audio effects.
Chain Select Editor	The area in an Audio Effect Rack where chains are given defined zones.
Connection Kit	An invented term to describe a section in my patches where the SABRe multi-sensor and remote is connected.
Device Activator	An invented term for a group of Max objects that allows the SABRe remote to control the Master Counter.
Digital Audio Workstation	Software for music production. It is often used to edit audio files and to record music.
encapsulation	The process of selecting a group of objects in a Max patch and concealing them in a subpatch.
fixed electronics	Musical soundtracks that remain unchanged from performance to performance, such as MP3 files.
live electronics	Electronic sounds that are created or processed live.
live processing	Live or recorded data that is manipulated live with the aid of technology (such as a DAW) and outputted to an audience. Musical data includes capturing vocal or instrumental sounds through a microphone and is outputted via speakers.

Macro Controls	Knobs on a Live Rack that can be connected to the parameters of any devices within the Rack.
Master Counter	An invented term that refers to the **counter** object in my patches that controls many other parts of the patch.
Max	Programming software developed by Cycling '74 that uses visual, object-based code. It is sometimes referred to as Max/MSP/Jitter.
Max for Live	A version of Max software that is integrated into Ableton Live.
message	In Max, messages display and output information.
object	A box in Max that represents code. Each object has its own name and can be programmed to undertake specific actions.
parameter	A setting of a Live audio effect that can be modified.
Parameter Router	An area in my patches that routes the sensor position to the corresponding Live device control subpatches.
patch	Code written in Max for Live or Max software. Occasionally, this term may also refer to files in other software (Ableton Live patch, for example).
preset	Saved parameter settings for Live devices.
pseudo interaction	An illusion of interaction between a performer and an electronic soundtrack created by the performer's extensive practice with the track.
scene	A group of settings in a live processing patch that correspond to a section of a musical score.
Sensor Boundaries	A segment of my patches that determines when the sensors have passed a pre-defined boundary.
Sensor On/Off Router	A part of my patches that allows or prevents the sensor data from passing through the rest of the patch.
Snippet	Segments of a Max patch that have been copied and saved for future use.

soundscape	A collection of sounds that form a landscape of sounds.
soundworld	A concept for using sensors wherein the performance space can be navigated through to interact with audio effects.
subpatch	An object in Max, called **p**, which is essentially a patch within a patch.
Track Muter	A subpatch that I created to activate and de-activate Live tracks.

INTRODUCTION

In the Western contemporary-classical tradition, it is common for musicians to perform alongside a fixed soundtrack, such as an MP3 file. With this medium, the electronic layer is the same in every performance. Alternatively, performers may choose to perform with live electronics, which are generated as the performance occurs. These allow for greater variety from performance to performance and increase the potential for interactivity between the performer and electronics.

When I started this research, I wanted to integrate technology into my practice so that I could seamlessly interact with my computer to generate live electronics in performance. A significant problem that I faced was figuring out how to communicate with the computer when I already had an instrument to interact with. When I investigated what other performers had already done, I noticed how little had been written about live electronics from the performer's perspective. Research undertaken by violinists Mari Kimura and Victoria Johnson, flautist Elizabeth McNutt, multi-instrumentalist Seán Mac Erlaine, and singer Anna Einarsson revealed valuable knowledge about the intricacies of performing with electronics. Their personal accounts provide insight into how performers experience technology.

Building on a growing body of literature that examines music practice and technology through the lens of the performer, the aim of this thesis is to explore how interactive technology can enable performers to be creative and what effects it might have on performance practice. The technological device that was chosen for this research was the SABRe multi-sensor and remote. Since this is a relatively new invention, little repertoire exists for it. To develop repertoire for the SABRe sensors, I took on several roles including performer, remixer, improviser, composer, collaborator, and programmer, resulting in two remixes, six collaborative compositions, and one original composition.

A recital is presented in association with this thesis to showcase some of the compositions discussed herein. While the performances of each composition are important outputs, they do not show the full picture. The written side of this research discusses the rich processes that took place to prepare these performances. The format is a seven chapter, semi-autoethnographic thesis. The main text weaves between reportative, analytical, and narrative writing, supported by screenshots from the software I used, pictures of my notes, and audio examples. The narratives were constructed from a reflective journal that I kept for four and a half years, and excerpts are clearly marked in the text with small font size and indentation.

The first two chapters set out contextual information about my performance practice and the music technology that I chose to work with. The purpose of Chapter One is to clarify my approach to this research, beginning with an assertion of my philosophical worldview and background information about why I decided to conduct this research. This is followed by my research questions and an acknowledgement of the areas that I drew upon to design this research. The methods I used to complete this research are then discussed in detail. Finally, the chapter concludes with an overview of the software and hardware that I used in performance.

Chapter Two presents the timeline of the nine compositions that I performed, with a separate introduction to each. The aim is to distinguish the unique characteristics of each composition, enabling a concurrent discussion of these works in further chapters. Full scores are provided in the appendices; however, to facilitate the examination of features such as structure, range, and extended techniques, this chapter contains musical examples.

The third, fourth, and fifth chapters describe the process of preparing performances, illuminating the complexities of switching between artistic and technical thinking. Chapter Three investigates the considerations of programming sensors for performance.

The first part of the chapter explores how I developed a concept for using the sensors through journaling and visualization. The main aesthetic considerations that are raised here include interactivity, expansion, and integration. The latter half of the chapter focuses on the relationship between the performer's mind and body by examining topics such as gesture, movement, and meaning.

Chapter Four covers the complex process of programming by describing how I built the Max for Live patches for performing with the sensors. This includes screenshots of the patches and descriptions of how different elements were connected to one another. Although this chapter involves technical details, it is intended to show how my artistic practice informed the programming process and vice versa. An underlying theme highlighted throughout this chapter is the difficulty of translating artistic ideas into computer language.

Chapter Five examines the process of selecting and modifying Ableton Live audio effects for five compositions. In particular, the relationship between the bass clarinet part and the audio effects is considered. This chapter also illustrates how each Live Set was set up and clarifies how the sensor data is used in Live. To aid in the description of various electronic sounds, links to YouTube clips are provided in the footnotes.

Chapter Six ties together the entire thesis by analyzing and discussing themes that emerged as the research unfolded. The main purpose of this chapter is to re-examine the role of the performer in the context of contemporary performance culture by exploring relevant topics such as remixing, musical identity, ownership, composition, and collaboration.

Chapter Seven brings the thesis to a close with a summary of key findings and suggestions for future research.

CHAPTER ONE: WORLDVIEW AND APPROACH

1.1 Introduction

The interconnectedness of all areas of my practice became evident when I began to write this thesis. To string my tangled web of a practice into a linear narrative seemed almost impossible. Early on, I created a table of contents to organize my research, only to edit it a hundred times over. It was challenging to decide which heading a topic would be discussed under when it seemed relevant to several.

The aim of this chapter is to set out the context within which this thesis was written, to state my research questions, and to explain the methods that I utilized to undertake this research. The first section contains a statement on my philosophical worldview, clarifying the lens through which this research was conducted. Relevant information about my musical background is provided to explain how I chose my research topic, and my research area and questions are defined. The section on methods presents a complex web of activity that I undertook to complete this research and discusses the emergent nature of artistic methodologies. The chapter ends with an introduction to the software and hardware that I used in performance and a justification for using the selected technologies.

1.2 Philosophical Worldview

Every researcher has their own set of beliefs and assumptions that influence the decisions they make to design and undertake their research project. Different authors have termed this concept in varying ways; Denzin and Lincoln denote it as the *interpretive* or *theoretical paradigm* and Creswell refers to it as a *philosophical*

worldview.[1] Generally, the philosophical worldview encompasses three beliefs: the nature of being (ontology), the theory of knowledge (epistemology), and how knowledge is uncovered (methodology).

I approached this research from an ontological-relativist standpoint, with the assumption that each person has their own reality; [2] therefore, with this view, multiple realities exist in the world, preventing a singular truth from existing. In each reality, knowledge is constructed socially and experientially. In other words, knowledge can be studied within different realities through social interaction and experience. This research investigates my own reality as an artist, including my relationships with others, and attempts to de-construct my experiences of music making with the aim of uncovering hidden knowledge from within my practice.

Regarding the theory of knowledge, the main belief here is that 'we cannot separate ourselves from what we know.'[3] Since our way of knowing the world is embodied,[4] this epistemology accepts that there will be subjectivity in research. Subjectivity is acknowledged through the logical examination of our interactions with the world. Denzin and Lincoln describe this examination as *hermeneutic* and *dialectic*. In understanding processes and relationships, an interpretive methodology (hermeneutics) must be implemented and then investigated through reasoning that considers contradictory ideas (dialectics).[5] These ontological and epistemological standpoints pertain to the constructivist-interpretive paradigm and provide the philosophical grounding necessary for discussing my overall process (methodology) of conducting this research (see section 1.5).

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[1] Denzin, Norman K. and Yvonna S. Lincoln (eds.): *The Sage Handbook of Qualitative Research*, 4th edn. (London: SAGE Publications, 2011), 12; Creswell, John W.: *Research Design: Qualitative, quantitative, and mixed methods approaches*, 4th edn. (London: SAGE Publications, 2014), 5.
[2] Denzin and Lincoln (eds.): *The Sage Handbook of Qualitative Research*, 102–103.
[3] Denzin and Lincoln (eds.), 104.
[4] In other words, the only way we know the world is through our bodies.
[5] Denzin and Lincoln (eds.): *The Sage Handbook of Qualitative Research*, 104–105.

1.3 Background

It was not until the end of my bachelor's degree that I performed with electronics for the first time. For my final degree recital, I chose to perform Wayne Siegel's *Jackdaw* for bass clarinet and fixed track.[6] *Jackdaw* is a highly rhythmic composition that requires the performer to be precisely in time with the electronic track. Learning to play *Jackdaw* was a challenge because the fixed track was relentless and, by nature of a fixed medium, unresponsive. I particularly enjoyed the pseudo interaction between the electronic and bass clarinet parts because it was challenging. By *pseudo interaction*, I mean that the audience would perceive the interplay between the performer and the electronic sounds as interactive, but in reality the performer is able to create this illusion from extensive practice with the track.

The lack of real interaction between the performer and the electronics means that I can adapt to the track, but the track cannot adapt to me. This can also be frustrating for other performers. As flautist Elizabeth McNutt recounts, 'performing with fixed accompaniment is like working with the worst human accompanist imaginable: inconsiderable, inflexible, unresponsive and utterly deaf.'[7] Similarly, in an article describing her own practice with interactive computer music, violinist Mari Kimura writes that she does 'not want a recorded tape part to synchronise with, or a straight jacket [sic] to confine [her] in timing either'.[8] Her choice of the words *confine* and *straitjacket* encapsulates the disassociation performers can feel when performing with fixed electronics. This is particularly the case when the performer must follow a click track.

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[6] Siegel, Wayne: *Jackdaw* (self-published, 1995 rev. 2000).
[7] McNutt, Elizabeth: 'Performing Electroacoustic Music: A wider view of interactivity', *Organized Sound*, 8/3 (2003), 299.
[8] Kimura, Mari: 'Creative Process and Performance Practice of Interactive Computer Music: A performer's tale', *Organised Sound*, 8/3 (2003), 290.

This contrasts with other types of performance where there is more than one participant. For example, in chamber music, the performers interact onstage on many different levels to stay in time together and are all active participants of the performance; however, solo performers performing with an electronic track are solely responsible for staying in time, even though there are technically two participants: the performer and the track.

As another example, balance and blend are two issues that need to be navigated when there is more than one voice in performance. Chamber musicians work together on these issues, often meeting halfway, but fixed tracks do not have this capability. Not only are performers of fixed electronic works required to sacrifice control over timing to the track, but they are also fully responsible for issues of tuning, balance, and blend.

While preparing *Jackdaw* for my Bachelor of Music recital, I experienced a sense of renewed responsibility over my performance practice due to the challenges of working with fixed electronics. As part of my master's degree, I sought out more works for bass clarinet and fixed electronics. I performed works such as Gráinne Mulvey's *Periastron,* Ed Bennett's *Monster*, and Zachary W. Smith's *Searching for the Edge*.[9] Mulvey's and Bennett's electronic works require the performer to line up key moments with the fixed track; however, they also allow rhythmic flexibility. Smith's composition requires rhythmic accuracy and performers are provided with a click track. It was these works that sparked my interest in exploring the interaction between performers and computers on a deeper level.

[9] Mulvey, Gráinne: *Periastron* (Dublin, Ireland: Contemporary Music Centre Ireland, 2010); Bennett, Ed: *Monster* (Dublin, Ireland: Contemporary Music Centre Ireland, 2005); Smith, Zachary W.: *Searching for the Edge* (self-published, 2016).

Eventually, I performed two works with live electronics: Kathryn Norman's *Paul's Walk* (which also included visuals) and Frank Lyons' *Stung*.[10] I was struck by how different an experience it was to perform these works. Performing with live electronics required a different approach to practising and a willingness to embrace unpredictability and uncertainty. Each time I practiced *Paul's Walk,* I was never able to predict what electronic sounds would emerge, which was both frightening and exhilarating. Additionally, *Paul's Walk* is semi-improvised and I found myself more involved in the creation of sound than ever before. This inspired me to look for technology that would allow more creative input from the performer. Ultimately, my experience performing with different types of electronics was the starting point for my doctoral research.

1.4 Research Area

The original aim of this research was to study the possibilities of new technology in performance, specifically through the lens of the performer. Other performers who have already contributed to this area include Seán Mac Erlaine, Mari Kimura, Elizabeth McNutt, Anna Einarsson, and Chagall. Mac Erlaine researched and designed his own bespoke setup for performance, which includes the Livid Code controller and the Softstep foot controller.[11] As another example, Mari Kimura has highlighted some problems of performing with tape, the Zeta Violin MIDI Controller VC-225, and pitch trackers.[12] In a similar vein to Kimura, flautist Elizabeth McNutt discussed the difficulties of using various set-ups, including electronic tracks, foot pedals, and pitch tracking.[13] Another key performer, Anna Einarsson, examined the use of music technology from a phenomenological perspective, providing insight into how performers experience live

[10] Norman, Kathryn: *Paul's Walk* (self-published, 2015 rev. 2017).
[11] Mac Erlaine, Seán: 'Redesigning a Performance Practice: Synergising Woodwind Improvisation with Bespoke Software Technology' (PhD diss., Dublin Institute of Technology: 2013).
[12] Kimura, Mari, 'Performance Practice in Computer Music', *Computer Music Journal*, 19/1 (1995), 64–75.
[13] See McNutt, Elizabeth: 'Performing Electroacoustic Music: A wider view of interactivity', *Organised Sound*, 8/3 (2003), 297–304.

electronics.[14] Additionally, there are many videos online featuring hardware such as the MiMu gloves. Of particular interest are videos of the singer Chagall explaining her use of the MiMu gloves.[15]

I had heard that an augmented bass clarinet was being developed in Switzerland. This project eventually resulted in the SABRe multi-sensor device.[16] My original research questions were as follows:

1. How might new technology such as the SABRe Bass Clarinet [multi-sensor and remote] change the performance practice of an individual musician?
2. In what way does integrative music technology enable creativity in the practice of performing musicians?

I felt these questions would best be explored through the discipline of artistic research since they emerged from practice and required further practice to search for the answers. In attempting to answer these questions, my aim was to create or collaborate on several new works for clarinet or bass clarinet and the SABRe sensors. My objectives were to explore the performer's role in the creation of music, the performer-technology relationship, and the composer-performer relationship. The three areas that informed my research were artistic research, autoethnography, and action research.

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[14] Einarsson, Anna: 'Experiencing Responsive Technology in a Mixed Work: Interactive music as embodied and situated activity', *Organised Sound*, 22/3 (2017), 418–427.

[15] See BMus Commercial Music Performance [University of Westminster]: 'Chagall The Doc with Academic Interviews' (22 June 2017), https://youtu.be/8aagMS59HXw.

[16] SABRe stands for Sensor Augmented Bass Clarinet Research. See Schiesser, Sébastien and Jan C. Schacher: 'SABRe: The Augmented Bass Clarinet' (International Conference on New Interfaces for Musical Expression (NIME), Ann Arbor, MI, 2012). There is currently no published literature on performing with SABRe sensors; however, it should be noted that performer-composers Stephan Vermeersch and Matthias Mueller have composed and/or collaborated on multiple works for SABRe sensors in the past decade. Their performance outputs are valuable to the area of research surrounding the SABRe sensors. For more information, please visit their respective websites: https://stephan-vermeersch.be/ and https://www.matthiasmuellerclarinet.com/. For a list of compositions for SABRe sensors, see APPENDIX K: LIST OF COMPOSITIONS FOR SABRe SENSORS.

1.4.1 Artistic Research

Artistic research is an emerging discipline, particularly in the field of music, and has lagged behind the disciplines of visual arts and design. Henk Borgdorff, a prominent voice in the discourse on artistic research, set out his argument in a document based on a lecture he presented several times in 2005. He writes that '[t]he crux of the matter is whether a phenomenon like research in the arts exists – an endeavour in which the production of art is itself a fundamental part of the research process, and whereby art is partly the result of research.'[17]

At the time of Borgdorff's article, the discussion over whether or not practice-based research in the visual arts is acceptable as research in academia had already been taking place for fifteen years.[18] For example, Christopher Frayling considered the difference between 'research into art and design', 'research through art and design', and 'research for art and design' in an article in 1993.[19] The words *into*, *for*, and *through* are small but significant as they distinguish between different approaches to art research.

Frayling describes 'research *into* art and design' as historical or theoretical research.[20] Art (including music) is the focus of research into art, but the researcher is not taking on the role of artist, although they may draw on their artistic knowledge to inform the research. In music, this may be viewed as more established areas such as musicology, historically informed performance, or ethnomusicology.

Research for art and design is delineated by Frayling as '[r]esearch where the end product is an artefact' and 'where the goal is not primarily communicable knowledge'.[21]

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[17] Borgdorff, Henk: 'The Debate on Research in the Arts', in Proceedings of Sensuous Knowledge: Focus on artistic research and development, (2006), 1.
[18] Borgdorff, 'The Debate on Research in the Arts', 4.
[19] Frayling, Christopher: 'Research in Art and Design', Royal College of Art Research Papers, 1/1 (1993–1994), 5.
[20] Frayling, 'Research in Art and Design', 5.
[21] Frayling, 5.

The difference between research *for* and research *through* art is that research for art does not have an additional research component outside of the final work of art, whereas research through art does. Frayling's examples of research through art include materials research, development work, and action research.[22] The emphasis here is that artists experiment within their medium instead of from the outside and they assume both the role of the artist and of the researcher.

After Frayling's work, different variations of the term 'research through the arts' have emerged. For example, Borgdorff uses the term 'research in the arts' and argues that 'the artistic practice itself is an essential component of both the research process and the research results.'[23] With this view, not only is the researcher taking on a second role as artist, but they are also using their artistic practice to conduct their research and create art simultaneously.

Finally, *artistic research* was the third term to emerge. As part of a discussion in Norway more than two decades ago, Søren Kjørup explains that several theoreticians raised the idea of artistic research as a study of creative processes.[24] This view emphasizes that producing a performance or artwork is not the main focal point of the research. Instead, the core of the research is the process of creating that performance or artwork. The end product would be the study of creative processes, along with the artistic output, such as a musical performance or artwork. This is not very different from Borgdorff's 'research in the arts', except that this discussion on artistic research accentuates that the artistic process is the object of study. In other words, the output of the performer is only the tip of the iceberg; what lies beneath the surface is the performer's process and this is where a substantial part of the research takes place.

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[22] Frayling, 5.
[23] Borgdorff, 'The Debate on Research in the Arts', 7.
[24] Kjørup, Søren: 'Pleading for Plurality: Artistic and other kinds of research' in *The Routledge Companion to Research in the Arts* (Abingdon, England: Routledge, 2010), 25.

In line with Borgdorff's view, artist and researcher Gabriella Arrigoni takes the stance that artistic research is 'a process that positions art practice as simultaneously methodology and outcome of the research'.[25] This is echoed in Efva Lilja's book on artistic research:

> **The Definition** *"Artistic research is research conducted with artistic practice as its base and artistic practice as its object."* After an animated discussion in a circle of artists and researchers, Lars-Göran Karlsson, a sociologist with a passion for art, made this brilliant statement.[26]

These two statements share the idea that artistic practice becomes research if it takes on the dual role of producing both art and methodology. Pianist and scholar Darla Crispin provides a clear example of this, writing that 'when artistic practice becomes one of the tools used by the researcher in their own research practice, a crucial boundary is crossed into the realms of Artistic Research.'[27]

The *SHARE Handbook of Artistic Research Education* (written by an international network of authors in higher education)[28] proposes a detailed, yet open-ended statement that artistic research is 'the action of undertaking artistic work – composing and performing music, producing artworks and exhibitions and enacting all kinds of cultural practices'; furthermore, it 'can be undertaken as part of a self-conscious strategy to find something out, to conduct an enquiry, to ask questions about something' and 'to pursue an exploration of some aspect of the world'.[29] This definition places an emphasis on the intention of the researcher – to uncover knowledge. The researcher is actively trying to discover something through their practice, not only by engaging in their practice, but also by asking questions that stem from the practice itself.

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[25] Arrigoni, Gabriella: 'Epistemologies of Prototyping: Knowing in artistic research', *Digital Creativity*, 27/2 (2016), 100.
[26] Lilja, Efva: *Art, Research, Empowerment: The artist as researcher* (Stockholm: Elanders, 2015), 14.
[27] Crispin, Darla: 'Artistic Research and Music Scholarship: Musings and models from a continental European perspective', in *Artistic Practice as Research in Music* ed. by Mine Doğantan-Dack (New York, NY: Ashgate, 2016), 57.
[28] SHARE is an acronym for 'Step-Change for Higher Arts Research and Education'.
[29] Wilson, Mick and Schelte van Ruiten (eds.): *SHARE Handbook for Artistic Research Education* (ELIA, 2013), 320. SHARE is an acronym for 'Step-Change for Higher Arts Research and Education'.

Crispin also highlights the importance of enquiry. She describes artistic research as a 'novel terrain on which enquiry may be explicitly grounded not only in the kinds of questions that arise through the experience of the finished performance […] but also those generated through the work of practice'.[30] This stresses how central the artistic practice is to the research process.

These discourses on artistic research have influenced my own views and guided my research project. It became clear that the benefit of undertaking this type of research is to pursue questions that an external researcher would not be able to identify or would not be able to answer. For this reason, I have focused on my practice as a performer, rather than the works that I performed. I have embraced the process-driven nature of artistic research and have attempted to investigate my own practice in a rigorous way.

1.4.2 The Action Research Cycle

To help structure the research process, I drew inspiration from the action research cycle and its four stages of planning, acting, observing, and reflecting (see Figure 1).[31] This model is compatible with artistic practice itself, which is iterative by nature. By breaking the iterative process into smaller steps, it is easier to understand the artistic process and to notice themes as they emerge.

[30] Crispin, 'Artistic Research and Music Scholarship', 57.
[31] Herr, Kathryn and Gary L. Anderson: *The Action Research Dissertation: A Guide for Students and Faculty* (SAGE Publications, 2005), 5.

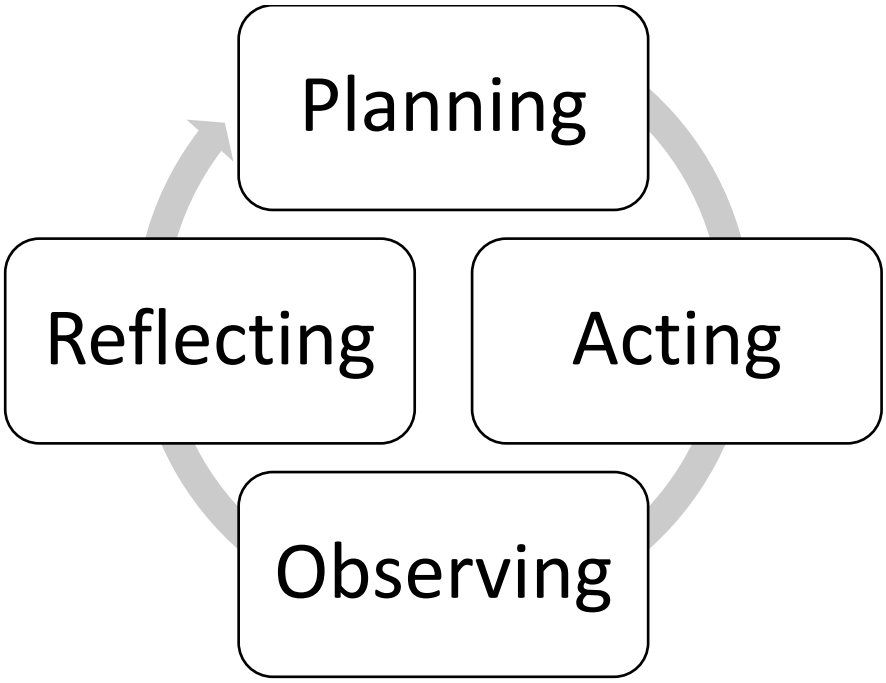

Figure 1: The Action Research Cycle

Using the action research cycle as a model was particularly helpful for ensuring that I formalized the last two stages: observing and reflecting. Practising the clarinet requires planning and action, but observing and reflecting is often given much less time in a practice space. Taking videos, notes, and keeping a reflective journal ensured that I was documenting my research as it happened.

1.4.3 Autoethnography

Unlike with action research, I did not find the area of autoethnography to be helpful in structuring or undertaking my research. Instead, it equipped me with useful guidance on how to discuss and analyse a subjective topic, such as my own practice, within a broader context.

Heewon Chang's book, *Autoethnography as Method*, was a valuable resource for trying to understand how the self relates to others. Chang addresses the concept of culture, which is what she sees as 'a product of interactions between self and others in a

community of practice'.[32] The individual, she argues, is 'a basic unit of culture'.[33] By viewing individuals in this way, the artistic researcher is part of a much larger fabric.

Within my own context, my research attempts to reveal valuable knowledge about contemporary performance culture by examining my interactions with myself, technology, and other musicians. This is done through 'cultural data analysis and interpretation', transforming 'bits of auto-biographical data into a culturally meaningful and sensible text'.[34] Chang explains this approach to autoethnography further:

> Instead of merely describing what happened in your life, you try to explain how fragments of memories may be strung together to explain your cultural tenets and relationship with others in society. In this sense, autoethnographic data analysis and interpretation distinguish their final product from other self-narrative, autobiographical writings that concentrate on storytelling.[35]

Throughout this thesis, I interweave pictures, screenshots, audio examples, and reflective excerpts into the main text to build a narrative that provides an authentic and detailed analysis of my practice.

1.5 Methodology

One of the challenges with artistic research is that the plan of action is not necessarily clear or well-structured ahead of time, such as in scientific disciplines. In arts practice, ideas emerge as processes unfold and this makes it difficult to discuss methodology. Although Robert Burke and Andrys Onsman believe that 'selecting a methodology in artistic research not only functions as a conceptual framework for the researcher but also guides its dissemination',[36] others believe that artistic researchers do not

[32] Chang, Heewon: *Autoethnography as Method* (Walnut Creek, CA: Left Coast Press, 2008), 23.
[33] Chang, *Autoethnography as Method*, 23.
[34] Chang, 126.
[35] Chang, 126.
[36] Burke, Robert and Andrys Onsman: *Perspectives on Artistic Research in Music* (Lanham, MD: Lexington Books, 2017), 3.

necessarily need to select a methodology at the beginning of a project. As Lilja observes, an artistic research methodology 'develops over time, during the work'.[37]

From my experience, both points of view are helpful. I did write about methodology even before my research began and it did guide my activities; however, it also interfered with my artistic process. After developing a plan for undertaking my research, I was focused on following the plan rather than the experimental and explorative processes of creative work. Once I set my plan to the side, I was able to immerse myself in my artistic practice. My methodology became more detailed and clear as I prepared performances and reflected on my activity.

I conducted my research through bass clarinet and clarinet practice, performance, reflection, interactions with others, and computer programming. Figure 2 is a diagram of my methodology and is intended to show the interconnectedness of all areas of my research. Arrows connecting the main methods, such as performing or reflecting, demonstrate how undertaking one activity affected another. For example, the way I programmed the sensors was highly influenced by my practice and performance reflections. Similarly, after speaking with one of my supervisors or upon receiving feedback from an audience member, I reflected on the conversation and this was then fed back into my next practice or programming session. Sometimes different methods overlapped. For instance, programming and practising were two activities that were intertwined.

[37] Lilja, *Art, Research, Empowerment*, 57.

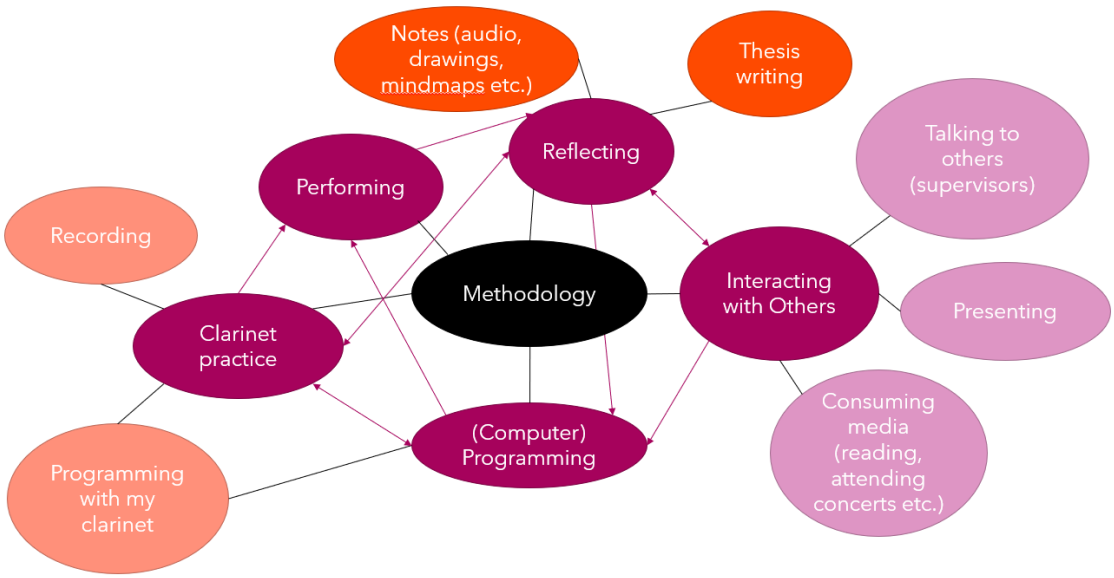

Figure 2: Methodology

My clarinet (and bass clarinet) practice is the driving force behind this research. Individual practice sessions were varied and included maintenance practice, learning scores, memory work, improvising, recording, programming, and practice with sensors and electronics. Some weeks I practised every day and sometimes I would not practice at all for a month. My focus shifted to different activities depending on my timeframe and what needed to be accomplished:

> What I didn't realize is that during the research process, different areas will 'bloom' at different times. For example, the first twelve months of my degree were primarily spent practicing, reading, and programming. I did not do any performing and I barely did any writing. In my second year, I wrote over 20,000 words and performed, but did less reading.[38]

I also did not know that there would be a global pandemic during my degree, which greatly impacted my opportunities to perform. Instead of performing live, I spent more time recording performances at home during 2020 and 2021. Performances, whether live or recorded, were opportunities to test out my work, to garner feedback, and most importantly, provided me with material to reflect upon.

[38] Reflective Journal Entry, 01 March 2021.

Reflection, as a method, involved keeping a reflective journal, taking notes in various forms, and the occasional video reflection. My reflective journal is both digital and handwritten, although handwritten notes were eventually scanned or typed up for analysis. Instead of trying to write reflective entries on a regular basis, I wrote whenever I had something to reflect upon or when I needed to make sense of something that had happened. One technique I used for this was to interview myself. I would write a series of questions in my journal and then attempt to answer them.

Occasionally, I encountered writer's block and recorded myself on video, speaking freely. Then I would watch the video back and take notes on what I had spoken about in the video. This idea of talking through my ideas, rather than writing them, came out of one of my clarinet lessons:

> The interesting thing is that once I started talking, my brain entered a new mode where it was highly focused on the task at hand (talking about my process). I've noticed that putting myself on the spot can produce two completely different reactions. The first one is that I feel like a deer stuck in the headlights and my brain freezes. This can sometimes happen when someone questions me and the question surprises me so much that even if I know the answer, suddenly my brain can't access it. The second reaction is what happened in this last session. When Paul [Roe] put me on the spot to record our conversation I actually found that I was highly focused and was forming ideas in my head that were new to me.[39]

Many of my notebooks contain visually-orientated notes such as mind maps, doodles, and diagrams. Although most of my notes were written in a notebook or on my computer, I also used a whiteboard; there was something about the impermanence of drawing on a whiteboard that was appealing. Writing this thesis was also a significant act of reflection as I had to read through and analyse a lot of data, and then distil it all into words. Not only was thesis writing a type of reflective writing, but knowing that I was going to have to write a thesis in the first place helped me to be aware of what should be recorded:

[39] Reflective Journal Entry, 21 November 2019.

> I knew I was going to have to write about my process of preparing *Stung* for performance [in my thesis] so I was actively analyzing every step of the way as it happened. As soon as a theme emerged, then I would write it down and reflect on it.[40]

Note-taking and documentation was not always successful, as I expressed to fellow researchers at the Artistic Research Perspectives Seminar at TU Dublin:

> At this point, I should just mention that I did try to write about the process of preparing *Stung* before I even performed it, but I found it was really hard to separate myself from the process while I was in the middle of it. I also tried to document each step of the process, but because my approach was very experimental and I used a lot of trial and error, I found that documenting the process in a traditional way was actually getting in the way of my creative process.
>
> By trying to note down every little thing I was doing, I was getting distracted from my practice. So in this way, I actually think that being too organized and too methodical can hinder artistic research.[41]

I found it difficult to document my practice as it materialized because it distracted me from the task at hand. What worked better for me was to write short notes on my activity as close to the time it happened as possible and then to write an in-depth reflection later, when I had the time and space to do so. Of course, the problem with this approach is that sometimes I did not understand my shorthand:

> An interesting topic that surfaced [in supervision] was the idea of proximity when writing a reflection. Last week, I wrote my reflection 6 days after the lesson. If I write a reflection directly after an event, I feel that my observations will be more accurate; however, I found that writing 6 days later gave me a more objective clarity on the events of the session. This raises the question whether or not I should record what happened as soon as possible, but leave the reflection writing to a later day in the week.
>
> From my notes, I can see that we discussed the idea of iteration, but I cannot fully remember what this refers to. Maybe this is why I should be recording the events as soon as possible so that I don't forget what my notes refer to.[42]

Interacting with others is a multi-faceted method that encompassed conversations I had with other people, presentations that I gave, and the consumption of media.

[40] Artistic Research Perspectives Seminar Script, 01 March 2021.
[41] Artistic Research Perspectives, 01 March 2021.
[42] Reflective Journal Entry, 22 October 2019.

Conversations with audience members, peers, and my supervisors were highly influential. These were often crucial points where I received feedback, whether solicited or unsolicited, and it provided me with information on how my performances were being received. Other conversations included more casual chats where I explained my research project to someone or listened to someone else explain their research to me.

Sometimes this feedback was technical in nature, such as one lecture recital where I learned that the balance between the bass clarinet and the electronics was not quite right:

> [T]here was a lengthy discussion about the levels of the electronics in the question period following my lecture recital. Most of the front row of the audience found that the levels were good, but the second row wanted to hear more of the electronics. After watching the recordings from this event, I believe that I may need to raise the levels of the electronics in subsequent performances.[43]

At other times, I became aware of how much I was influenced by the people around me:

> Conversations with other people are like detective work and send me off chasing 'clues', sometimes leading me to helpful 'evidence' that I can use. These social interactions are an important part of the artistic process. I often hear the phrase, 'artists don't live in a vacuum' and the deeper I explore my research topic, the more I believe this to be true. Making art seems to be a refraction of social and cultural experience. I use the word refraction instead of reflection because artists do not merely bounce elements of the world back into their art–the artist's experiences in life bend through the artist and then end up in art.[44]

These conversations highlight the dialogical nature of this research, with new information and insights emerging from dialogue.

Giving presentations and attending conferences was another important part of my research. Although it is difficult to pinpoint exactly how much these events affected the research process, some entries from my reflective journal provide insight into what I was absorbing. The first entry of note was a report I wrote about attending the International

[43] Reflective Journal Entry, 14 May 2020.
[44] Reflective Journal Entry, 31 January 2020.

Clarinet Conference in Belgium and the Doctors in Performance conference in Lithuania, both in my first year in 2018.[45] This report explains the sheer number of events that I attended:

> As proposed, I participated at the International Clarinet Conference in Ostend, Belgium and observed the Doctors in Performance conference in Vilnius, Lithuania.
>
> In Belgium, I attended one workshop, two lectures, and ten concerts. I also performed in a forty-member bass clarinet ensemble and attended two rehearsals in preparation for this performance. The conference showcased the highest calibre of clarinet performance from around the world. I was fortunate enough to attend several concerts that were related to my own research topic. The level of electroacoustic performance was varied, with a myriad of different technical setups and genres. As intended, I spent a lot of time asking questions about the SABRe technology and acquired the SABRe sensors and remote by the end of the conference for my research project.
>
> In Lithuania, I attended two keynote presentations, seven recitals, three lecture recitals, and four papers which all focused on artistic research themes and topics. The artistic research (AR) conference highlighted the varied choice of methodology available to artistic researchers, with presenters from 22 different countries. The calibre of performance was high and the instruments varied; however, there were many different approaches to artistic research with no clear overarching method or framework. On reflection, the most striking feature of the conference was the broad range of topics and research approaches, stemming from various disciplines and musical genres. This seems to suggest that there are many ways forward in the future of artistic research and that there is keen interest in AR around the world.
>
> Both conferences were extremely beneficial and will influence the shape and direction of my research, especially at such an early stage.[46]

Some of the notes that I scribbled during the Doctors in Performance conference were interesting to read several years on:

> If all sound can be generated within a patch, what is the point of the performer really?? Does interaction become a gimmick? How do I prevent SABRe as coming across as a gimmick rather than a creative enabler? […]
>
> I was really quite bored during [their] performance because I was expecting [them] to play the [instrument removed] and all [they] did was push buttons to make electronic sounds. I wasn't engaged. […]
>
> [T]he performance aspect of [their] piece fell a little flat – I think that is the problem with a computer doing decision making and generating material. We

[45] For conferences hosted by the International Clarinet Association, see https://clarinet.org/. For Doctors in Performance conferences, see http://harps.lmta.lt/en/events/doctors-in-performance/.
[46] Reflective Journal Entry, 07 September 2018.

> really needed a better view of the performer to get a better feel for the piece.[47]

Not all my notes were this critical, but these excerpts show that I was trying to learn from other performers and understand what I wanted to do differently from them.

I was also influenced by many different types of media, such as reading books and articles, attending concerts, listening to music, or watching videos online. An example of this is Garth Knox's *Viola Spaces*, which are eight studies for viola with both solo and duo versions.[48] On his website, Knox has three videos for each study; the first is of him playing the solo study, the second is an instructional demonstration of the study, and the third is a performance of the duo version. I was inspired by his studies early on and thought about creating something similar for bass clarinet and SABRe. Although I ended up going in a different direction, Knox was one of many performers who inspired me to expand my practice and learn new things such as improvising.

The standard practice of taking notes while reading books or journal articles not only helped me to make sense of what I was reading, but also allowed me to pinpoint where my ideas came from. For instance, in the following journal excerpt, I was reflecting on artistic research terminology and was already aware that labels can be restrictive to creative activity:

> I like […] the title for the book […] *Artistic Practice as Research in Music*. It links practice, research and music in a way that is both open-ended and distinct. Instead of simply calling it 'practice', the authors have also chosen to call it 'artistic practice' which appeals to me because of the creative nature of my practice. This also leaves the door open for my practice to incorporate other elements that are not necessarily musical, leaving the potential for the visual arts, dance, and drama to be part of my future research. By saying 'research in music', this defines the end goal of the research to be musical, but does not limit the artistic practice leading to the end goal to purely musical forms.[49]

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[47] Notes from my Doctors in Performance notebook, September 2018.
[48] Knox, Garth: *Viola Spaces* (Schott Music, 2004–2007). See also Knox, Garth: 'Viola Spaces': https://www.garthknox.org/compositions/viola-spaces/.
[49] Reflective Journal Entry, 16 January 2018. See Doğantan-Dack, Mine: *Artistic Practice as Research in Music* (New York, NY: Ashgate, 2016).

Similarly, I reflected on videos that had an impact on me. At the start of my research, I watched a lot of videos online to become familiar with the kinds of technology performers were using in performance:

> I watched a few videos demonstrating interactive gloves [MiMU Gloves] that communicate with a computer music programme via gestures. […] I also watched a video of an interactive sound instrument with sounds generated by active lights held and moved by the performer [John Burton]. […]
>
> I guess the interesting thing about the gloves is that they allow the body to interact with open space. The body's movements interact with space and depending how the gloves are pre-programmed, communicate something within that space. The difference with the bass clarinet is that I am interacting with a physical object, not open space.
>
> The other difference is that the bass clarinet uses air as its main expressive element, not gesture. Sound is created with air. This is similar to the voice, although instead of a vocal box, I have a wooden/metal instrument.
>
> This makes me think about my own performance. I have a bass clarinet and a clarinet, two instruments that I use to make music. Mostly I use my air and fingers to change the sound of the instrument, and my tongue as well (but that is not seen by the audience). Instrumental performances are expressive from the body language of the performer, the sound of the breath, the body posture, the facial expressions, the subtle swaying of the body to the sound…[50]

Everything that I listened to, watched, and read contributed to the direction of this research.

Programming, which involved creating patches in Max for Live, was not an isolated activity. Ideas for programming stemmed from clarinet practice and interactions with others. The technical limitations and practicalities of using the SABRe multi-sensor caused me to stop and consider aspects of my clarinet practice that I did not need to before. For this reason, programming became central to my research because it necessitated making decisions on practical and creative levels.

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[50] Reflective Journal Entry, 16 March 2018. Ableton: 'Chagall live performance with mi.mu gloves | Loop' (24 May 2017), accessed 20 May 2022, https://youtu.be/2ahP8lPwIKs. Leafcutter John [John Burton]: 'Leafcutter John @ XOYO (Beam/NIME night) 'Light Thing'' (2 July 2014), accessed 20 May 2022, https://youtu.be/2jllLHfSEfs.

The methods I used to complete this research were not procedural; I was not following a list of steps, rather I was creating them as I went along. My clarinet practice was the starting point and the other methods emerged in time as I attempted to answer my research questions. Ultimately, the resulting methodology is a web of interconnected methods that emerged over time, allowing an iterative and malleable artistic process.

1.6 Software Overview

Music technology is constantly evolving and there is a plethora of choice in terms of both hardware and software setups. In late 2017, I searched for software that would be ideal for live performance. Prior to this research I had little experience with digital audio workstations (DAW) so I asked my brother, Nicholas Barz, for advice. At the time, he was a DJ in Toronto, Canada and had worked with many different types of music production software. Since my primary use of the software would be for performance, he recommended Ableton Live. I had also seen others using Live in performance. For example, composer Frank Lyons used Live for the live processing of his composition *Stung*, which I performed with him in May 2017.

I decided to purchase Ableton Live 9 (with a free upgrade to Ableton Live 10) since it seemed to have the most flexibility for live performance. Live has a traditional timeline view for making music called Arrangement View; however, it also features Session View, a unique way of organizing music recordings into columns and rows instead of in a linear timeline. Figure 3 shows an example of Session View from one of my early projects, with colourful columns which are called tracks. Tracks on the left side can be either audio tracks or MIDI tracks and the ones on the right side are return tracks. Clips are stored within audio and MIDI tracks. A single clip can be played on its own or a whole row of clips (a scene) can be played by clicking the Scene Launch button in the Master Track. I have used Session View for performance and Arrangement View for recording.

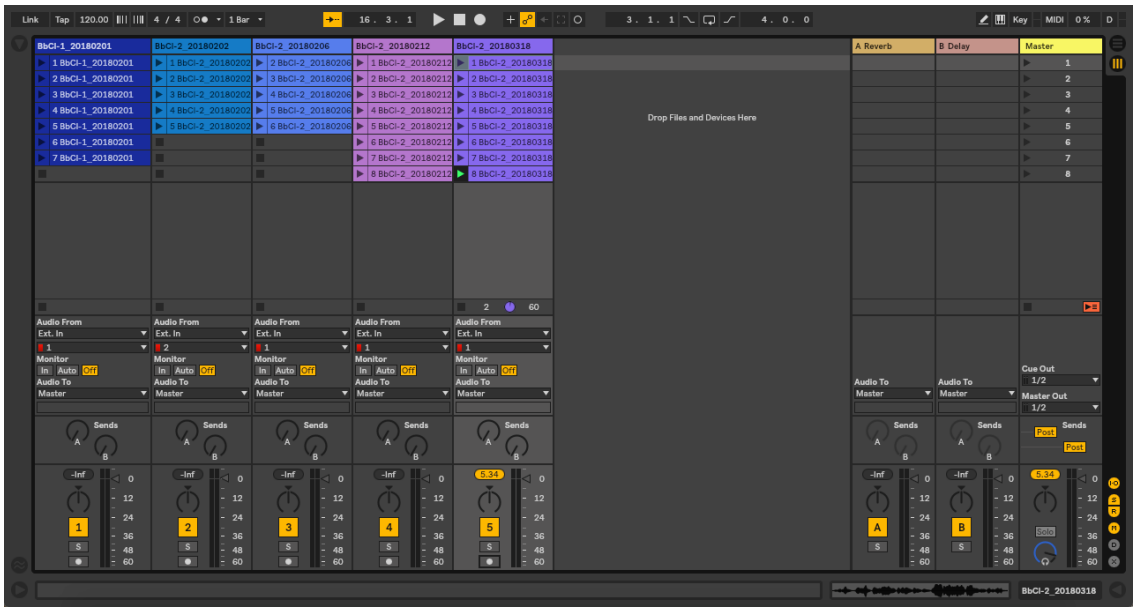


Figure 3: Session View in Live

An important factor for selecting Live as my DAW is that it is packaged with a version of Max called Max for Live. Max for Live is a visual programming environment that allows programmers to build complex systems for performance.

1.7 Hardware Overview

After settling on software, I started a new search for a device that would let me control Live while playing the clarinet or bass clarinet. I developed a list of criteria that this device would need to fulfil. First, it needed to be compatible with Live/Max for Live. Then it needed to be portable so that I could take it with me anywhere. Most importantly, I wanted this device to allow me to play my clarinet or bass clarinet while simultaneously controlling the DAW, without needing to press keys on the laptop during my performances.

I was searching for hardware that could be integrated into performance so that I would not be turning away from the audience to turn knobs or click buttons. Although foot pedals may seem like the obvious choice because some performers (such as guitarists) use them seamlessly, they still went against my search for more integration (see section

3.2.3). Foot pedals are a separate object to the performer and their instrument, and I was searching for a more streamlined setup.

This criterion also eliminated wearable sensors, such as the Myo Armband and the MiMU gloves, since they require physical movements that would not allow me to play clarinet at the same time. Full-body motion capture suits are expensive and not ideal for portability. I was left with two options: motion capture using one of Microsoft's Kinect cameras or SABRe's multi-sensor and remote.

I chose the newly developed SABRe multi-sensor device and remote as it was specifically designed to be used with clarinets and saxophones (see Figure 4). The multi-sensor device consists of four sensors in a small black box that is strapped onto the performer's instrument. Three of the sensors are positional (yaw, roll, and pitch) and the fourth sensor calculates the performer's air pressure from the mouthpiece. SABRe's multi-sensor box also comes with a two-button remote and software that connects the two devices to the computer via Bluetooth wireless technology (see Figure 5).

Figure 4: SABRe Sensor Box[51]

[51] Photographs taken from SABRe's website: https://www.sabre-mt.com/.

Figure 5: SABRe Multi Sensor, straps, and remote[52]

Part of the attraction of SABRe's multi-sensor was the ability to send the sensor data using the Open Sound Control (OSC) protocol to Max. I only use SABRe's software to connect the sensors to my laptop's Bluetooth module and to send the sensor data to Max for Live via OSC. When I started this project, I was using SABRe's software on a MacBook Pro.[53] Its clunky user design necessitates too much clicking and there are too few audio effects. When I switched to a Dell laptop in mid-2019, I was surprised to discover that the software is even less user-friendly on Windows. Still, it serves its purpose for sending the sensor data to Live.

I have used several different microphones during this research project. For recording directly into my laptop, I use the Samson Meteorite USB microphone. For performance, I have tried using a stationary condenser microphone positioned on a stand in front of

[52] Photographs taken from SABRe's website: https://www.sabre-mt.com/.
[53] I have used two laptops during this research project: a mid-2010 MacBook Pro and a 2019 Dell XPS 15.

me; however, the problem with this is that moving away from the microphone changes the sound. For performances outside of TU Dublin, I borrowed a Samson AirLine 77AH1 microphone that clipped onto the bell of my bass clarinet. I pointed the microphone at the upper joint for the best overall sound.

Later, the Samson microphone seemed to be the source of unwanted crackling and popping noises, so I purchased a SubZero Clip-on Instrument Condenser Microphone from Gear4Music. This is not a wireless microphone and the cord running into the audio interface can sometimes be a nuisance, but it is good value. I also purchased a SubZero Woodwind Strap Clip that allows the microphone to be attached to my bass clarinet or clarinet. Eventually, I decided to stop attaching the SubZero microphone to my bass clarinet because it picked up too many key noises. Instead, I clip the microphone to my music stand. The issue with this is that moving away from the microphone can result in weaker audio effects.

For the first few performances, I borrowed either a Tascam iXZ microphone and guitar interface or the Apogee Duet 2. I have since purchased Focusrite's Scarlett Solo, 3rd Gen, which is good value and portable. The main drawback of this interface is that it does not allow for the performer to send sound to the speakers and the monitor at the same time. Without a monitor, it can be difficult to hear the live electronics while performing.

I use whichever speakers are available to me at the venue in which I am performing. Different institutions have different equipment. I have performed in a variety of locations, mostly with a simple two-speaker setup, but on occasion I have enjoyed an eight-speaker setup and a monitor. In 2020, the TU Dublin Conservatoire purchased the Yamaha Stagepas PA system for me to use for my research. From March 2020 to mid-2021, there were COVID-19 public health restrictions that prevented and discouraged access to the university facilities; therefore, it was not until mid-2021 that I was able to practice with a full setup (speakers, sensors, etc.).

1.8 Conclusion

This chapter presented the contextual framework for this research project, as well as an overview of the software and hardware that will be discussed throughout this thesis. It is important to recognize that this research investigates my experience as a performer from an ontological-relativist standpoint, with the aim of understanding the relationships and processes involved in performing contemporary music with interactive technology. This research is qualitative and utilizes a semi-autoethnographic format to communicate my experiences.

This chapter also contains a discussion of my methodology, with an emphasis on its iterative and emergent nature. I approached this research with the intention of discovering the creative possibilities of using the SABRe multi-sensor and I was also curious how adopting this technology might change my performance practice. The essential point here is that my practice is both a research method and the focus of the research. The next chapter introduces the nine compositions that I worked on with the SABRe multi-sensor device.

CHAPTER TWO: ARTISTIC WORKS

2.1 Introduction

Upon starting this research, I did not know what works I would perform, nor did I have any prospects of collaboration. I did not see myself as a composer, but I was interested in the idea of improvisation. I had little experience with DAWs, such as Pro Tools and Ableton Live, so I spent time learning how to use Ableton Live and Max for Live by watching tutorials on YouTube and taking online courses through Udemy. I had not decided what compositions to work on yet so I tried improvising with Live audio effects.

I first worked on a new version of Frank Lyons' *Stung* that would allow me to control the live processing with sensors. As I re-worked the live processing, I noticed similarities between what I was doing and remixing.[1] This gave me the idea for my next project, which was to remix Amanda Feery's *Star Maker*, originally written for unaccompanied bass clarinet. I created the sensor version of *Star Maker* in 2019 and performed it twice in 2020.

I had met composers Frank Lyons and Amanda Feery and sensed that they would be open to the idea of me experimenting with their works for the purposes of this research. I discussed this with both composers before adding live processing to their works, but I was wary of creating new versions of their works without their direct involvement. After performing *Stung* and *Star Maker*, I reflected on my artistic process and role as a performer. This inspired the creation of my own composition, *Dréimire Mhuire*, for solo clarinet.

[1] For a discussion on remixing related to my work, see section 6.1.

Around the same time, I also worked on a second piece by Frank Lyons; after performing *Stung*, he had approached me about adding live processing to a new composition, *Hex 2*. Although I started working on this in early 2019, it was not recorded until late 2020 and was performed for a live audience for the first time in April 2022.

Finally, from late 2020, I collaborated with composer Yue Song on a series of short works for bass clarinet and live processing. Song had attended a few of my lecture recitals at the university and was interested in what I was doing with the sensors. We started a collaboration that approached the sensors in a completely different way than what I was doing on my own. Song was interested in having different audio effects active in particular parts of the score, which challenged me to integrate the sensors in a new way.

2.2 *Stung*

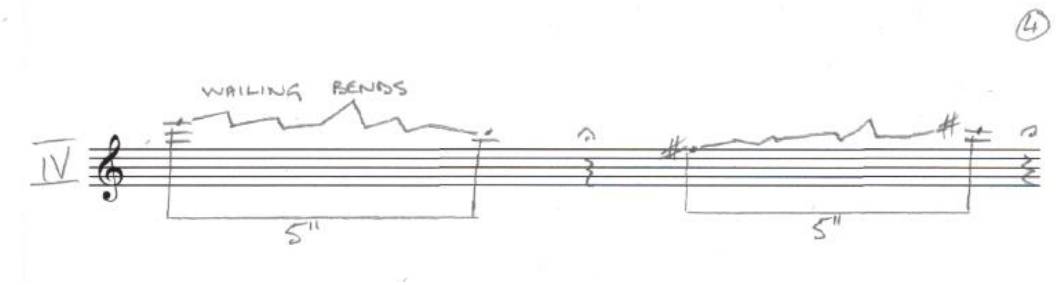
Stung was composed in 2010 by Frank Lyons of Ulster University in Northern Ireland for bass clarinet and live processing.[2] It was commissioned by Paul Roe as 'the result of a collaboration between Roe and Lyons'.[3] *Stung* is a modular piece that is comprised of various sections, as outlined below:

> The bass clarinet part contains an [I]ntroduction, six numbered sections (I-VI), five lettered sections (A-E), and a [C]oda. The performer must always start with the Introduction and end with the Coda. The performer can choose to follow the Introduction with any of the numbered sections and then alternate between lettered and numbered sections until they have all been performed once. This flexible layout allows the performer to either leave the order of sections to chance during performance, or decide through experimentation how best to order them in rehearsal.
>
> *Stung*'s score does not include barlines or time signatures. The time element of *Stung* is almost entirely controlled by the performer and even if the

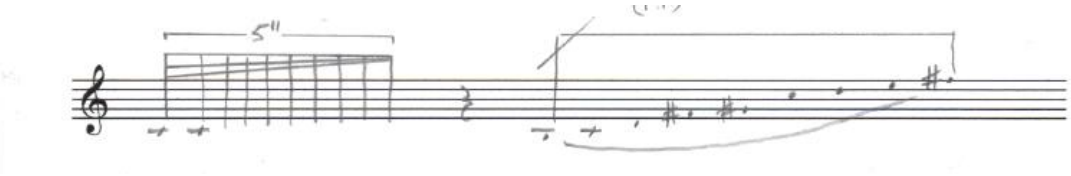
[2] For the score, see page 210. For more information about Frank Lyons, see https://www.ulster.ac.uk/staff/fr-lyons (staff profile at Ulster University) or https://www.cmc.ie/composers/frank-lyons (Contemporary Music Centre biography).
[3] Barz, Marcella: 'A Contextual Analysis of Solo Bass Clarinet Music by Irish Composers' (MMus diss., Dublin Institute of Technology: 2017), 68. For more information about Paul Roe, see his website: https://www.paulroemusic.com/.

> performer chooses to have someone else operate the live electronics, the technician reacts to the performer's sounds.[4]

Although there are no barlines or time signatures, *Stung* is a highly rhythmic piece. Rests are carefully placed throughout the work to allow room for the live processing to sound. In general, the numbered sections are brief passages that feature different textures and timbres, such as breath sounds, wailing bends, or multiphonics (see Example 1). The Introduction, Coda, and lettered sections are longer and share musical ideas with the numbered sections, creating a sense of continuity in an otherwise modular work. Some of the ideas that are expanded in these sections include quick passages that are interspersed with short trills and rests, accelerated (or decelerated) gestures on a single note (see Example 2), musical gestures that sweep up and down the bass clarinet, and quick, punctuated rhythms (see Example 3).



Example 1: Lyons, *Stung*, Section Number Four



Example 2: Lyons, *Stung*, Section D

[4] Barz, 'A Contextual Analysis', 69.

Example 3: Lyons, *Stung*, Section E

Originally, Roe performed this work, with Lyons improvising the live processing using Ableton Live. In 2016, I started studying *Stung* with Roe and then performed it in May 2017 in my master's recital with the composer. After this performance, I became interested in performing *Stung* more frequently. I was inspired by two elements of the performance: the live electronic layer that Lyons added created an engaging interactivity between the acoustic bass clarinet sounds and the electronic medium; and the live processing of my bass clarinet produced a myriad of interesting sounds that intrigued me.

I knew the composer would not always be available for performances so I contemplated performing *Stung* as a solo work. In the performance notes for *Stung*, Lyons specifies that '[t]he live electronic processing (Ableton Live Patch) may be controlled by the bass clarinettist or by a separate performer'.[5] It was also around this time that I had heard about the SABRe sensors and I thought it might be interesting to see if I could control the live processing with the sensors, rather than stopping during the performance to turn knobs or push buttons on a device.

I discussed my idea with Lyons and he was interested to see what I could come up with. The resulting process of figuring out how to control the processing with the sensors and integrate them into performance was not dictated by the composer. He was interested in the performance that ensued, but I was left to my own artistic devices to programme and prepare the work.

[5] Lyons, Frank: *Stung* (Dublin, Ireland: Contemporary Music Centre Ireland, 2010), performance notes.

2.3 *Star Maker*

After completing the SABRe sensor version of *Stung* in early 2019, I was not yet ready to seek out collaborations on new works. I reflected on this period in time in one of my journal entries:

> I needed more repertoire and remixing already existing works seemed like a good place to start. I was already learning new software and dealing with shifts in my practice. Starting off by composing my own works or jumping into a collaboration was not practical.[6]

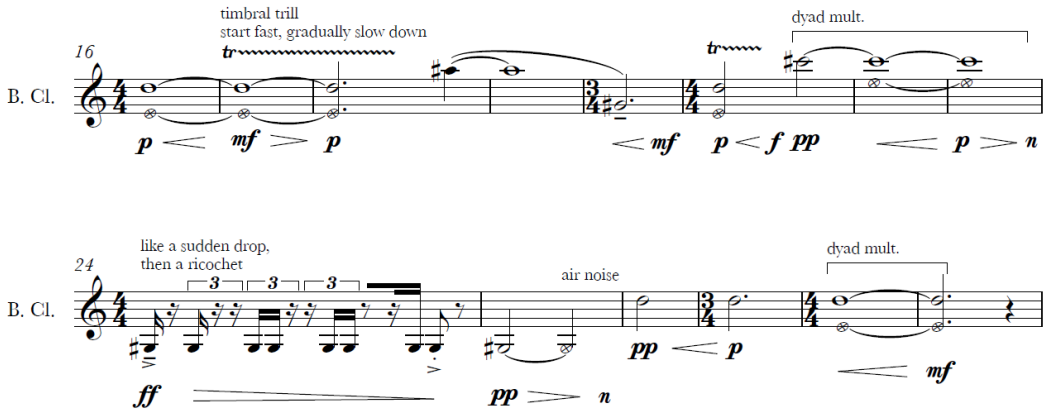
Although I had developed skills for using Live and Max for Live through the creation of *Stung*'s sensor-based performance, I decided it would be best to gain a deeper understanding of Live's and Max for Live's capabilities through independent work so I chose to perform Amanda Feery's *Star Maker* (2015) for solo unaccompanied bass clarinet.[7]

I had already performed Feery's solo unaccompanied bass clarinet works (*Rattle* and *Star Maker*) on several occasions. I thought that they would be suitable works to add live processing to because there is a spaciousness in the bass clarinet part that would allow the electronics to develop. I discussed this with Feery after giving a clarinet workshop to her composition students in early 2019. Originally, I was thinking of adding electronics to *Rattle*, purely for experimental purposes; however, Feery suggested that *Star Maker* might be more appropriate for this. I started to create the live processing for *Star Maker* in mid-2019.

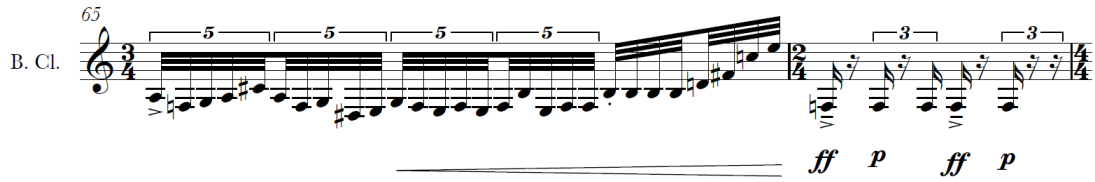
Star Maker begins with long, gentle multiphonics but quickly becomes fragmented with sudden dynamic changes and unpredictable low note bursts (see Example 4). The sudden shifts in emotion between fragility and frustration make this a challenging composition

[6] Reflective Journal Entry, 04 October 2020.
[7] For the score, see page 225. For more information about Amanda Feery, visit her website: https://www.amanda-feery.com/. Additionally, links to her scores can be found at the Contemporary Music Centre website: https://www.cmc.ie/composers/amanda-feery.

to perform. *Star Maker* ends with a flurry of the lowest notes on the bass clarinet that are interjected by ricochet-like rhythms (see Example 5).



Example 4: Feery, *Star Maker*, 16–29



Example 5: Feery, *Star Maker*, 65–66

2.4 *Dréimire Mhuire*

During the process of working on *Stung* and *Star Maker*, I developed a growing desire to compose my own work. Part of the reason was that I was struggling with the concept of ownership and felt uncomfortable adding electronics to someone else's work. I had also been interested in creating a Live Set in Live for improvisation for some time so I returned to exploring improvisation on both the clarinet and bass clarinet. I recorded my improvisations so that I could listen back and analyse them later.

One day, I was listening to one of my earlier recordings and I really liked what I heard. I re-played what I had recorded and continued to improvise, adding on more material. I then recorded my second improvisation and returned to it on another day. After several days of returning to my recordings, I realized it was not an improvisation anymore. My

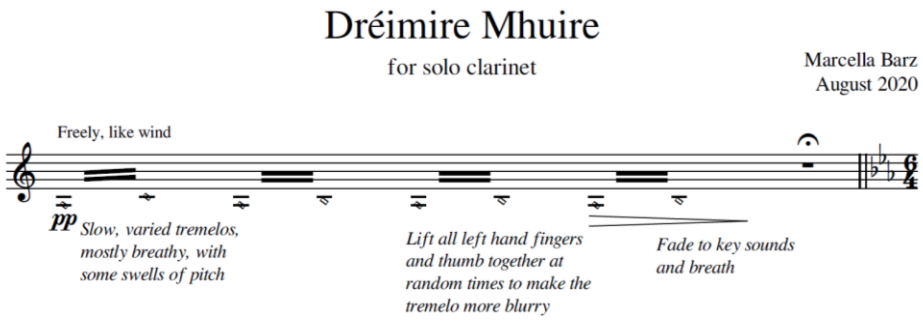
improvisations became tools for composition, although I was not conscious of this at the time. Eventually, I observed that the composition had reached a natural conclusion, so I decided to notate it.

The inspiration for the title, *Dréimire Mhuire* (Mary's ladder) came from an Instagram account (@blathannafiaine) that documents wildflowers around Ireland in the Irish language. The colours and shapes of the flowers, along with the folklore behind the Irish names of the flowers, inspired the initial improvisation, the development of the composition, and the eventual addition of the electronics. *Dréimire Mhuire* can be played as a solo composition on its own, or with the addition of SABRe sensors to create live processing.

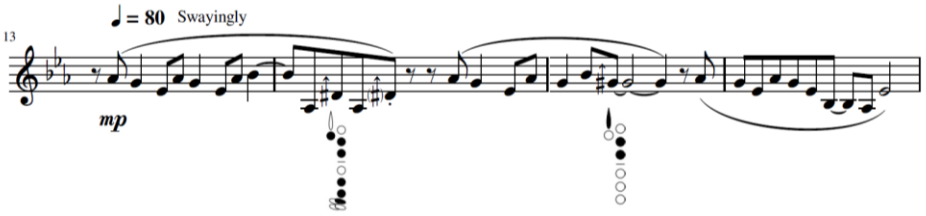
By creating my own composition, I was able to explore the addition of electronics in a freer way. This directly contrasted with my experience of adding electronics to works by other composers (see section 6.3.2).

Dréimire Mhuire's clarinet part is spacious, free, and expressive.[8] The first phrase is like a preface, a group of tremolos that balance delicately between breathy sounds and normal tone (see Example 6). After the first phrase, the piece centres on G minor, although this was not intended when I was improvising. Each phrase is slow, melodic, and lilting at times. Some notes are not played with normal fingerings because they are designed to be microtonal, creating a blurry tone (see Example 7).

[8] For the full score, see page 229.



Example 6: Barz, *Dréimire Mhuire*, 1–5



Example 7: Barz, *Dréimire Mhuire*, 13–16

2.5 *Hex 2*

Hex 2 is a composition by Frank Lyons for bass clarinet, fixed electronic track and live processing, and marks the second work in a series, after *Hexagram of the Heavens* for bass guitar and effects pedals. Lyons describes the connection between the two pieces as such:

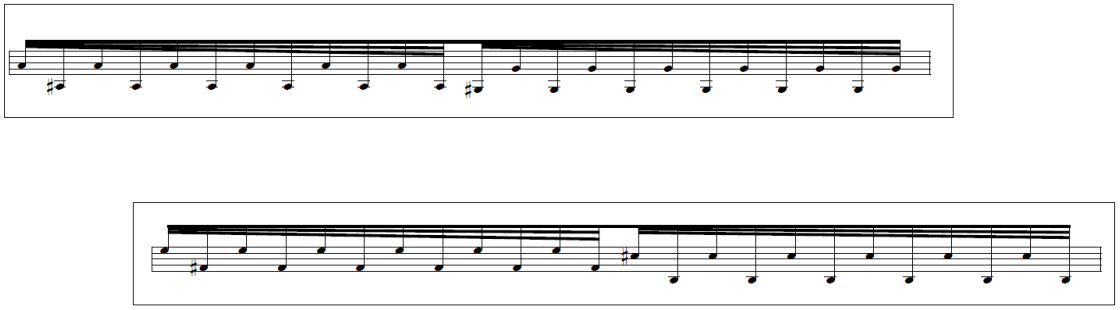
> These are the first two works in a series investigating how common features in flexibly-notated material and soundtracks can provide, at once, unity and scope for variety in interpretation by musicians playing different instruments, and in live sound processing. Both use the same pitch material, derived from the all-triad hexachord, and both soundtracks contain structural cues at identical points.[9]

Hex 2 contains six pages of bass clarinet material and a soundtrack that is about fifteen minutes long. The soundtrack, comprising of 'transformed samples' has twelve distinct sections and each page of the bass clarinet part corresponds to a section of the soundtrack. The performer moves through pages one to six of the score and repeats this again for the last six sections of the soundtrack. Lyons describes the interaction between

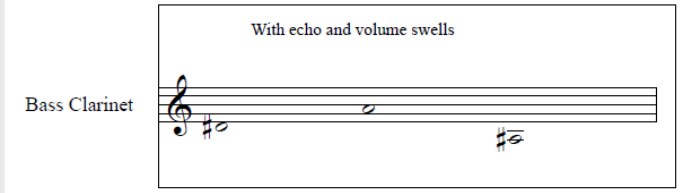
[9] Lyons, Frank, e-mail message to author, 13 December 2021.

the bass clarinet, live processing, and soundtrack as an 'overlap to obscure sectional boundaries in a Lutosławski-inspired chain form'.[10]

All six pages of the score are modular and contain a variety of cells that the performer can move through in an improvised way, although the performer must move through each page separately and in succession.[11] There are distinctive musical gestures on each page (see Example 8 and Example 9). Lyons composed the melodic material of each cell from Joni Mitchell's *Amelia*, which 'are harmonically filtered through permutations of the all-triad hexachord (0,1,2,4,7,8)'.[12]



Example 8: Lyons, *Hex 2*, excerpt 1 from Section One



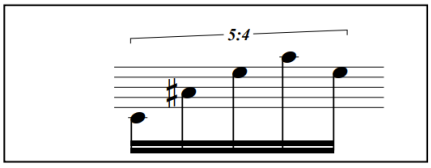
Example 9: Lyons, *Hex 2*, excerpt 2 from Section One

The first type of cell in Section 1 (the first page of notation) can be seen in Example 9. These long notes are accompanied by Lyons' instructions to add 'echo and volume

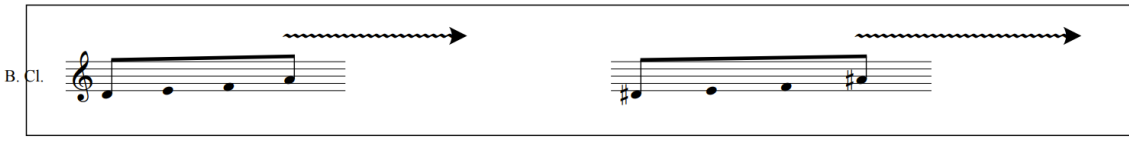
[10] Lyons, Frank, e-mail message to author, 13 December 2021.
[11] For full score, see page 231.
[12] Lyons, Frank, e-mail message to author, 13 December 2021.

swells', which are suggestions for the live processing. Example 8 shows the second type of cell, with groups of notes in repetitive patterns. These are marked with feathered beams, indicating that there should be an acceleration. Lyons rarely indicates articulation in the score. When I worked with him on the piece, I suggested that I could vary the articulation, with some groups slurred and others articulated with *staccato* or slap tonguing. Lyons was receptive to this idea; therefore, I have practiced it in different ways so that I can improvise the articulation in the moment.

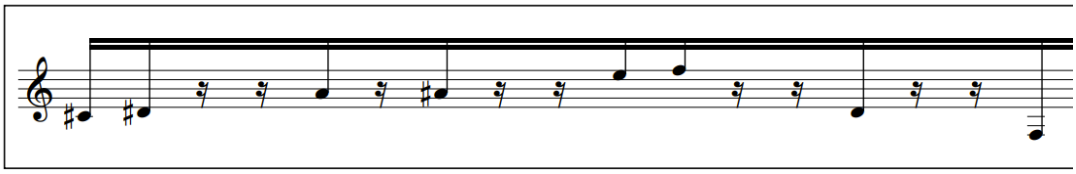
On the second page of the score, there are three different types of cells. The smallest ones only contain a quintuplet each (see Example 10), which contrast with the other much longer cells. Depending on what is happening in the soundtrack and the live processing, I approach the quintuplets in different ways. Sometimes I play the grouping quickly and at other times, I stretch it out. The second type of melodic fragment is a repeating four-note grouping; the arrows in Example 11 indicate that the four-note gesture should be repeated continuously until moving on to the next. The third type of cell has an erratic quality due to the unpredictable placement of rests between semiquavers (see Example 12).



Example 10: Lyons, *Hex 2*, excerpt 1 from Section Two

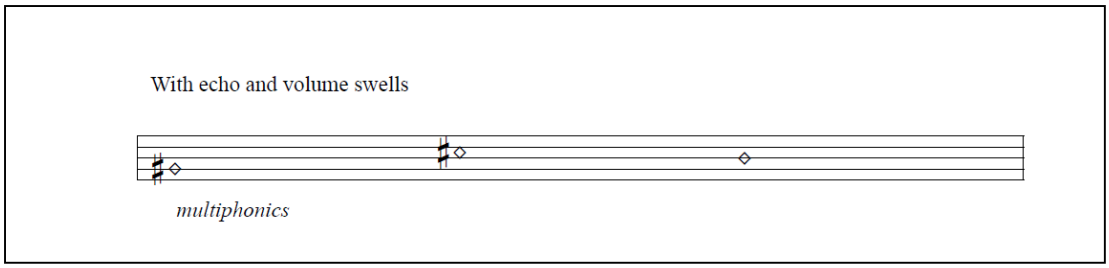


Example 11: Lyons, *Hex 2*, excerpt 2 from Section Two

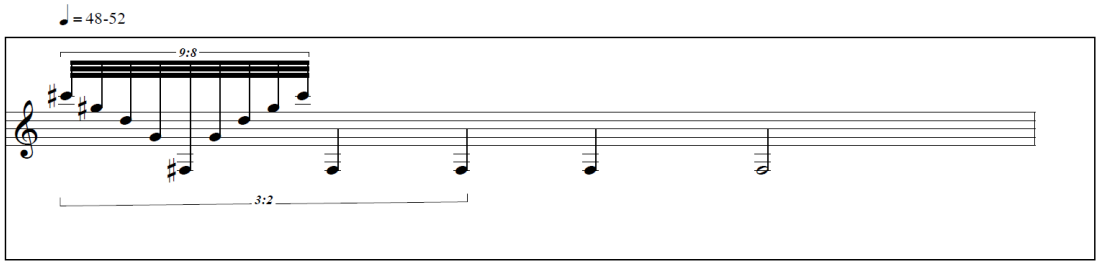


Example 12: Lyons, *Hex 2*, excerpt 3 from Section Two

Some of the multiphonics in Section Three were not possible in the registers that Lyons wrote in the score. Since the pitches in *Hex 2* are important, I did not want to change them. Instead, I moved some of the multiphonics down an octave, such as the cell shown in Example 13, so that they could be overblown. Again, the instructions to add 'echo and volume swells' are just suggestions for the live processing. The second type of cell on this page is an arpeggio-like gesture, followed by repeated notes (see Example 14).



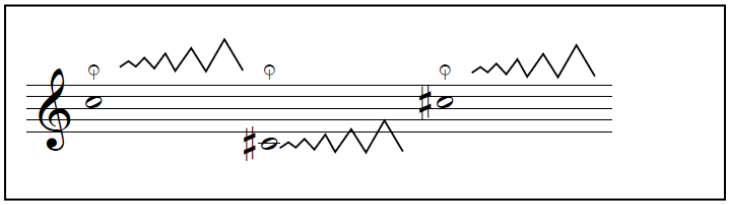
Example 13: Lyons, *Hex 2*, excerpt 1 from Section Three



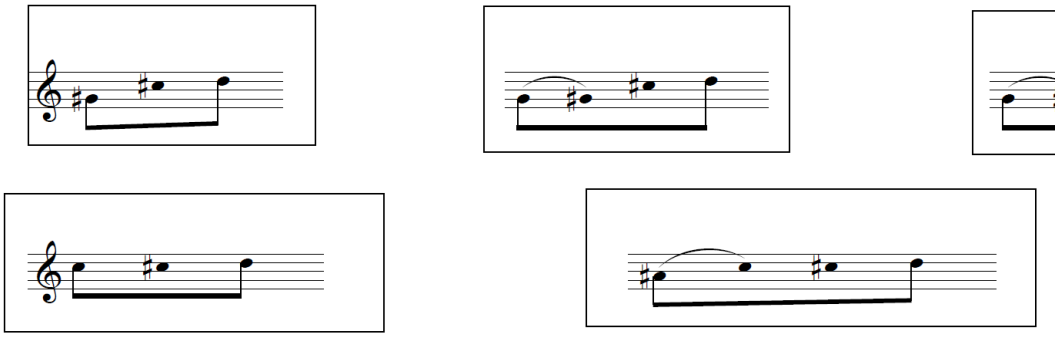
Example 14: Lyons, *Hex 2*, excerpt 2 from Section Three

On the fourth page, some of the cells include wide vibrato and slap tonguing, which evokes the sounds of an electric guitar's whammy bar (see Example 15). The note is initiated with a slap tongue and the vibrato should get wider and wilder as the note progresses. The rest of the cells are short and work best when they are repeated and followed by other cells without a break in between (see Example 16). Although Lyons

has marked ‘as fast as possible’ as a tempo direction, many of the cells move over the break, making it difficult to play them at top speed.[13]



Example 15: Lyons, *Hex 2*, excerpt 1 from Section Four

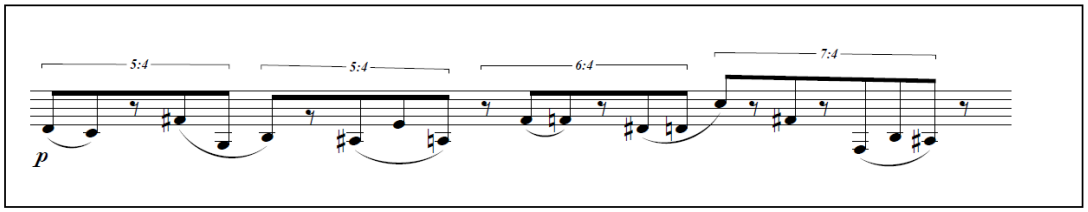


Example 16: Lyons, *Hex 2*, excerpt 2 from Section Four

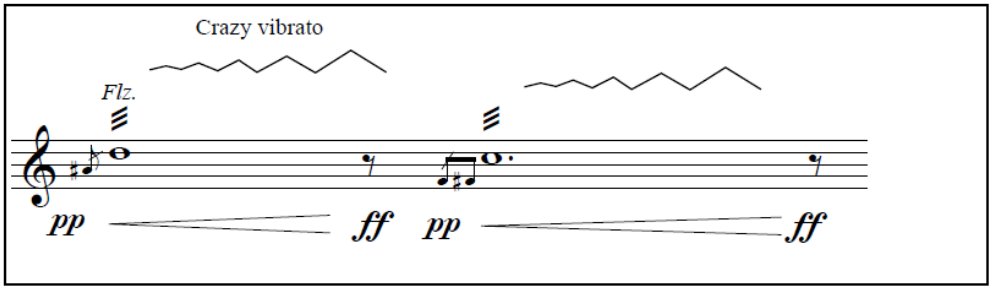
The first type of cell in Section Five contains groupings of four, fix, six, or seven notes. Generally, these groups start small and become progressively larger, generating a feeling of acceleration (see Example 17). The second kind of musical gesture combines grace notes, flutter tonguing, and ‘crazy vibrato’ (see Example 18).[14] Again this is evocative of the whammy bar on electric guitars.

[13] For full score, see page 231. On the clarinet and the bass clarinet, ‘over the break’ refers to the movement between the lower register (chalumeau) and the middle register (clarion). This can be a difficult manoeuvre at fast
speeds.

[14] For full score, see page 231.

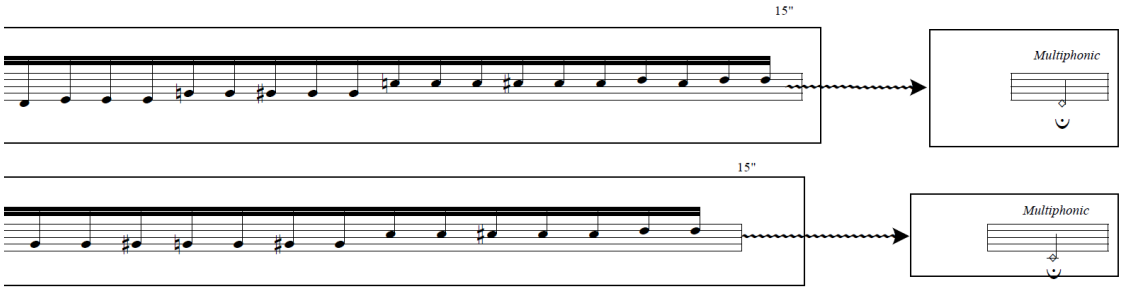


Example 17: Lyons, *Hex 2*, excerpt 1 from Section Five



Example 18: Lyons, *Hex 2*, excerpt 2 from Section Five

In the final section, the melodic fragments ascend quickly, with random repetitions of notes, sometimes indicating with an arrow to continue on to a multiphonic (see Example 19). Sometimes I play the multiphonics with a root note of C or D down an octave for variety.



Example 19: Lyons, *Hex 2*, excerpt from Section Six

Overall, each section of *Hex 2* contains a selection of melodic fragments that can be moved through freely. When I first approached the score, I followed the notation fairly literally. With time, I started to improvise more, including changing the rhythms, and repeating or omitting sections of a cell. This is much easier when I am practising with the

soundtrack and live processing because it is more interactive, and I find the electronics give me more musical ideas to play around with. With sparse details in the score, I tend to improvise dynamics and articulation, changing the character of each cell depending on what I hear coming out of the speakers.

2.6 Collaboration with Yue Song

My collaboration with Yue Song began just before the first COVID-19 lockdown in Ireland in March 2020 (see Figure 6).[15] Although it was not until mid-2021 that we were able to collaborate in person, Song composed five short works for bass clarinet and live electronics and we worked together to create the live processing.

At first, the pieces were just named by number; the first work was provisionally called *No. 1*, the second *No. 2*, and so forth. After working on the live processing, Song chose to re-title her compositions *Unstoppable Spirals, Above Dublin*, *Wandering Consciousness*, *Stories in the Wind*, and *Bamboo After Rain*.

[15] For more information about the composer, please visit Song's website: https://www.yuesongmusic.com/.

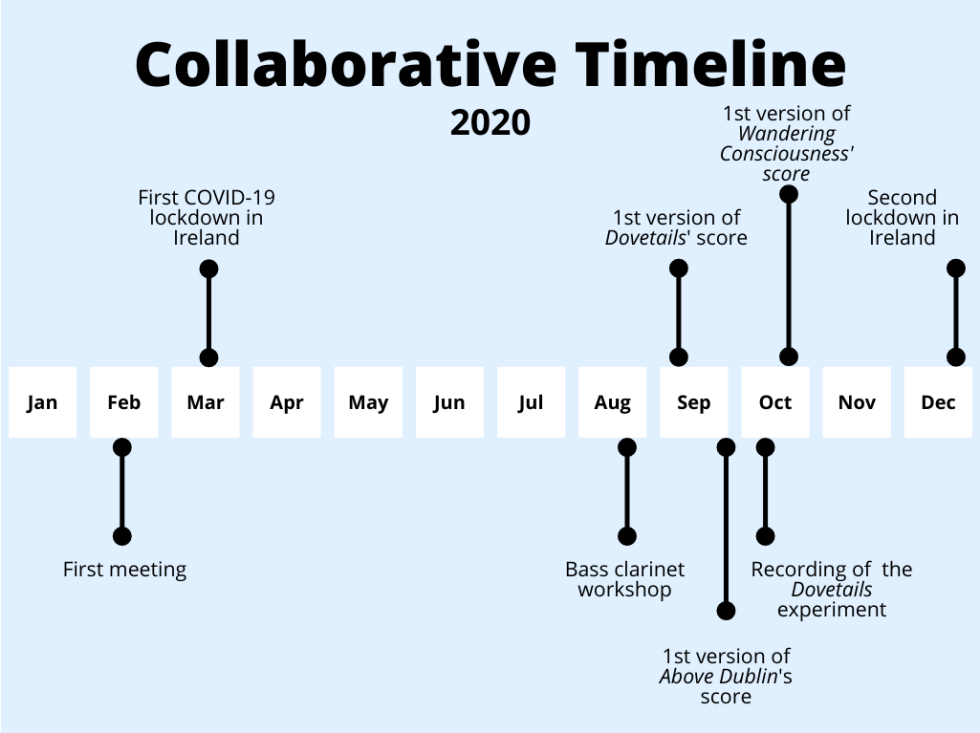


Figure 6: Collaborative Timeline with Yue Song, 2020

For all the works, Song composed the bass clarinet part before we added live processing. The following sections introduce each composition. For an in-depth analysis of our collaboration see Section 6.5.2.

2.6.1 *Dovetails* and *Unstoppable Spirals*

The first composition that Yue Song wrote for me has one bass clarinet part and two different versions of the live processing. I received the score in September 2020 (see Figure 6). We emailed back and forth about my progress learning it, with audio recordings for demonstrations, and Song revised it three times during this month. I performed the work without electronics at TU Dublin's composers' workshop, which took place over Zoom in October 2020.

Since we were not able to meet in person, I experimented with adding live processing to the bass clarinet part and recorded it. After listening to this recording, Song mixed and mastered the final version, which she entitled *Dovetails* (after the compositional

technique of the same name). *Dovetails* was never performed live, but the recording was broadcast on Kevin Free's radio programme, 'Oboes and Overtures', in Athlone on 31 January 2021.[16]

In October 2021, we returned to the score to re-visit the live processing (see Figure 7). Instead of tweaking the processing, Song decided it would be best to make a completely new version. I performed this at TU Dublin's Artistic Research Days in April 2022 under the title of *No. 1*, but Song has since renamed it *Unstoppable Spirals*.

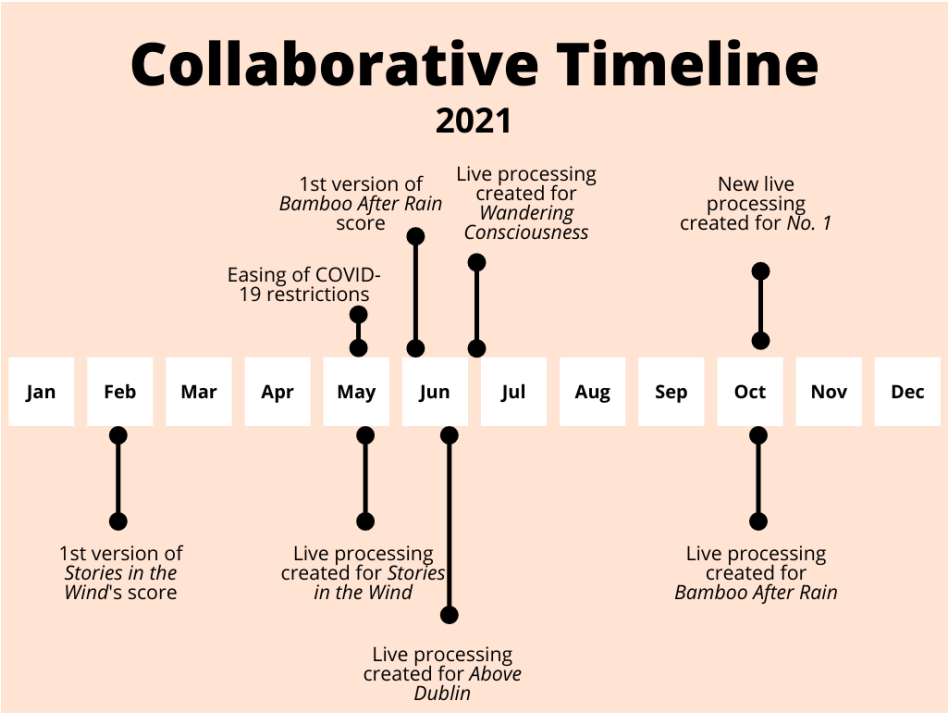


Figure 7: Collaborative Timeline with Yue Song, 2021

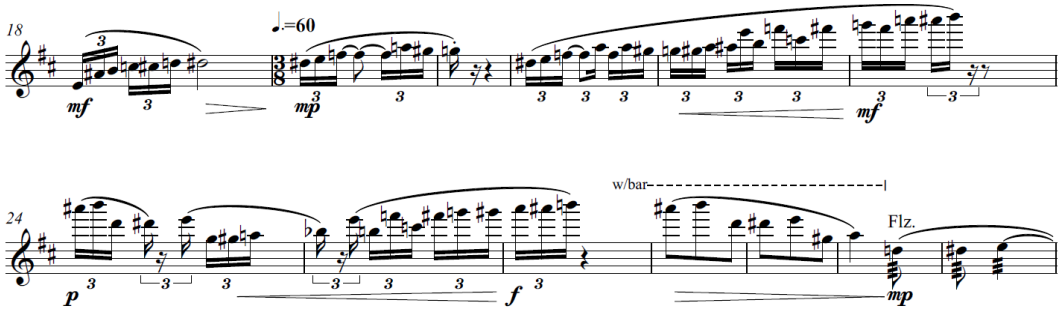
Unstoppable Spiral's bass clarinet part is idiomatic and showcases the strengths of the instrument.[17] In the short span of approximately three minutes, the performer takes the audience on a journey from the lowest note of the bass clarinet to the highest note that

[16] Song, Yue: 'Dovetails', *Oboes and Overtures*, Athlone Community Radio, Athlone, Ireland, 31 January 2021.
[17] For the full score, see page 237.

can be squeaked out, as is the instruction in bar 46. The dynamics are varied, ranging from a breathy *pianissimo* to *fortissimo* in the highest register.

The main pulse is often obscured by ties that are held over the main beats, creating an improvisatory feel. This can be seen in many places in the score such as bar 4, as well as bars 10–11. Another feature that contributes to the improvisatory feel is the presence of triplets and sextuplets, which can be found throughout the score.

Overall, the bass clarinet part is technically challenging, spanning the full range of the bass clarinet and incorporating some common extended techniques such as flutter tonguing and breathy sounds. Bar 19 is the start of a particularly difficult passage that pushes the limits of the upper register of the bass clarinet (see Example 20). I found myself inventing new fingerings to manage this section.



Example 20: Song, Unstoppable *Spirals*, 18–30

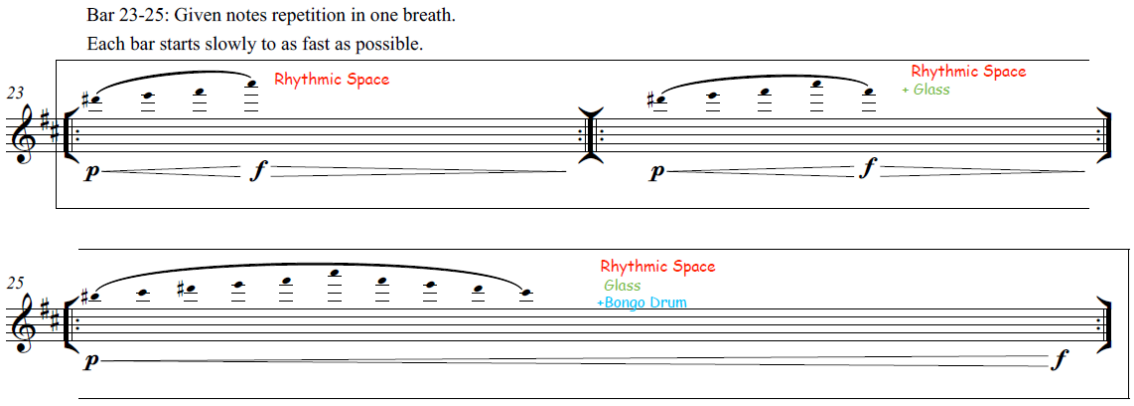
2.6.2 *Above Dublin*

I received the second bass clarinet part in September 2020 (see Figure 6). The title, *Above Dublin*, is inspired by the surrounding view of Dublin, which can be seen from the rooftop terrace of TU Dublin Grangegorman's new arts building, East Quad. Based on my suggestions and recordings, Song made revisions to *Above Dublin* in November 2020, but by the end of December 2020 Ireland was moving into another strict lockdown, so Song and I put our plans for adding electronics to her pieces on hold.

In May 2021, the restrictions from the COVID-19 pandemic started to lift in Ireland (see Figure 7). This allowed Song and I to meet at the university on a regular basis and in June, Song and I created the live processing setup for *Above Dublin.*

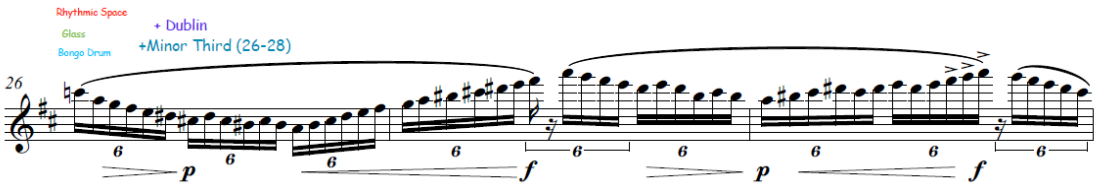
Above Dublin covers the full range of the bass clarinet, from C_2 (sounding $B♭_1$) to $C♯_6$ (sounding B_5).[18] Similar to *Unstoppable Spirals*, some of the notes were so high that I did not know their fingerings. I searched for bass clarinet *altissimo* fingerings online, but many of them were out of tune on my instrument so I ended up inventing my own.[19]

A feature that sets *Above Dublin* apart from the rest of the works in this series are the repeated bars starting in bars 23 and 35. In the first repeated section, starting in bar 23, there is a sense of growth as more notes are added to each bar (see Example 21). This eventually leads into bar 26, with a challenging flurry of notes (see Example 22). This is a good example of Song's virtuosic bass clarinet writing; although it may be a difficult line to learn, it is worthwhile to have the bass clarinet treated as a genuine solo instrument.



Example 21: Song, *Above Dublin*, 23–25

[18] For the full score, see page 240.
[19] The brand of my bass clarinet is Uebel.



Example 22: Song, *Above Dublin*, 26–28

The second repeated section, starting in bar 35, is lower in register (see Example 21). This time, there is a sense of diminution as each bar becomes shorter with fewer and fewer notes. The *accelerando* in bar 39 adds to the sense of urgency.

As slap tonguing is one of my favourite extended techniques, Song used it in several of her works. In *Above Dublin*, slap tonguing is used tastefully. In bar 13, the slap-tongued notes work well for generating emphasis. In bars 52–53, there are many more slap-tongued notes, creating more of a texture than an accent.

Rhythmically, *Above Dublin* is fairly straightforward and is similar to *Unstoppable Spirals* in that semi-quavers are often juxtaposed with triplets and sextuplets. The most difficult passages in *Above Dublin* are those that reach into the *altissimo* register, making it a good piece for developing familiarity with this register.

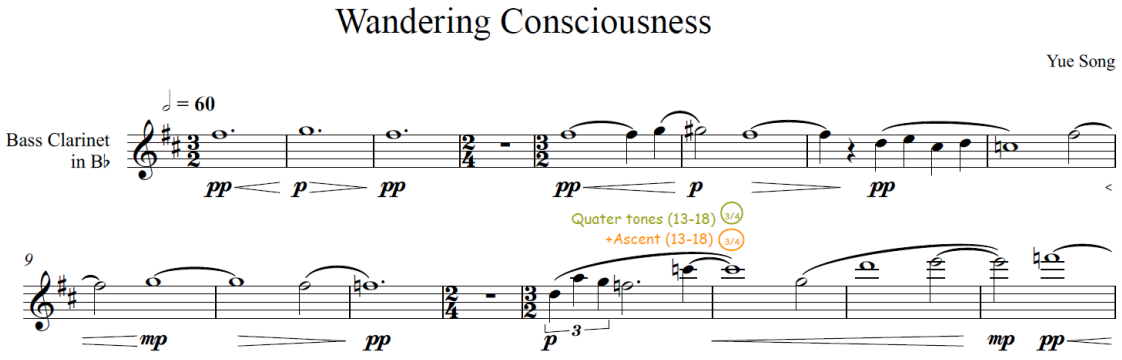
2.6.3 *Wandering Consciousness*

The first version of the score for *Wandering Consciousness* was completed in October 2020. After I worked on this piece for a while, Song made some corrections and then we developed the live processing in July 2021, a week after *Above Dublin* (see Figure 7).

Out of the five compositions, *Wandering Consciousness* is the least technically challenging.[20] There are more long notes than in any of the other works and the rhythms are straightforward (see Example 23). Although the range is from C♯₂ (sounding B₁) to

[20] For the full score, please see page 243.

C♯$_6$ (sounding B$_5$), most of the work centres around the mid-register. There is also minimal use of extended techniques, namely key clicks and multiphonics.



Example 23: Song, *Wandering Consciousness*, 1–16

Generally, the mood of *Wandering Consciousness* is calm and the dynamics are softer than in Song's other bass clarinet works. There is a jazzy undertone in some places, such as in bars 38 and 56, which encourages a dark and airy tone.

Wandering Consciousness provides a pleasant change of pace to Song's other works. Although I welcomed the challenges posed by *Unstoppable Spirals*, for example, it took much less time to learn *Wandering Consciousness*.

2.6.4 *Stories in the Wind*

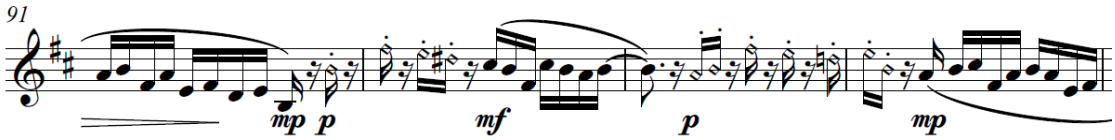
Song sent *Stories in the Wind* to me in February 2021 (see Figure 7). The first performance took place without electronics at TU Dublin's student composers' workshop in March 2021. She also sent me an updated score in April 2021, marked with ideas of what audio effects to use and where they could go in the score. Using this version of the score, I programmed the Live Set and Max for Live patch before we met in person in May 2021. Song then revised the score one last time after our meeting.

I was scheduled to perform *Stories in the Wind* with electronics at TU Dublin's student composers recording session in May 2021, but I encountered technical difficulties on the

day of the recording session. The recordings were made in-person at TU Dublin and broadcast over Zoom to the students. Unfortunately, I was not able to figure out why sound was not coming out of the speakers until after the session had ended. I stayed behind in the recital hall and recorded a performance of *Stories in the Wind* with the live processing but did not notice that the gain was very low on my recording device. I re-recorded *Stories in the Wind*, with video, on 4 June 2021.

At seven minutes long, *Stories in the Wind* is the longest of the five works, and possibly the most demanding.[21] The range spans from C♯$_2$ (sounding B$_1$) to C♯$_6$ (sounding B$_5$), but mostly focuses on the middle and high registers. Again, I had to get creative with fingerings, particularly for B$_5$ and C♯$_6$. The fingerings in this register can be extremely awkward so I tried to find ones for each particular situation, also keeping in mind tuning issues.

A prevalent characteristic of this work are the breathy notes, which are interspersed with regular ones (see Example 24). With a tempo marking of 100 beats per minute, switching between an airy and regular tone is difficult and requires a lot of careful, slow practice.

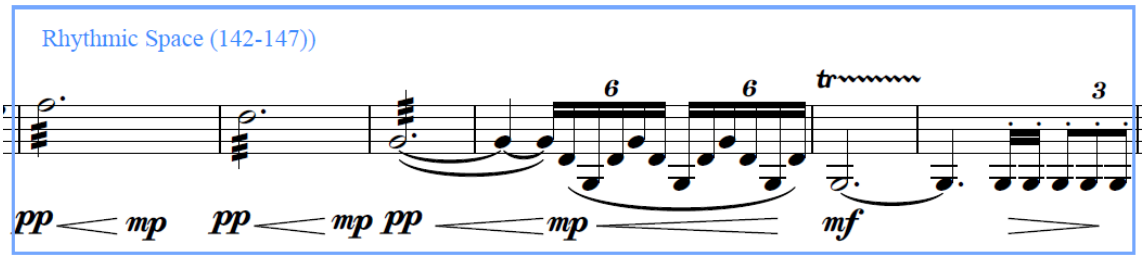


Example 24: Song, *Stories in the Wind*, 91–94

The *staccato* passages starting in bars 39 and 58 also pose challenges because high notes on the bass clarinet do not always speak quickly. I found myself developing a method of articulating, solely for this piece, which does not include using my tongue.

[21] For the full score, see page 246.

There are many extended techniques in *Stories in the Wind*, including multiphonics, a multiphonic tremolo, slap tonguing, and flutter tonguing. As always, Song employs them sparingly for colour or texture. An example of this is the flutter tonguing starting in bar 142 (see Example 25).



Example 25: Song, *Stories in the Wind*, 142–147

The first three works mainly contain *legato* phrases, with very little articulation. *Stories in the Wind* is the first in this series to explore a variety of articulations and to mix them in with shorter *legato* passages. This is a substantial work for the bass clarinet and captures many of its best features.

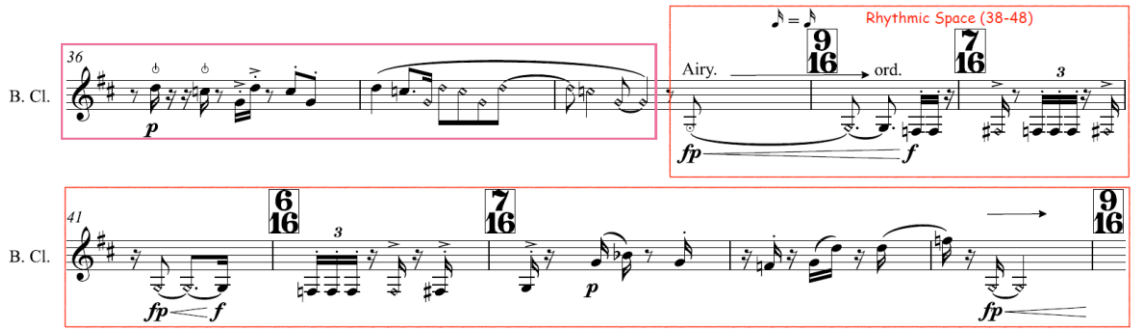
2.6.5 *Bamboo After Rain*

The original version of *Bamboo After Rain* was composed for Paul Roe, who was teaching a module on collaboration to Song and other postgraduate students at TU Dublin. I received the score in June 2021 and we worked on the live processing setup in October 2021 (see Figure 7).

Although the range of C_2 (sounding $B\flat_1$) to F_5 (sounding $E\flat_5$) is the smallest of all the works, I spent more time learning *Bamboo After Rain* than any of the other pieces.[22] The rhythms and time changes from bars 39 to 49 were the most difficult (see Example 26). Even at a slow tempo, metronome practice was hampered by the semi-quaver triplets,

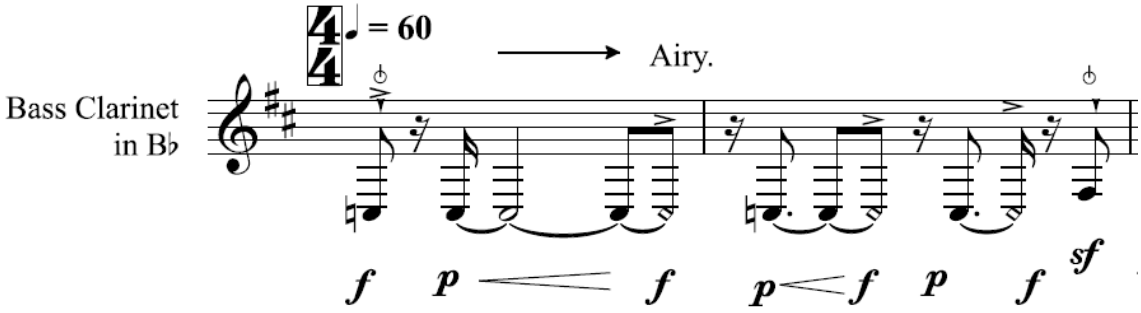
[22] For the full score, see page 251.

such as in bar 40. Eventually, I decided that the only way to perform this section up to the tempo of 100 beats per minute was to abandon my rhythmic perfectionism and listen for the groove.



Example 26: Song, *Bamboo After Rain*, 36–45

Song employs many extended techniques in *Bamboo After Rain*, including slap tonguing, multiphonic tremolos, flutter tonguing, and a multiphonic glissando. Many of these techniques are particularly effective when combined with the live processing. For example, the slap tonguing at the beginning, together with the Borg and Storm Delay audio effects, mimic the sounds of thunder (see Example 27).



Example 27: Song, *Bamboo After Rain*, 1–2

Bamboo After Rain shares many characteristics with the other four works, including the juxtaposition of semi-quavers against triplets and the sweeping *legato* phrases. The staccato articulations and breathy sounds that are interspersed throughout *Stories in the Wind* can also be found in *Bamboo After Rain*.

CHAPTER THREE: GESTURE-MAPPING—MOVEMENT AND SOUND

3.1 Introduction

This chapter will look inwards at my practice, focusing on the methods and aesthetics that I utilized while conceptualizing the use of sensors in performance, as well as various topics relating to physical movement and the human body.

I started this research in January 2018 with the aim of creating performances with live electronics. Since I had never used Max for Live or Ableton Live software before, I spent six months learning how to use them. I also researched different interactive technologies before purchasing the SABRe sensors and remote in July 2018 (see section 1.7). Following this, I proceeded to encounter my first significant obstacle. Now that I had the sensors in my hand, how did I want to use them? What could I do with them? What were my limitations?

The SABRe multi-sensor box contains four sensors that send data to the SABRe software: yaw, pitch, roll, and air pressure. The yaw, pitch, and roll sensors detect changes in rotation on the x, y, and z axes, therefore requiring physical movement to vary the numerical data that is sent to the computer. The air pressure sensor is similar; it outputs numerical data based on changes in air pressure, measured through a tube that is attached to the clarinet mouthpiece.

Initially, I was more interested in using the air pressure sensor, due to its novelty, but I found the yaw, pitch and roll sensors more engaging in practice because they necessitate physical movement. The challenge was deciding how to implement the yaw, pitch, and roll sensors because a connection needed to be programmed between physical movement and the resulting electronic sounds. In the field of human-computer

interaction, this is called gesture mapping, 'the connection between structures, or gestures and audible results in a musical performance or compositions'.[1]

3.2 Conceptualizing and Aesthetics

Before I began programming in Max for Live, I needed to develop a concept as to how I would physically use the sensors in performance. The main question confronting me was, *how would my movements be creating or affecting the electronic sounds?* Developing a concept was a complex process of creating some sort of mental structure or method and was an important stage in my artistic process. By considering many different ideas and moulding them into a mental framework, I developed a personal aesthetic that guided many of the decisions that I made at later stages.

The main methods I used to conceptualize were journaling and visualization (see section 1.5). An excerpt from my journal shows an early attempt at conceptualizing:

> Since the sensors output numbers, anything I wish to do creatively has to [be] translated into a numerical operation. This is a big adjustment for me because I have to completely adjust my language and conceptual outlook on creativity […]
>
> 1. I can control dials, sliders, and other movable objects with numbers
> 2. I may be able to move 3D visual objects around using the xyz-axes
> 3. I should be able to use the air pressure sensor (and the other sensors) to control certain parameters like colour
> 4. I could use the output numbers in an equation to generate something random and potentially interesting
>
> But the real question is, what do I really want to use the sensors for creatively? How do I want to use them to expand my practice and add dimension to my performance?[2]

This journal entry reveals how I was toggling between thinking technically and artistically. I wrote about the sensor data and listed programming ideas, but then quickly

[1] Christopoulos, Charalampos: 'From Gesture to Sound: A study for a musical interface using gesture following techniques' (MSc diss., Universitat Pompeu Fabra: 2014), 3–5.
[2] Reflective Journal Entry, 30 August 2018.

questioned how the sensors would make an artistic impact in performance (see section 4.4).

Another important method of conceptualization was to imagine the kind of interaction I wanted with the electronic sounds. Below is an example of a key moment during one of my visualizations:

> I close my eyes and try to visualize performing. The switch between real and imagined is not always easy, so I think of some questions to prompt me into the imagined space. How do I want my movements to affect the electronic processing? Do I want to be able to make specific events happen? With these questions in mind, I imagine myself on stage. I pick up my bass clarinet and start performing the way I normally would. I notice that the electronics seem to be part of my environment, like birds singing in the trees or the wind whistling through the leaves. I am not making the sounds happen. They are responding to me and the entire space around me.
>
> I open my eyes, realizing what had just occurred to me. It seems clear to me now. I do not want to be fully in control of the electronics. I want to be able to perform naturally and spontaneously and have the electronics respond in their own way. The sensors are an opportunity to hear my environment from different angles; I can choose to switch between each angle to explore my environment. I open up my laptop, ready to start experimenting with the programming in Max for Live.[3]

The act of visualizing was an embodied process valuable for focusing on what I was trying to achieve, without the distraction of my immediate surroundings. It also aided me in determining the type of interaction I wanted to have with the electronics.

3.2.1 Interactivity

My search for greater interactivity with electronics has been at the forefront of my research process and has been strongly influenced by my past experience performing with fixed electronics (see section 1.3). In one of my journal entries, I reflected on the differences between performing with fixed electronics and live electronics and came up with the following analogy:

> Playing with a fixed track is like being a ghost in an environment that reacts in the same way with each performance. After practicing with the track long

[3] Reflective Journal Entry, 19 November 2018.

> enough, it is easy to know when to jump out of the way of the environment or when there is space to (step out) and perform.
>
> With live processing, the environment is created by the same material each performance, but the things that make up the environment are created in real-time by the performer. Instead of being a ghost in the environment, the performer is an artist creating the scenery, the objects, and the backdrop. If the performer suddenly stops, the environment won't continue to be created. (If the performer stops during a fixed track work, the environment won't stop, it will continue on its merry way without even noticing.[4]

This extract from my journal hints at the two interconnected aspects of interactivity that I wanted to achieve with the SABRe sensors, namely control and response. I wanted to feel in control of the sensors so that I could influence the live processing and I wanted to receive a response from the live processing that reacted to what I had just played.

Interactive music technology needs to be able to receive information from the performer and have the ability to respond. Response is crucial to the concept of interactivity and is one of the main reasons I wanted to work with interactive music technology. Even though this extract from my reflective journal is in reference to improvisation, it provides insight into what I enjoy about interactivity:

> I find it easier to have a second voice in improvisation, someone or something to bounce ideas off of and to create a musical dialogue with. I enjoy the interaction because it is more engaging for me as a performer.[5]

What I like about interactivity is what Aaron Smuts calls the *relevance* of a response; for example, 'we interact in a conversation when we say something and another person responds with a relevant question, comment, criticism, or elaboration.'[6] Live processing creates the feeling of a musical dialogue because it responds to what is being played in real time.

My setup, consisting of a laptop and the SABRe sensors and remote, allows different levels of interactivity. In her thesis on interactive electronic vocal compositions,

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[4] Reflective Journal Entry, 28 September 2020.
[5] Reflective Journal Entry, 01 October 2019.
[6] Smuts, Aaron: 'What Is Interactivity?', *The Journal of Aesthetic Education*, 43/4 (2009), 63.

Julieanne Klein describes three levels of interaction. The SABRe sensors and remote enable the performer to achieve what Klein describes as the first level of interaction, where 'the performer only controls one element, such as the triggering of sound files or establishing tempi'.[7] I used the sensors and the remote to trigger different programming settings. This low-level kind of interaction allowed me to have precise control over the timing of the live electronics.

The ability of the SABRe sensors to 'hear' the performer takes interaction to another level. The various sensors 'listen' to the movements of the bass clarinet and measure air pressure in the mouthpiece and then the programming patch sets the parameters of how the live electronics will respond to variations in movement and pressure. This fits with Klein's description of the second level of interaction, where 'the computer listens and *responds* in real time to the performer in a quasi-intelligent interpretation of the performer's input'.[8]

The result of Klein's 'second level of interaction' is that 'the sound and even structure of the composition can change dramatically from performance to performance, as the work is subjected to a vast array of interpretive decisions made by the performer'.[9] This may also be what Andrew Johnston et al. described as 'ornamental interaction' where 'musicians use a virtual instrument as an "ornament" […] surrender[ing] detailed control of the generated sound and visuals to the computer'.[10]

Klein's third level of interaction 'is based on properties of improvisation'. At this level, the score is non-existent 'while the computer "responds" intelligently in accordance'.[11]

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[7] Klein, Julieanne: 'Live and Interactive Electronic Vocal Compositions: Trends and techniques for the art of performance' (DMus diss., McGill University: 2007), 24.
[8] Klein, 'Live and Interactive', 25.
[9] Klein, 25.
[10] Johnston, Andrew, Linda Candy, and Ernest Edmonds: Designing and Evaluating Virtual Musical Instruments: Facilitating conversational user interaction', *Design Studies*, 29/6 (2008), 566.
[11] Klein, Julieanne: 'Live and Interactive Electronic Vocal Compositions', 25.

This level of interactivity is more complex. Robert Rowe describes interactive improvisation as 'the greatest challenge for machine musicianship' where the 'machine must contribute a convincing musical voice in a completely unstructured and unpredictable environment'.[12] Third-level interaction, such as artificial intelligence, is beyond the scope of this project.

Second level interaction has an indeterminate quality, requiring both composers and performers to surrender a certain degree of control. As stated earlier, I wanted to have some control over the SABRe sensors, but only to a certain extent. I enjoy performing compositions that allow for substantial variability from performance to performance.

> Performing can be reproducible and predictable to a certain extent, but why should it be? What is exciting about that? From my experience, performance is much more powerful and interesting when there are elements of VUCA: volatility, uncertainty, complexity, and ambiguity. Not knowing how a performance will go and how exactly it will be shaped is part of the performer's challenge.[13]

One of the reasons I was drawn to performing with live processing is because the results are never exactly the same. Composer Todd Winkler describes both the benefits and drawbacks of indeterminacy:

> Composers interested in process, relationships, action, and dialogue may prefer highly indeterminate actions that are improvisational or based on processes where the specific outcome is unknown. The outcome may vary from completely surprising results to a range of known possibilities. Compared to predetermined actions, indeterminate actions tend to be more spontaneous, expressive, and interactive. They also can be more difficult to implement, harder to control, and less reliable.[14]

As Winkler points out, the more indeterminate a work becomes, the harder it is to control the results. In this sense, I was pulled in two different directions. I wanted to be able to control some aspects of the live processing, but I also wanted to be surprised by the electronic sounds.

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[12] Rowe, Robert: *Machine Musicianship* (Cambridge, MA: MIT Press, 2001), 277.
[13] Reflective Journal Entry, 16 November 2019.
[14] Winkler, Todd: Composing Interactive Music: Techniques and ideas using Max, (Cambridge, MA: MIT Press, 1998), 29.

The balance between control and variability is something that was at the forefront of my mind while I was creating the live processing patches. The concept of malleability helped me to develop a structure for the live processing that allowed room for variability, but also left me in control of the electronics. When something is malleable, it has a structure that is pliable and can be re-shaped without breaking. The following journal entry is an example of my developing thoughts on malleability:

> I am picturing some sort of interface that is like a building. The outer structure of the building is defined, but the material is not. The inner structure is loosely defined, but the furniture is not. Now that I think of it, I am also picturing a building that can be de-constructed and re-built like Lego blocks. A kind of interface where things function separately but can be combined into something bigger. Something where I can add and remove sections of the interface without the whole thing collapsing. [15]

Ultimately, the conceptual framework that I developed for programming the sensors was to allow control over the electronics, with elements of indeterminacy.

3.2.2 Expansion

Not only does live processing allow for variability from performance to performance, but it also opens up a whole new world of sounds. My interest in electronic sounds was influenced by many contemporary works that encourage the performer to adopt an expanded soundworld with extended techniques such as slap tonguing, flutter tonguing, and multiphonics. These techniques are standard in contemporary music culture and they expand the sound palette of composers and performers alike; for example, slap tonguing creates sounds such as string *pizzicato* or a variety of percussive sounds.

Working with music software, such as Max for Live, permits composers and performers to go even further and expand beyond the capabilities of mechanical instruments, with the addition of electronic timbres, textures, and layers. This expansiveness is possible

[15] Reflective Journal Entry, 01 March 2018.

with both fixed and live electronics; however, with live electronics, performers have greater influence over the electronic sounds that are produced.

Composer Jonathan Harvey describes the expansiveness of live electronics as such:

> With live electronics…two worlds are brought together in a theatre of transformations. No-one listening knows exactly what is instrumental and what is electronic any more… When they lack their connection to the familiar instrumental world electronics can be inadmissibly alien, other, inhuman, dismissable (like the notion of flying in a rational world). When electronics are seamlessly connected to the physical, solid instrumental world an expansion of the admissible takes place, and the 'mad' world is made to belong.[16]

I was interested in integrating the electronic and clarinet sounds so that the electronics became an extension of my instrument. Since all the bass clarinet parts were composed before the live processing was developed, it was important to become familiar with the bass clarinet sounds first. My aim was to create electronic timbres and textures that would not only stimulate my imagination and provide a layer to play from, but also ones into which I could blend.

3.2.3 Integration

> My research problem is that as a performer, I feel disconnected from digital music technology in performance. […] I often wonder, in performance and as an audience member, what the technology is actually adding to the performance, and if it is even taking away from the performance.[17]

My experience watching other performers use technology was one of the catalysts for this research. One performance in particular stands out. I vividly remember attending a semi-improvised concert in which the performer played bass clarinet with live electronics. Unfortunately, the performer spent half of the evening turned away from the audience, twirling knobs and pushing buttons on their controller. To manipulate the electronics, the performer stopped playing the clarinet and turned to the side of the stage, unintentionally closing off their body language to the audience. The magic of the

[16] Harvey, Jonathan: 'The Metaphysics of Live Electronics', *Contemporary Music Review*, 18/3 (1999), 80.
[17] Reflective Journal Entry, 28 August 2019.

electronic sounds vanished every time I was distracted by the performer's closed-off body language. After the concert ended, I questioned how technology could be better integrated into music performance so that the performer does not inadvertently create a barrier between themself and the audience.

The term *integration* describes the result of combining 'separate parts or elements […] into an integral whole'.[18] When performing with electronics, I believe it is essential to integrate the electronics into the performance environment as much as possible. Percussionist Matthew Jordan has a similar view and writes in his doctoral thesis that the integration of 'acoustic and electronic elements' when performing live with electronics is of 'the utmost importance'. He provides some general guidelines to assist with this process:

> First, ensure that the aesthetics of the stage are suitable for a performance environment. Cables should be dressed appropriately and care should be taken to make the computers and technology appear as inconspicuous as possible to give the audience the impression that it will be a musical performance and not a computer exhibition'.[19]

I also strive to minimize clutter in the performance environment to remove any unnecessary visual distractions, but I have discovered that sometimes the tidiness of the performance space is out of my control. Oftentimes there is not enough time before a performance to worry about the appearance of the cords. When I perform at TU Dublin, I am usually the one setting up the performance space, including the speakers. This can take up to thirty minutes. Performance spaces are frequently booked so there does not tend to be too much time for setting up. If I am performing outside of TU Dublin, there is usually someone else who is responsible for setting up the speakers and cables.

Another factor to consider is the amount of contact the performer needs to have with their device(s) before the performance begins. It would be ideal to not press any keys on

[18] "integration, n." *OED* Online, (Oxford University Press, 2019).
[19] Jordan, Matthew G.: 'Performing Live with Electronics: A percussionist's guide to the performance practice of electroacoustic percussion music' (DMus diss., Florida State University: 2018), 9–10.

the laptop once the performance has started so that the performer and the audience are not distracted by the technology. Other performers have also tried to reduce these actions. Violinist Mari Kimura explains that she 'wanted to appear to use the computer as seamlessly as possible on stage' by 'minimising the numbers of keys on the computer' that need to be pressed 'in front of the audience before the performance starts'.[20]

Using the SABRe sensors does require some key pressing before performance. The sensor direction needs to be set before each performance. It is best to have a second person to set the direction while the performer holds their clarinet or bass clarinet in a neutral position because it is difficult to set the direction properly while holding an instrument. Even leaning slightly forward to reach the laptop can set the direction of the sensors incorrectly. I hope that future versions of the SABRe software will allow the performer to set the playing direction simply by using the SABRe remote.

The last point on integration is to consider how the electronic sounds can be integrated with the bass clarinet part and the performer's movements. In December 2018, at the end of my first year of research, I presented a lecture recital on my research process. One of the questions I was trying to answer was, 'what is the relationship between physical movements and sound in performance, and is this relationship an important consideration when integrating sensor technology into music performance?' At this point, I was only starting to realize how important the integration of movement and sound is for sensor-based performance.

3.3 Movement and The Body

> Originally, I was seeking integration of technology into my practice. What I didn't foresee was that this would actually influence me to start considering my practice as one where the body and mind are connected and integrated. No matter the biological/neuroscientific knowledge of the mind-body relationship, my previous practice did not include consideration of the body

[20] Kimura, Mari: 'Creative Process and Performance Practice of Interactive Computer Music: A performer's tale', *Organised Sound*, 8/3 (2003), 289.

> in more than a mechanical role (purpose of controlling the instrument). But when physical movement changes non-clarinet sounds (electronic processing) the body becomes more noticeable (from performer's perspective). This leads to an increased self-awareness and an internal debate over planning movements to get a certain type of processing or to move naturally and embrace the indeterminacy of the electronics.[21]

I knew that I would have to programme the sensor data so that particular movements would either control or manipulate the live electronics; however, I did not want these movements to appear arbitrary. In other words, I wanted to integrate my physical movements with the resulting electronic sounds to avoid a 'magic show' of effects. An example of a 'magic show' would be if a performer intentionally moved the clarinet in a variety of different directions to trigger various sound effects, without having thought through how their movements would be perceived. A show of effects such as this demonstrates what the technology can do, but not what the performer is capable of.

I began an exploration of my own physical movement while playing the bass clarinet, without the sensors. I recorded myself practising excerpts from *Stung* over a two-month period (October and November 2018) using my smartphone. In one recording, I explored making intentional movements while only playing a single note. In other videos, I experimented with using adjectives as a prompt for a particular passage that I was recording. I wanted to see if there was a physical difference between performing a passage in a clear, sharp, or aggressive manner. In another video, I tried to experience words such as 'excited' and 'surprised' through my body and then contrasted it with a recording where I had no expressive intentions.

While watching these videos back, I noticed how I altered my physical movements depending on my expressive intentions. I discovered that making different kinds of movements completely changed the way I perceived my own performance. There were times when I was shocked that the way I felt while performing did not match how I actually looked when watching the video back. For example, I experimented by filming

[21] Reflective Journal Entry, 06 January 2021.

myself using gestures that were exaggerated. An entry from my reflective journal recounts the events from this day:

> The videos Paul [Roe] took of me in our supervision session will be the most vital as they show my complete lack of movement while playing clarinet. We then took [another] video (as an experiment) to see what it would be like if I did use big movements. My reaction to watching these videos was that there was something engaging and different about the use of exaggerated movements. There was a change in expression and as viewers, Paul and I both agreed that the difference was striking.[22]

At the time of creating these big movements, I felt awkward and a bit ridiculous. After watching the recording back, I was surprised that it did not look awkward or ridiculous. This was a seminal moment because I suddenly realized that I could expand my range of movement beyond what I was accustomed to.

Overall, watching videos of myself playing, while specifically focusing on my physical presence, enabled me to become more aware of my body in performance. I observed that I do not always coordinate physical movements with musical passages. Even though I could not see how I looked while playing, I started to feel and hear that the movements did not correspond with the sounds in the way that I intended. In some videos, I repeated sections when I was not happy with the result before watching them back. During this time, I became acutely aware of how the mind and body affect each other and explored areas of research related to the mind-body relationship.

3.3.1 The Mind-body Relationship

Until recently, the mind has been highly favoured over the body in what has been termed *mind-body dualism*. This Cartesian model of thinking about the mind and the body was the outcome of René Descartes' philosophical work. Descartes theorised that the mind and the body are completely separate and 'can exist independent of one another'. He also believed that although the mind and the body are separate, they are able to interact

[22] Reflective Journal Entry, 24 October 2018.

and therefore can influence one another; however, it was his view that 'the mind is superior to the body in this interaction'.[23]

Émile Jaques-Dalcroze, a forward-thinking music pedagogue of the early twentieth century, devised the principle that 'the body is an inseparable ally of the mind' and the 'body and mind should harmoniously perform their divers functions, not only separately but simultaneously'.[24] Jaques-Dalcroze was interested in the mind-body relationship in a holistic sense. Marja-Leena Juntenen and Heidi Westerlund explain that '[i]n Dalcroze exercises the senses, body, mind, emotions and music fuse into one experience'.[25]

Unfortunately, the Cartesian mode of thinking has shaped how performance has been studied in the Western classical music world. Marja-Leena Juntenen and Heidi Westerlund critique the Cartesian model of thinking about music, writing that '[w]ithin the Cartesian frame, music appears as permanent ideational structures to be known (cognised) rather than something to be done, felt or experienced'.[26] This means that music research has long centralized on the score, prioritizing research that focuses on the mind and leading to a neglect of the body. This is explained further by Mine Doğantan-Dack in a chapter on the role of gesture in piano performance:

> the activities of *thinking* and *knowing* have been predominantly conceived as taking place in a disembodied mind, and essentially through rational-discursive processes [...] Because of their evident connection with the body, *affective* phenomena – including feelings, emotions, and moods – remained at the periphery of this epistemological landscape.[27]

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[23] Mohammed, Akomolafe Akinola: 'A Critique of Descartes' Mind-Body Dualism', *Kritike*, 6/1 (2012), 100.

[24] Jaques-Dalcroze, Émil: *Eurhythmics, Art and Education*, trans. Fred Rothwell (New York: Arno Press, 1930/1985), 108, in Juntenen, Marja-Leena and Heidi Westerlund: 'Digging Dalcroze, or, Dissolving the Mind–Body Dualism: Philosophical and practical remarks on the musical body in action', *Music Education Research*, 3/2 (2001), 208.

[25] Juntenen, Marja-Leena and Heidi Westerlund: 'Digging Dalcroze, or, Dissolving the Mind–Body Dualism', 210.

[26] Juntenen and Westerlund, 'Digging Dalcroze', 205.

[27] Doğantan-Dack, Mine: 'In the Beginning was Gesture: Piano touch and the phenomenology of the performing body', in *New Perspectives on Music and Gesture* ed. by Anthony Gritten and Elaine King, (Farnham, England: Ashgate, 2011), 243.

From my own experience as a student of classical music, particularly as an undergraduate, the Cartesian model of thinking was dominant, with most performance classes focused on the interpretation of scores or on the body in terms of developing technique (see section 6.3). Affective phenomena were rarely addressed, the exception being some chamber music and large ensembles classes.

Despite my undergraduate education taking place in the 2010s, research into affective phenomena was moving along by the 1970s. This research began 'providing useful theories relating to how embodied thoughts and actions allow us to know and understand the world in which we inhabit through artistic performance activities like music and dance'.[28] Jane Davidson and Mary Broughton examine the body's role in performance:

> The musician's body is not just the tool for producing exquisite musical sound. The performer's musical thoughts and feelings are embodied in a holistic sense; transformed into a multimodal display in order to express and communicate with others. Thus, the body is crucial to several processes in the task of solo performance: thought, feeling, production, and communication, regardless of the particular intricacies of the instrument or voice.[29]

In a chapter on musical gestures, music researcher Alexander Jensenius states that 'concepts' such as embodiment are central to the understanding of 'complex processes such as action and perception, and the interaction of mind and physical environment'.[30] This interaction between the mental and physical environment has become a focal point in my research.

Previously, I would have relied heavily on cognitive processes to prepare performances, focusing only on my body for the technical aspects of clarinet playing. Although

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[28] Davidson, Jane W. and Mary C. Broughton: 'Bodily Mediated Coordination, Collaboration, and Communication in Music Performance', in *The Oxford Handbook of Music Psychology*, 2nd edn. ed. by Susan Hallam, Ian Cross, and Michael Thaut (Oxford, England: Oxford University Press, 2016), 573.
[29] Davidson and Broughton, 'Bodily Mediated Coordination', 575.
[30] Jensenius, Alexander Refsum, Marcelo M. Wanderley, Rolf Inge Godøy, and Marc Leman: 'Musical Gestures: Concepts and methods in research' in R. Godøy & M. Leman (Eds.), *Musical Gestures: Sound, movement, and meaning*, (New York, NY: Routledge, 2010), 12.

embodiment is a concept that I have been aware of for several years, it was the process of connecting my physical reality to the resulting electronic sounds that has necessitated an exploration into the relationship between my body and mind. The following excerpt from my journal shows the difficulties I encountered as I tried to understand this relationship:

> I am having trouble figuring out where to start programming movements/processing for *Stung*. […] What is left to figure out is how movement will play a role in this piece because that element was not crucial to the first version of the piece.
>
> […] Movements are necessary for controlling the processing to some degree. […] What gestures might I make? What meaning might my movements communicate?[31]

3.3.2 Gesture

In the field of neuroscience, *gesture* is loosely defined as 'a physical movement that is not mechanically effective, and […] should incorporate a measure of the signaller's intention to communicate';[32] therefore, gesture exists in the physical world as a movement, but also contains information about intention that is generated in the mental environment. A similar definition is provided by Jensenius in a chapter on gestures in musical contexts. He defines gesture in performance as 'body movements that evoke meaning' thus 'build[ing] a bridge between movement and meaning'.[33] Gesture can be seen as the connection between the mental and physical environments of living beings.[34]

Oftentimes, musical passages can be referred to as gestures. To avoid confusion, I will refer to all audible gestures in this thesis as *musical gestures* and all physical gestures as *gestures*.

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[31] Reflective Journal Entry, 10 January 2019.
[32] Hobaiter, Catherine and Richard W. Byrne: 'What is a gesture? A meaning-based approach to defining gestural repertoires', *Neuroscience and Biobehavioral Reviews*, 82 (2017), 4.
[33] Jensenius et al., 'Musical Gestures', 12.
[34] Jensenius et al., 13.

Movement exists and is perceived in the physical environment. Movement can be described as the displacement of an object from one location to another, without any intended communicative meaning. For instance, if I pick up my clarinet, this is a movement. The action of breathing before starting a piece of music is a movement. Taking a bow at the beginning or end of a piece, however, is a gesture because it has the attached communicative meaning of respect—thanking the audience for their time and attention.

The connection between sound and movement is present in any musical genre and style since movement is necessary for sound production, even the simple push of a button to start a track. The push and release of keys on my bass clarinet are movements with the intention of controlling my instrument; however, the intention behind movement can vary greatly. In their article 'Music and Movement', Laura Bishop and Werner Goebl draw attention to the variety of functions movements have such as producing sound, communicating (expression or intention, for example), or technical to shape sound qualities.[35]

Three of the sensors that I am using require what Jensenius calls *control gestures*. These gestures 'work as elements of a system such as in the control of computational and interactive systems'.[36] Control gestures are essentially the same as what Bishop and Goebl call 'sound-producing gestures' which are 'directly involved in producing or modifying sounded tones'.[37] These so-called gestures fit better into the category of 'movement' since they are not meaningful in the way that other movements are.

[35] Bishop, Laura and Werner Goebl, 'Music and Movement: Musical instruments and performers', in *The Routledge Companion to Music Cognition* ed. by Richard Ashley and Renee Timmers, (New York: Routledge, 2017), 349.
[36] Jensenius et al., 'Musical Gestures', 14.
[37] Bishop and Goebl, 'Music and Movement', 351.

Movements rendered by moving the clarinet (and by extension, the SABRe sensor box) produce or modify sounds in Live on the computer. Through practice with these sensors and observations of others using them, it has become clear that the sound-producing movements that control live electronics are not meaningful on their own and should be used carefully.

3.3.3 Meaning

In the Oxford Dictionary, meaning is defined as 'implied or explicit significance'.[38] To *mean* something is to attempt to communicate something of value and it implies that there is a degree of cognitive intention. In their studies of primate gestures, Catherine Hobaiter and Richard Byrne use the word *meaning* in reference to 'many systems of animal communication' that 'involve the transfer of detailed information'. They use the example of 'primate alarm calls' which 'may encode not only a type of predator, but also the level of risk'.[39]

In a musical context, meaning is defined by Jensenius as 'the mental activation of experience' and it exists in the mental environment, rather than in the physical environment.[40] It is worth considering Jensenius' definition with the aid of an analogy. If a pianist performs a piece that moves some of the audience to tears, it is possible that these audience members might shed tears without thinking about the sadness they are experiencing. They may physically feel the sadness of the piece, but they may not actively think about the emotion *sadness*. With Jensenius' definition, meaning is only assigned to an experience when the mind is involved.

To further support Jensenius' definition that meaning is only created by the mind, I will use Leonard Meyer's argument that meaning is 'not a property of things'.[41] This means

[38] Oxford Dictionary of English, under the entry for *Meaning* (noun).
[39] Hobaiter and Byrne, 'What is a Gesture?', 4.
[40] Jensenius et al., 'Musical Gestures', 13.
[41] Meyer, Leonard B.: *Emotion and Meaning in Music* (Chicago, IL: University of Chicago Press, 1956), 34.

that meaning does not physically belong to anything. As an example, Meyer explains that a stimulus like a large rock may have different meanings to different people. He gives the example of a geologist, a farmer and a sculptor all looking at a large rock and creating different meanings based on their own lived experiences. The geologist sees the recession of a past glacier, the farmer sees 'the necessity of having the field cleared for plowing', and the sculptor sees 'the possibility of artistic creation'. By itself, he argues, the rock is meaningless.[42] In this example, meaning is not communicated through gesture, but it is created in the mind of each person as they observe the rock.

If we compare Hobaiter and Byrne's definition with Jensenius', then the main similarity is that meaning is developed by the mind and one of the ways it is communicated in the physical world is through gesture. Although meaning is derived in our minds, the way it is communicated is not necessarily (or exclusively) by speech or text. This is explained very well by John Dewey:

> If all meanings could be adequately expressed by words, the arts of painting and music would not exist. There are values and meanings that can be expressed only by immediately visible and audible qualities, and to ask what they mean in the sense of something that can be put into words is to deny their distinctive existence.[43]

Meaning in the context of music, then, is an attempt to express something in a way other than words alone. As Dewey argues above, musical meaning has a unique quality because it cannot be expressed verbally or by text. Meyer describes musical meaning as a 'closed system' since 'it employs not signs or symbols' that refer 'to the non-musical world of objects, concepts, and human desires'.[44] Performance is intentional as performers intend to convey something, whether they mean to express a carefully re-constructed version of the composer's intentions or their own ideas, thoughts, and emotions.

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[42] Meyer, *Emotion and Meaning*, 34.
[43] Dewey, John: *The Act of Expression* (New York, NY: Penguin Group, 2005), 77.
[44] Meyer, *Emotion and Meaning*, vii.

In conclusion, meaning is not embedded in physical objects: it is created in the mind of a being. It can be communicated in various ways, such as in art, speech, or gesture, but it does not have to be communicated at all in order to exist (such as in Meyer's rock example). Meaning contains significance, which can be detailed information used in communication (such as in primate calls) or something more abstract in music and art. In this dissertation, meaning will refer to *musical meaning* and it will centralize on its creation and communication in performance. Building on Jensenius' definition, I am defining meaning as the mental cultivation of experiential information.

3.4 Conclusion: The Evolving Organism

In this chapter, I have discussed a variety of complex theoretical ideas, such as 'gesture' and 'interactivity', which arose when I first attempted to build the programming patch for *Stung*. My explorations of these concepts directly informed and influenced my approach to programming and performance. As I investigated each area, I compared my practice to a flowering plant (see Figure 8):

> I have been thinking of my artistic process for some time as an evolving organism. Thinking of how plants have various stems that shoot off in different directions, my artistic research process is very similar. One event can cause various shoots to grow in different directions, but they are still connected at the point they were first realized. Flowers on the same plant bloom at different times and I feel that my research is similar. I may find great interest in one area of my research (such as the concept of movement/gesture) and later this may shift to a different area (such as remixing).[45]

[45] Reflective Journal Entry, 07 October 2020.

Figure 8: Image of a Flower from the Kew Gardens, London, England[46]

Although my research is a singular project, the areas within are interconnected and influence one another. By researching different topics, such as gesture, I developed an understanding of them, and this impacted my approach to programming and performance. For instance, researching the area of gesture influenced me to focus on the relationship between the mind and the body, developing my awareness of the body in performance. Thus, the body became central to many programming decisions. The next chapter will illustrate how the concepts and aesthetics discussed in this chapter not only influenced my approach to programming, but also directly impacted the structure of my Max for Live patches.

[46] This photograph was taken by the author.

CHAPTER FOUR: THE COMPLEXITY OF PROGRAMMING

4.1 Introduction

This chapter will focus on outlining the processes taken to create live processing patches in Max for Live that work with the SABRe sensor and remote. The first part of this chapter will explain the key elements of the first patch that I created for performing Frank Lyons' *Stung* with sensors. The second part will expand upon concepts that are discussed in the first part.

Most of this chapter will focus on the technical aspects of using Max for Live in conjunction with the sensors; however, these technical details will be explored through the lens of the performer. For example, discussions will cover how I built the processing patches and how performance informed the way I programmed.

Although various parts of my patches are organized neatly under headings in this chapter, the process of programming was often messy:

> When I was in the process of integrating SABRe's multi-sensor and remote into Frank Lyons' *Stung* for bass clarinet and live processing, everything about the process felt muddy and unclear. I had no idea what I was doing, I was searching around in the dark, trying to figure out how to make it work.[1]

It was only through the iterative process of experimenting, testing, and reviewing that I gradually developed several different techniques for using the SABRe sensors and remote in performance.

[1] Reflective Journal Entry, 5–18 April 2019.

4.2 Elements of a Typical Patch

The flowchart in Figure 9 shows how data flows through the programming patch for *Stung*, with the SABRe sensor data shown in blue and the SABRe remote data in orange.[2] I have developed my own terminology for thinking about and discussing my Max for Live patches and this flowchart shows many of the components that I have named. These will be explained thoroughly in the following sections.

Figure 9: Flowchart for *Stung* patch

[2] Please see Section 1.7 Hardware Overview for more information about the SABRe sensor and remote.

The data enters the Max for Live patch from the Connection Kit. If we follow the remote data (in orange) in Figure 9, it flows from the Connection Kit into the Master Counter. The Master Counter sends the counter information to many areas of the patch including the Sensor On/off Router, the Track Muter, the Sensors Boundaries, and the device control area. The sensor data (in blue) flows from the Connection Kit into the **live.slider** and **live.dial** objects (marked in the flowchart as '[s]ensor sliders/dial and gates').[3] It then passes through the Sensor Boundaries and is routed by the Parameter Router before finally being funnelled into the device control subpatches.

The first live processing patch that I created (for *Stung*) became the template for the rest of the patches. In order to understand how I approached the programming for the rest of the works, it is important to break down the components of the patch. This will help to explain how different sections work together to bring the sensor and remote data into my performance environment.

4.2.1 Setting up the Sensors

As mentioned in the previous chapter, three of the four sensors in the SABRe multi-sensor device send numbers to the computer based on changes to the x, y, and z axes (see section 3.1). The sensors are strapped to the clarinet so when the performer moves the clarinet, the sensors will detect this. The data outputted from the multi-sensor can then be used to trigger, manipulate, or create electronic sounds.

My method for programming the sensors always begins with the creation of a Live Set, which is an Ableton Live document, saved as an ALS file with the file extension .als. Each Live Set contains its own tracks and audio clips (see Figure 10). Tracks are distinguishable in Session View by their colourful labels and are made up of clip slots (rows within a track) which can be recorded into. Audio tracks can house audio effects or Max for Live

[3]In this chapter, the names of Max objects will be in bold. For example, **live.slider** and **live.dial** are the names of objects that function as sliders and dials respectively.

audio effects, the latter of which I have used to programme the data from the sensors and remote.

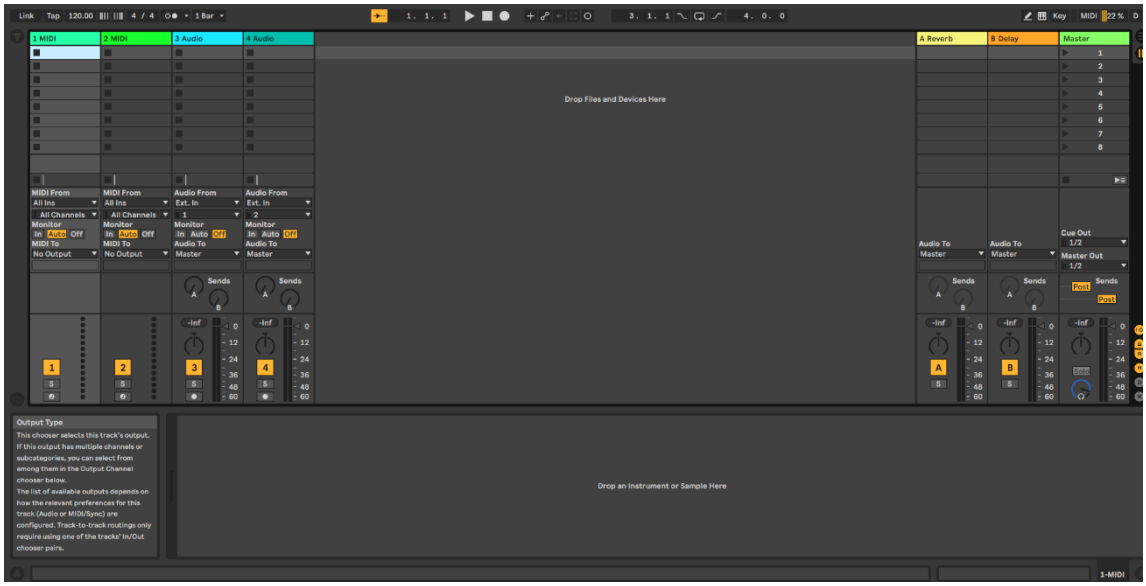

Figure 10: New Live Set

Connecting the SABRe sensors to Max for Live was possible using the Open Sound Control (OSC) protocol, which is a way of communicating between devices (like MIDI). The sensors connect to the SABRe software with Bluetooth wireless technology and then from within the software, OSC can be enabled by clicking the Activate OSC button (see Figure 11).[4] I use both the SABRe software and Live in performance, but the SABRe software only functions as a way to pass data from the sensors to Live.

[4] When I first purchased the SABRe multi-sensor, I did not realize it was not compatible with version 3.0 of Bluetooth wireless technology. To use the sensors with my older laptop, I had to purchase a Bluetooth 4.0 USB dongle.

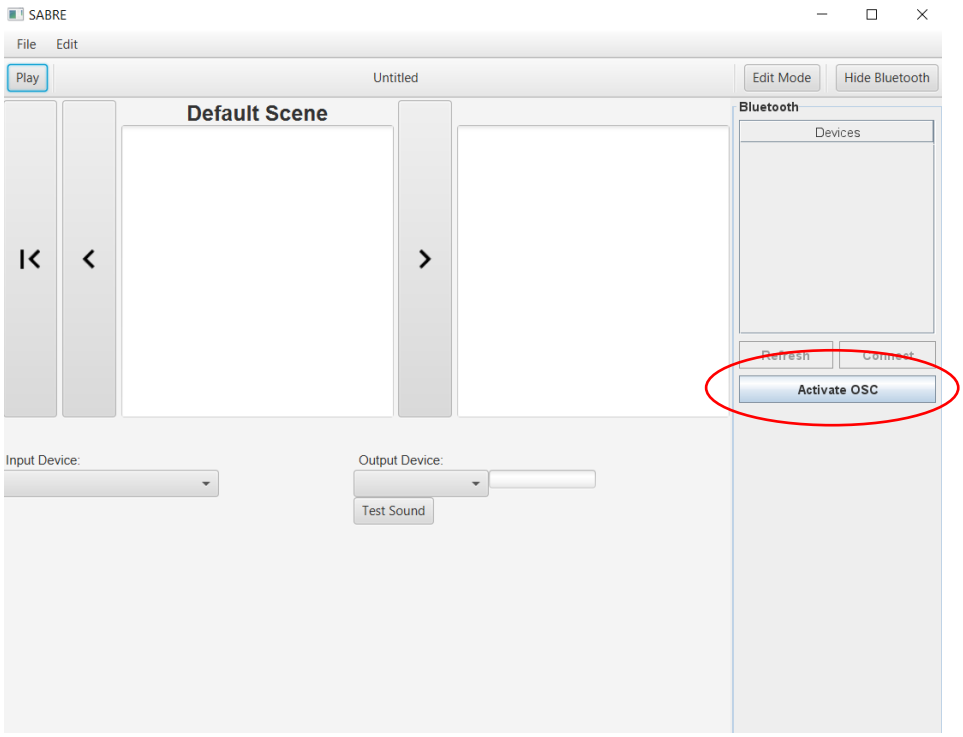

Figure 11: SABRe software for Windows

After activating OSC, a pop-up window displays a port number that can be used to receive the sensor and remote data in Max for Live (see Figure 12). The default port (last four numbers) is 4444.

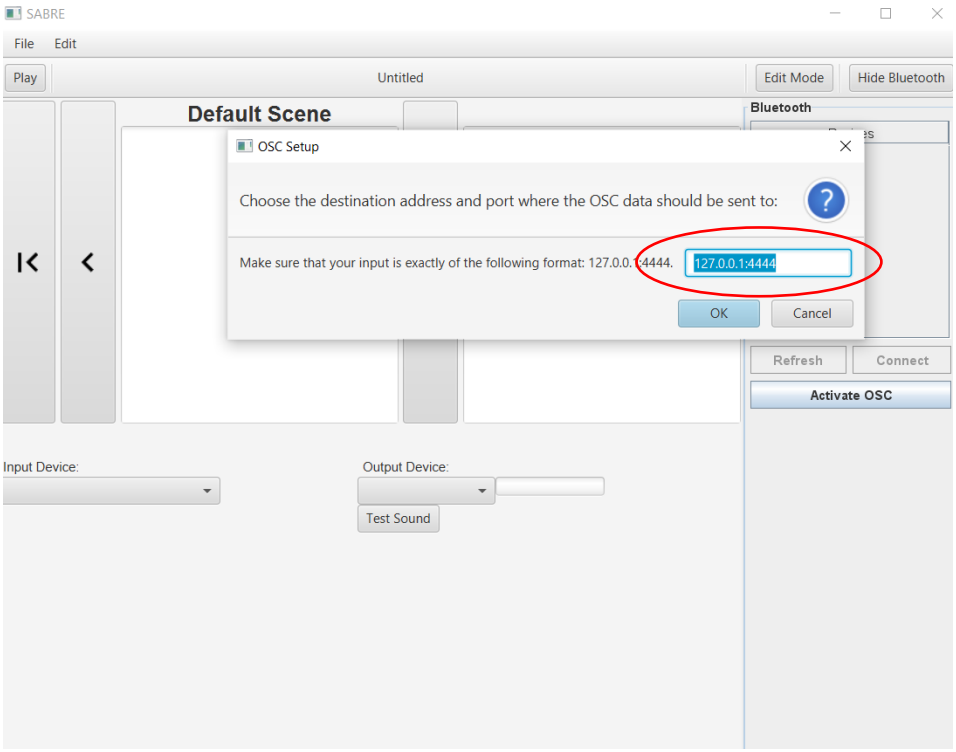

Figure 12: Windows OSC setup

When I first started using the SABRe sensors, there was no information on how to receive their data in Max for Live. After browsing through information online about how OSC might be compatible with Max for Live, I discovered external Max objects that can be downloaded. In Max and Max for Live, objects are visual representations of code, rather than textual code that is typical of many programming languages. Objects are the main building blocks of the patch and there are many types, each with their own name. The external objects I found online were developed by the Centre for New Music and Audio Technologies (CNMAT) Berkley and are called *odot* objects.[5] They are easily recognized by the **o.** prefix at the beginning of the object name.

The **udpreceive** object receives OSC data. Using trial and error as a method, I connected the **udpreceive** object to a **print** object and saw the words 'FullPacket' in the Max

[5] Centre for New Music and Audio Technologies: 'Downloads', https://cnmat.berkeley.edu/downloads, last accessed 20 June 2022.

Console, followed by a bunch of meaningless numbers. The Max Console is a tab that can be opened to view 'status information, error messages, and warnings',[6] and the **print** object allows background information to be printed into the Max Console. The **print** object is useful for problem-solving, particularly when things are not connecting properly or more information is needed. In this case, the word *packet* in 'FullPacket' insinuated that the sensor data was being sent as a group, rather than by each separate sensor.

To try and separate the sensor data, I connected the **udpreceive** object to an **o.route** object and then used the **o.print** object to view the incoming data in the Max Console. With the addition of the **o.route** object, the sensor data was printing separately for all four sensors in a format such as '/Sabre/Sensor/Yaw', followed by a number (see Figure 13).

Figure 13: The Max Console

[6] Cycling '74: 'Max Console', https://docs.cycling74.com/max8/vignettes/max_window, last accessed 20 June 2022.

To route the sensor data in four different directions (one for each sensor), I hypothesized that I could use the format printing in the Max Console, such as '/Sabre/Sensor/Yaw', as the argument for the **o.route** object. Arguments define objects and follow the name of the object. In Figure 14, for example, the text on each object starts with the name **o.route**, followed by an argument, such as /Sabre/Sensor/Roll or /Sabre/Sensor/Pressure. This routed the data into four separate categories corresponding to each of the sensors: yaw, pitch, roll, and air pressure.[7]

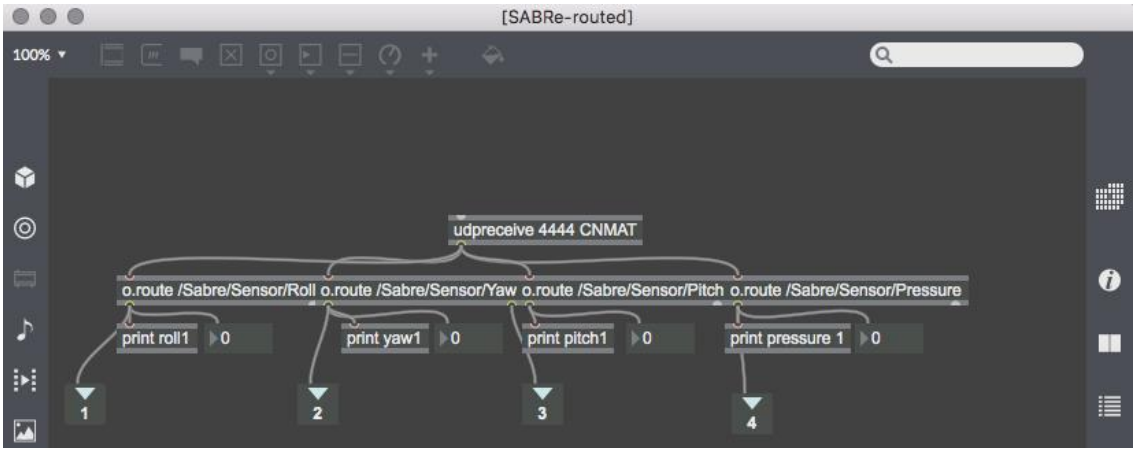

Figure 14: Separated sensor data

Following this, I connected **number** objects—which display numerical data—to the **o.route** objects (see Figure 14) so that I could see the data change as I moved the sensor box around with my hand. This confirmed that the data was live. Then I connected the **o.route** object for the pitch sensor (changes on the y-axis) to a **live.slider** object to watch the slider move up and down on the screen as I moved the sensor box up and down in the air. I did the same thing for the air pressure and yaw sensors in order to have a better visual of the incoming data. For the roll sensor, I connected it to a **live.dial** object because it better represents the x-axis (see Figure 15).

[7] The yaw, pitch, and roll sensors detect changes in rotation on the x, y, and z axes. The air pressure sensor measures air pressure through a tube that is attached to the performer's mouthpiece.

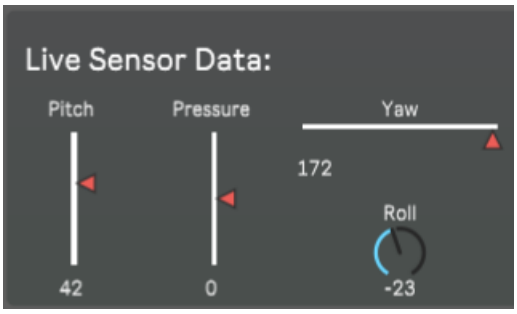

Figure 15: **Live.slider** and **Live.dial** objects

With the sensors connected, the next issue was getting the SABRe remote data into Max for Live. The remote is a two-button device that also uses Bluetooth wireless technology to connect to the SABRe software. From there, the remote data is sent via OSC and received in Max for Live with the same **udpreceive** object as the sensors. I followed the same naming format as the sensors to determine what argument I should use for the **o.route** object—'/Sabre/Remote'.

To separate data for the left and right buttons on the remote, I used two more **o.route** objects with arguments '/Right_Button' and '/Left_Button' respectively (see Figure 16). Finally, to confirm that I was getting live data from the remote, I connected **button** objects to the **o.route** objects. **Button** objects light up when they receive data; therefore, I was able to see the left and right **button** objects light up whenever I pressed the left or right button on the remote.

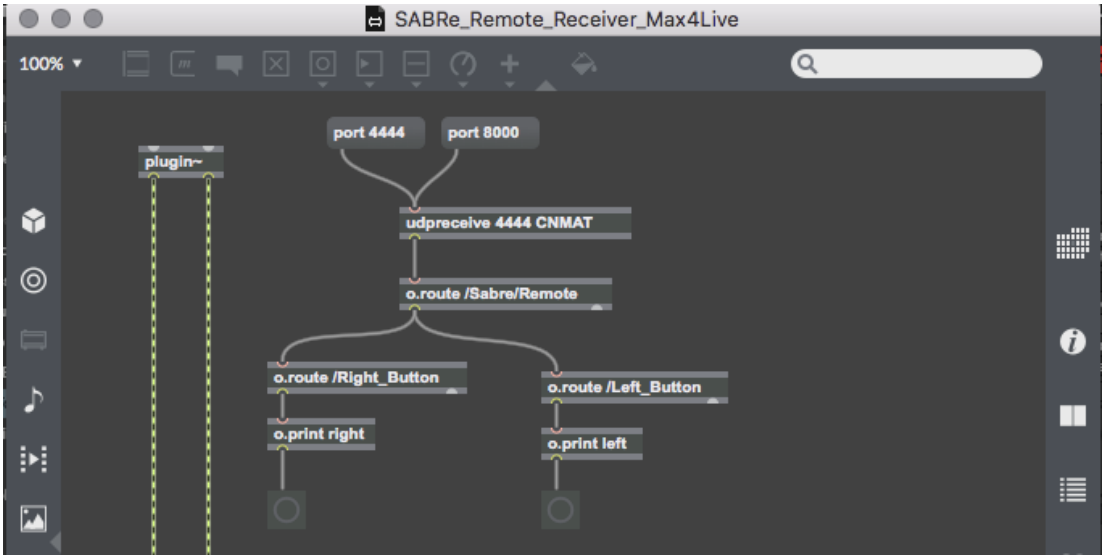

Figure 16: First Draft of the Remote Receiver

I eventually fed the sensor and remote data through the same **udpreceive** object to receive all the data simultaneously (see Figure 17). This was the first draft of the Sensor and Remote Receiver and it functioned as the essential building block for several of my patches.

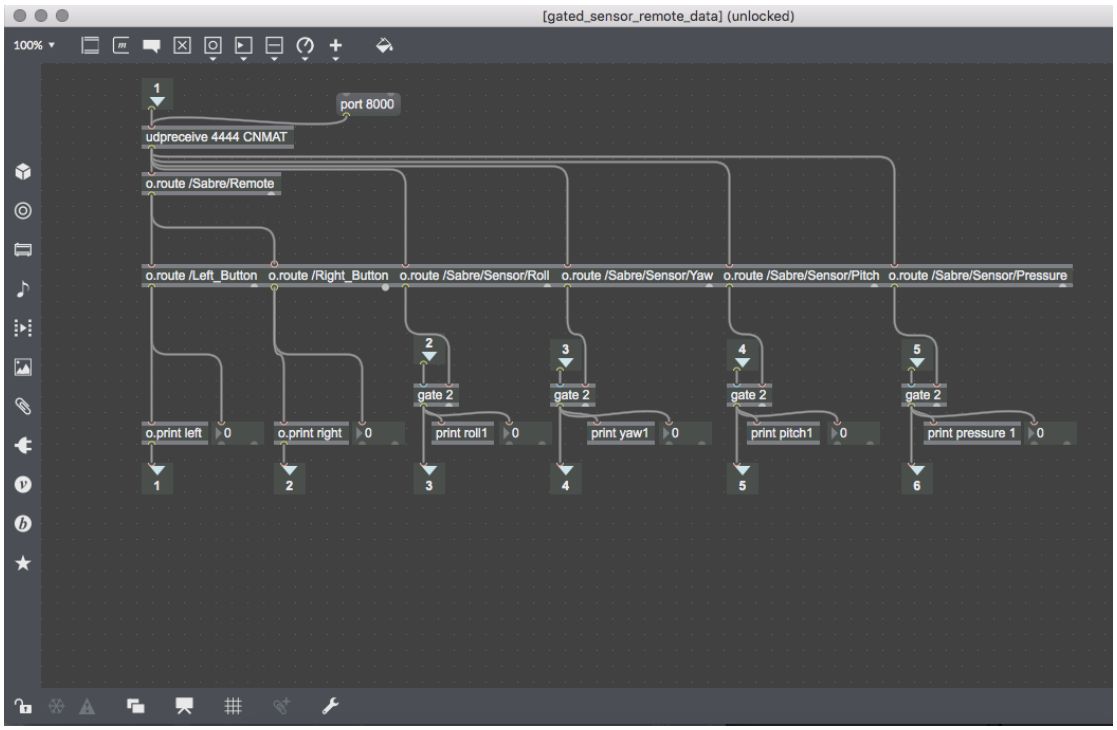

Figure 17: The Sensor and Remote Receiver

I built a second version of the Sensor and Remote Receiver to make it visually tidier and to add further connectivity to the sensor box. The SABRe multi-sensor also has two buttons on it that are separate to the remote, but work in the same way. There were times while practising that the SABRe remote fell off my bass clarinet, where it was attached by double-sided tape. If this were to happen in performance, it could ruin the performance. The sensor box is strapped to the clarinet so there is no chance of it falling off; therefore, if the remote were ever to fall off in performance, I could simply use the buttons on the sensor box to trigger what is needed.

I used the same process to receive the sensor buttons in Max for Live that I did for the remote buttons. I employed trial and error to establish which arguments to use for the **o.route** objects. The arguments that worked were 'SABRe/Sensor/Left_Button' and 'SABRe/Sensor/Right_Button' (see Figure 18).

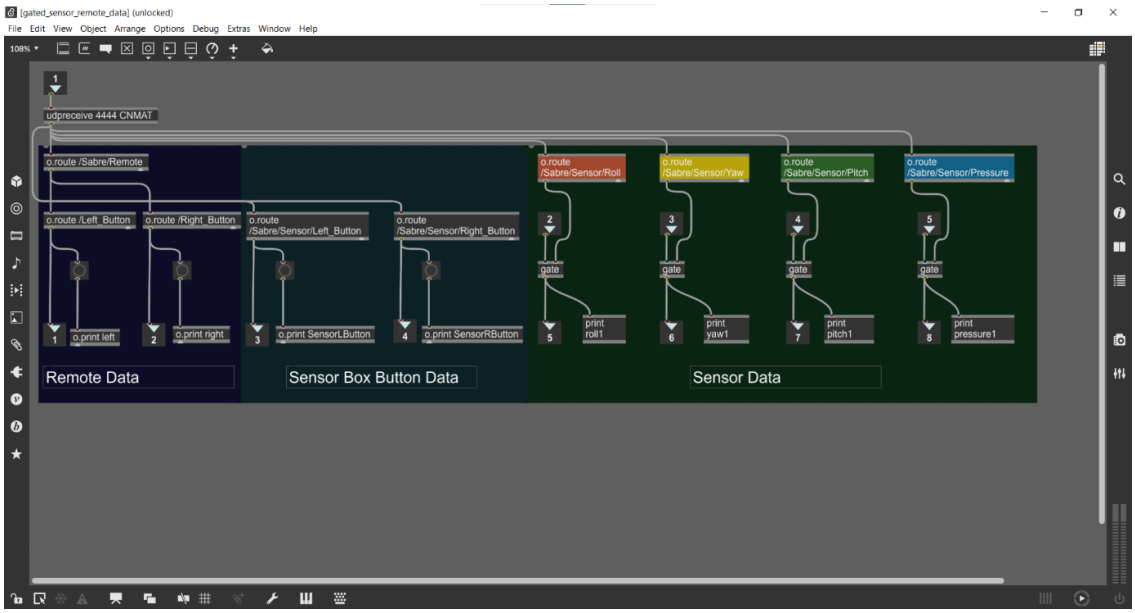

Figure 18: Sensor and Remote Receiver 2

In order to use the remote buttons and sensor buttons in different ways, rather than only having the option of single clicking the left or right button, I found a Max patch on a Cycling '74 forum that I could adapt. Max user Leigh Marble built a Max patch for single-pressing, long-pressing, and double-pressing remote buttons and graciously shared it online.[8] I adapted this for my own needs (see Figure 19).[9]

[8] https://cycling74.com/forums/how-to-make-a-double-tapclick-button-for-monome

[9] The white textual explanations that can be seen in some of the Figures, such as Figure 19, are actually objects called **comments**. These text boxes can be used to label items or to leave explanations for future users of the patch. I often used these to leave reminders for myself.

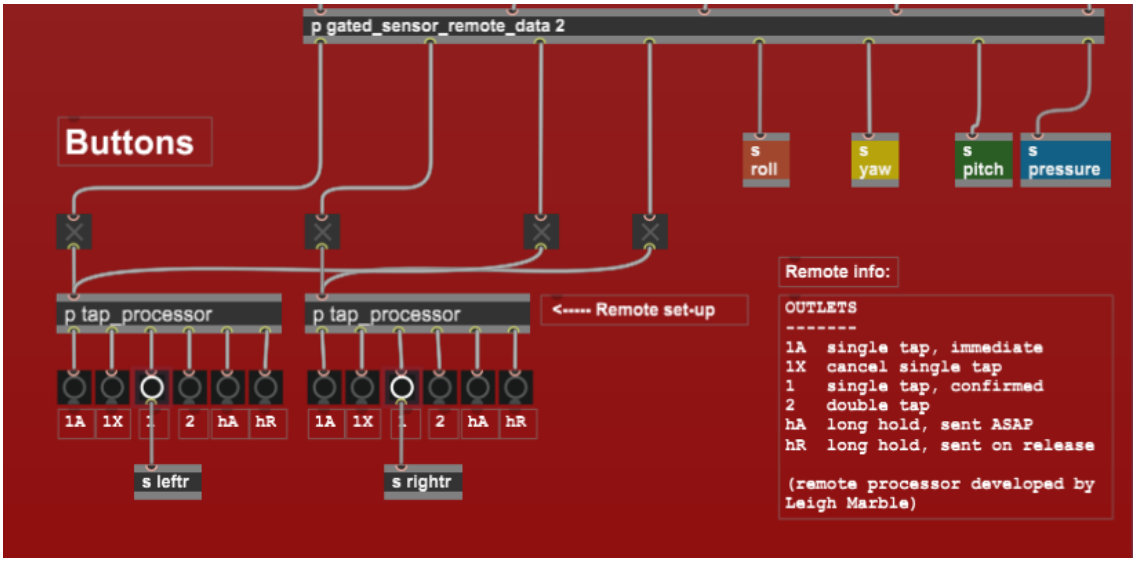

Figure 19: Adapted Leigh Marble Remote Patch

Building on other people's work is a part of programming culture and is well described by Paul Schuette:

> The larger issue here is that outright stealing is an accepted part of programming culture. Pieces of code are borrowed, share [sic] and ripped from other people, and this is what you are expected to do. The best programmers working right now never start with an entirely blank screen. The problem is that people who are new to writing computer code sometimes feel a tinge of morality running up their spine when they "borrow" a piece of code for the first time. But imagine the comparison: nobody feels like they are stealing anything from the people who spoke Latin when they are teaching their kids English.[10]

In this case, Marble freely shared his remote patch online, but it is a good example of not re-inventing the wheel when it comes to programming.

4.2.2 The Connection Kit

The Sensor and Remote Receiver is part of the Connection Kit, an essential part of my patches (see Figure 20). The Connection Kit is saved as a snippet in Max for Live so that it can be easily pasted into new patches. The main purpose of this kit is to receive the sensor and remote data and send it off to other parts of the patch. It also includes some

[10] Schuette, Paul: Demystifying Max/MSP: A Guide for Musicians Approaching Programming for the First Time, (Ebook: Self-published, n.d.), 6.

objects that are useful for troubleshooting, such as an area for editing the port number and the ability to restrict sensor or remote data.

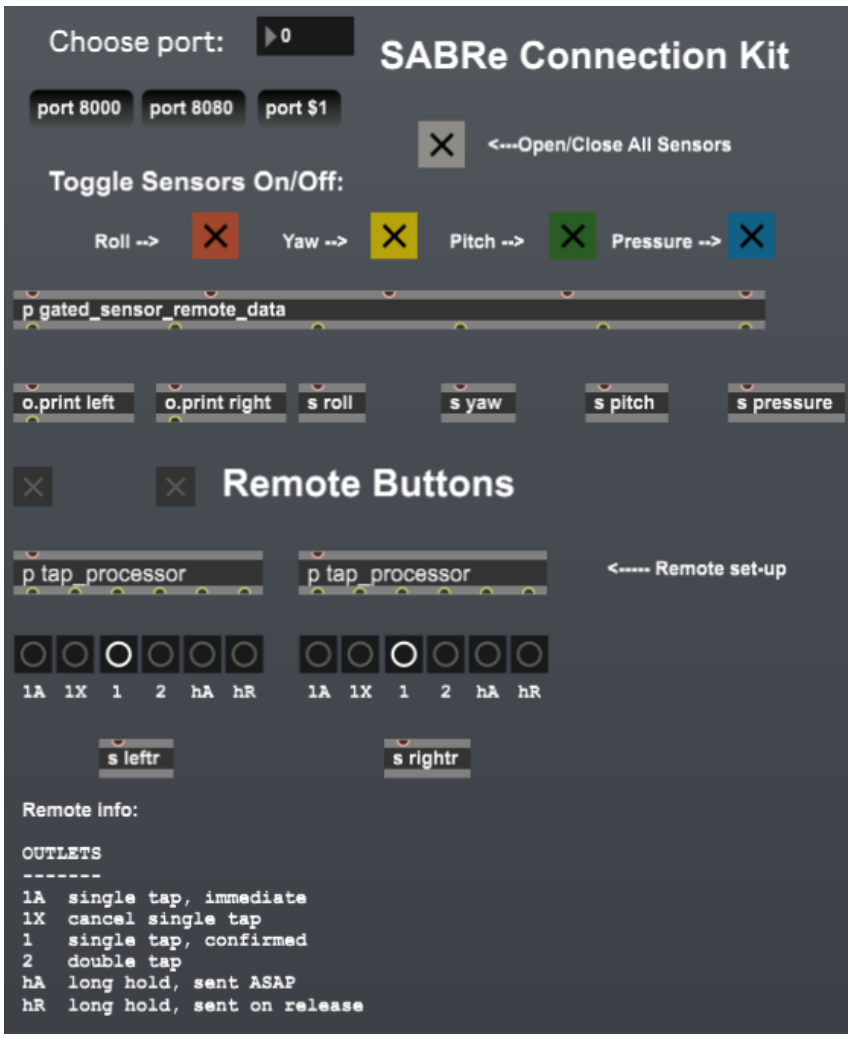

Figure 20: The Connection Kit

At the top of the Connection Kit is the port area. The default port is 4444, but there were times when I had problems with this port and used another one. When this happened, I tended to use ports 8000 and 8080.[11] Clicking on the 'port 8080' or 'port 8000' messages

[11] I only encountered problems with ports on my MacBook Pro. The default port 4444 has always worked on my newer laptop (XPS 15).

overrides the default port.[12] If the default port is changed in Max for Live, then it also needs to be changed in the SABRe software.

The **s roll**, **s yaw**, **s pitch**, and **s pressure** objects, shown in Figure 20, send the sensor data to other areas of the patch. The matching objects that receive this data are **r roll**, **r yaw**, **r pitch**, and **r pressure** respectively. The **s** and **r** object names are short for send and receive and remove the necessity of patch cords.

The toggle buttons, marked with a black X, are like light switches. They have two options: on or off. The toggles are connected to **gate** objects within the **p gated_sensor_remote_data** subpatch, which can be seen in Figure 17. The toggles in the Connection Kit open and close the gates in this subpatch, only letting the sensor data through if they are open.

Many of these objects were only added for troubleshooting purposes and I did not end up needing them in performance. For example, the purpose of the gates was to restrict the sensor data to only one stream at a time when I was first building the patch. Similarly, the sensor toggle buttons and those under the **o.print left** and **o.print right** objects were helpful for understanding and checking the flow of data, but they were not necessary in performance. In later patches, I ended up removing certain features because they became redundant. For example, the colourful sensor toggles were all added to Performance View for troubleshooting before my first performance of *Stung* (see Figure 21), but I excluded them from future versions (see Figure 22).[13]

[12] Messages are necessary for passing information around the patch and can be used to change the way an object behaves. Messages are distinguishable by their rounded edges, whereas objects have sharp corners.

[13] Performance View is a feature of Max for Live that allows the user to select what parts of the patch will be seen in the Max for Live audio effect in Live.

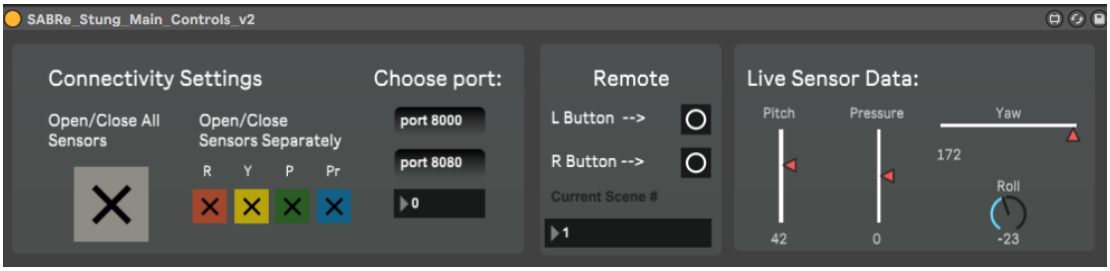

Figure 21: Performance View of *Stung*'s First Patch

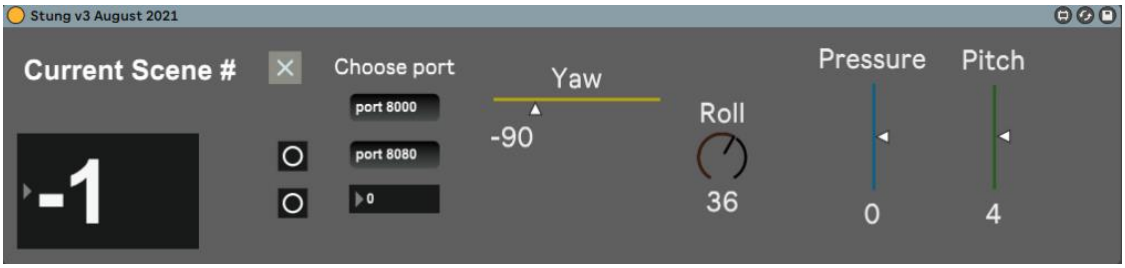

Figure 22: Performance View of *Stung*'s Second Patch

The most important toggle in the Connection Kit is the grey one (see Figure 20), which is connected to the sensor toggles. It must be turned on for performance or the patch will not work. In my first few patches, this toggle had to be turned on every time I opened Live, but eventually I connected a **loadbang** object to it so that it would automatically switch on when the patch loaded. This helped to cut down on the amount of time I spent setting up before a performance.

4.2.3 The Counter Object

While developing the live processing for *Stung*, I imagined each of its thirteen sections as 'scenes' due to their differing characters.[14] I decided to mirror the structure of the bass clarinet part in the patch itself by breaking it into thirteen sections, controlled by the **counter** object. The **counter** object moves backwards or forwards through a specified range of numbers, which makes it ideal for controlling the order of events in performance. In many of my patches, I refer to this **counter** object as the Master Counter to differentiate it from other **counter** objects.

[14] For an introduction to the composition *Stung*, please see Section 2.2.

Figure 23 shows an example of the Master Counter area in my second version of *Stung*'s patch. The arguments for the **counter** object show that it moves through numbers -1 to 13. Each of the numbers between -1 and 13 trigger a group of settings in the patch, which I will henceforth refer to as a scene. Numbers 1 to 13 represent the thirteen sections of *Stung*, and -1 is a pre-performance scene. Scene -1 was added while working on *Star Maker*'s live processing so that the **counter** object has one setting with the audio turned off. This is helpful in a performance situation so that none of the audio effects are active while setting up or talking to the audience.

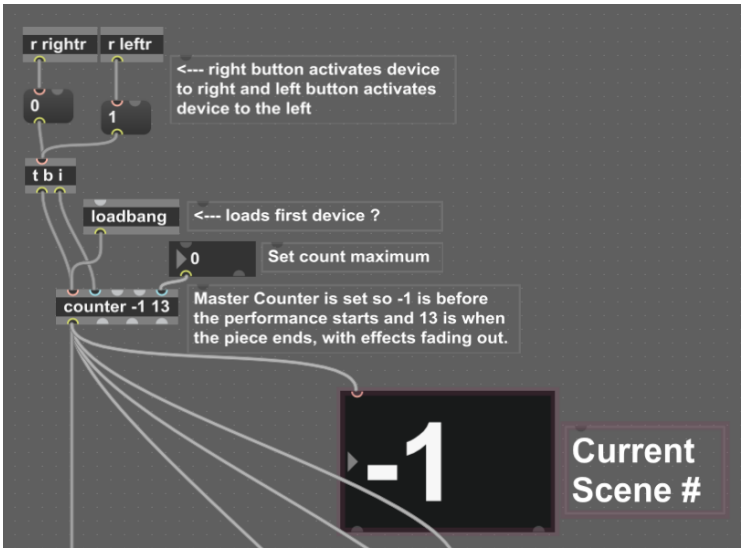

Figure 23: The Master Counter Area in *Stung*'s Second Patch

To progress through the scenes that the **counter** object controls, I created the Device Activator. This allows the SABRe remote to control the Master Counter. Figure 23 shows the **r leftr** and **r rightr** objects, which receive the remote data from the Connection Kit. The Device Activator works by using the **t** object (short for trigger) to send either a zero or a one to the **counter** object (to set direction) and triggers the **counter** object to move to the next scene. Pressing the right button on the SABRe remote sends a 0 to the **counter** object, setting it to move through the numbers chronologically. Pressing the left button sends a 1 to the **counter** object, setting it to move in reverse chronological order.

If we take *Stung*'s patch as an example, with the scene number set to 1, the right button on the remote will move the Master Counter forward to 2, whereas the left button will move it back to scene 13. I programmed it to work in two directions so that if I made a mistake I could return to the correct scene. It was also helpful to be able to use the remote to navigate between sections while practising.

For *Stung*, I decided on a particular order for the numbered and lettered sections in advance, instead of choosing randomly in performance.[15] This is because each scene was pre-programmed with different effects, preventing the order from being changed in performance. At the time I built the programming patch, the only way I could have programmed random sections was by typing a letter or number into the laptop in performance to trigger the right effect. The decision not to do this was based on my desire to integrate the electronics into performance and not distract the audience by pressing keys on my laptop (see 3.2.3). The other issue with employing a random order is that there are many pages to the bass clarinet part and it would cause a delay in performance to search for the right section if I did not decide on the order in advance. I used the Master Counter setup for all the other patches that are part of this research, with minor modifications to accommodate their differences.

The Master Counter controls many areas of the patch, including the Track Muter, the Sensor On/off Router, the Sensor Boundaries, and the Parameter Router, all of which will be discussed in the following sections.

4.2.4 The Track Muter

The **p** object is a subpatcher (also referred to as a subpatch), which can be thought of as a patch within a patch. It is a convenient way to hide areas of the patch that work in the background and do not need to be visible. Figure 24 shows the Track Muter subpatch **p**

[15] The order I chose was simply the one that the composer sent to me. In the future, I will adopt different orders so that it is not always the same.

Stung track muter. The Track Muter was designed to turn on the audio tracks in Live (which contain the audio effects for each scene) and to mute those that were not needed. It is directly controlled by the Master Counter.

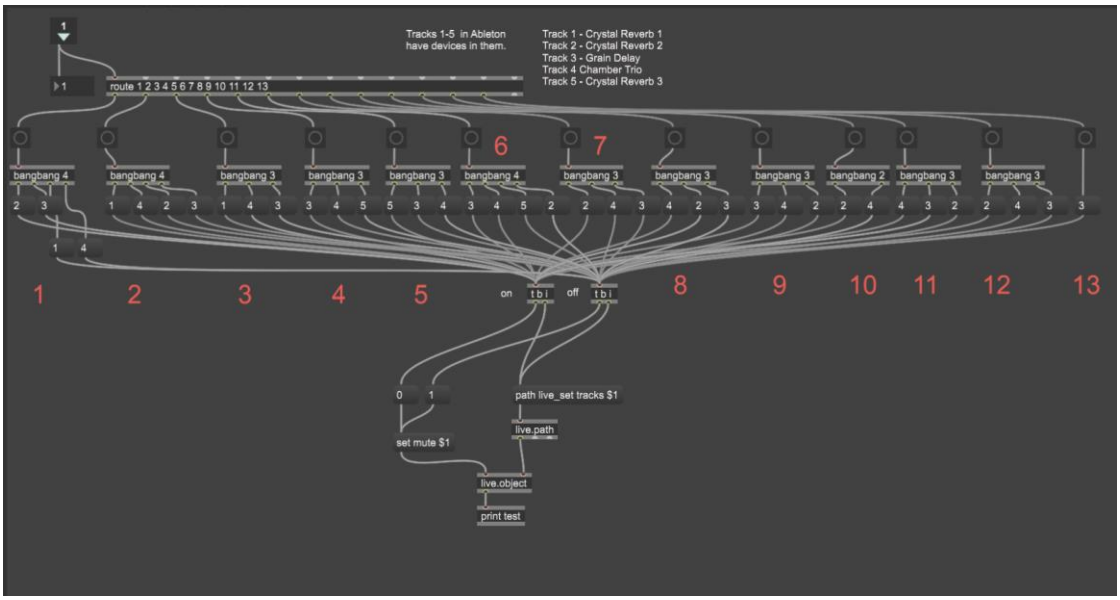

Figure 24: **p Stung track muter**

The **route** object receives the current scene number from the Master Counter and uses this to determine which audio tracks need to be activated or de-activated. Each scene contains its own settings that are pre-programmed to turn on and off the appropriate audio tracks in Live. The programming for this is relatively straightforward, but it must be done in advance.

To control Live from within Max for Live, I used the Live Object Model (LOM) reference (see Figure 25).[16] The LOM is quite complicated at a first glance and there was surprisingly little information online about how to use it. My main method was trial and error. Once something worked, I copied and pasted this into future patches.

[16] Cycling '74: 'LOM – The Live Object Model': https://docs.cycling74.com/max8/vignettes/live_object_model.

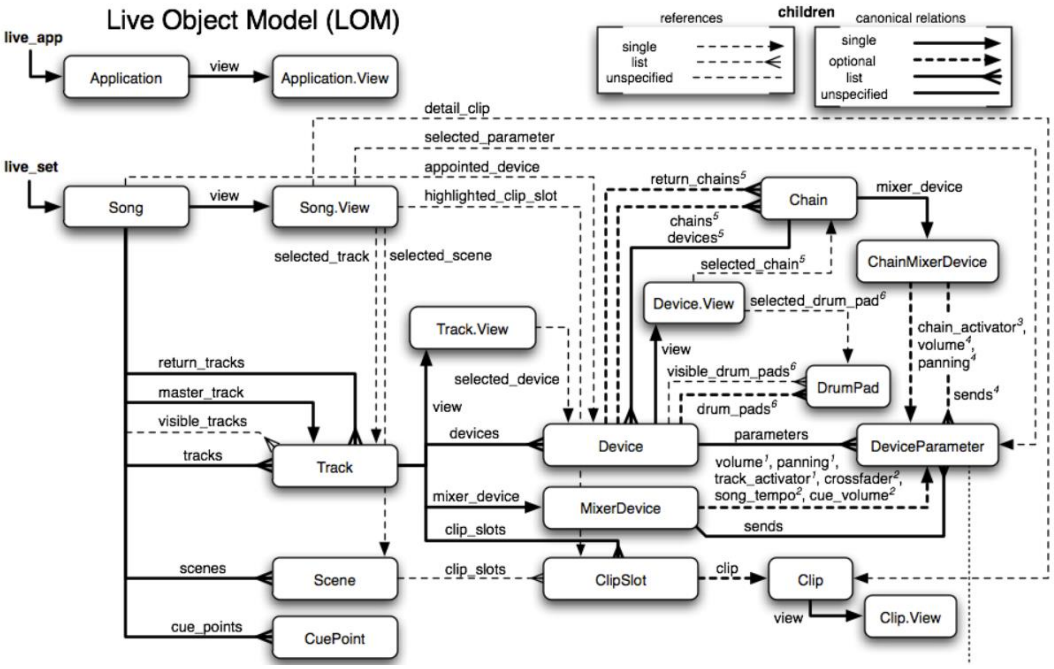

Figure 25: Live Object Model

4.2.5 The Sensor On/off Router

When programming *Stung*, I decided to only use one or two of the sensors for each scene, rather than having all four sensors active at once. The main reason for doing this was to keep the programming as simple as possible. To control the flow of sensor data within the main part of the patch, I created the Sensor On/off Router. The Master Counter sends the scene number to the **route** object, as seen in Figure 26, which then triggers the **gate** objects in Figure 27 to open or close. The **gate** objects function as doorways that can either be open or closed and control whether or not the sensor data continues through to the rest of the patch.

In Figure 26, scenes are labelled by large, red numbers and the messages above these indicate which sensors are active or inactive during a particular scene. This information is sent to the **router** object (see Figure 27), which controls the sensors' **gate** objects.

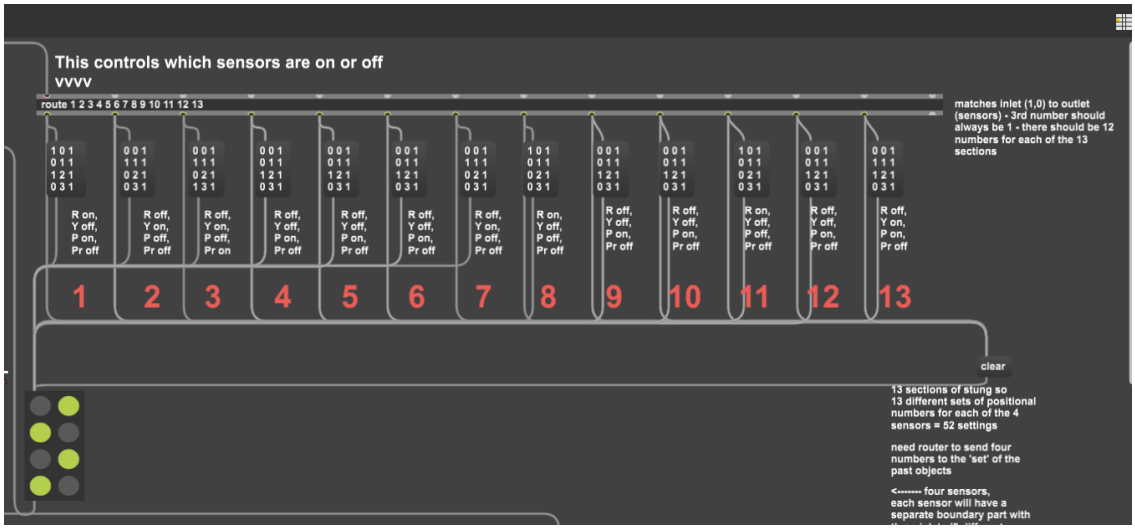

Figure 26: The **route** object in the Sensor On/off Router

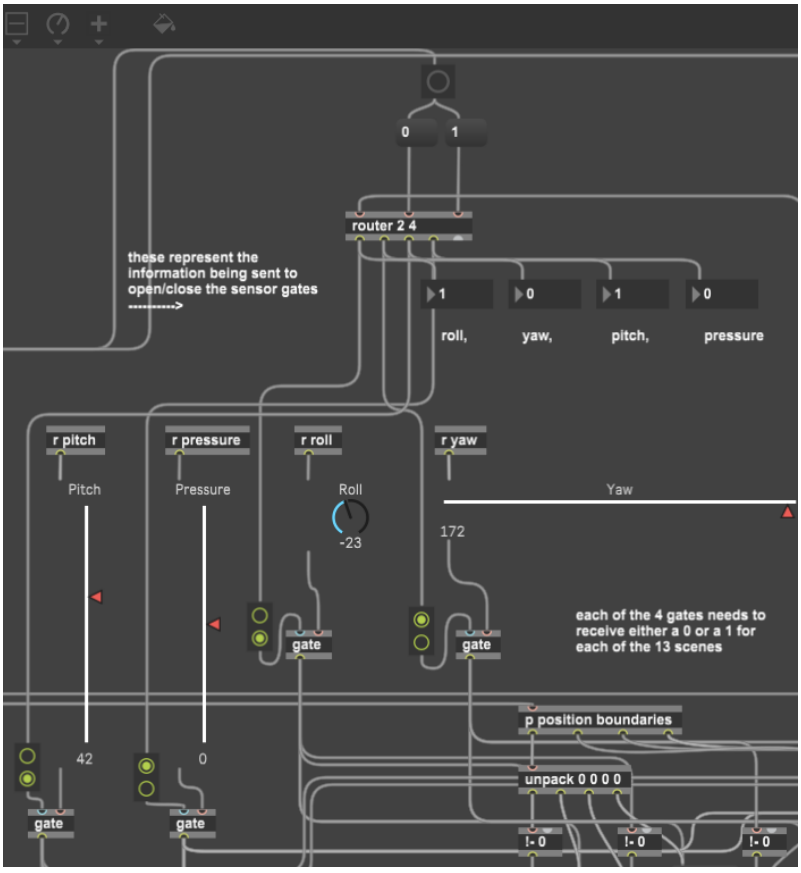

Figure 27: The Sensor On/off Router **gate** objects

4.2.6 Sensor Boundaries

If a sensor's gate is open, its data will continue to the Sensor Boundaries (see Figure 28). The Sensor Boundaries is an area of the patch which triggers changes to the audio effects in Live based on the position of the sensors. Before I developed this, I tried to connect the sensor data to different knobs on Live audio effects, but this resulted in poor interaction between myself and the electronic sounds.

> I am sitting in the practice room because I have connected the pitch (y-axis) sensor to the transposition knob on a harmonizer audio effect and I want to hear how it sounds. As I move my bass clarinet up and down, the transposition dial moves. I put my headphones in, excited to hear the results.
>
> As I start to play, I hear electronic sounds swirling around. Every little movement I make changes the transposition knob and it sounds out of control. I try to compensate by moving less, but it feels like my body is caged in. I have no control over the transposition dial and the resulting electronics sound either way too high or way too low. There is no subtlety to the sounds.
>
> I stop playing and let the electronic sounds fade out. My mind wanders back to one of my recent clarinet lessons where we discussed simplicity. Perhaps I need to go in a more minimalistic direction.[17]

The problem with connecting the sensors directly to Live audio effect parameters is that there is a lack of control for the performer. I also tried switching between a variety of audio effects by moving the bass clarinet in different directions. Unfortunately, this was unsuccessful because as I switched from one audio effect to another, the sound of the previous audio effect would suddenly cut off. Although these methods did not work out, it led me to the concept of creating 'boundaries' for the sensors.

The way that the boundaries work is that when a sensor outputs a number greater than what I have specified, an audio effect parameter moves to a pre-determined setting. Similarly, if the sensor outputs a number lower than what I have specified, the parameter will automatically change to another pre-determined setting. In this way, the boundaries simulate a performer turning knobs on their music controller. I adopted this approach

[17] Narrative based on Reflective Journal Entry, 29 August 2018.

for performing *Stung* because it was easy to move between the sensor boundaries without the resulting sound being too wild.

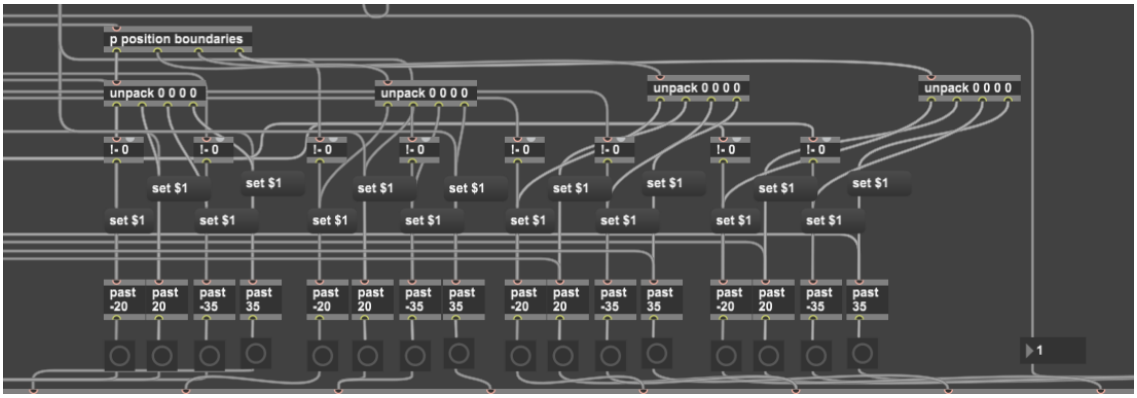

Figure 28: Sensor boundaries

The **p position boundaries** subpatch is where the sensor boundaries are pre-programmed (see Figure 29). For example, in Scene 1 of *Stung*, there are two active sensors: pitch and roll (see Figure 30). If the sensor outputs a 10 or higher, then setting C is triggered and changes the parameters of a Live audio effect. If the sensor outputs between -10 and 10, setting B is activated, and if the sensor number runs below -10, then the audio effect is set to setting A. This is done by using the **past** objects (see Figure 28).

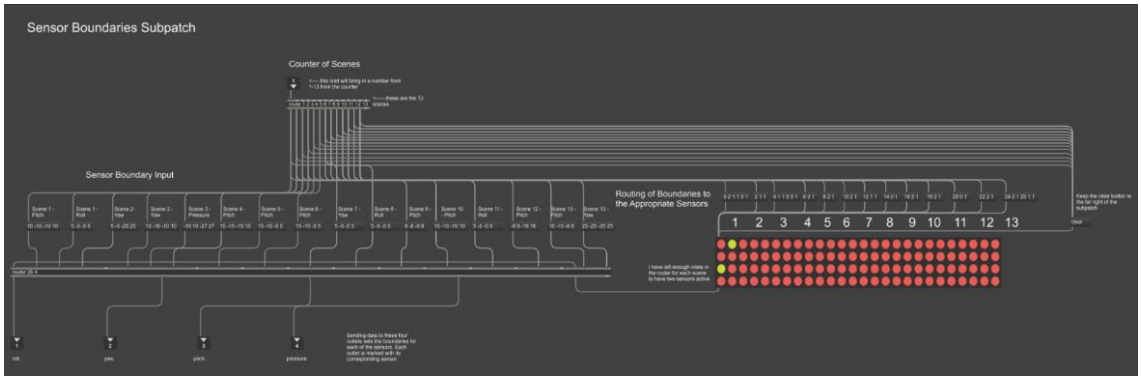

Figure 29: **p position boundaries** subpatch

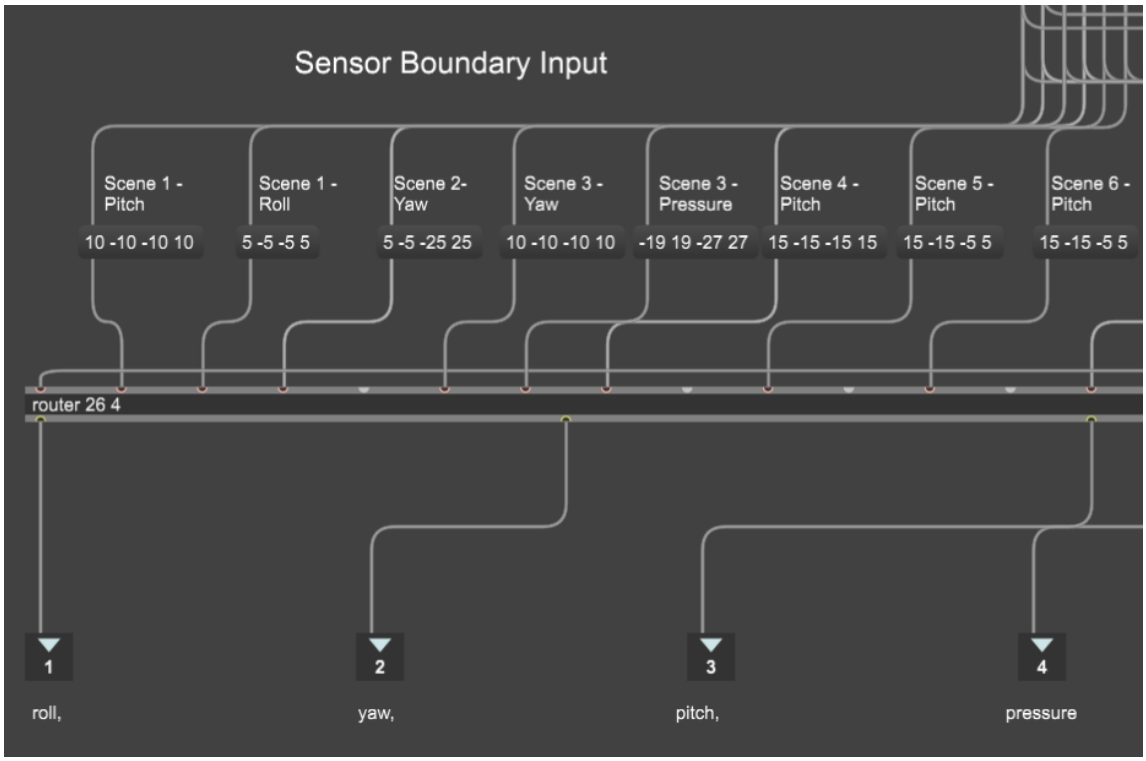

Figure 30: An extract from the **p position boundaries** subpatch

4.2.7 The Parameter Router

For the sensors to change the audio effect parameters, the data must first go through the Parameter Router, which is hidden in the **p parameter router** subpatch. This router connects the Sensor Boundaries with the parameter settings. The **past** objects, visible in Figure 28, trigger **button** objects, which emit a 'bang'. The bangs are routed by the **route** object, which determines where they need to go based on the current scene number.

For *Stung*, each of the four sensors have three distinct positions that can trigger different parameters in Live (see Figure 31). *Stung*'s thirteen sections are pre-programmed separately, so there are fifty-two different outlets the bangs can be sent to before exiting the **p parameter router** subpatch (only twenty-four of them are visible in Figure 31).

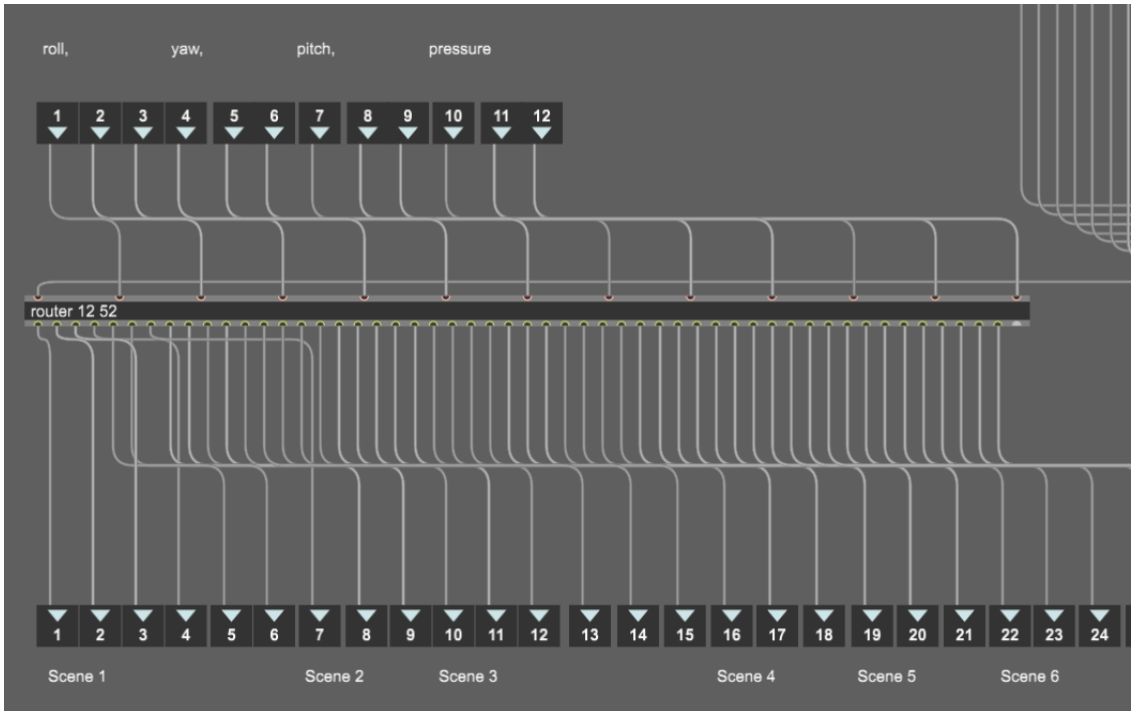

Figure 31: Top-left view of *Stung*'s Parameter Router

The messages (dark grey boxes) visible in Figure 32 match the twelve sensor inlets with the fifty-two outlets. Pre-programming the live processing in this manner was a painstaking process which I managed to avoid in later patches, but it resulted in a successful first performance of *Stung* with the sensors.

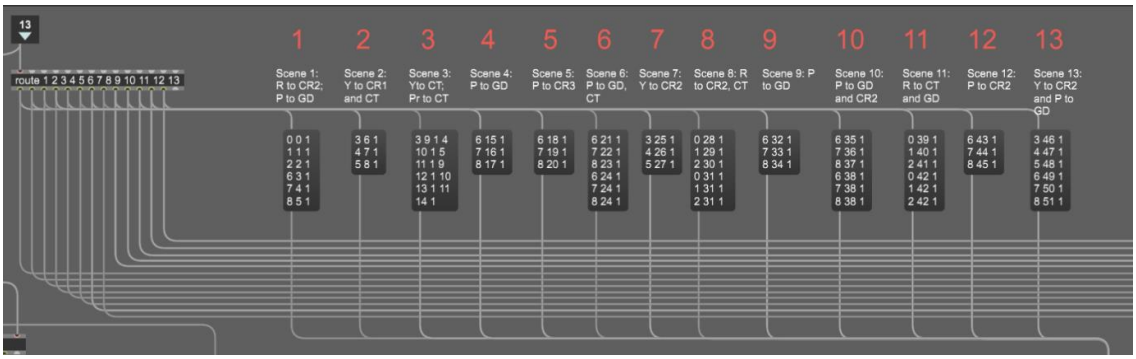

Figure 32: Top-right view of *Stung*'s Parameter Router

4.2.8 Live Device Controls

Once the bangs exit the Parameter Router, they enter Live device control areas. For *Stung*, there are thirteen device control subpatches corresponding to *Stung*'s thirteen

sections (see Figure 33). These are marked by large red numbers. Within these subpatches, each active sensor has three different settings that control the Live audio effects, depending on where the sensors are positioned in space.

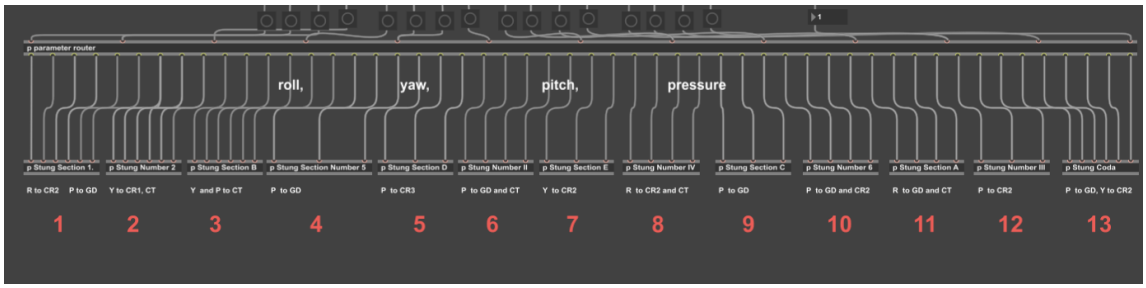

Figure 33: Live device control area

Each device control area is made up of two parts. The top left contains a control panel (see Figure 34) and the bottom half of the subpatch sets all of the desired parameters and values in the Live audio effects (see Figure 35).

Figure 34: *Stung*'s device control panel for scene 4

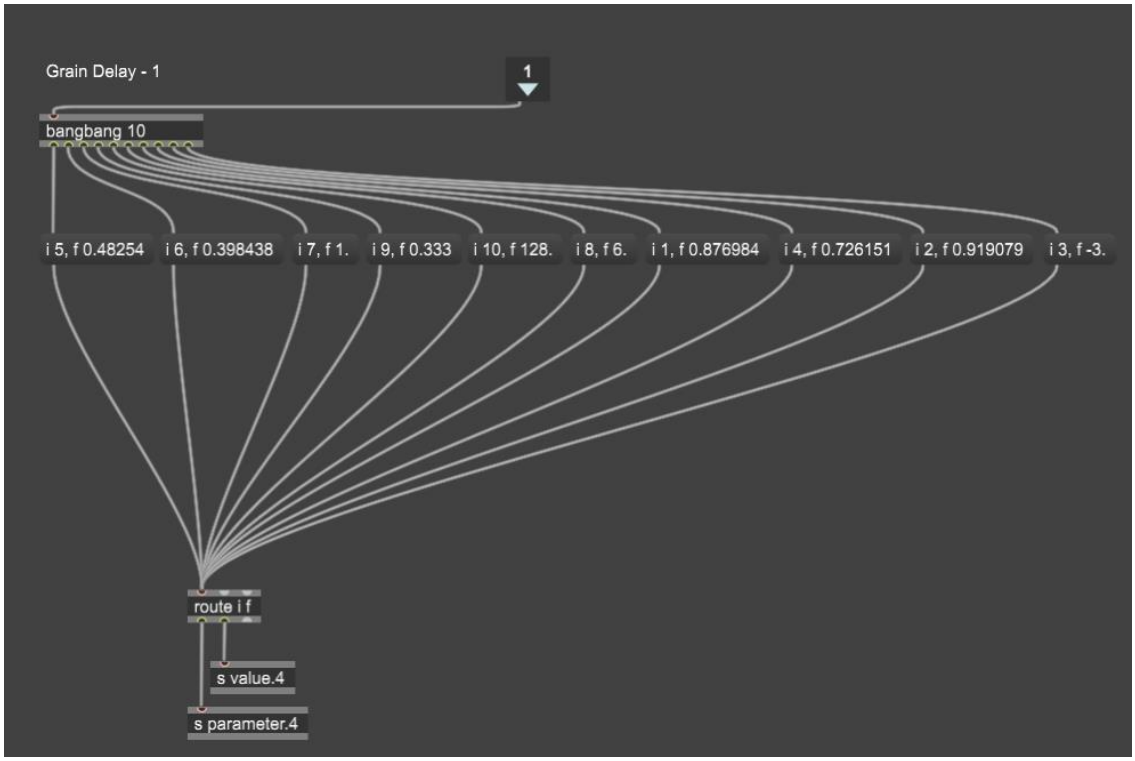

Figure 35: Scene 4 values and parameters

4.3 Improvements to Later Patches

I noticed that while I was practising and performing *Stung*, the programming for the last six or seven scenes was much better than the first five. This was due to the fact that I programmed the scenes in order from start to finish, and as I gained experience in programming, I improved at it. Likewise, each composition that I worked on following *Stung* included new ideas on how to structure the patches and became simpler but more sophisticated in design. The following sections will detail programming features that are unique to *Star Maker*, *Hex 2*, *Dréimire Mhuire*, and Yue Song's collection of bass clarinet works.

4.3.1 Enhanced Performance View

The second patch that I created was for *Star Maker* and I drew on *Stung*'s 2019 patch as a template to get started. One of the most important modifications that I made was to enlarge the scene number in the Performance View so that it was more visible while

performing (see Figure 36). I was straining my eyes during the first two performances of *Stung* just to make sure I was on the right scene number. With the larger scene number, I was able to quickly glance at my laptop during performance and this created a greater sense of ease.

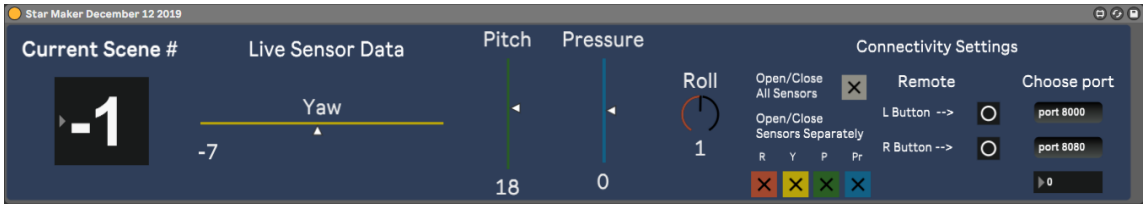

Figure 36: *Star Maker*'s Performance View

The colourful toggles that I initially used for troubleshooting became redundant so I removed these for *Hex 2* and later patches, freeing up space to further enlarge the scene number and sensor visualizations (see Figure 37). Enlarging the **live.slider** and **live.dial** objects allowed me to see more easily while performing. This enabled me to quickly glance at the current positions of the sensors and develop an enhanced sense of my virtual performance environment.

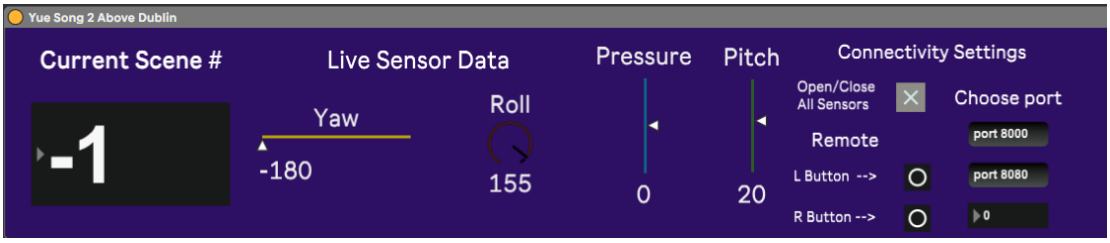

Figure 37: *Above Dublin* Performance View

4.3.2 Organizing Patches

A lot of components in *Stung*'s patch were visible in the main area of the patch, adding unnecessary clutter. An example of this is *Stung*'s Sensor On/off Router (see Figure 38). To clean up the look of *Star Maker*'s patch, I encapsulated the Sensor On/off Router in another subpatch,[18] **p SM sensor on off router** (see Figure 39). Similarly, the Sensor

[18] To encapsulate something in Max is to select all the desired objects and place them in a subpatch, where messy programming can be 'hidden'.

Boundaries do not need to be visible in the main part of the patch, so for *Star Maker*, I separated each sensor and hid them in **p** objects (see Figure 40).

I also continued to colour code the sensors. Data from the yaw sensor, for example, is coloured in yellow so if I am trying to find a yaw object, I just need to look for yellow-coloured objects in my patch.

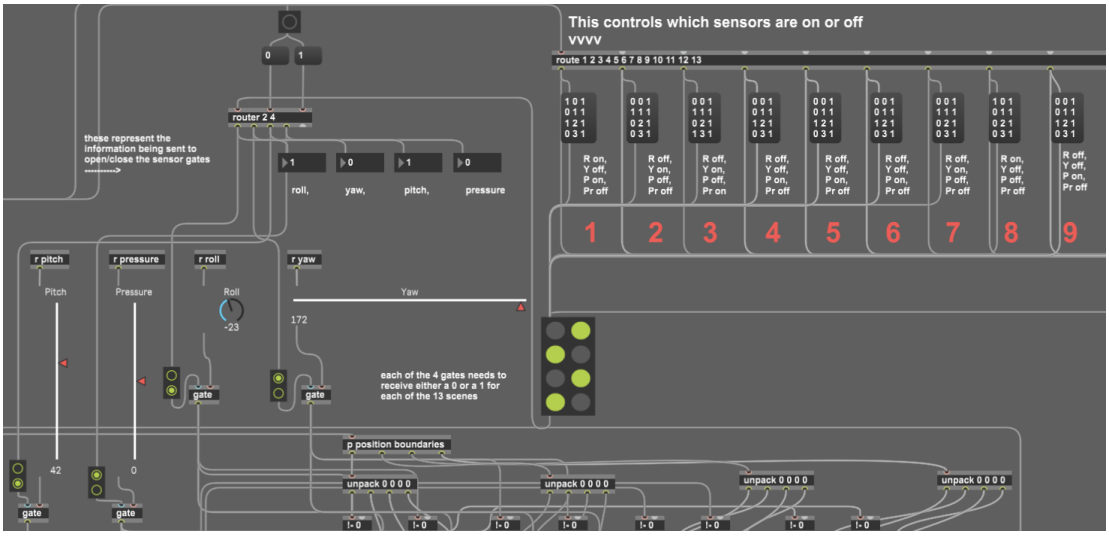

Figure 38: Clutter in *Stung*'s patch

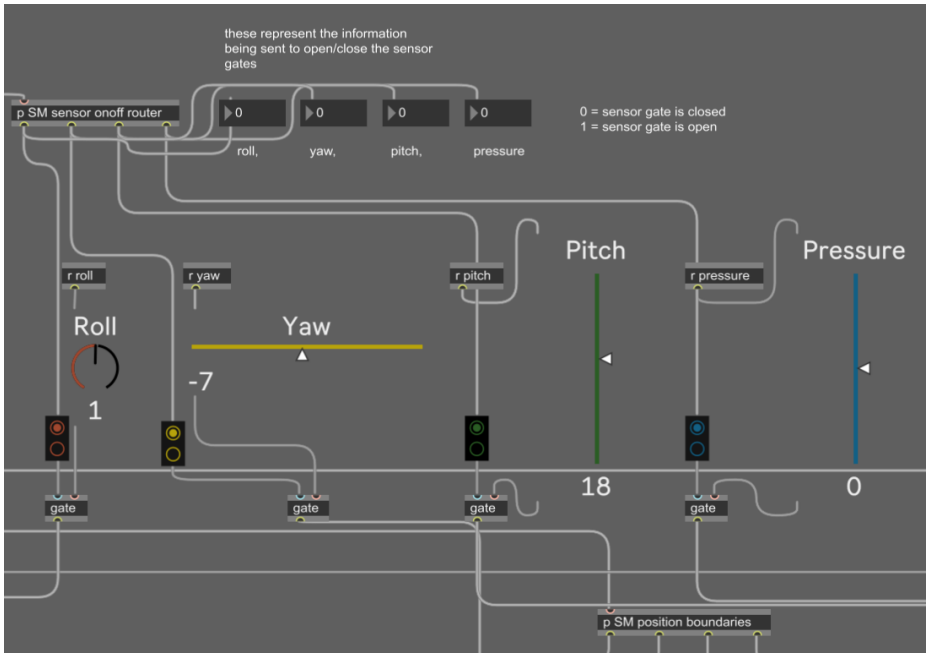

Figure 39: Top-right area of the *Star Maker* patch

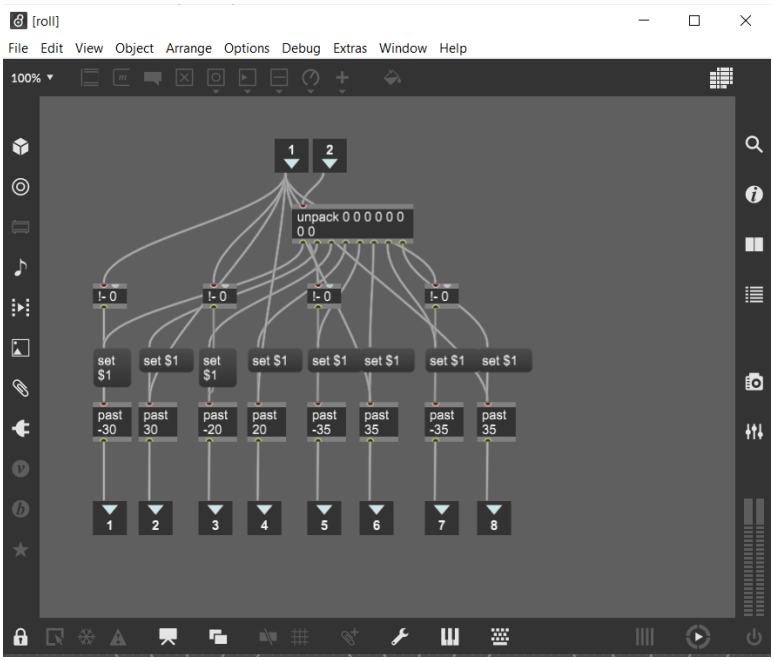

Figure 40: *Star Maker* Sensor Boundaries subpatch (roll sensor)

Keeping my patches organized is helpful not only for myself, but also for others who may use them in the future. Encapsulating components such as the Sensor Boundaries and colour coding the sensors makes it easier to understand the flow of data within the patch and how everything works together. Although these details do not directly affect the performance, understanding how the patch works is important if the performer needs to tweak something for their circumstance. For example, I have created a second version of *Star Maker*'s patch that allows me to capture a video of myself performing from my webcam. The more organized the patch is, the easier it is to edit the patch and repurpose it for a new situation.

4.3.3 Looper Control

Aside from adding live processing to Feery's *Star Maker*, I also added an improvisation of air sounds at the beginning (see section 6.2). While I was working with my supervisor, Paul Roe, we tried adding the improvisation as an experiment in one of my lessons. The air improvisation is recorded into Live's Looper device and is then played back throughout the first half of the work. The result is an added sound layer that ties together

the acoustic bass clarinet part and the live processing. In other words, it helps to integrate the live processing with the bass clarinet part.

The addition of the Looper device means that there are some changes to the programming that are unique to *Star Maker*, as I did not use the Looper again for any of the other works. The Master Counter contains a sequence of numbers from -1 to 4 and controls the additional subpatch **p SM Looper Control** (see Figure 41).

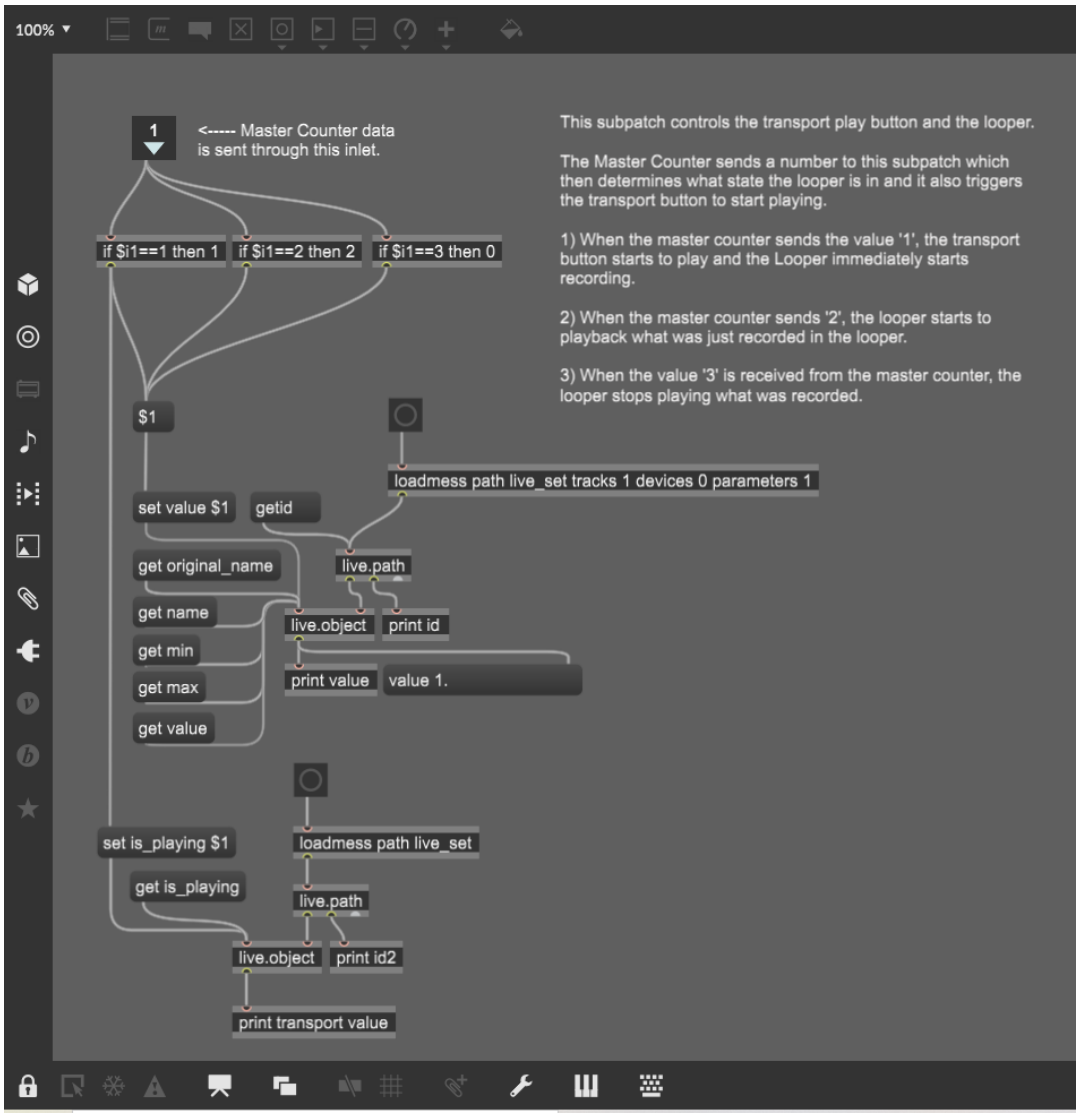

Figure 41: *Star Maker*'s looper control subpatch

In the **p SM Looper Control** subpatch, data from the Master Counter is received by an **inlet** object and is passed on to three **if** objects. These objects simply pass on the number specified if a certain condition is met. For example, if the first **if** object receives a 1, then it outputs a 1. This allowed me to programme different commands for the Looper based on the scene number.

When the Master Counter is set to -1 or 0, the Track Muter de-activates all tracks so that no sound is producible. It is designed this way so that the performer can discreetly check that the remote is working by right-clicking once, moving from scene -1 to scene 0. This was a small improvement that I added after performing *Stung*. During the first two performances of *Stung*, the audio effects were always active, even before I started playing. This means that when I was announcing my pieces, the microphone could potentially pick up my voice or other sounds and process it, sending strange noises out of the speaker. Although this could be amusing to the audience, it is much better for the performer to be able to have a pre-performance setting with all audio turned off.

When the Master Counter is set to 1, the Looper starts recording and the performer can begin the improvisation of air sounds. When the performer is finished with their improvisation, they can move the Master Counter to 2 and the Looper will play back the improvisation that was just recorded. At this stage, another audio track containing audio effects for the first half of the piece is unmuted. When the Master Counter reaches 3, it switches to the second set of audio effects and turns off the Looper. At the end of the performance, one more click will set the Master Counter to 4 and all audio effects will be muted.

4.3.4 The Soundworld Approach

The live processing for *Stung* and *Star Maker* was built on a scene-based concept, where the sensors control parameters of Live audio effects by passing pre-programmed boundaries. The main drawback of this approach is that the programming took a lot of

time. Another issue was that activating and de-activating audio effects in the middle of the performance could result in sounds being suddenly cut off. While performing *Stung*, I waited until the sound faded out completely before moving between sections so that I did not cut off the electronics. Unfortunately, this increased the length of the composition and created flow problems between sections.

When I created the live processing for my own composition, *Dréimire Mhuire*, I decided to develop an alternative method that would reduce the amount of time I spent programming and allow audio effects to fade. I was searching for a way to use the sensors so that I could use my natural performance movements to move through different audio effects. I imagined myself moving around in a sphere, interacting with the space around me to trigger different sounds. This concept became my soundworld approach.

To develop this concept, I chose to use the yaw sensor as the main way to navigate through the soundworld of audio effects. When holding the bass clarinet, the yaw sensor is the easiest to control over an extended period of time. The soundworld is created by dropping an Audio Effect Rack into a Return Track in Live and filling it with the desired audio effects (see Figure 42). Each audio effect in the Audio Effect Rack becomes a chain, which can be given a specified zone (shown in blue) in the Chain Select Editor. The yaw sensor is then connected to the Chain Selector, which moves through the zones, activating any audio effects in its path and de-activating those that are not.

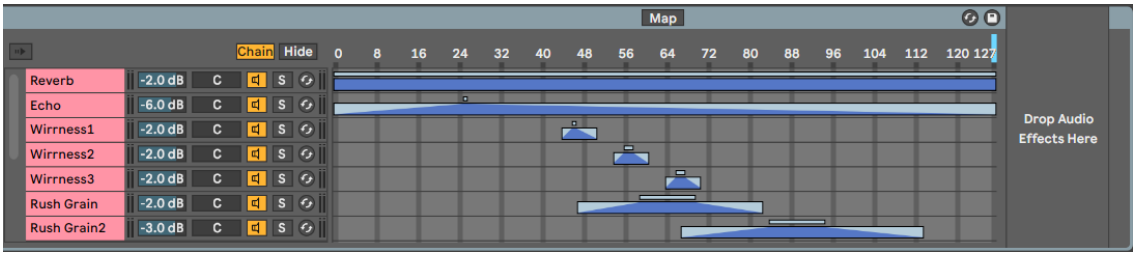

Figure 42: *Dréimire Mhuire*'s Chain Select Editor

To programme this, I created a subpatch called **p chain selector Centaury**. Using the **scale** object, the yaw sensor data is scaled to the Chain Select Editor's range of 0—127 (see Figure 43), before being sent to the Chain Selector control panel, shown in Figure 44.

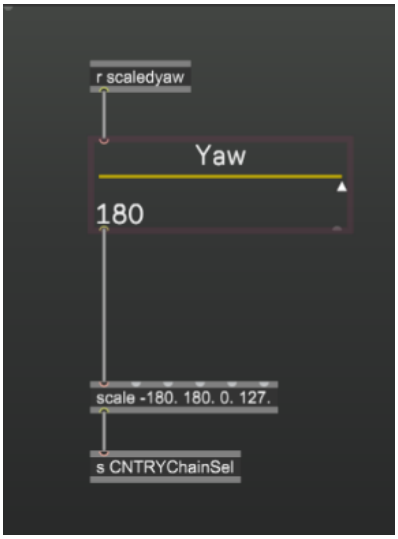

Figure 43: Top-right view of the **p chain selector Centaury** subpatch

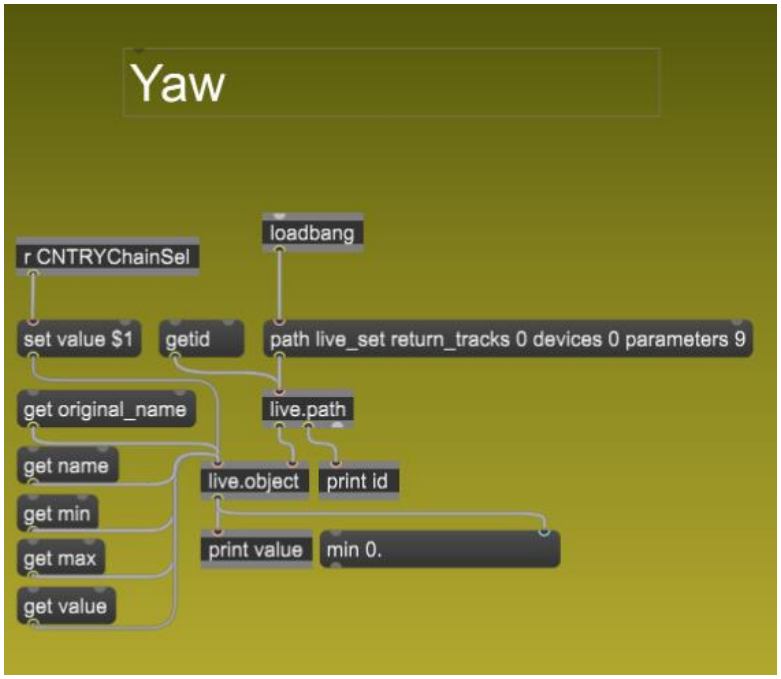

Figure 44: Top-left view of the **chainselectorcentaury** subpatch

In addition to using the yaw sensor to move the Chain Selector through a soundworld of audio effects, I also programmed the roll and pitch sensors to change select parameters of the audio effects. This is done by using the Sensor Boundaries, but in a simplified manner because there is only one scene to programme. By only programming one scene, it eliminated the need for the Parameter Router.

After the sensor data leaves the Connection Kit, it enters the sensor slider and dial area, as shown in Figure 45. A minor change that I made to this area in *Dréimire Mhuire*'s patch is the addition of the **scale** object to scale the sensors to my natural range of movement. For example, the roll sensor has a range of -180 to +180, which is a 360-degree rotation; however, in performance, I would move my clarinet or bass clarinet in a much smaller range. For this reason, I scaled down the sensor data to match the amount of rotation I would actually use while performing.

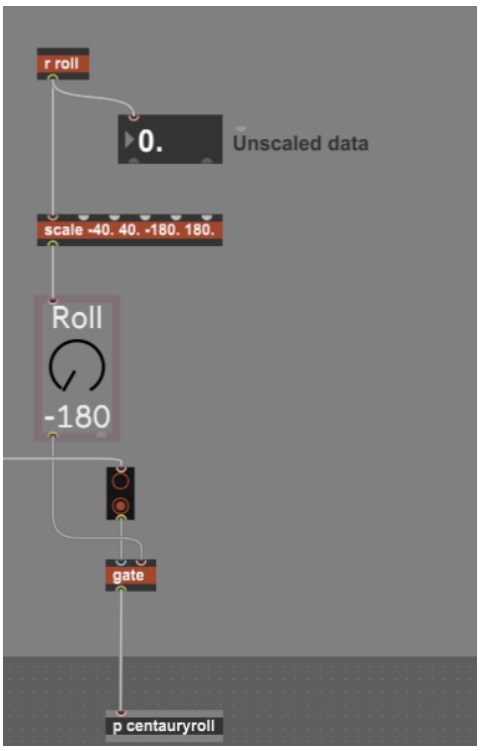

Figure 45: *Dréimire Mhuire* roll sensor data flow

Once the sensor data goes through the **scale**, **live.dial**, and **gate** objects, it enters the **p centauryroll** subpatch, which houses the Sensor Boundaries area and the Live device

controls (see Figure 46, Figure 47, and Figure 48). Since there is only one main scene in *Dréimire Mhuire*'s processing, there was no need to use the Parameter Router. For example, in *Stung*'s processing patch, I created device controls for thirteen different sections, but in *Dréimire Mhuire*, I only created one device control for the pitch sensor and one for the roll sensor. This substantially reduced programming time.

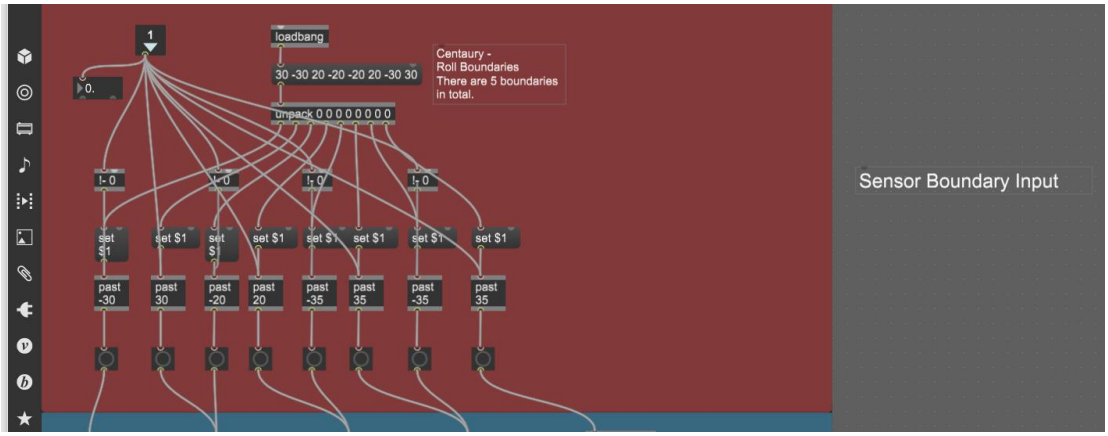

Figure 46: Top view of the **p centaury roll** subpatch

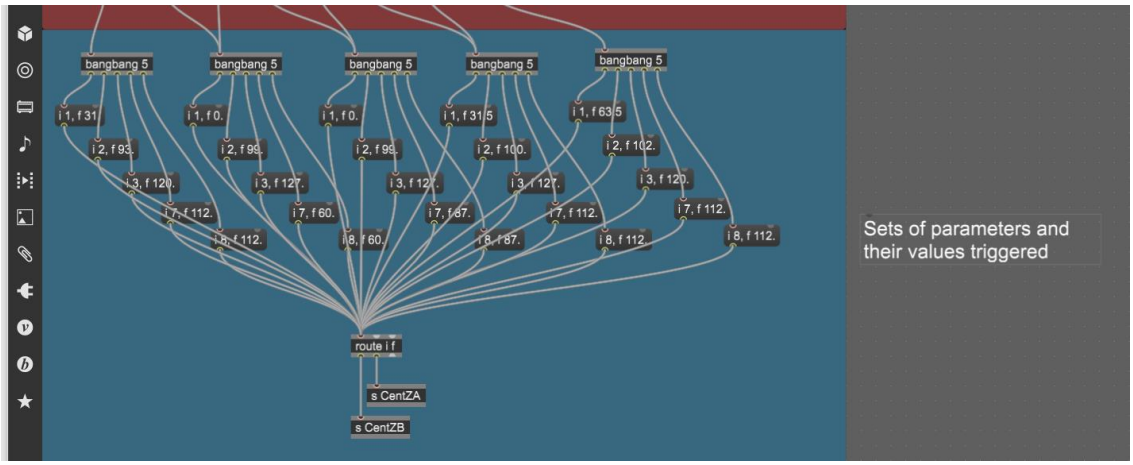

Figure 47: Middle view of the **p centaury roll** subpatch

Figure 48: Bottom view of the **p centaury roll** subpatch

4.3.5 Live Processing and a Fixed Soundtrack

The unique aspect of programming *Hex 2* was combining its fixed soundtrack with live processing. I did not programme each section of *Hex 2* like I did for *Stung*, even though both pieces are modular in structure. The main difference between *Stung* and *Hex 2* is that *Hex 2* contains a fixed soundtrack. Texturally, *Hex 2* is already dense with its soundtrack and bass clarinet part. I adopted the soundworld approach for *Hex 2* because a more complicated live processing approach, like the one I created for *Stung*, would likely get lost in the dense texture.

The first time I performed *Hex 2* was during the COVID-19 pandemic so I programmed it specifically to be performed at home. The controls for launching the soundtrack, seen in Figure 49, are mixed in with the controls that were necessary for capturing video on my webcam. The **select** objects are connected to the Master Counter via an **r** object. When they receive information that matches their argument, then they send out a bang. For example, when the **select 1** object receives a 1, it emits a bang which then triggers a **call fire** message that starts playing *Hex 2*'s soundtrack.

The Master Counter was set from -1 to 2. It made sense to use -1 as a pre-performance setting and scene 0 to record a clap so that I could line up the audio and video recordings after performing. When the Master Counter is set to 1, the soundtrack is triggered, the Audio Effect Rack containing all the audio effects becomes active, and the performance

starts. At the end of the performance, setting the Master Counter to 2 lets any sound remaining in the system fade out, while also disabling audio input.

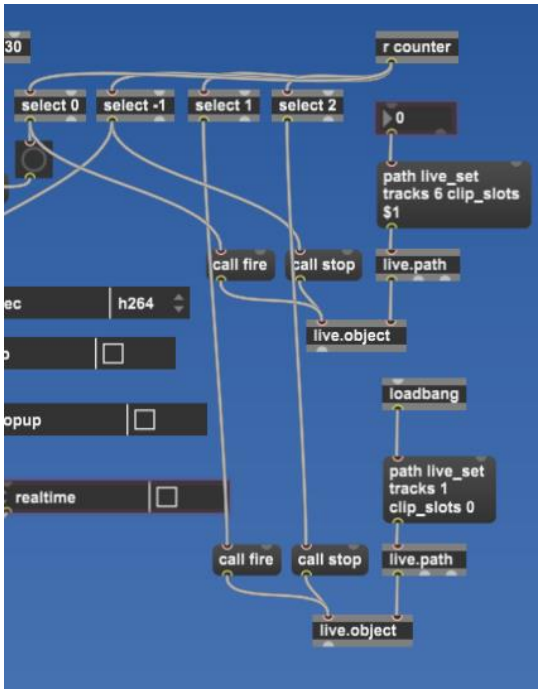

Figure 49: Triggering *Hex 2*'s soundtrack in Live

4.3.6 Mixing Approaches and New Techniques

By 2020, I had started collaborating with Yue Song on her series of works for bass clarinet and the SABRe multi-sensor (see section 2.6). By this time, I had developed different approaches to programming the sensors. This was beneficial to our collaboration because I was able to combine these different methods to implement Song's ideas. Additionally, I also developed two new techniques by working with Song.

Most of her works are programmed in a scene-based manner to accommodate her desire to have audio effects tied to particular passages in the bass clarinet part. To move through Song's sequence of effects, I often only needed to programme the SABRe remote. In some of Song's works, however, I used the soundworld approach to navigate through audio effects, but in a way that was choreographed. For example, in *Above Dublin*, there is a section where Song wanted to activate audio effects, one at a time,

culminating in a complex frenzy of bass clarinet and electronic sounds. The difficulty of programming this was that I did not want to be pressing the remote button every few bars to activate a new effect. Instead, I decided to place all audio effects that were needed in that section of the piece in an Audio Effect Rack. I modified the soundworld approach by placing them in the Chain Select Editor in a stair-like manner so that I could activate them one at a time by moving in a certain direction (see Figure 50).

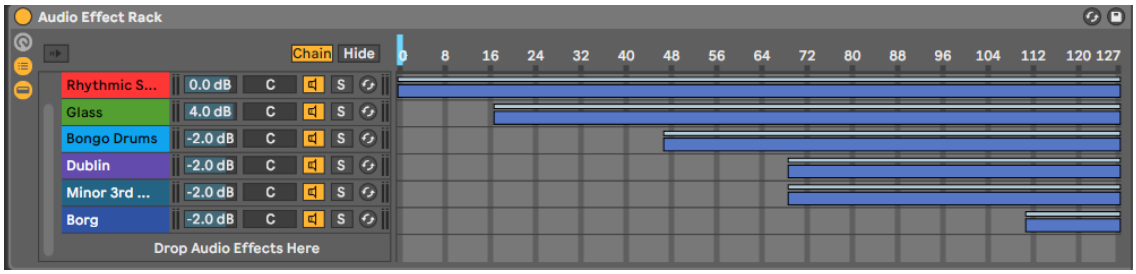

Figure 50: *Above Dublin* Audio Effect Rack

In addition to using the sensors to navigate through different effects, Song and I also tried using the sensors to alter effects that were already active. To do this, I used the same parameter boundary method that I used for *Stung* (see section 4.2.6). We experimented with all the sensors, including the air pressure sensor. An example of this is at the beginning of *Bamboo After Rain* where there is a long section in the score with the effects Borg and Storm Delay active; the roll sensor modifies Borg and the air pressure sensor modifies Storm Delay.

One of the new techniques that I developed during our collaboration was using a performance gesture to trigger changes in the electronics. There were places in some of Song's works where it was difficult to use the remote, so I decided to try using the sensors to navigate the sequence of effects instead. I immediately thought of the gesture that I use in chamber music when I am giving a cue with the bass clarinet. This gesture involves lifting the bass clarinet upwards and bringing it back down again to communicate the beat to other performers. I decided to use this same gesture to cue the electronics because it would be easy to control and would feel natural.

The downside to this approach is that sometimes when I am moving while performing, I lift my bass clarinet upwards, accidentally triggering the wrong effect. For this reason, I built in a counter-gesture to move backwards through the effects. This is done by dropping my bass clarinet in a downwards motion. In Max for Live, I achieved this by feeding the pitch sensor data into **past** objects (see Figure 51)[19]. In *Bamboo After Rain*, for example, if the pitch sensor moves past +18, it outputs a bang, moving the Master Counter to the next setting. Similarly, if the pitch sensor moves lower than -15, then a bang is emitted, moving the Master Counter's backwards.

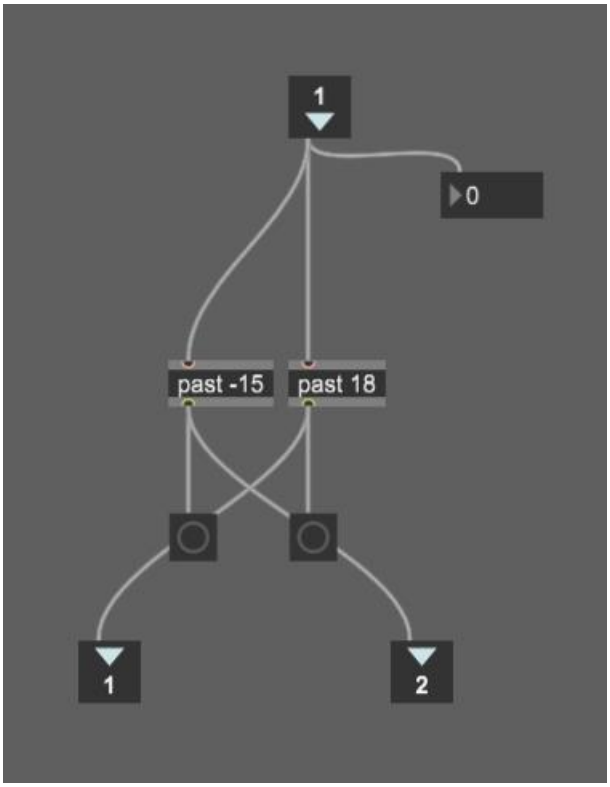

Figure 51: **sitwmovementcontrol** subpatch for *Bamboo After Rain*

The second technique that I developed was using a timer to fade in or fade out effects. In some of Song's works, the audio effects change every few bars. For example, in *Stories in the Wind*, there are several changes between bars 40 and 43. In bar 40, the audio

[19] In Figure 51, the first input is connected to the pitch sensor. The first output is connected to the left button on the remote and the second output is connected to the right button.

effect Rhythmic Space is active, but it needs to be turned off in bar 41. Then only two bars later, two different effects, Ascent and Rhythmic Space, need to become active. There is not enough time between bars 40 and 43 to control all of this with the remote or with a gesture, so I employed the fade-in technique. On the second beat of bar 41, I lift my bass clarinet up with the aforementioned gesture to trigger the electronics. Over the course of 6 seconds, the Ascent and Rhythmic Space are slowly brought to life so that by the time I reach bar 43, they are clearly audible.

To generate the fade, I used the **line** object (see Figure 52). I used a message to specify how I wanted the **line** object to act. In Scene 3 of *Stories in the Wind*, I wanted Ascent and Rhythmic Space to fade in over six seconds so I created a message to notify the **line** object to generate a ramp from off to on over 6000 milliseconds.[20] The **line** object directly controls the return tracks in Live where Ascent and Rhythmic Space are housed.[21] With this method, I can fade audio effects in or out over any number of seconds.

[20] This message reads, '0, 1 6000'.
[21] For more on how I used return tracks, see section 5.2.

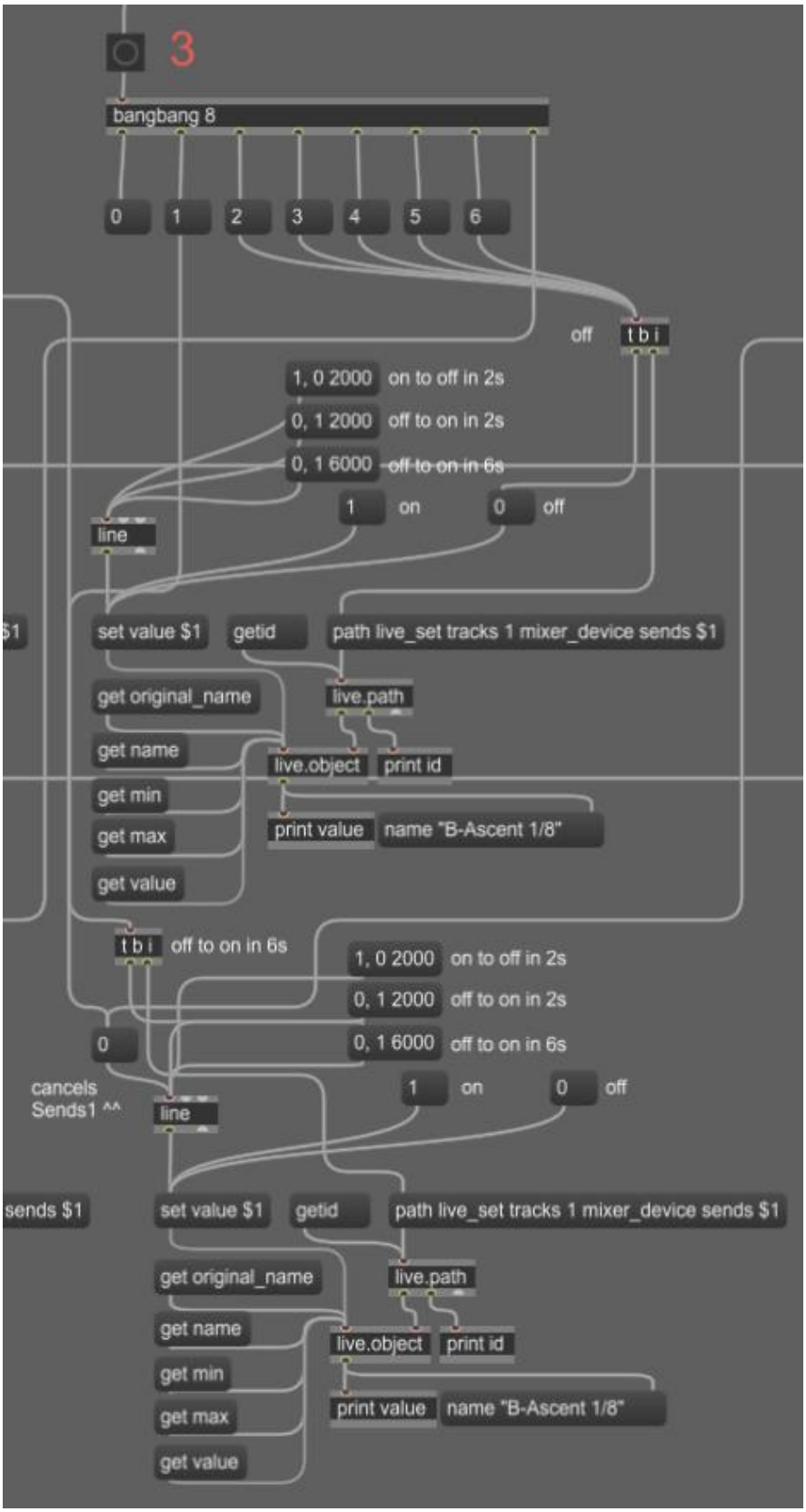

Figure 52: an extract from the **p BARsendswitch** subpatch showing the **line** object

4.4 Practice-informed Programming or Programming-informed Practice?

It has been beneficial to be both the performer and the programmer during this project. I have been able to experience the problems with my programming and find solutions until I feel at ease as a performer. This ended up as a collaboration of sorts with myself, alternating between the roles of performer, programmer, and researcher. The switch between roles was engaging and revealed insights into my practice that I may not have noticed otherwise.

In particular, I experienced a tension between my role as a programmer and my role as a performer that was present at all stages of the research process; however, I noticed it most acutely while building performance patches in Max for Live. The practicalities of using Max for Live would pull my mind in one direction and my artistic vision would pull it in another. This tension was beneficial to my experience as both a performer and programmer.

Artistic tasks, such as practicing and performing, and technical tasks, such as programming, require different modes of thinking. Consequently, one of the most challenging aspects of using Max for Live is translating creative ideas into a programming language. Computers are not inherently musical, but programmers have developed software that allows musicians to incorporate computers into music performance. Ge Wang describes the shortcomings of computers:

> [O]ne thing to keep in mind is that while computers are wonderful tools, they can also be wonderfully stupid. Computers are inflexible and demand precision and exactness from the programmer. They don't know to inform us even of our most obvious mistakes (unless someone has told the computer precisely what to look for). Furthermore, since we must formulate our intentions in terms of the syntax of the underlying [computer] language, musical ideas are not always straightforward to translate into code.[22]

[22] Collins, Nick and Julio d'Escriván (eds.): *The Cambridge Companion to Electronic Music* (New York, NY: Cambridge University Press, 2007), 55–56.

Translating my artistic ideas into a programming language proved to be challenging, but it was through constantly switching between practice and programming that I made progress. I was able to experiment with every version of my Max for Live patches and improve them based on my experiences using them while practising. I not only listened to how each section sounded, but I also paid close attention to the relationship between my movements and the resulting electronic sounds. I took notes about what did not feel or sound right.

The ability to edit the patch and tailor it to my own needs was extremely valuable. Not only did this enhance the quality of the electronic layer, but it also allowed me to develop a patch that felt physically comfortable for my body. If the performer finds the sensors difficult to control, then it will distract them from playing their instrument. On the other hand, if the performer finds the sensors easy to control, then their physical movements and gestures will appear more natural.

From a programming perspective, I was surprised to find how important it is to consider the performer's body in relation to using the sensors. Some of the questions I asked myself while programming were as follows:

- How much can I lift the bass clarinet up without straining?
- How far can I move the bass clarinet in any one direction without ruining my embouchure?
- How long can I hold the bass clarinet in any one position?

I was in the advantageous position of being able to explore these questions and tailor the sensors to my abilities. The main physical consideration that I explored was range of movement. There are many factors that affected this including the equipment I was using, the weight of the instrument, and the notes played.

In terms of equipment, I previously used a long peg to support the weight of the bass clarinet; long pegs are designed so that the performer can stand while performing. One of the challenges I discovered while using the sensors was that the long peg did not allow me enough freedom to move around. As an alternative, I started using a shoulder strap, which was pivotal in opening up my range of physical movement. The standing peg only allows the performer to stand in one location, whereas the shoulder strap grants the performer freedom to move the bass clarinet in different directions, to lift it up, or to tilt it downwards. This expanded range of movement was essential for taking advantage of the sensors' capabilities.

The trade-off for using the shoulder strap is that the weight of the bass clarinet is no longer supported by the floor. Instead, most of the weight of the instrument is placed on the shoulders of the performer and this presents its own problems. For example, the lowest notes on the bass clarinet require most or all of my fingers and pressing the keys down on the front of the instrument pushes it towards my body. It is difficult to play certain notes while using a shoulder strap without resting the bass clarinet on my leg. This means that my range of movement, such as being able to lift the bass clarinet, can be very small for particular notes.

Not only did practice inform my programming, but programming informed my practice. The more experience I gained programming, the more attention I paid to my body while practicing with the sensors. By doing so, I was able to make better decisions while creating the performance patches in Max for Live.

4.5 Conclusion

This chapter provided an in-depth look into programming the SABRe sensors and remote, as well as a short commentary on how the activities of performing and programming can influence one another. Although this chapter is technical in nature,

many performative aspects are discussed to highlight how each programming decision affects the ensuing performances.

A recurring theme in this chapter was the necessity of problem-solving. Each of the nine works that I created patches for required a different approach because of the structure and content of the bass clarinet scores. For example, the modular, scene-based approach that I employed for *Stung*'s patch would not have worked for *Dréimire Mhuire* or *Hex 2*, so I used Audio Effect Racks to create a 'soundworld' instead. The more I performed, the more I noticed what could be improved in each successive patch. I continuously revised my approach to programming so that it would take less time and would be easier to set up before a performance. By the time I collaborated with Song on her five compositions, I had already developed many techniques for programming the sensors. I was able to utilize these to create patches for Song's compositions, some of which contained many audio effects that needed to be activated and de-activated in a timely manner.

While programming the sensors, I often oscillated between technical and artistic thinking, trying to strike a balance between the practicalities of using the SABRe sensors and seeking nuance and meaning in my performance practice. The granular details of the programming process support my desire to develop greater integration between the performer and technology, with the performer at the centre of all programming decisions. The technical details in this chapter are directly related to the next chapter, which explores the process of developing the live electronic soundscape.

CHAPTER FIVE: THE AESTHETIC CONSIDERATIONS OF AUDIO EFFECTS

5.1 Introduction

As delineated in the last chapter, the Max for Live patches that I created allow the SABRe sensors and remote to control elements of Live, such as audio effect parameters and the Chain Select Editor. This chapter will explore the process of selecting and modifying audio effects, including why I decided which audio effects to use and which of their parameters to control. To aid in the description of how the effects process the sound of the bass clarinet or clarinet, links to sound clips on YouTube are provided in the footnotes. To indicate that there is an audio example, the '🔊' icon is used in the text. This icon also acts as a link and can be clicked on to access the audio clips.

Each composition already had a completed bass clarinet or clarinet part before I added the sensors and live processing; therefore, the main factor that I considered was which effects would work best with the bass clarinet or clarinet part. Frank Lyons' *Stung* was the first composition that I created a patch for.[1] I examined the score purely hoping to find some sense of direction for developing the live processing. With each performance that followed my first performance of *Stung*, I became more deliberate about studying the score and used it as a point of entry for building Live Sets and Max for Live patches. There were three specific features that I investigated in the scores while developing a concept for the live processing: structure, aperture, and the clarinet range.

When I am considering the structure of a score, I am asking, 'is the musical material linear or modular?', and 'are there clear sections in the score?' *Stung* and *Hex 2* are both examples of a modular structure. With these works, the bass clarinet material is

[1] See section 1.1 for more information on Frank Lyons' *Stung*.

arranged in clearly marked sections or boxes that do not have to be performed in a certain order. The difficulty with this type of layout is that a certain degree of randomness needs to be accommodated in the live processing patch. The programming needs to allow for the performer to choose different pathways during the performance.

Star Maker, *Dréimire Mhuire*, and all of Yue Song's compositions follow the traditional linear 'start to finish' layout. This presents its own challenges for programming the live processing. Some audio effects work well in one section of the piece but can be underwhelming or overpowering in another. For this reason, it is important to consider at what point the performer will activate or de-activate audio effects; switching audio effects in the middle of a phrase may cause unwanted interruptions to the flow of music. Looking at the structure of the work can help determine what kind of live processing to create.

Another factor that should be considered is aperture—how much of an opening is there in the bass clarinet or clarinet part for electronics to develop and be heard? Generally, phrases with many notes become busy when live processing is added, leading to a thick texture. If audio effects are continuously active, it is comparable to leaving the damper pedal on the piano down for too long—the proliferation of sound can either become magical or muddy. On the other hand, long notes and rests allow for electronic sounds to develop and be heard. Some audio effects, such as certain phasers, require a longer period of time to unfold than quick-reacting effects like grain delays. Much of this is also influenced by the tempo. If a passage of notes is played at a slow tempo, the effect can be markedly different than if it is played quickly.

Finally, the range of the clarinet plays a key role in determining the resulting electronic sounds. I have discovered that audio effects will produce wildly different sounds depending on whether a low or high note is played. If there are quick leaps in register in a particular passage, it can be difficult to find an effect that is appropriate. The direction

of the phrase can also determine if the audio effect will work well or not; when I was collaborating with Yue Song, she pointed out that some audio effects, such as Live's Ascent, work better in an upward passage rather than in a descending passage.

Selecting audio effects is not a simple task. A good knowledge of the score and an artistic vision are required to shape the potential effects of the live processing. Additionally, Live's presets can be modified to create vastly different results. The rest of this chapter will describe my experience selecting and modifying Live audio effects for my performances.

5.2 The Audio Effects for *Stung*

There are two different Live Sets for performing *Stung*: the original from 2019 and a revised version from 2021. The audio effects of the 2019 version are housed in tracks two to six (see Figure 53). The first track holds the programming created in Max for Live, as discussed in the previous chapter, and the seventh track is a dry signal of the bass clarinet input. After practising *Stung* with the sensors and audio effects, I decided not to use the dry signal because the effects do not overpower the bass clarinet.[2] The 2019 Live Set also includes one return track with Reverb.

[2] The purpose of the dry signal is to boost the bass clarinet levels. Without the dry signal, the bass clarinet will still be heard, but it will not be amplified through the speakers (without effects).

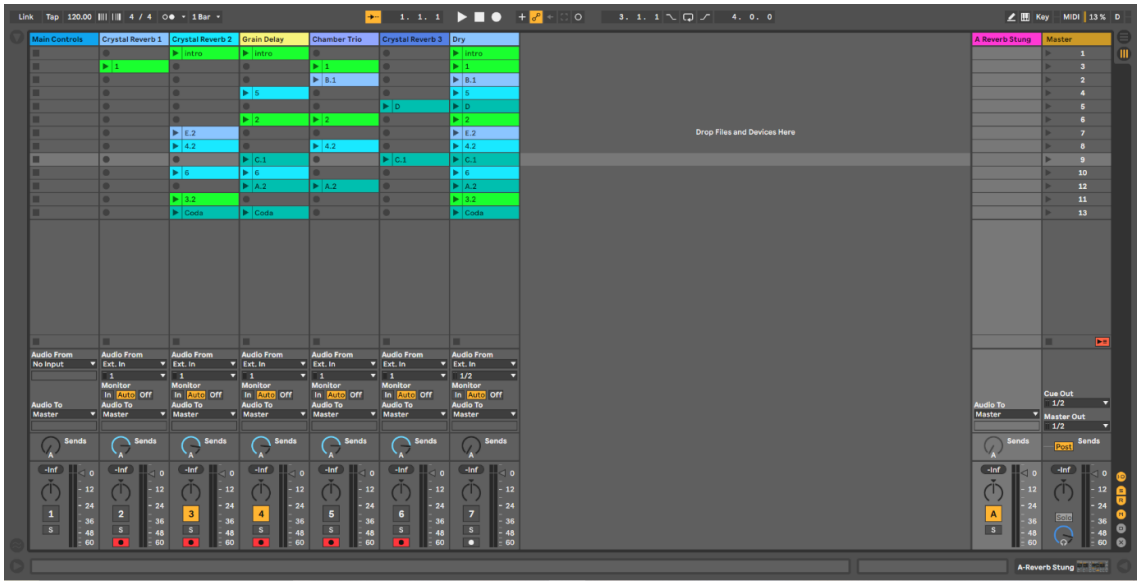

Figure 53: The 2019 Live Set for performing *Stung*

The revised 2021 Live Set is set up differently to make a small, but significant improvement. When I performed the 2019 version, I de-activated tracks when switching from one scene to another, leading to the audio effects being cut off as soon as the track was de-activated. To solve this problem, the 2021 Live Set houses audio effects in return tracks, instead of regular audio tracks (Figure 54).

I routed the bass clarinet input through the *sends* dials of the second audio track, marked in Figure 54 as Bcl Input. These determine how much of the audio track is sent to the associated return track. The sends dials correspond to return tracks via a lettering system (A, B, C, etc.). For example, in Figure 54, the sends dial A will direct its audio signal to return track A, entitled Crystal Reverb. The return tracks route their signals back to track three (With Effects). The benefit of this setup is that even when the sends are switched off (-inf dB), any sound still travelling through the return tracks will continue to be sent to the speakers and will not suddenly be cut off.

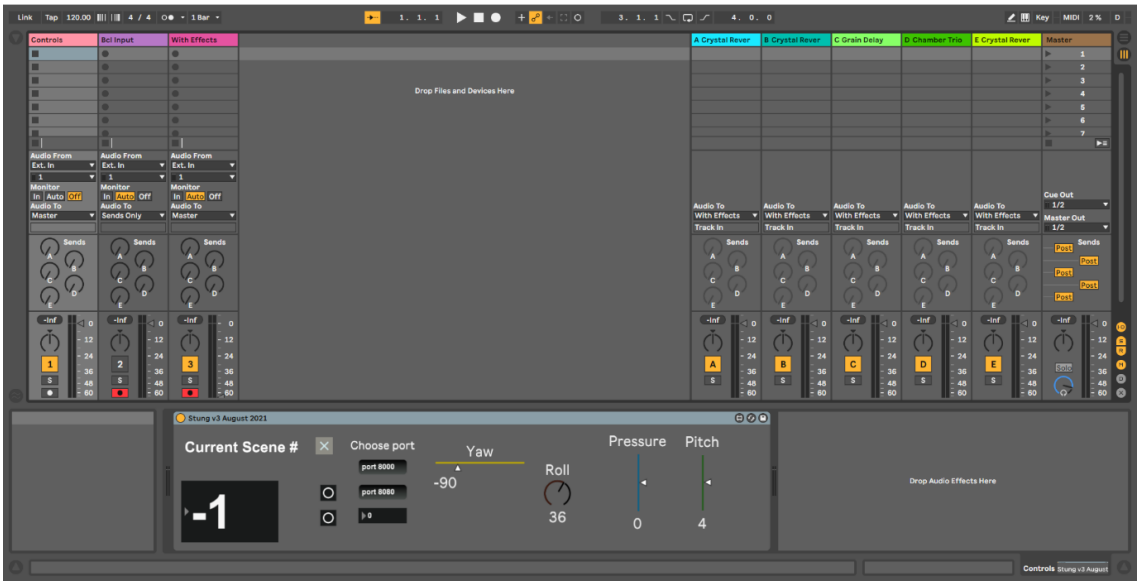

Figure 54: The 2021 Live Set for *Stung*

It was not difficult to select audio effects for *Stung* because the composer's version already included live electronics. Frank Lyons sent me his Live Set for *Stung*, containing all the audio effects he used when controlling the live processing himself. In an email to me, he wrote the following:

> Please feel free to improvise your own processing – what I have done is a rough guide only. The sensors might open up wider possibilities.[3]

Although Lyons was open to a different version of the live processing than his own, I decided to use his audio effects and section order (see Figure 55), mostly because I was unfamiliar with Live at this point. To create the live processing for *Stung*, Lyons uses audio effects Grain Delay and Reverb, as well as Audio Effects Racks entitled Crystal Reverb 1, Crystal Reverb 2, and Chamber Trio. Audio Effect Racks are shells that can contain many audio effects (see Figure 56). For my performances of *Stung*, I used the same effects as Lyons, but I also created my own Rack using one of his Crystal Reverb Racks as a template. I thought it was fitting to name this 'Crystal Reverb 3'.

[3] E-mail correspondence with Frank Lyons, 9 Jan 2019.

Reverb on for whole piece.

Intro – Crystal Reverb 2 (higher pitch) plus Grain Delay

I – Crystal Reverb 1 (lower pitch) plus Chamber Trio

B – Chamber Trio

V – Grain Delay (high pitch)

D – Crystal Reverb 1 (lower pitch)

II – Chamber Trio plus Grain Delay

E – Crystal Reverb 2 (high pitch) – very light processing

IV – Crystal Reverb 2 (high pitch) plus Chamber Trio

C – Chamber Trio (low pitch) plus Grain delay

VI - Crystal Reverb 2 (high pitch) plus Grain Delay

A - Chamber Trio plus Grain Delay

III - Crystal Reverb 2 (high pitch) – very light processing

Coda - Crystal Reverb 2 (higher pitch) plus Grain Delay

Figure 55: Lyons' Live Processing and Section Order for *Stung*

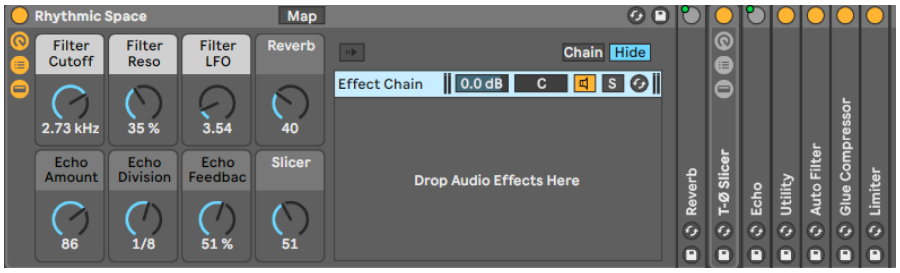

Figure 56: Live's Audio Effect Rack, entitled Rhythmic Space

After determining which audio effects to use, I concentrated on how they affected the sound of the bass clarinet. I set up my bass clarinet and a microphone, playing excerpts from *Stung* and listening for the result of each effect. This approach was physically tiring and it was difficult to hear the electronics while I was playing because the sound from the bass clarinet overpowered the sound coming out of my headphones. To solve this

problem, I decided to record each section of *Stung* into Live and add audio effects on playback, adjusting the parameters of the effects in real time.[4]

Applying audio effects to recordings worked very well when I did not have access to speakers to practice with, but in an ideal situation, it would be best to experiment with audio effects in a room with speakers. It is much easier to hear nuance in the live processing through headphones than in a room with speakers because there are no room acoustics; however, the audience will not experience the electronics through headphones so it is better to practice in the performance space to gauge how the live processing will actually sound.

By experimenting with the parameters of each audio effect, I established which parameters could be changed by the sensors in performance and which parameters should remain unchanged. It was easy to decide which parameters not to change because changing them would produce unwanted sounds, such as strange clicking noises or extremely loud sounds that overpower the bass clarinet line. Conversely, other parameters were not selected because they did not alter the bass clarinet sound enough.

The more difficult decisions were determining which parameter changes fit the style of the composition, or even of a particular section. To develop an idea of the kinds of sounds I wanted to hear, I listened to Paul Roe and Frank Lyons' recording of *Stung* on SoundCloud.[5] I noticed that each section of *Stung* had its own character and I did not want the sensors to take away any of the character. I did not try to copy Lyons and Roe's performance of *Stung* exactly, but I did try to emulate the palette of electronic sounds that Lyons achieved.

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[4] Parameters change how the effect works; some parameters of the Reverb effect, for example, include the Dry/Wet and Predelay dials.

[5] Lyons, Frank, 'Stung', *SoundCloud*, 17 March 2013, *https://soundcloud.com/frank-lyons/stung*, accessed 27 December 2021.

I programmed all of *Stung*'s sections in order, starting with the Introduction. This process went something like this:

> As I listen back to my recording of the Introduction section of *Stung*, I activate audio effects Crystal Reverb 1 and Grain Delay. I am in the middle of trying to decide which parameters of these audio effects the sensors will control. Crystal Reverb 1 is an Audio Effect Rack, so there are eight Macro Controls that I can manipulate to change the effects that make up the Rack.
>
> I move each knob back and forth, listening for how it changes the bass clarinet recording. I can see why Frank Lyons named this audio effect Crystal Reverb, as it seems to create high noises that sound like little pieces of distant crystal. As I move the dry/wet dial, the effect becomes weaker and stronger. I like the idea of using the sensors to control this dial because I can't imagine I would want constant crystal sounds.[6]

As I continued to select the audio effect parameters that the sensors would control, I developed a better sense of the function of each parameter and how different sounds can be created. The following narrative recounts this realization:

> I am working on scene six, which is Section Two of *Stung*. The active effects are Grain Delay and Chamber Trio. I have had a bit of experience using Grain Delay now so I have discovered that all sorts of interesting sounds can be made by changing its parameters. For instance, depending how the settings are altered, it can make the bass clarinet delay (echoes) sound like a swarm of insects or the rush of ocean waves. In this scene in particular, I have adjusted the parameters to create a delay that sounds like a tolling bell. I decide to leave Chamber Trio's parameters constant because Section Two is only a few bars long and it does not need a lot of room for variation. This will also keep the programming to a minimum.[7]

As the end of this excerpt indicates, I was balancing between my thoughts as a performer and as a programmer. I was constantly searching for particular sounds that would fit into my view of *Stung*'s soundscape, such as the tolling bell, yet also thinking ahead to how it would need to be programmed.

After determining which audio effect parameters I would alter with the sensors, I needed to decide which sensors would control these parameters. I watched videos of myself practising each section of *Stung* to determine which sensor would be the most suitable.

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[6] Reflective Journal Entry, 24 January 2019.
[7] Reflective Journal Entry, 26 January 2019.

For example, if I noticed that I was moving my bass clarinet up and down a lot, then it made sense to use the pitch sensor to alter the audio effects.[8] I wanted to programme it this way so that my natural movements would affect the electronics, meaning that I could perform as I normally would, just as if Lyons was there controlling the electronics beside me. I did not want to have to think about moving in a certain way. If I had not watched the videos during the programming process, the connection between the sensors and the resulting electronics would have lacked depth. It may have forced me to make unnatural movements in performance in order to produce audible changes to the processing.

The following table shows which sensors are active in each section of *Stung*, as well as what parameters they are controlling:[9]

Scene Number	Section of *Stung*	Active sensor(s)	Audio Effect(s) Controlled	Parameters Controlled (of Audio Effect)
0	Introduction	Pitch	Grain Delay	Dry/Wet
		Roll	Crystal Reverb 2	Dry/Wet (of the Rack's Grain Delay)
1	2	Yaw	Crystal Reverb 1	Reverb Decay Time
			Chamber Trio	Pitch (Grain Delay, chain 1), Pitch (Grain Delay, chain 2)
2	B	Yaw	Chamber Trio	Pitch (Grain Delay, chain 1), Pitch (Grain Delay, chain 2)
		Air Pressure	Chamber Trio	Dry/Wet (Resonators, chain 1), Dry/Wet (Resonators, chain 1)

[8] Note that here, *pitch* refers to the pitch sensor (y-axis rotation) and not musical pitch.
[9] To hear how the effects listed in this table sound, an audio recording on YouTube is provided: https://youtu.be/jstX41w-RwE. The first performance of the SABRe version of *Stung* can be viewed here: https://youtu.be/GcFEtD7yRpI. This was recorded by Matthias Mueller at SABRe Day in Zurich, Switzerland on 2 February 2019.

3	5	Pitch	Grain Delay	Spray, Frequency, Pitch, Random Pitch, Beat Delay
4	D	Pitch	Crystal Reverb 3	Reverb Density
5	2	Pitch	Grain Delay	Spray, Random Pitch
			Chamber Trio	None (constant values)
6	E	Yaw	Crystal Reverb 2	Beat Delay (of the Rack's Grain Delay)
7	4	Roll	Chamber Trio	Pitch (Grain Delay, chain 1), Pitch (Grain Delay, chain 2)
			Crystal Reverb 2	None (constant values)
8	C	Pitch	Grain Delay	Pitch
9	6	Pitch	Grain Delay	Pitch, Dry/Wet, Beat Delay
			Crystal Reverb 2	None (constant values)
10	A	Roll	Grain Delay	Spray, Pitch
			Chamber Trio	None (constant values)
11	3	Pitch	Crystal Reverb 2	Dry/Wet (of the Rack's Grain Delay)
12	Coda	Pitch	Grain Delay	Frequency, Pitch, Random Pitch, Beat Delay
		Yaw	Crystal Reverb 2	Dry/Wet and Beat Delay (of the Rack's Grain Delay)

Table 1: Sensor Mapping for *Stung*

The process of connecting the sensors to particular audio effects and their parameters was largely one of trial and error. The activities of practising and programming were separate but fed into one another through my blue notebook. Pages from this provide a glimpse into the rather messy process I experienced:

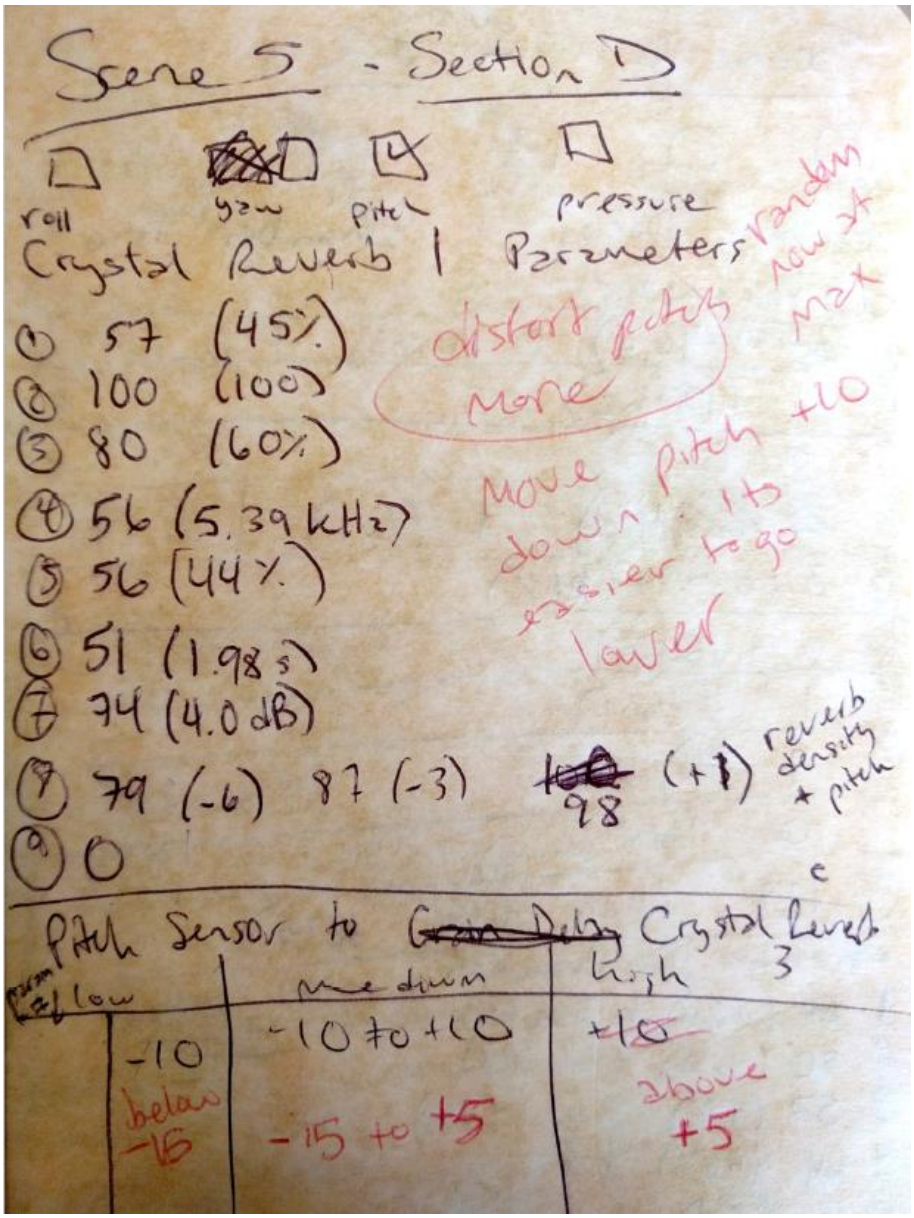

Figure 57: Scene Five from My Blue Notebook

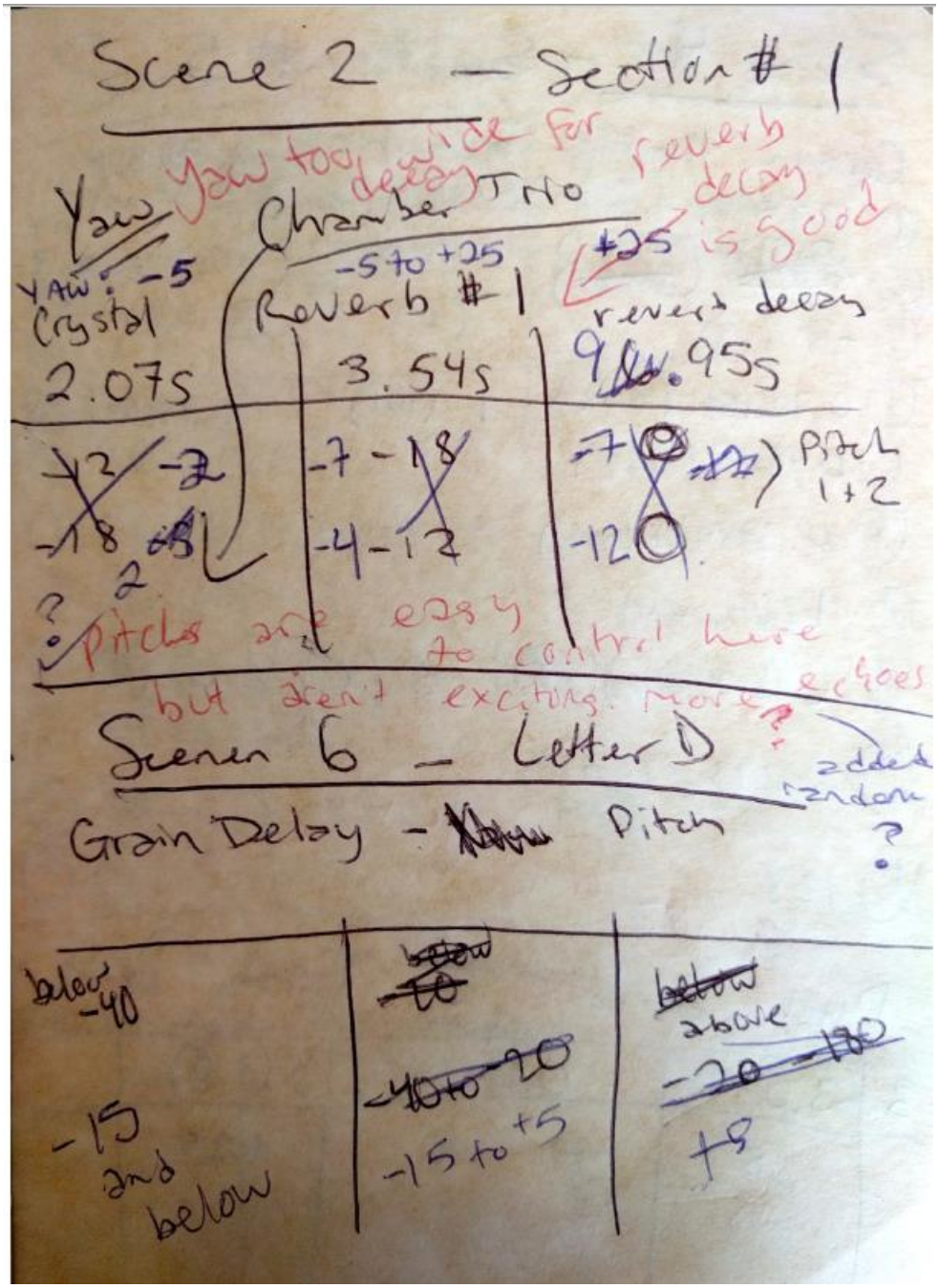

Figure 58: Scene 2 from My Blue Notebook

Different coloured pens show the layers of notes I made as I trialled my patch for *Stung* in the practice room. Notes were scribbled down hastily to avoid getting in the way of my creative process and anything that did not work well in practice was crossed out and replaced with a new idea. I never intended to show these pages to anyone because they were part of the process of preparation, not the final product. If I had known they would

end up in my thesis, I would have taken the time to write neater, construct proper sentences, and date each note; however, these pages capture the iterative and often disorderly nature of preparing for a performance.

5.3 The Audio Effects for *Star Maker*

As I created the live processing for *Star Maker*, I developed my own vision for the electronic layer by experimenting with different audio effects. Aside from referencing the score, I also drew on my memories of performing *Star Maker* as a solo work. During the performance of this piece, I often imagined bleak, isolated landscapes like the tundra, inspired by the ethereal multiphonics and long notes that characterize *Star Maker*'s opening. Images of dark skies, purple sunrises, and flat, wide-open plains were part of my embodied experience performing *Star Maker* and undoubtedly influenced the resulting electronic soundscape.

Star Maker's Live Set has four audio tracks (see Figure 59). The Max for Live programming is contained in a Max Audio Effect in the first track, Looper and Reverb are housed in the second track, and the other audio effects for processing the bass clarinet are in tracks three and four.

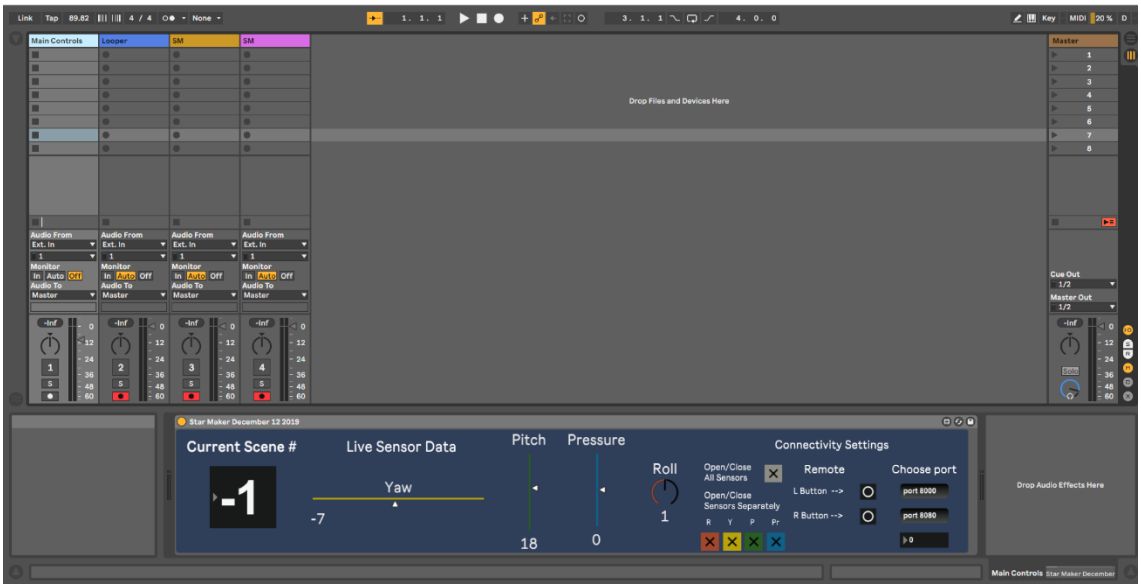

Figure 59: *Star Maker*'s Live Set

As discussed in the previous chapter, I decided to add an improvisation of air sounds to the beginning of the SABRe version of *Star Maker* (see section 4.3.3). I used Live's Looper to record the improvisation and play it back during the first section of the composition (see Figure 60). To strengthen the breath sounds on playback, I experimented with adding Live's Reverb after the Looper (see Figure 61). This reverb amplifies the recorded air improvisation, making it sound less like human breath and more like the whistling of wind.[10]

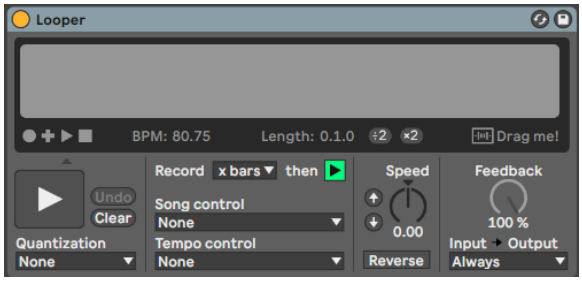

Figure 60: Live's looping device

[10] A recording of *Star Maker* with electronics is available on YouTube: https://youtu.be/l6urDSxL1s0.

Figure 61: Live's Reverb

Along with Looper and Reverb, audio effects in the first section of *Star Maker* also include Live's Delay and my custom-built Audio Effect Rack, which I named Arctic Blue Expanse. This Rack consists of three chains of audio effects. The first and second chains contain Live's Grain Delay and Resonators (see Figure 62). I modified both Grain Delays and renamed them Crystal Delay and Bass Muffle. The third chain contains another Reverb effect, intended to generate a more spacious feeling.

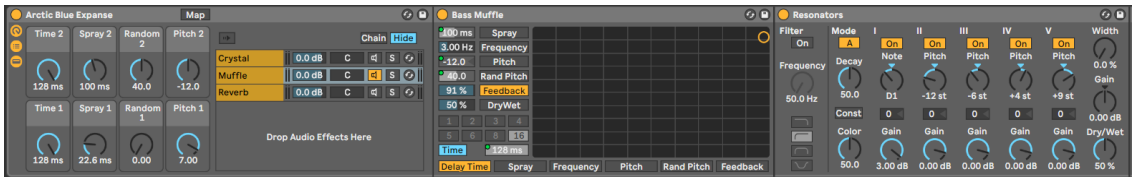

Figure 62: Arctic Blue Expanse (2nd chain visible)

In the first chain, Crystal Delay, inspired by Lyons' Crystal Reverb, creates a chorus of high-pitched glass sounds, like several people gliding their fingers around the rims of wine glasses. This is followed by Resonators, which subdues Crystal Delay ever so slightly.[11] In contrast, the second chain contains Bass Muffle, which produces muffled, low sounds; to me, it sounds like someone playing an organ underwater, with the bass clarinet stop drawn.[12] When all three chains are active at the same time, they each contribute a layer of timbre that results in a full-bodied and nuanced electronic soundscape.[13]

[11] Arctic Blue Expanse's first chain: https://youtu.be/W9eNVf3hcPI. For comparison, the same sound clip without any effects (bass clarinet only): https://youtu.be/aEwSAZiA0d4.
[12] Arctic Blue Expanse's second chain: https://youtu.be/2DrdbSlLdRU.
[13] All three of Arctic Blue Expanse's chains: https://youtu.be/rGoC2mjoDa0.

I chose to add a one-second delay to distance the effects from their source input (the bass clarinet). To achieve this, the Delay device is placed to the left of Arctic Blue Expanse, which means the delay will be processed first. Effects in the Arctic Blue Expanse Rack are processed afterwards, resulting in an obscured connection between the original bass clarinet input and the sound that comes out of the speakers.

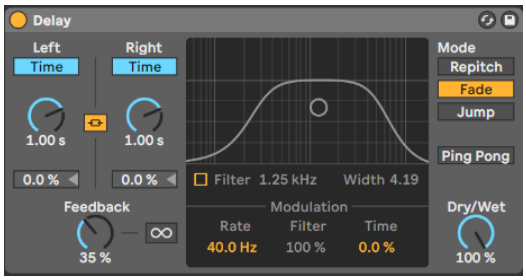

Figure 63: Live's Delay device

In the latter half of *Star Maker*, the bass clarinet part becomes increasingly moody and fragmented. The long notes and multiphonics that characterized the first section are replaced with interjections of accented low notes that mimic ricochets and passages of fast notes. Consequently, the aperture is much narrower, meaning that there is not a lot of time or space for electronics to develop. Instead of selecting completely different audio effects, I decided to modify Arctic Blue Expanse. My intention was to maintain consistency in the electronic soundscape, but even small adjustments to the Rack resulted in a completely different palette of sounds.

Arctic Blue Expanse 2 consists of three chains: two pairing together Grain Delay and Resonators and one with Reverb. As with Arctic Blue Expanse, the first two chains each hold Grain Delay and Resonators (see Figure 64). The first chain creates a mild scratchy, metallic sound so I named this preset Tinny Spray.[14] The second chain modifies the bass clarinet so that it sounds seven semi-tones higher, producing a high-

[14] Arctic Blue Expanse 2's first chain: https://youtu.be/S81OWjDnb9Y. No effects (bass clarinet only): https://youtu.be/yAEkGGYEd1M.

pitched and artificial bass clarinet tone, like a toy bass clarinet.[15] As with Arctic Blue Expanse, I added reverb to the third chain in order to create a feeling of expansiveness.[16]

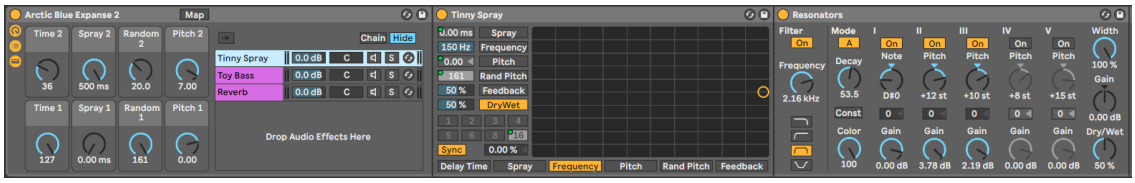

Figure 64: Arctic Blue Expanse 2 (1st chain visible)

The role of the sensors in *Star Maker* is to add variation to the live processing by controlling the audio effects. In the first half of *Star Maker*, I programmed the yaw and pitch sensors to manipulate the Macro Controls of the Arctic Blue Expanse rack. The eight Macro Controls are dials that are mapped to the parameters of the audio effects that are within the Audio Effect Rack. I mapped four of the controls to Crystal Delay in the first chain and the remaining four to Bass Muffle in the second chain. This means that the Resonators and Reverb effects remain unchanged throughout *Star Maker* and are not affected by the sensors. The pitch sensor is programmed to affect two Macro Controls and the yaw sensor controls four others. The remaining two Macro Controls are not controlled by sensors because I sensed that there was already enough potential for interaction and variation.

In the first half of *Star Maker*, I also programmed the air pressure sensor to control the Delay device that precedes Arctic Blue Expanse. The higher the air pressure, the longer the delay will be. Generally, playing louder achieves a higher value for the air pressure sensor; therefore, at stronger dynamics, the delay will be longer. As with the yaw and pitch sensors, there are five boundaries that can be crossed, triggering changes to the Delay device settings.

[15] Arctic Blue Expanse 2's second chain: https://youtu.be/yuUd8495_-s.
[16] All three of Arctic Blue Expanse 2's chains: https://youtu.be/MQF9Gwi-bPo.

All four sensors are utilized in the second half of *Star Maker*, with each sensor controlling two of the Macro Controls of Arctic Blue Expanse 2. As with the first section, there are five boundaries the sensors can cross that will change the parameters of Arctic Blue Expanse 2. Four parameters from both Tinny Spray and Toy Bass Clarinet are mapped to the Macro Controls. With each of the sensors conceivably changing different parameters at the same time, there are numerous possibilities for varying the live electronics.

From a performance perspective, although the live processing produces a particular palette of timbres and textures, the indeterminacy is generated by the sensors which control the audio effects. With multiple sensors active at one time, and each with five different settings, one performance of this version of *Star Maker* is never the same as another.

5.4 *Dréimire Mhuire*'s Soundworld

Somewhat inspired by the idea of virtual reality, my approach for *Dréimire Mhuire* was to create a virtual environment of audio effects that could be explored by moving the clarinet around in the performance space. By placing effects in different locations along a plane, the performer can move through it in either a planned or un-planned way, listening and reacting to their virtual environment.

Dréimire Mhuire was the first Live Set that I created with audio effects in return tracks. The success of this setup inspired an improved Live Set for *Stung* (see Section 5.2), as well as the Live Sets for *Hex 2* and Yue Song's compositions. The leftmost track contains the Max for Live programming (see Figure 65). The second audio track, entitled Centaury, passes the bass clarinet input to return tracks A and B. Return track A (Yaw) contains the Audio Effect Rack with all the audio effects necessary for the performance of *Dréimire Mhuire*. Return track B (Dry) is an empty track and acts as a dry signal for the bass clarinet. The audio signals from return tracks A and B are routed back to the third audio track, entitled With Effects.

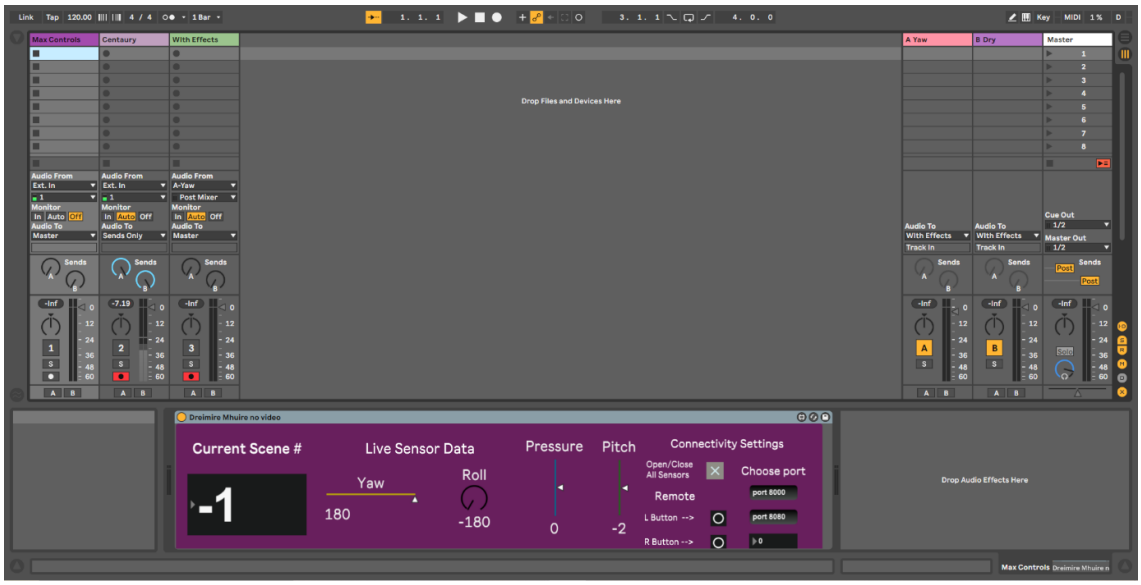

Figure 65: *Dréimire Mhuire*'s Live Set

The Audio Effect Rack in return track A, entitled Dréimire Mhuire, acts as the soundworld for *Dréimire Mhuire*'s live processing (see Figure 66). I built on my experience creating the Arctic Blue Expanse Rack for *Star Maker* and developed a much more intricate one for *Dréimire Mhuire*. Altogether, there are ten audio effects and one Audio Effect Rack in the Dréimire Mhuire Rack.

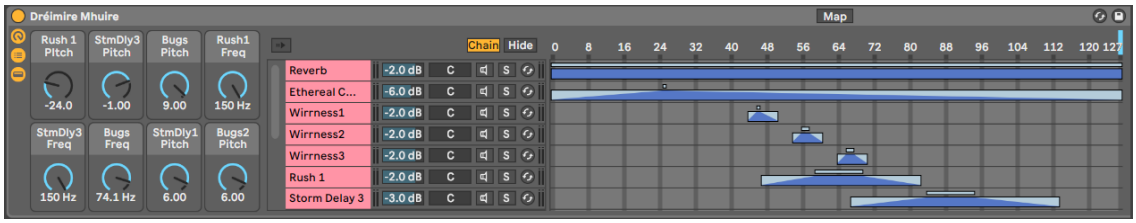

Figure 66: The Dréimire Mhuire Audio Effect Rack

The effects are placed in zones along the Chain Select Editor (shown in blue in Figure 66) so that they are not all active at the same time, although certain effects like Reverb are always active. My intention was to create a soundworld of effects that can be navigated through. The yaw sensor is the easiest to control while playing the clarinet, so I programmed it to control the Chain Selector, which is a thin blue bar that moves through the zones and activates any effects that are below it.

Building the Rack was an iterative process. First, I searched for audio effects that fit the soundscape I was trying to build:

> I am sitting at my desk, with my laptop open in front of me and my clarinet in my hand. I am trying to decide which audio effects to use to create the live processing for my composition, *Dréimire Mhuire*. My first task is to decide on a type of reverb that I can leave on for the entire performance. I like to imagine that reverb is like the backdrop to a theatre set, it helps to create an environment and an atmosphere that the rest of the clarinet and electronic sounds can melt into.
>
> I scroll through the list of Ableton Live's preset reverbs and settle on one of my favourites, Frozen Build Up. I pick up my clarinet and play through the opening of *Dréimire Mhuire*. Unfortunately, as I suspected, Frozen Build Up does exactly what it says—it builds up over time, so much so that it can become overwhelming from continuous clarinet input. It's time to go back to the drawing board.
>
> I use the hot-swap button to quickly access the list of reverb effects and continue the same process until I finally come across one called Basement. Initially, I overlooked it because its name did not match my aesthetic. Whenever I play *Dréimire Mhuire*, I picture the beach at Bull Island in Dublin, with the sandy dunes and tall grass. I can almost feel the wind on my skin. The name 'Basement' does not fit that aesthetic, but I am glad that I tried it because it is the sound that I am searching for.[17]

I also experimented with modifying zones and creating fades so that there is a seamlessness of movement when moving in and out of a zone:[18]

> After having sampled various audio effects, I have settled on a few for *Dréimire Mhuire*'s live processing and I am arranging them in an Audio Effect Rack. I am mostly working with Grain Delays, including variations of Wirrness and Rush, but I also recently discovered an Echo effect named Ethereal Canyon. Right now, the effects all need to be arranged into zones, which stretch out over a specific area and determine where the effects will be activated and de-activated.
>
> I drag Ethereal Canyon's zone so that it takes up about a third of the length of the Zone Editor. I pick up my clarinet, with the sensors attached, and start playing the beginning of *Dréimire Mhuire*, listening to how it sounds when I activate and de-activate Ethereal Canyon. As I play, I notice that moving out of its zone causes an instant loss of colour. I stop playing and drag the corners of the zone, creating a fade so that moving out of its zone won't cause such an abrupt change.
>
> As I continue to fiddle with Ethereal Canyon's zone, I come to the conclusion that it should be part of the backdrop, like the Basement reverb. I drag the fade ranges from both edges so that there is only a small area at the left side where the effect will be heard at full volume. To test it out, I play the opening

[17] Reflective Journal Entry, 02 September 2020.
[18] Ethereal Canyon: https://youtu.be/AIHWomX3zwc. No effects: https://youtu.be/Ru0FpuJTrJo.

> of *Dréimire Mhuire* again and move around as much as possible, listening carefully to the result. Satisfied, I decide to add the next few effects.[19]

Much of this experimentation was done with my clarinet, focusing on how different effects worked together to create the different layers of the soundworld. I arranged the zones in the Dréimire Mhuire Rack so that interesting sounds would be produced no matter which way I moved the clarinet. To do this, I positioned their zones in a strategic way so that there were no empty areas in the Chain Select Editor. I layered different effects together so that the soundworld has more depth. For example, I positioned Wirrness 1 and Wirrness 2 over Bugs 2 and Rush 1, and Wirrness 3 over Rush 1 and Storm Delay 3 (see Figure 67).

Figure 67: Upper and Lower View of the Dréimire Mhuire Rack

The last significant step in the programming process was to decide which effects to vary and which sensors would control their variation:

> In order to add more variation to *Dréimire Mhuire*'s soundworld, I am deciding which audio effect parameters should be modified by the roll and pitch sensors. I am experimenting with changing the parameters of effects which will have the most impact on the overall sound. From my previous experience with the sensors, I know that changing the parameters of Grain Delay can create some unique changes to the sound palette.

[19] Reflective Journal Entry, 04 September 2020.

> My aim is to modify audio effects with large zones because I am more likely to spend more time in a larger zone during performance. The three Wirrness effects have the smallest zones so I will leave them as is. I record a short clip of *Dréimire Mhuire* into Ableton Live so that I can change the parameters of Rush 1 as the clip plays. I shift the Spray, Frequency, Pitch, and Random Pitch values higher and lower to get a sense of how it sounds. This is a time consuming process and I do the same with Bugs, Bugs 2, Storm Delay 1, and Storm Delay 3.
>
> Through this experimentation, I develop a general idea of the type of electronic sounds I want to hear while performing. In the end, I choose eight parameters from the audio effects to map to the Macro Controls. I also choose five different settings for each of the eight parameters, based off my experiments with shifting their values. This means that the roll and pitch sensors can move the Macro Control dials to five different notches on the dial. Now that I am finished with the programming, I am excited to try out the soundworld that I have just created.[20]

Many of the audio effects in the Centaury Rack are Live presets, including the Basement Reverb, the Ethereal Canyon Echo, and the Wirrness and Rush Grain Delays. The presets often provide me with a good starting point and then I edit them as needed. Sometimes, I edit the presets so much that the name no longer describes the sound, such as in the case of the Grain Delays that I named Storm Delay and Bugs, or the Audio Effect Rack that I named Wind Harp by the Sea.

🔊 The Wirrness effect creates bubble-like sounds. I edited the Wirrness effect to produce three variations, named Wirrness 1, Wirrness 2, and Wirrness 3 (see Figure 68). The original Wirrness preset did not use the transposition setting so the main change that I made was to set the transposition to one semi-tone higher for Wirrness 2 and Wirrness 3 and one semi-tone lower for Wirrness 3.[21] The result of this is three different watery sounds.

[20] Reflective Journal Entry, 10 September 2020.
[21] Wirrness 1, 2, and 3: https://youtu.be/eYPEnujl1a8. No effects: https://youtu.be/6eksUmSmWek.

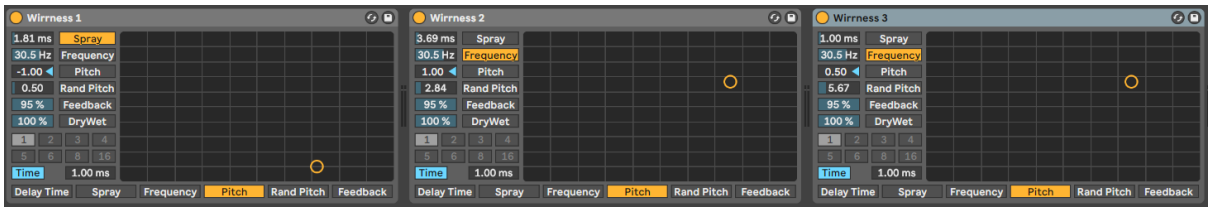

Figure 68: Wirrness 1, 2, and 3 (for comparison)

Since Wirrness is a strong effect, it can quickly become overwhelming. To prevent it from being activated too often, I gave all three Wirrness' small zones in the Chain Select Editor (Figure 66). I also discovered while practising with the sensors that if I placed the three Wirrness zones near each other, I would often activate them as a group, causing an effect that sounds like a group of underwater bubbles.

Another Live preset that I modified slightly was the Grain Delay entitled Rush (see Figure 69). The most significant change I made was to set the Pitch parameter to -24, which causes the input source to be pitch-shifted two octaves down. The result is a low rumble, like distant thunder or rough seas.[22]

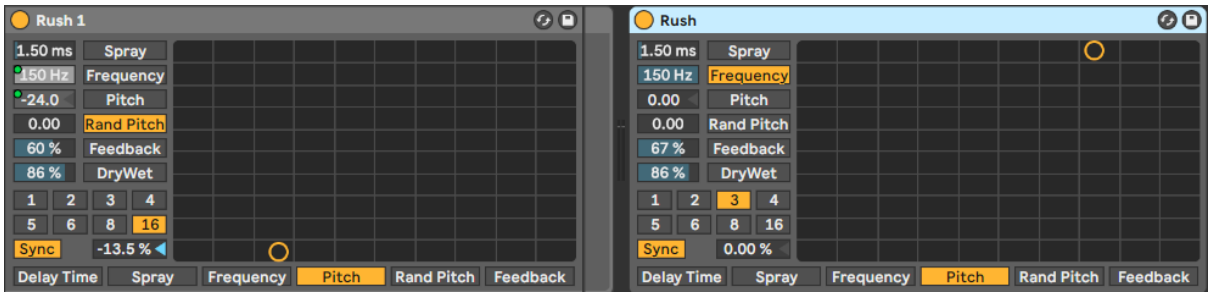

Figure 69: Rush 1 and Rush (Live's Preset)

The Grain Delays that are entitled Storm Delay 1 and Storm Delay 3 are loosely based on the Rush preset. Like Rush 1, they create a stormy atmosphere by severely distorting the input source. Storm Delay 1 features a short delay time of one semi-quaver, with the Beat Offset Percentage set to the maximum, 33.3% (see Figure 70). The Pitch parameter is set to 6.00, which pitch-shifts the input source up the interval of a perfect fifth.[23] In

[22] Rush 1: https://youtu.be/le2Ge57ojrY.
[23] Storm Delay 1: https://youtu.be/9228bKSRY3M.

contrast, Storm Delay 3's Beat Division is set to eight semi-quavers, with the Beat Offset Percentage at -33.3%, which shortens the delay time slightly (see Figure 71).[24] Storm Delay 3's Pitch parameter is also set much lower, at -1.00, which means that the input source is pitch-shifted downwards by one semi-tone.

Another factor that sets Storm Delay 3 apart from Storm Delay 1 is that it is paired with the Ethereal Canyon Echo audio effect. By placing Ethereal Canyon after Storm Delay 3, the graininess is softened and the delay time is obscured.[25] Layering effects is a technique that I learned while creating *Star Maker*'s live processing and I continued to experiment with it with *Dréimire Mhuire*'s patch. I found that over time, all Grain Delays began to sound similar, but when I coupled them with another effect, it created an entirely new result.

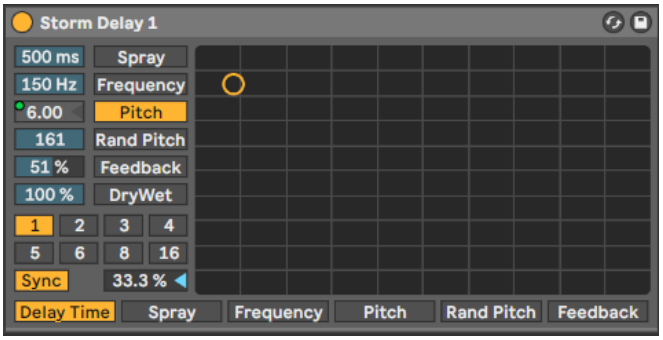

Figure 70: Storm Delay 1

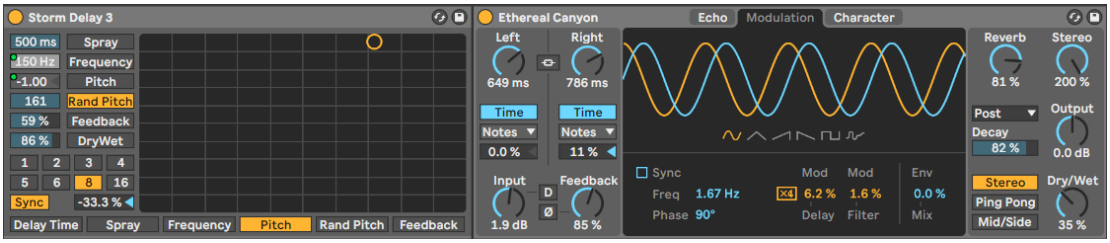

Figure 71: Storm Delay 3 and Ethereal Canyon

[24] Storm Delay 3: https://youtu.be/Aj49MVuDF4I.
[25] Storm Delay 3 and Ethereal Canyon: https://youtu.be/sv7fLZfTsG8.

Bugs and Bugs 2 are Grain Delays that create an insect swarming effect, mixed with the high-pitched whooshing sounds of an underground metro. When compared, the most audible difference is that Bugs generates higher-pitched sounds. This is because it is set to pitch-shift up nine semi-tones, whereas Bugs 2 is only set to pitch-shift up six semi-tones.[26] The purpose of having two different versions of the Bugs-style effect is to give the electronic soundworld variation so that moving within the performance space yields different results; thus, Bugs and Bugs 2 are situated on opposite ends of the Chain Select Editor and do not overlap.

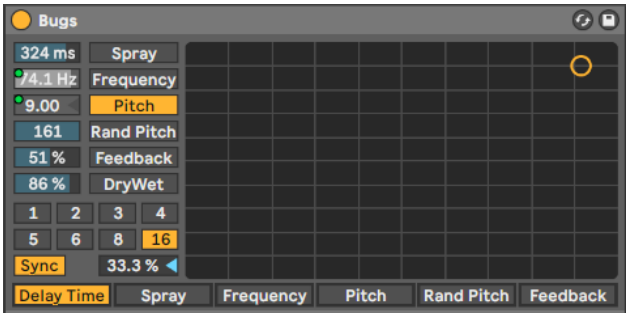

Figure 72: The Bugs Preset

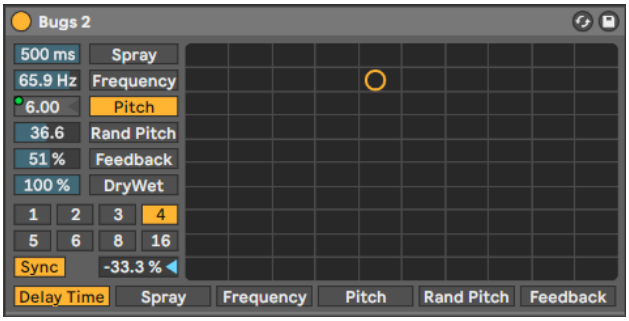

Figure 73: The Bugs 2 Preset

Wind Harp by the Sea is an Audio Effect Rack that I placed within the Dréimire Mhuire Audio Effect Rack. In contrast to the noisier effects, such as Rush 1, the Bugs Delays, and the Storm Delays, the Wind Harp Rack is much more mellow and pure.[27] The sound that is created by this Rack reminded me of Gráinne Mulvey's electronic composition,

[26] Bugs: https://youtu.be/Tr6QN35blak. Bugs 2: https://youtu.be/tmRlcFqxe9g.
[27] Wind Harp by the Sea: https://youtu.be/7uIP563euNY.

entitled *Aeolus*. Mulvey's piece is named after the Aeolian harp and incorporates sounds from one such harp designed by Mark Garry; consequently, I was inspired to name this Rack 'Wind Harp by the Sea'.[28]

Wind Harp by the Sea is built very similarly to the Arctic Blue Expanse Rack that I developed for *Star Maker*. There are three chains in the Rack: one with Reverb and two that combine Grain Delay with Resonators. 🔊 The first chain couples my original Grain Delay preset of Storm Delay with Live's Resonators device (see Figure 74). Storm Delay is very similar to Storm Delay 1 and 3 that are found elsewhere in the Dréimire Mhuire Rack. The root pitch of Resonators is set to F-sharp (transposed A-flat) in order to blend in with *Dréimire Mhuire*'s tonality. By placing Resonators second in the chain, it softens the graininess of the Storm Delay effect.[29]

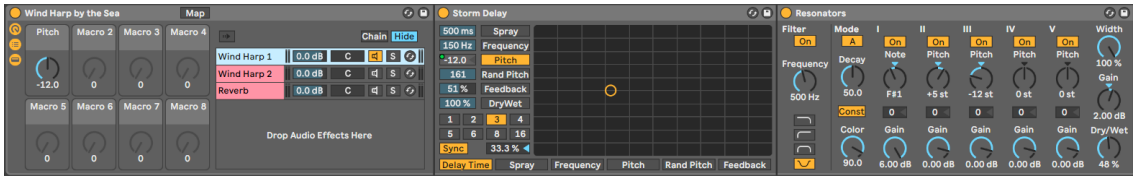

Figure 74: Wind Harp by the Sea (first chain visible)

🔊 Although the second chain is also built from Grain Delay and Resonators, it produces a contrasting result.[30] Instead of using the noisy Storm Delay preset, I modified the standard Grain Delay until I ended up with a preset that created an alien-like clarinet delay. Part of the success of this is setting Random Pitch to a moderately high number so that the delay sounds out of tune (see Figure 75). To avoid achieving a noisy type of delay, I set the Spray value to 0. For lack of a better title, I named this preset Low Hum. As the name suggests, Low Hum's Pitch parameter is set rather low at -12.0, pitch-shifting the input source down an octave.

---

[28] Mulvey, Gráinne: 'Aeolus', *Aeolus / Untouch*, Gráinne Mulvey and Christopher Fox, composers, Metier MDS29006, 2018.
[29] Chain 1 of Wind Harp by the Sea: https://youtu.be/Np7YRgUI2f0.
[30] Chain 2 of Wind Harp by the Sea: https://youtu.be/ZJCEE_Gt5zo.

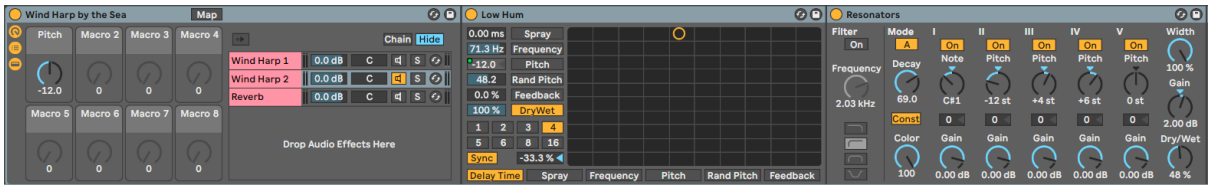

Figure 75: Wind Harp by the Sea (second chain visible)

Low Hum is followed by Resonators, which is intended to leave a subtle metallic aftertaste. The root pitch is set to C-sharp (transposed E-flat), which is another important note in *Dréimire Mhuire*'s tonality (see section 2.4). The first two chains function as separate layers, but they are heard as a unit. The third chain contains a Reverb audio effect that was modified slightly to create a backdrop suitable for the first two chains. Altogether, the three chains work together to create a nuanced and intricate effect.

In addition to using the yaw sensor to navigate the Rack's Chain Select Editor, the pitch and roll sensors control the Rack's Macro Controls. This enables them to vary audio effects that are contained in the Rack by changing their parameters. Table 2 shows which audio effects the pitch and rolls sensors control and which parameters of the audio effects they modify. The roll sensor changes the Pitch parameter of five Grain Delays and the pitch sensor changes the Frequency parameter of three Grain Delays. I programmed each sensor so that there are five possible settings for each parameter. Varying the audio effects adds further indeterminacy to each performance. I decided not to use the air pressure sensor in *Dréimire Mhuire* because I noticed there was already enough interactivity without it.

Sensor:	Macro Control Name (see Figure 66):	Audio Effect (Controlled by Sensor):	Effect Parameters that are Changeable:
Roll	Rush 1 Pitch	Rush 1	Pitch
	StmDly3 Pitch	Storm Delay 3	
	Bugs Pitch	Bugs	
	StmDly1 Pitch	Storm Delay 1	
	Bugs2 Pitch	Bugs 2	
Pitch	Rush 1 Freq	Rush 1	Frequency
	StmDly3 Freq	Storm Delay 3	
	Bugs Freq	Bugs	

Table 2: List of Audio Effect Parameters that the Roll and Pitch Sensors Modify[31]

Overall, there are two variable parts to *Dréimire Mhuire*'s soundworld: the activation and de-activation of the chains in the Chain Select Editor and the modification of the audio effect parameters. Initially, I used audio effects from *Star Maker* as a guide and then tried to create new sounds that evoked the feeling of being by the sea. What I learned from the process of creating the Live Sets for *Stung* and *Star Maker* allowed for a more interactive, integrated, and nuanced soundscape for *Dréimire Mhuire*. The next section continues to expand upon the soundworld approach, which I employed again for the performance of *Hex 2*.

5.5 *Hex 2*'s Soundworld

Hex 2's Live Set is similar to *Dréimire Mhuire*'s, with the Max for Live controls in the first track and the soundworld of effects in return track A. Return track B is a dry track that may or may not be used, depending on the performance space. Unique to *Hex 2* is an audio track that holds the composer's soundtrack. When the performer is ready to begin, the backing track can be launched with the SABRe remote or sensor remote. Other than that, the setup for *Hex 2* is not much different than for *Dréimire Mhuire*.

[31] Note that the pitch sensor is different from the 'Pitch' parameter of audio effects.

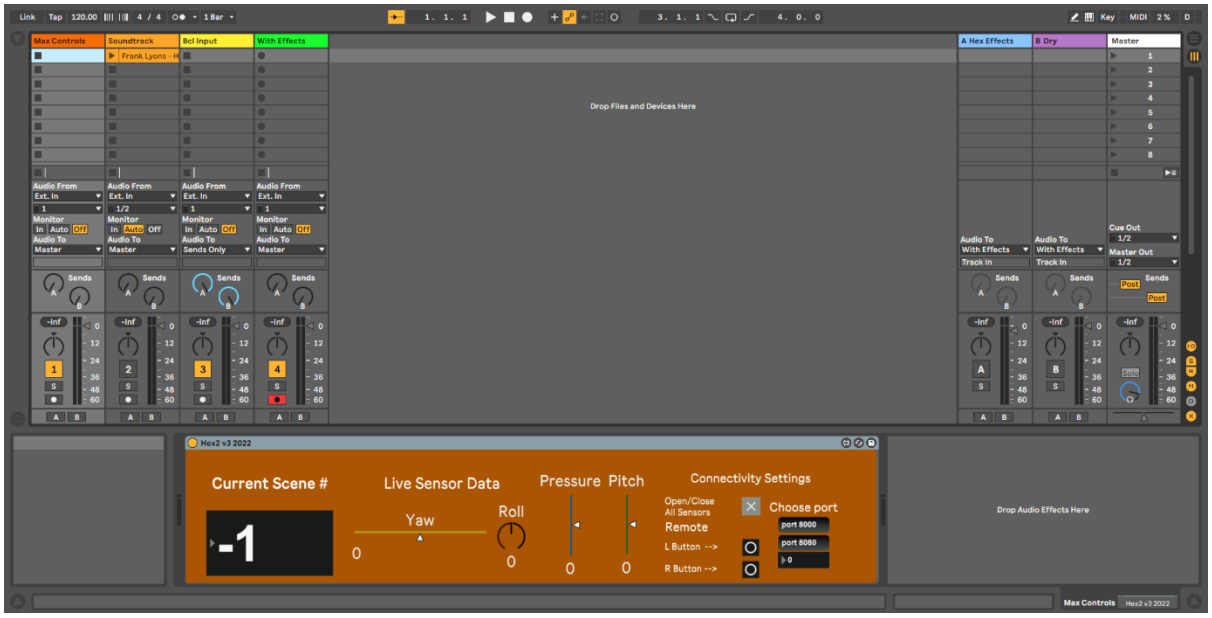

Figure 76: *Hex 2*'s Live Set

Choosing which audio effects to work with for the performance of *Hex 2* was a challenge because the fixed soundtrack already contains a lot of different textures and moods. My task was to develop a soundworld of effects that worked with all twelve sections of *Hex 2*, including both the soundtrack and the bass clarinet material. I also wanted to create a different soundscape than I had already become accustomed to with *Stung*, *Star Maker*, and *Dréimire Mhuire*.

Frank Lyons' soundtrack for *Hex 2* reminds me of the soundtracks of horror films. There is an eeriness to the types of sounds the composer created, hence the name that I used for the Audio Effect Rack—Eerie Spaces. This encouraged me to explore effects that evoke dark and creepy spaces (see Figure 77). In order to develop new sounds that were unlike those I used for other pieces, I focused on combining different effects. Most of the chains listed in Eerie Spaces contain at least two effects.

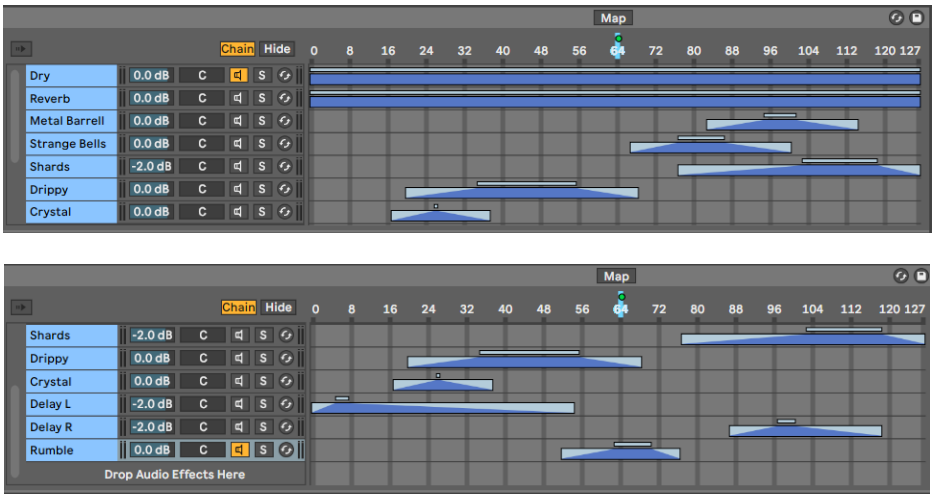

Figure 77: Top and Bottom Views of the Eerie Spaces Rack

The first chain is a dry signal of the bass clarinet input and does not hold any effects. The second chain contains a Live preset called Concrete Chamber, which is a very subtle reverb (see Figure 78). I chose Concrete Chamber because it makes the bass clarinet sound more distant and adds a shimmery, metallic resonance.[32] The only adjustment I made was to shorten its Decay Time because I did not want the Reverb, which is always active, to overpower the soundtrack or other effects.

Figure 78: Live preset Concrete Chamber, with shortened Decay Time

The Metal Barrell chain consists of two effects: Rush 4 and Outer Space (see Figure 79). Rush 4 is a Grain Delay that is based on Rush, which I discussed in the previous section. Rush 4's Pitch parameter is set low at -12.0 and the high Random Pitch value distorts the delay so that it is not in tune. On its own, Rush 4 is like an out of tune tuba-contrabass

[32] Concrete Chamber: https://youtu.be/mOnGRN5_D6w. No effects: https://youtu.be/4vif6_hOzYQ.

clarinet hybrid that tails the bass clarinet.[33] Outer Space is another one of Live's Reverb presets and is characterized by its long delay (7.15 seconds) that sounds metallic.[34] I was drawn to both Concrete Chamber and Outer Space because they were evocative of large industrial spaces where one might find old and abandoned metal objects.

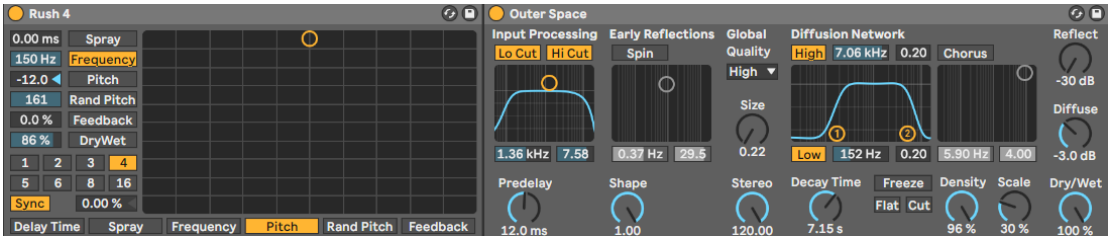

Figure 79: The Metallic Barrell Chain

When combined, these two effects produce interesting results for both short and long notes in the bass clarinet part. With short note values, a variety of resonant, percussive sounds are created.[35] On the opposite end of the spectrum, long notes sustain the metallic resonance, comparable to the sound of a gong that is dissipating after it has been hit.[36]

The next chain, Strange Bells, is named after the bell-like sounds that are created by combining Raspy with Forest Floor (see Figure 80). Originally, Raspy was modelled after Storm Delay 1, but I ended up modifying it so much that I ended up with a completely different result. On its own, Raspy creates a delay with a scratchy texture.[37] Previously, a lot of the Grain Delays that I worked with had low Pitch values, so I experimented with creating a higher one. Raspy's Pitch parameter is set to 12.0, which pitch-shifts the bass clarinet input up an octave, producing an artificial clarinet sound.

[33] Rush 4: https://youtu.be/2Cu_MrrdXz0.
[34] Outer Space: https://youtu.be/YppEtjdAEDs.
[35] Metallic Barrell chain: https://youtu.be/LFaPGT5chFU.
[36] Rush 4 and Outer Space (with long notes): https://youtu.be/7025UTfEwaY.
[37] Raspy: https://youtu.be/MXhNX29_rbc. Without effects: https://youtu.be/vGlagJg7VZ8.

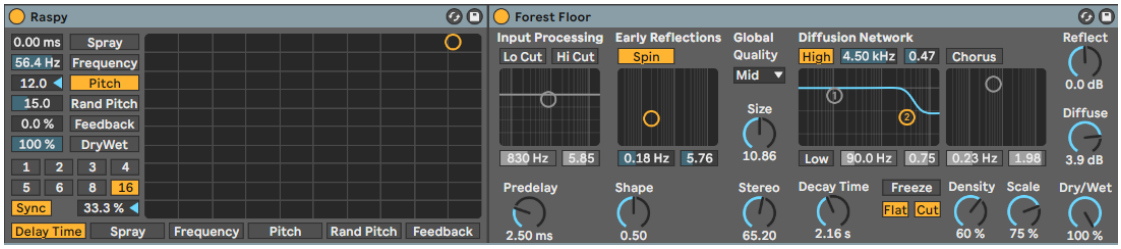

Figure 80: The Strange Bells Chain

Forest Floor is another one of Live's Reverb presets. There is nothing entirely special about it—on its own it just sounds like an ordinary reverb; however, when preceded by Raspy, it produces a cacophony of strange bell sounds.[38] As with the Metallic Barrell chain, the success of Strange Bells lies in its ability to produce interesting results for all twelve sections of *Hex 2*.

Shards is the fifth chain and it also contains one Grain Delay, followed by a Reverb (see Figure 81). The name Crystal Ascent is inspired by the upward and glass-like nature of the delay.[39] Many of the chains in the Eerie Spaces Rack have a metallic feel to them so I wanted to create a contrast with another type of timbre, without losing the industrial feel of the soundscape. By setting the Feedback to 54%, I ensured that there would be repetitions of the bass clarinet part, with each successive repetition getting higher and quieter. To achieve the crystal-like sounds that can be heard during the echoes, I set the Pitch parameter high at 10.5. With each delay, the pitch is shifted up 10.5 semi-tones.

Another Live preset, Sizzle is a Reverb device that produces a subtle and sizzle-like resonance.[40] By placing Sizzle after Crystal Ascent, it helps to distance the high pitches from the listener and prevents the tone of the delay from being too artificial.[41] I named this chain Shards because it reminded me of tiny fragments of glass (or crystal)

[38] Forest Floor: https://youtu.be/rDocTC7s20I. Strange Bells: https://youtu.be/9bvDUXpqdoM.
[39] Crystal Ascent: https://youtu.be/oTQcxetU-3g. Without effects: https://youtu.be/Wdiw4eUeKO0.
[40] Sizzle: https://youtu.be/gP1BIIH_25Y.
[41] The Shards chain: https://youtu.be/_QbfbRsgJKc.

shattering. I positioned this chain to the far right of the Chain Select Editor so that it will not be activated as often as the chains placed in the centre.

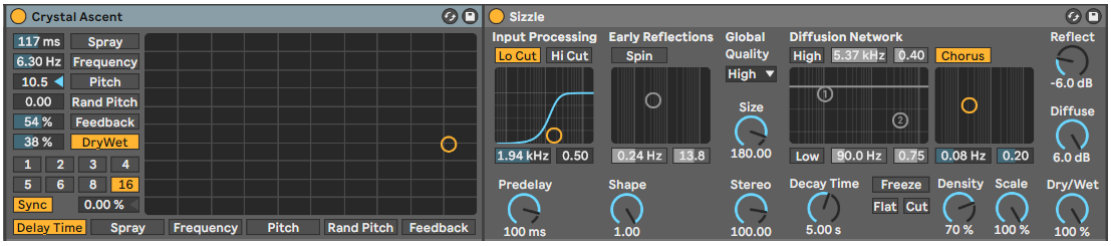

Figure 81: The Shards Chain

With all the chains, I drew inspiration from the soundtrack to develop the live processing soundworld. At the very beginning of the track, the electronics Lyons created evoke the image of a monster with goo dripping off its body or of leaky pipes in an underground carpark, leaving a trail of questionable liquid on the ground. With this in mind, I sought to create drippy sounds that would enhance Lyons' eerie atmosphere. The Drippy chain contains three audio effects: Great Buddha Unleashed, Drive High, and Prague (see Figure 82).

Great Buddha is a Live Phaser preset that I adjusted for my own purposes and renamed Great Buddha Unleashed.[42] The small adjustments that I made to Great Buddha caused it to sound wilder and less restrained, so it seemed fitting to rename it, rather than calling it Great Buddha 1. Great Buddha Unleashed is an intermittent effect, meaning that it is not constantly producing sound. Perhaps the reason the original preset was named Great Buddha is that it sounds similar to someone striking a Tibetan singing bowl.

Drive High is another Grain Delay that is part of Live's Core Library. On its own, it generates an off-putting scratchy texture.[43] To my surprise, when succeeded by

[42] Great Buddha Unleashed: https://youtu.be/LQM1OCLcJOo. Without effects: https://youtu.be/Cz7StBFL1nw.
[43] Drive High: https://youtu.be/j7uOJ0T6zQ8.

Resonators, the scratchiness is replaced with bird-like chirps.[44] Live has named several Resonators presets after large cities. Although I experimented with all of them, I liked Prague the best. It seemed to smooth out the rough edges of Great Buddha Unleashed and Drive High, creating an intricate array of drips and chirps.

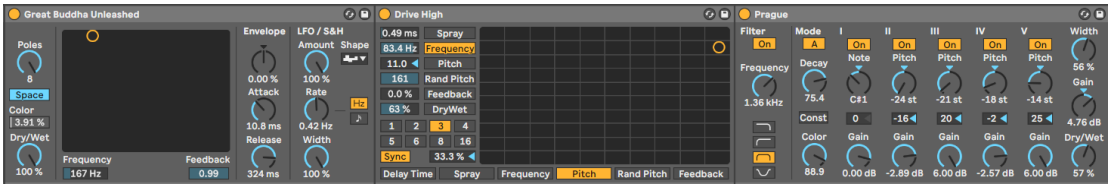

Figure 82: The Drippy Chain

The Crystal Reverb Audio Effect Racks that Lyons created for *Stung* inspired me and I based the Crystal chain on Lyons' Crystal Reverbs. Sound-wise, it is similar to the Shards chain in that it features a high-pitched, glass-like resonance. I surmised that this timbre would also work well for *Hex 2*. The Crystal chain comprises of a Grain Delay, entitled Crystal Delay 2, and a Live Reverb preset, entitled Bright Long Verb (see Figure 83).

The Crystal chain is another example of how placing a Reverb after a Grain Delay can create a more sophisticated, layered effect. On its own, Crystal Delay 2 is unrefined, but the addition of Bright Long Verb smooths out the rough edges.[45]

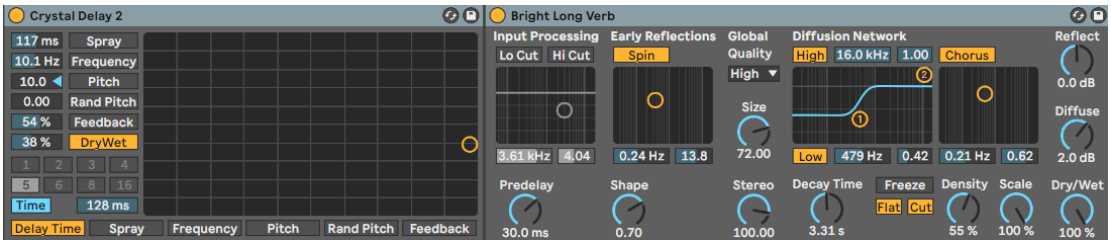

Figure 83: The Crystal Chain

[44] The Drippy chain (multiphonic example): https://youtu.be/8_0fiWMPLOA. The Drippy chain (quick passage example): https://youtu.be/we3MnNhqsAw.
[45] Crystal Delay 2 (long notes): https://youtu.be/rtRKhovpbuQ. Crystal Delay 2 (quick passage): https://youtu.be/ABdmg-EXkYs. The Crystal chain (long notes): https://youtu.be/9mpOJtG9xag. The Crystal chain (quick passage): https://youtu.be/-Ot-RUA1A8E.

The eighth and ninth chains in the Eerie Spaces Rack are identical, but they are placed on opposite ends of the Chain Select Editor and do not overlap. Delay L is placed on the left side and Delay R is placed on the right side. 🔊 There are two effects within these delay chains: a Resonators device, entitled Hex, and Live's Echo preset, entitled Simple Long Digi Delay (see Figure 84). Although I could have just placed Simple Long Digi Delay on its own, I wanted to alter the sound of the bass clarinet by placing Resonators in front of it.[46]

The Simple Long Digi Delay is a Live Echo preset. I changed it from a beat-synced delay to a time-based delay so that I could set the delay time to two seconds. Many of the chains contain Grain Delays, which by nature are short delays. By placing a few lengthier delays in the soundworld, it spreads out the occurrence of effects over time. This prevents the soundworld from becoming too dense.

Figure 84: *Hex 2* Delay Chain

🔊 The final chain, which I have named Rumble, contains a Grain Delay and an Echo (see Figure 85). The Grain Delay is another variant of Rush, so it was appropriate to name it Rush 4. The Echo is once again the Simple Long Digi Delay, but this time the delay is only set to 1 second so that it fades out sooner. 🔊 Rush 4 pitch-shifts the bass clarinet input down an octave, creating the effect of a contrabass clarinet. With the Random Pitch set to its maximum value, the contrabass clarinet sounds are in an out-of-tune disarray.[47]

[46] The Delay chain: https://youtu.be/TAWsqQzHt8k. Without effects: https://youtu.be/xl9kci9YrCo.
[47] Rumble chain (long notes): https://youtu.be/Hsg-uD9nIRU. Rumble chain (quick passage): https://youtu.be/rtxnSGDhOQg.

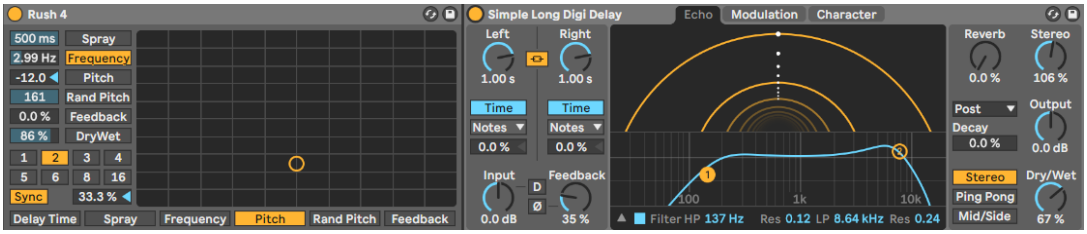

Figure 85: The Rumble Chain

With ten varied chains, Eerie Spaces produces a myriad of different sounds that the performer can explore by moving around. In addition, I programmed the pitch, roll, and air pressure sensors to alter the parameters of some audio effects in the Rack. As with *Dréimire Mhuire*, I mapped audio effects from the Rack to the Macro Controls and then programmed the sensors to control these. The mappings are shown in Table 3. Each parameter also has five different boundaries so that there are five possible settings for each of the Macro Controls.

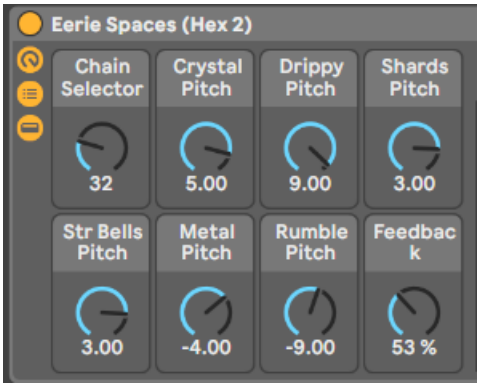

Figure 86: The Macro Controls for the Eerie Spaces Rack

Sensor:	Macro Control Name (see):	Audio Effect (Controlled by Sensor):	Effect Parameters that are Changeable:
Roll	Crystal Pitch	Crystal Delay 2	Pitch
	Shards Pitch	Crystal Ascent	
Pitch	Drippy Pitch	Drive High	
	Str Bells Pitch	Raspy	
Air Pressure	Metal Pitch	Rush 4 (from the Metal Barrell chain)	
	Rumble Pitch	Rush 4 (from the Rumble chain)	
	Feedback	Simple Long Digi Delay (from Delay L and Delay R chains)	Feedback

Table 3: Sensor Mappings for *Hex 2* audio effects[48]

The setup for *Hex 2* is like *Dréimire Mhuire*'s; however, their soundworlds are quite different. The soundworld setup was easy to perform with because there is no need to plan movements. It is also straightforward to set up in Live because there is not much to programme in Max for Live, compared with the approach I took for *Stung*. In the next section, the last composition to employ the soundworld technique, *Dovetails*, will be discussed.

5.6 The *Dovetails* Experiment

The first steps of my collaboration with Yue Song took place via email. Due to the COVID-19 restrictions in Ireland at the time, we had to be inventive to work together. After receiving the bass clarinet part for *Dovetails*, I practised it fairly intensively before I

[48] Note that the pitch sensors and the pitch parameters are not the same.

started to correspond with Song about what kinds of electronic sounds she was interested in creating. I started by sending her small clips from *Dovetails* with audio effects, but I quickly realized that this was a slow and tedious process.

Instead, I decided to create a soundworld, similar to what I had done with *Dréimire Mhuire* and *Hex 2*. My reasoning for this was that I could include a variety of audio effects to demonstrate how different effects reacted to the bass clarinet material. The recording I made was purely experimental and I never intended for it to become a research output, but Song really enjoyed it, so we decided to keep it. Song also mixed my recording of *Dovetails*, adding some extra echoes and small tweaks to the overall sound (see Figure 87).[49] Although we did not continue this method of working together, it was helpful to get us started.

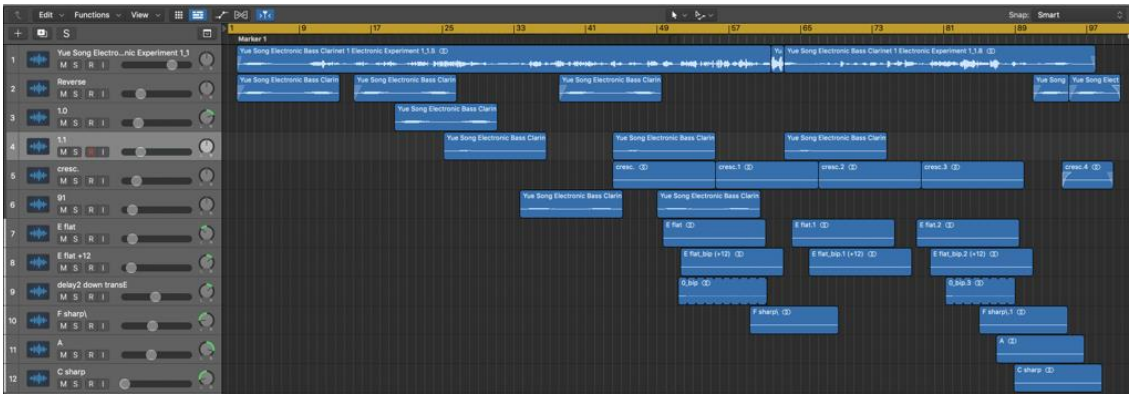

Figure 87: Song's Mixed Version of *Dovetails*

The Live Set for this first version of *Dovetails* was set up the same way as *Dréimire Mhuire* so it would be redundant to mention it again here. The Audio Effect Rack, on the other hand, is completely different. Since this Rack was experimental, I tried new combinations of audio effects, sometimes combining up to five in one chain. I derived the name Thrown Out to Sea retrospectively; it was inspired by Song's mother's reaction to hearing

[49] The mixed version of *Dovetails* can be listened to on SoundCloud: https://soundcloud.com/marcella-barz/dovetails-version-1-yue-song?utm_source=clipboard&utm_medium=text&utm_campaign=social_sharing.

Dovetails for the first time. The water-like sounds that are heard in *Dovetails* are most likely linked to those in *Dréimire Mhuire*, since I developed the two soundworlds within a short timeframe, thus using similar effects.

Per usual, the first chain in the Thrown Out to Sea Rack is a Reverb device (see Figure 88). I selected Live's preset Medium Stage and did not modify it (see Figure 89). Medium Stage is a subtle reverb, but it adds enough decay to the sound to give the impression of a larger space and darkens the bass clarinet tone.[50]

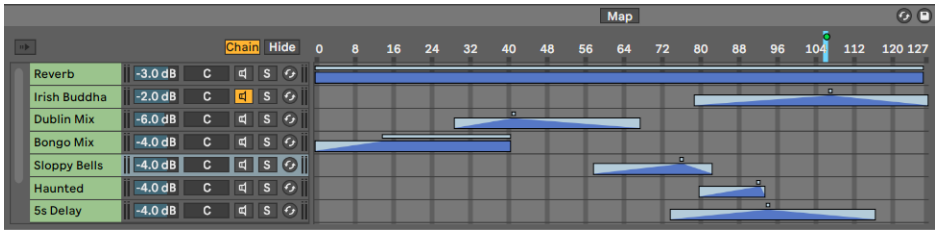

Figure 88: Thrown Out to Sea Rack (Top View)

Figure 89: Live's Medium Stage Reverb

The second chain, entitled Irish Buddha, contains two effects: Resonators and Phaser (see Figure 90). I have found that resonators are useful for changing the timbre of the bass clarinet and phasers distort the timing. The first effect in the chain is a Resonators preset. Live's core library contains many Resonators presets named after large cities, such as Los Angeles, Paris, or Tokyo. As I was creating this chain, I tried all the existing presets first, but none of them seemed quite right, quite possibly because I did not feel a connection to any of those cities. I modified Resonators until I was satisfied and named

[50] Medium Stage: https://youtu.be/1N3VGP44BEI. Without effects: https://youtu.be/cXFpom6GLME.

it Dublin, since that is the city in which it was created and I wanted to stick to the city theme.

The root pitch of the Dublin resonator is set to A-sharp, which is a C on the bass clarinet. I chose this pitch because the bass clarinet part begins and ends on a low C. The other modifications that I made to Resonators were based on instinct. I wanted there to be an audible resonance, but without causing the bass clarinet to sound like it is being played in a tin can. I also wanted to hear a hint of a metallic, string-like sound and I stopped modifying Resonators when I sensed that I had achieved that quality of sound.[51]

The second effect in the Irish Buddha chain is a Phaser preset, Great Buddha Unleashed. This is the same preset that I used in *Hex 2*'s Drippy chain (see section 5.5). In *Hex 2*, I placed this phaser before the Prague preset, but this time I decided to position it after the resonator, just to see how it would differ. When Dublin is placed in front of Great Buddha Unleashed, the bell-like sound is retained without taking anything away from the resonator.[52]

Figure 90: The Irish Buddha Chain

The third chain, Dublin Mix, combines Resonators, Grain Delay, and Phaser (Figure 91). The resonator is my Dublin preset and it is once again positioned first in the chain. The grain delay that follows is Rush 2, another variation on Live's Rush preset. Rush 2 causes a surge of sound, like the sound of water swelling, only much grainier.[53] By placing

[51] The Dublin resonator: https://youtu.be/bsn6SNZiK8E.
[52] The Irish Buddha chain: https://youtu.be/IGuwHFXgeE8.
[53] Rush 2: https://youtu.be/RIY1FVUk1n4.

the Dublin resonator in front of Rush 2, the bass clarinet timbre is obscured and the graininess is less noticeable. The phaser comes last in the chain and is a preset that I created to imitate the sound of Bongo Drums. This is a very subtle effect that is not easily heard on its own; however, when combined with other devices like Grain Delay, it creates a noticeable rhythmic pattern.[54]

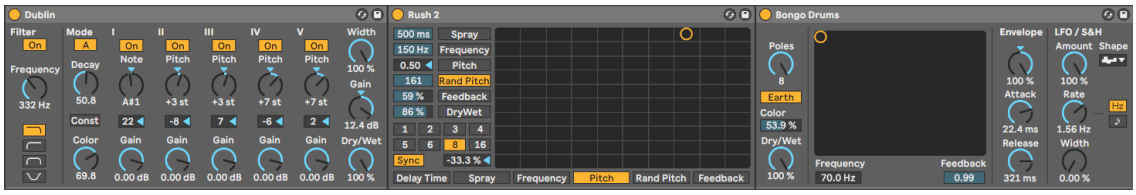

Figure 91: The Dublin Mix Chain

This mixture of effects produced interesting textures and unpredictable rhythms so I decided to experiment with it a bit more. In the fourth chain, I positioned Grain Delay first, followed by Resonators and Phaser (see Figure 92). Since this chain is not vastly different in construction to the Dublin Mix chain, I followed a similar naming pattern and called it the Bongo Mix chain. For variation, I swapped out Rush 2 for Rush 3. Rush 3 creates a flurry of MIDI-like bass clarinet sounds, not unlike something that would have been heard in old video games.[55] Once again, I used the Dublin resonator because I wanted to establish some homogeneity in the electronic part. The Dublin resonator muffles the flurried notes of Rush 3 and the Bongo Drums phaser adds some percussive sounds.[56]

Figure 92: The Bongo Mix Chain

[54] The Dublin Mix chain: https://youtu.be/QNTRe3FkLZs.
[55] Rush 3: https://youtu.be/eTa7iUheyDc.
[56] The Bongo Mix chain: https://youtu.be/tCtWszLiK1o.

After achieving some interesting new sounds with the Dublin Mix chain and the Bongo Mix chain, I was curious to see what would happen if I added more than three devices to a chain. The Sloppy Bells chain contains four devices: Grain Delay, Resonators, Phaser, and Delay. One discovery I made from creating these multi-device chains was that placing Grain Delay at the front of the chain removes the graininess of the effect, while still maintaining its characteristic randomness. Thus, the first effect in the Sloppy Bells chain is Storm Delay 4, another Grain Delay preset based on Storm Delay. By itself, Storm Delay 4 is another watery effect, like the sound of ocean waves pulling pebbles out with the tide.[57]

The Dublin resonator follows Storm Delay 4 and adds a pure or ethereal hum, almost like a choir singing in the background.[58] The phaser Great Buddha Unleashed is next in the chain and it produces bell-like sounds. Ironically, by adding Sloppy Delay to the end of the chain, it streamlines the bell tones so that they become rhythmical—not sloppy, as the name would suggest.[59]

The last multi-effect chain is Haunted, named after its eerie quality. It is similar to some of the other chains, such as Sloppy Delay and Irish Buddha, but instead of using the Dublin resonator, I created a little variety by selecting Live's preset LosAngeles (see Figure 93).[60] The bell-like tones are present in the Haunted chain but are rattlier in nature than the other chains.[61]

[57] Storm Delay 4: https://youtu.be/W4mnD312Rv0. Without effects: https://youtu.be/waH_JCRMZz4.
[58] Storm Delay 4 and Dublin: https://youtu.be/qJRHgIhiljw.
[59] The Sloppy Bells chain: https://youtu.be/OjRdhKII-B8.
[60] Live's preset LosAngeles is intentionally spelled without a space.
[61] The Haunted chain: https://youtu.be/NCSxLJMuIA4. Without effects: https://youtu.be/xdPakkynbd4.

Figure 93: The Haunted Chain

The last two chains contain Delay devices. After creating a few different soundworlds, I discovered that it is helpful to have delays of different lengths so that all the effects are not produced at once. Since many of the delays within multi-effect chains contain Grain Delay, the delay time is rather short at 128 milliseconds. Delay, on the other hand, can be set to up to five seconds (see Figure 94).[62] These longer delays can be layered with other chains so that different effects take place at various times, which cuts down on muddiness.

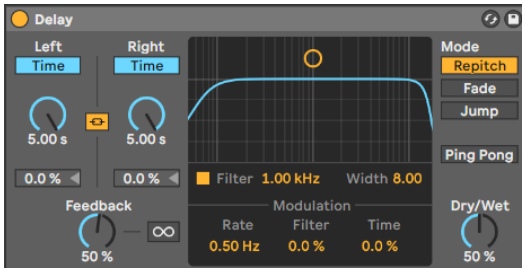

Figure 94: Five Second Delay

As with *Hex 2*, I placed two identical delays in different areas of the Chain Select Editor, with varied zone lengths (see Figure 95). When moving around the performance space with sensors, it can feel restrictive if there are no areas to move into without delays; therefore, I applied cross-fades so that there are only very small sections in the performance space where the delays will be heard at full volume.

[62] Five-second delay: https://youtu.be/TloQMr3Cc0w.

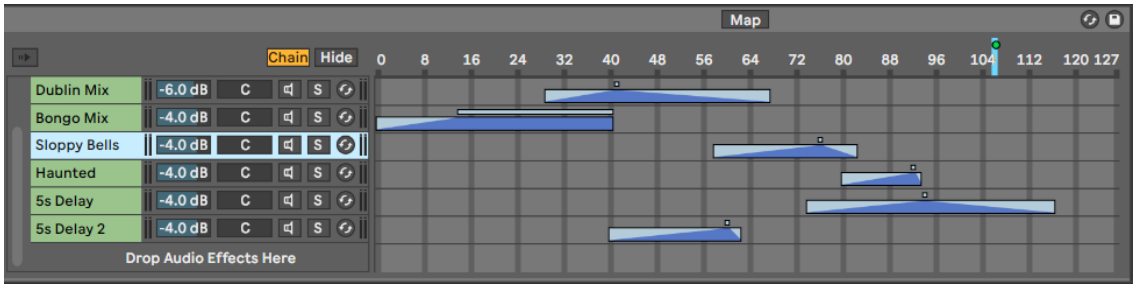

Figure 95: Thrown Out to Sea Rack (Bottom View)

While I was creating the Thrown Out to Sea Rack for *Dovetails*, I was not expecting Song to like the electronics. All the chains I created were intended to demonstrate different ways effects could be combined in chains to create interesting timbres and textures. For this reason, the process of selecting and modifying the audio effects for *Dovetails* was explorative and uninhibited, and it resulted in something unique.

5.7 Conclusion

This chapter explored my process of selecting and modifying audio effects to create live processing for various compositions. In the first section, I wrote about my experience as a beginner, creating the live processing for *Stung*. With *Star Maker*, I slowly started to explore different types of Live devices, such as Looper, as well as gaining experience building Audio Effect Racks. These became the foundation for *Dréimire Mhuire*, *Hex 2*, and *Dovetails*, wherein I used Racks to create a soundworld that the sensors could navigate through. Creating the live processing for each composition developed my own style of working with audio effects and gave me confidence to collaborate with Song on a further four works for bass clarinet and live processing (see sections 2.6 and 6.5.2).

My process of creating the live processing once again highlights how I oscillated between artistic and technical thinking during this research. For each work, I could not have created the live processing without my instrument. Being able to try out different audio effects to hear how they blended or contrasted with the bass clarinet or clarinet part was vital. This was also true of my collaboration with Song. I played bass clarinet during all our rehearsals, with Song listening to the result of each audio effect.

With our collaboration, we also created a dialogue that moved between artistic and technical thinking. Song chose all the audio effects for her works, often expressing her artistic ideas to me. In response, I explained to her the technical practicalities of using the sensors. Her creative ideas pushed my technical skills and knowledge, which in turn opened Song up to new ways of music making.

Another insight that I gained from constructing the live processing was the importance of studying the score. The type of score study that I am referring to is similar and different to a musicological study. For example, I did explore the musical structure of each composition; however, I also explored the score in a much more embodied way. I did not just sit down and study each composition at my desk. I also spent a lot of time practising each work to develop a feel for the music—not the music as a textual object, but the music as vibrations in the air:

> One of the challenges of this piece (like any piece) is that it is easy to get into a routine of playing each gesture the same way every time. When I am memorizing sections, I try to focus on re-exploring the music, without the score. It seems to engage a different part of me and I find this more exciting than picking through the notated score. The more I play off the page, the more that I feel I am making a contribution as an artist. I used to find playing from memory scary, but I am starting to find it more freeing now! It opens up my ears to the soundwaves, rather than subscribing myself to what I see.[63]

Finally, one last theme that surfaced during the process of creating the live electronics was the impermanence of each live performance. The ability of the sensors to modify audio effects creates indeterminacy. There is a measure of unpredictability with the performances of these works.

Partly, this is due to a flaw of the sensors. Oftentimes while I am using the sensors, the yaw, roll, and pitch sensors drift. The positions of the audio effects and the parameter

[63] Reflective Journal Entry, 03 May 2020. The composition that is referred to in this entry is Jane O'Leary's *a piacere*. Originally, I learned *a piacere* with the intention of adding live visuals to it, but I eventually decided that the area of live visuals was much too large to include in this research.

boundaries should be fixed in place, but due to the sensor drift, these do not always stay in the same place.[64] In this sense, the only sensor that is truly reliable is the air pressure sensor.

With the unreliability of the sensors and the intended indeterminacy of the electronics, no performance is ever the same. The ephemeral nature of these performances is one reason I enjoy performing them. No matter how much I practice, I can never predict what the outcome will be. The next chapter will build on the topics discussed in the last three chapters, tying together different threads with a renewed examination of the role of the performer.

[64] After attending SABRe Day in 2018, it became clear that this issue affected other SABRe users as well. Calibrating the sensors and standing further away from speakers help to cut down on the drift, but I have yet to find a complete solution to this issue.

CHAPTER SIX: RE-EXAMINING THE ROLE OF THE PERFORMER

6.1 Introduction

> [E]ach person's sense of musical identity—and other identities—is *not* isolated or fixed; it is contingent, fluid, and ever-changing, albeit imperceptibly at times. Our musical and personal identities change in relation to our musical and personal interactions, context, and the affordances that musical experiences provide.[1]

This quotation sums up what this chapter is about—the adaptable musical identity. Mine has shifted several times over the past few years, and because I have been undertaking this research, the changes have been well-documented in my reflective journal. This journal is not contained within one single book but is comprised of loose-leaf notes, notebooks, video entries, and written documents saved on my computer.

By keeping a reflective journal, I was able to look back at over four years' worth of notes and notice changes to my practice that I might not have otherwise observed. The first time I re-read my notes was in January 2021. I wrote a list of keywords and phrases in boxes as they surfaced in my writing (see Figure 96). When I finished going through the notes, I cut out each box and moved them around on my desk, looking for themes (see Figure 97).

[1] MacDonald, Raymond, David J. Hargreaves and Dorothy Miell (eds.): *Handbook of Musical Identities* (Oxford, England: Oxford University Press, 2017), 32.

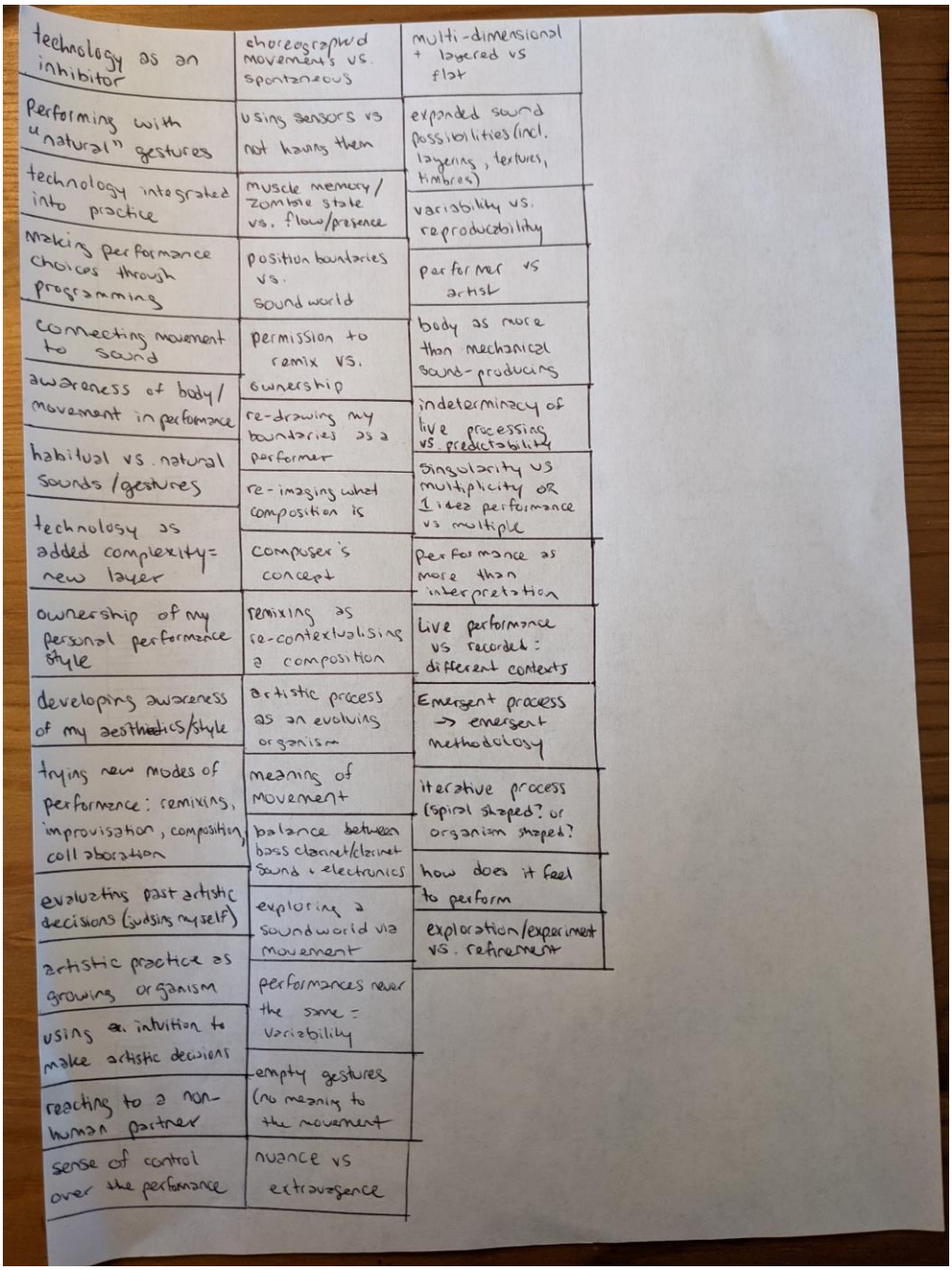

Figure 96: Keywords and Phrases

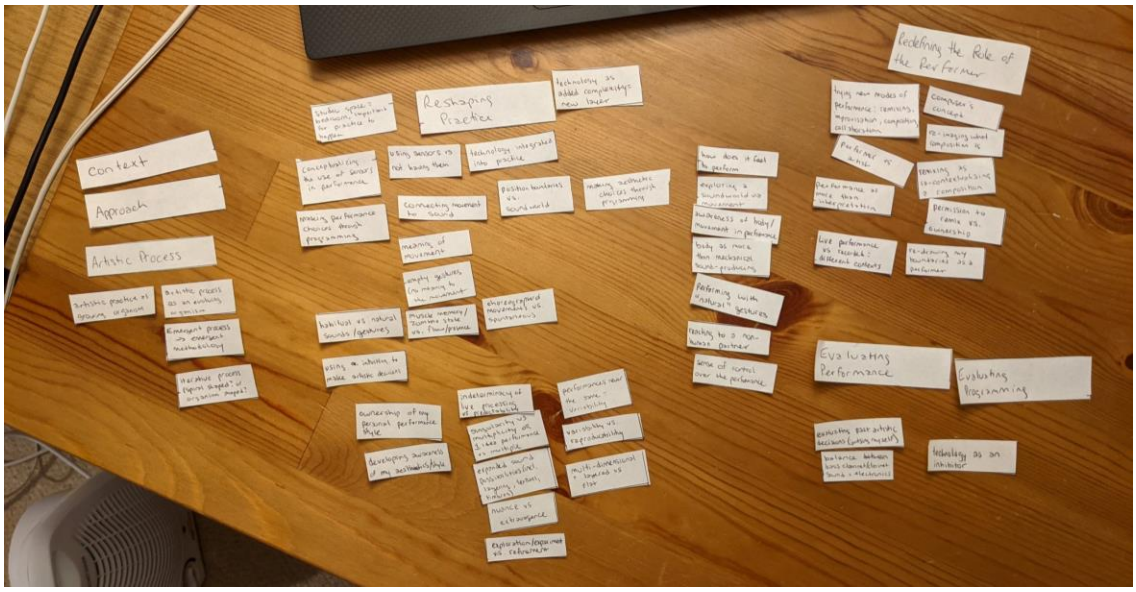

Figure 97: Searching for Themes

One of the themes that I identified was ‘reshaping practice’. I noticed that by working with the sensors, my view of the role of the performer had changed immensely. Instead of focusing on scores in the practice room, I was looking at other dimensions of music performance such as the role of physical movement. After this period of ‘reshaping practice’, another theme emerged, which I identified as ‘redefining the role of the performer’. This theme was about rethinking what it means to be a performer in current times.

I re-read my notes again in early 2022, sifting through more than four years of written data. This time, I extracted quotations from my journal entries and listed them in a table, along with the dates they were written. I chose each passage based on coherence and substance. When I completed the table, I had over sixteen thousand words. This was still too much data to work with, so I re-read each excerpt again and arranged them under thematic headings.

By reading excerpts from different time periods that all belonged to one theme, I was able to track how my thoughts developed over time. In this chapter, I have included many passages from my reflective journal to address topics relevant to contemporary

performance culture. The overarching theme is performance identity, and this is examined from several different angles.

6.2 Remixing and Recontextualization

Adding electronics to Amanda Feery's *Star Maker* without collaborating with her on the project made me feel extremely uncomfortable. Since *Star Maker* is an unaccompanied bass clarinet work, I needed to create a new palette of electronic sounds that did not exist in Feery's original composition. These would then be layered over the bass clarinet part and modified by the sensors (see section 5.3). In all the years I have been performing, I was never required to make such significant decisions about the kind of sounds that would be heard in performance. Even when I was programming Frank Lyons' *Stung* (see section 5.2), I was able to listen to Paul Roe's recording of *Stung* as a reference and use Lyons' Live audio effects.

While speaking with my supervisors about what I was doing, I became uncomfortable when asked if I was composing by creating an electronic layer:

> [W]hen I had supervision with [Paul McNulty], he had asked me if I felt that I was 'composing' in some way by adding electronics to the works of composers. This question stuck with me because I was not sure how to answer it.[2]

I did not feel like I was composing because the act of composing a notated score from scratch and adding electronics to a pre-existing work are not the same. I reflected on this in many journal entries:

> When I was programming the live processing for *Stung* and *Star Maker*, I was really conscientious to keep the original concept of the composers intact.
>
> It is difficult to describe what the concept is. Is it what makes the composition recognizable as that composer's work? For *Stung*, the concept is a modular score, with different sections alternating in a randomized way. There is a jazzy undertone to the work. A lot of the concept is preserved in the bass clarinet score.

[2] Reflective Journal Entry, 31 January 2020.

> For *Star Maker*, the concept is a child-like exploration of sound, particularly non-traditional sounds. For me, the concept seems to be a free and imaginative exploration of bass clarinet sound. (Yet again, this concept is preserved in the score). There is also a sense of duality: pretty, ethereal multiphonics and long, held notes versus interruptive, rhythmic bursts.
>
> The concept for every piece is unique and is what I believe truly belongs to the composer. I wanted to preserve the concepts of both composers so I spent a lot of time developing audio effects that would work with the original concept.[3]

The composer's concept is called different things by different people. For example, Eduardo Navas calls it 'the spectacular aura' in his book on remixing. He writes that 'a music remix, in general, is a reinterpretation of a pre-existing song, meaning that the "spectacular aura" of the original will be dominant in the remixed version.' Navas also refers to the spectacular aura as the 'essence' of a composition.[4]

Remixing is a word befitting of the activities that I was undertaking. In the context of music, the Oxford English Dictionary (OED) provides the following definitions for the act of remixing:

> To create a new version of (a recording) by rebalancing or recombining the separate instrumental or vocal tracks; (now also) to reinterpret or rework (an existing music recording), typically by altering the rhythm or instrumentation, often in a radical way.[5]

It is believed that the concept of remixing developed in Jamaica, although it was called *versioning*. This was the 'practice of releasing different versions of an original recording' and was 'done by dropping out or reworking the vocals and instrumentation on a soundboard's mixer, extending certain sections of the song, and sonically reinventing other elements of a recording through the use of various gadgets and effects pedals'.[6] More specific terms have been suggested by Navas, such as the *selective remix*, which denotes 'adding or subtracting material from the original composition', and the

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[3] Reflective Journal Entry, 04 October 2020.
[4] Navas, Eduardo: *Remix Theory: The aesthetics of sampling* (Vienna: Springer, 2012), 66–67.
[5] "remix, v." *OED Online* (Oxford University Press, 2019), www.oed.com/view/Entry/162240.
[6] Gunkel, David J.: *Of Remixology: Ethics and aesthetics after remix* (Cambridge, MA: MIT Press, 2016), 15–16.

reflective remix, described as 'not just extended or enhanced versions of a recording, but also creative reinterpretations of a single source'.[7]

The terms 'versioning' and 'remixing' resonated with me. Versioning, specifically, suggests that music (or art, in general) is not fixed, but changeable and adaptable. Remixing is also a compelling word that insinuates there is more than one source or author involved. Since remixing is a widely used word and one that I consistently used in my journal entries, I will use it to describe my work with Lyons' and Feery's compositions:

> I have been using the term remixing to describe the activity that I am undertaking. I am re-working the material of others by carefully considering the original concept of the composition. I am also exploring how the composition will come across in performance with the addition of new elements, such as sensors and electronic processing.[8]

My remix of Feery's *Star Maker* included extension, by adding an improvisation of air sounds at the beginning, and re-instrumentation, with the addition of an electronic layer (see section 4.3.3). I did not make any changes to the notated score, but the same cannot be argued for the composition itself, if we consider that a composition encompasses more than the physical score. By extending *Star Maker* with an improvisation and creating textures and electronic timbres that interact with the bass clarinet part, the composition is no longer in its original context. In this way, remixing *Star Maker* was a way of recontextualizing it:

> Remixing does not require a concept because this already exists with the first version of the work. Composing is when the concept is developed. Remixing is when the concept is re-contextualized. I don't view adding live electronics to Amanda Feery's work as composition. I extended and re-contextualized her work to fulfill my own practice's needs.[9]

My remix of *Star Maker* was a more radical departure from the original composition than my remix of *Stung*. The latter did not involve extension or re-instrumentation; however,

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[7] Navas, *Remix Theory*, 66.
[8] Reflective Journal Entry, 31 January 2020.
[9] Reflective Journal Entry, 04 October 2020.

it was still an act of recontextualization. Originally, *Stung* was performed by two people: the bass clarinettist and a technician controlling the live processing. In my version, the SABRe sensors replace the technician. The reasons for recontextualizing *Stung* in this way were mostly practical. With the addition of the sensors, I do not need to schedule rehearsals with another person, nor do I need to find someone to control the live processing. During the COVID-19 pandemic, this point also worked in my favour, as rehearsing with a second person was not allowed or encouraged for a long period of time.

6.3 Towards a New Identity

In one of my reflections, I wrote that I believe 'it is possible to either deliberately change the composer's concept while remixing, or to misinterpret what the composer intended'.[10] I was terrified at the idea of misinterpreting Lyons' and Feery's compositions because I was worried about how they would feel hearing their compositions transformed into something different. This fear was also mixed with guilt. My perception was that I was stepping outside of my boundaries as a performer and crossing into an unknown realm, somewhere halfway between composer and performer. As I re-read my notes, I noticed that the word *boundaries* kept appearing:

> Is it ok to remix this composition? Am I violating any boundaries by remixing, even if the composer consented?
>
> There is a sort of guilt to unpack here. Guilt that I am overstepping the boundaries of a performer.
>
> I start to question the label of 'performer'- if a performer is there solely to interpret, perhaps I don't want to be just a performer anymore.[11]

I was making creative decisions based on what I thought fit my identity as a performer and I was avoiding anything that rested outside my role as a performer. The shocking realization was that I was no longer certain of my identity. Perhaps I wanted to be more than a performer or something different altogether.

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[10] Reflective Journal Entry, 04 October 2020.
[11] Reflective Journal Entry, 06 January 2021.

So how was my musical identity as a performer constructed? Where did all my preconceived notions of how a performer should act come from? One way to understand my musical identity is to reflect on my musical education. From an early age, I participated in musical festivals and competitions. I developed the idea that I would win first place if I achieved perfection in my performances. Perfection, in my mind, was to accurately perform the details in the score: pitches, rhythms, dynamics, and tempo markings.

> As a classically trained musician, I was taught that there is an 'ideal' or 'best' performance and that is what we, as performers, should strive for. We are taught this through competitions and performance festivals.[12]

The idea of perfection was never something that was explicitly taught to me by my teachers, but it was something that I absorbed through these types of social and cultural situations. Lisa McCormick points out one of the issues with competitions:

> In a desire to be fair, jury members often resort to concentrating on objective aspects of performance, such as speed, accuracy, and volume, which can be singled out and tallied quite easily. But these are hardly the qualities of musicianship that matter the most. Artistry is neither quantifiable nor objective, and for that reason, the ranking system used in competitions is meaningless.[13]

It is possible that my understanding of 'perfection' developed in these types of situations, but this is not to say that the competitions I participated in were not worthwhile. These were also opportunities for me to perform regularly, to watch other performers, and to socialize with others. Over many years of competing, I also developed my own strategies for dealing with nerves and for memorizing music.

Another major contribution to my musical identity was studying as an undergraduate at the University of Victoria in Canada. Classes in music history and theory examined the

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[12] Reflective Journal Entry, 06 January 2021.

[13] McCormick, Lisa: 'Higher, Faster, Louder: Representations of the International Music Competition', *Cultural Society*, 3/1 (2009), 13.

lives of composers. We analysed scores and listened to recordings, but the focus was never on the performers themselves. Even classes dedicated to performing ended up being about what the composer had notated in the score. Every artistic decision made on stage was expected to be supported by some symbol in the score, or our knowledge about the composer's background and compositional style. Interpreting the score with sensitivity to the wishes and intentions of the composer was paramount.

> In music history and theory courses, I was taught mainly about the perspective of composers. I was taught that certain notes are more important than others and that particular chords/pitches or textures mean something. Musical elements were the composers' expressions and performers are merely to interpret these as accurately as possible.
>
> In none of these classes did I learn anything about the perspective of performers. What was the relationship between the first/premiere performer and the composer?
>
> Can performance be more than interpretation? Can performers be involved in the compositional process?[14]

As such, my view of the performer's role was to interpret the work of composers and master my own technical abilities so that I could perform as true as possible to the composers' intentions. In other words, my way of practising and performing (at this time) was primarily score-focused.

6.3.1 Improvisation

My discomfort in remixing the work of others was the first hint that I needed to question my role as a performer. The second activity that encouraged further self-reflection was improvising. Initially, the purpose of improvising was to become comfortable enough with it so that I could create a Max for Live patch that would enable me to improvise with the SABRe sensors and live processing. Although this patch never materialized, improvisation significantly impacted the direction of my research by opening me up to new ways of practising and of understanding my instrument.

[14] Reflective Journal Entry, 06 January 2021.

After taking up the bass clarinet in 2015, I performed much more contemporary music than classical music. Compositions such as Kathryn Norman's *Paul's Walk* and Amanda Feery's *Rattle* require some improvisational playing, and performing these pieces encouraged me to get more comfortable with it. When I finally decided to actively practise improvising, I had no idea how to begin.

The first challenge was becoming comfortable with not having sheet music in front of me. As a classically trained musician, I studied for many years to be an expert at playing from a score. I am not alone in this regard. As Stephen Nachmanovitch points out in his book on improvisation, '[m]any musicians are fabulously skilled at playing the dots on the printed page, but mystified by how the dots got there in the first place and apprehensive of playing without the dots'.[15] Or as composer Ed Bennett told Paul Roe during their collaboration, 'if I write for some great professional players who make a lovely sound but who don't put any of their own input into it I'd be worried because I would think, oh they can only play what's on the page'.[16] I wanted to be a musician with the ability to play beyond the page, but like many other musicians, improvisation was a foreign world to me and I was completely lost without a score in front of me. The following journal entry describes this challenge:

> What I am really struggling with is that I do not have a sheet of music in front of me directing me what the style of the music should be and where it should go. My practice has become very open-ended in a way that I have never experienced before. The possibilities seem endless at this point, maybe that is a good thing?[17]

A lot of uneasiness stemmed from not knowing how to begin an improvisation. I needed to develop trust with myself that I did not need a score as an impetus. One of the

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[15] Nachmanovitch, Stephen: *Free Play: Improvisation in life and art* (New York, NY: Penguin Putnam, 1990), 9.
[16] Roe, Paul: 'A Phenomenology of Collaboration in Contemporary Composition and Performance' (PhD diss., University of York: 2005), 156.
[17] Reflective Journal Entry, 16 January 2018.

techniques that my supervisor suggested was that I improvise from a score that I was familiar with:

> Paul [Roe] suggested I play *Star Maker* for 3 minutes, but improvise on different sections and not follow the order of the piece. I did this and felt that it was nice to be able to stretch out some of the parts that I really like about *Star Maker*. It was refreshing to explore the piece in a new way.
>
> Then Paul asked me to improvise freely for 1 minute. This was much more difficult for me, especially because I do not know where to start when improvising. At least improvising off of *Star Maker* gives me some content to start with. I had the idea to start with one note and then play whatever notes came to mind after the starting note. I found that I choose what next note to play based off of what fingering I imagine in my mind.[18]

Improvising from a score I was already familiar with was a positive experience. I realized that there were sections of *Star Maker* that I wanted to explore more, and improvising allowed me to do this within an open structure (of three minutes). Free improvisation was much more difficult to get into, and I often resisted it by putting it off. I began to unpack my resistance to improvisation in my reflective journal so that I could understand what was stopping me:

> There are two things that I think make me most resistant to improvisation. The first is that I have (until recently) considered improvisation as something only jazz musicians do. The second is that […w]hen I improvise, I often have my inner editor judging what I play. This means that when I do improvise, I often feel like I improvised 'badly' and this prevents me from having a positive experience.[19]

The first point of resistance was a question of identity. When I was a child, my exposure to improvisation was mostly through jazz music. My brother became an excellent jazz improviser at a young age and I often attended jazz band concerts that he performed in. In my mind, jazz improvisation was my brother's domain and I could not compare to him. I did join my secondary school's jazz band so that I could play the saxophone, but I never tried improvising solos. Instead, I gravitated towards classical, score-based music.

[18] Reflective Journal Entry, 01 October 2019.
[19] Reflective Journal Entry, 01 October 2019.

My first experience improvising was when I was sixteen and spent a month in Berlin with my father one summer. While I was there, I had weekly lessons with a local jazz clarinettist and I finally became comfortable enough to improvise. This was because I was away from my home and all the people who knew me as a classical musician. I was able to try something new without being compared to anyone else. Upon returning to Canada, I re-adopted my classical music identity and my interest in improvisation was stowed away.

In 2018, I read books about improvisation by authors such as Derek Bailey, Bruce Ellis Benson, and Stephen Nachmanovitch.[20] I was introduced to many different perspectives on improvisation and developed awareness of styles other than jazz. My perspective on improvisation was changing. Instead of viewing it as something that belonged only to those who were good at it, I realized that it is something that can be learnt through practice.

The second point of resistance was my own judgement of what I do, referred to as my *inner editor* (see previous journal entry). This inner voice constantly judges every sound that comes out of my instrument. I wanted to record my improvisations to document them, but I was hesitant to do this.

> The idea of recording them [my improvisations] makes me feel quite vulnerable […] because I have this pre-conceived notion that the quality of one's improvisation shows their level of musical creativity.[21]

Somehow, I had developed the idea that a good improvisation was the work of an incredibly creative person and that if I improvised, it would reveal how uncreative I really am. This was a form of the imposter syndrome, 'a psychological term that refers to a pattern of behavior wherein people (even those with adequate external evidence of

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[20] Bailey, Derek: *Improvisation: Its nature and practice in music* (New York, NY: Da Capo Press, 1992); Benson, Bruce Ellis: *The Improvisation of Musical Dialogue: A phenomenology of music* (Cambridge, England: Cambridge University Press, 2003); Nachmanovitch, Stephen: *Free Play: Improvisation in life and art* (New York, NY: Penguin Putnam, 1990).
[21] Reflective Journal Entry, 08 August 2018.

success) doubt their abilities and have a persistent fear of being exposed as a fraud'.[22] Although there are likely other factors, my belief that improvisation could expose my lack of creativity was mainly driven from my experience as a classical, score-based musician. As someone who had spent many years learning the creative masterpieces of others, I had spent little time exploring my own musical ideas.

One technique that helped me to quiet my inner editor was to doodle on a piece of paper while listening to my recorded improvisations:

> There was something about drawing to improvisations that made me listen to my improvisation in a non-judgmental way. Normally, if I was listening to a recording of myself improvising, I would be critiquing it and noticing all the things that didn't go exactly the way they could have. But by drawing, it forced me into a new listening space.[23]

Another factor that was important was having enough energy. There were times that I spent most of my practice sessions working with scores and by the time I got around to improvising, I lacked the energy.

> Last night I was inspired to improvise after reading a section of Nachmanovitch's *Free Play*. I warmed up and practiced some other pieces first and then at the end of my practice went to improvise. I found that I did not like anything I came up with because it seemed random and nothing went together. There was no flow. I think that leaving the improvisation to the end of my practice, when I was tired, was not a good idea. Perhaps we only have so much creative energy to use at one time, and then we need a break before trying again. But the building was about to be closed up, so I went home.[24]

Being in the right mood to improvise was also important:

> I talked to PR [Paul Roe] about 'being in the right mood' for improvising […] I can remember, in some aspect of my mind, how it felt to be in this mood. If I were to describe it, it would be that I felt this energy in my body that I needed to let out. It is similar to the kind of energy one would get after listening to someone really inspiring.[25]

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[22] Mullangi, Samyukta and Reshma Jagsi: 'Imposter Syndrome: Treat the cause, not the symptom', *JAMA*, 322/5 (2019), 403. JAMA is the acronym for the Journal of the American Medical Association.
[23] Reflective Journal Entry, 19 November 2019.
[24] Reflective Journal Entry, 14 October 2019.
[25] Reflective Journal Entry, 19 November 2019.

Over time, I developed my own strategies for improvising, including making it the main task of the day to ensure I had enough energy to practice:

> After all of the exercises and studies, I moved on to working on improvisation, the main goal of the day. On a previous day I had already worked on C major pentatonic, so I decided to move on to G major pentatonic. Using [Paul Roe's] technique, I started by playing the scale normally and focused on getting really familiar with all of the notes. Then I started to mix up the scale degrees and change direction as much as I wanted to. When I felt comfortable with the notes in the scale, I started to create melodies by jumping around the scale.
>
> One thing I was aware of was rhythm. I struggle to improvise with a solid tempo, so I was trying to keep a beat. Eventually, I came up with a melody that I really liked and without thinking about it too much, I developed two phrases that repeat (AABB). I then video recorded myself playing it to test how comfortable I was with it.
>
> […] Even though I came up with the melody, I still had to practice it so that I could play it smoothly over and over again. The two phrases seemed to develop naturally. When I was improvising and heard a melody or pattern that I liked, I played it a few times over to make sure that I would remember it. The second phrase developed out of the first one. I felt that I was following my ear.
>
> I tried to come up with the next section, but I think at this point I was starting to overthink it (i.e., getting too much into music theory). I will try and add on to the song next time I practice, but I would also like to improvise on a different key next time.[26]

This excerpt shows that I was already treating improvisation as a compositional tool, although I was not aware of it at the time.

6.3.2 Composition and Ownership

After two and a half years of practising improvisation on a semi-regular basis, I composed *Dréimire Mhuire*, almost by accident (see section 2.4):

> I was inspired by an Instagram account, @blathannafiaine, which showcases Irish wildflowers in the Irish language. This composition was originally an improvisation that I recorded on my phone during the COVID-19 pandemic. When I listened to it the next day, I was surprised that I enjoyed it so I continued improvising, adding a little bit every day.[27]

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[26] Reflective Journal Entry, 10 April 2020.

[27] Performance Notes for *Dréimire Mhuire*, 17 November 2021. Unfortunately, the original improvisations that I recorded on my phone were lost when I dropped my phone into the canal while out walking. Fortunately, I had already notated it by this time.

Although I had not intended to compose as part of this research, I had been interested in the idea of composing for quite a while. Improvisation became the tool that I needed to get started. The entire process of working on *Dréimire Mhuire*—from improvising, to notating, to the premiere performance—not only gave me insight into the world of composition, but also performance.

> As a performer, there is a degree of separation between oneself and the audience. This is because the works belong to someone else – the composer. In a way, it is a safety blanket. If the performance doesn't go to plan, the composer can always be blamed. Maybe the piece wasn't good enough or it didn't sit well on the instrument. Or maybe it was simply a difficult piece of music to learn. There are so many excuses when it is separate from oneself. Even if these are just things that are thought and never expressed out loud.[28]

It was strange then to perform my own composition in front of a live audience, but not as scary as I had imagined. In fact, after the premiere performance of *Dréimire Mhuire*, I felt liberated. This was because I had full ownership over the performance. Ownership is a theme that resurfaced repeatedly throughout this research and frequently in association with remixing. The rest of this section will expand on the earlier discussion of remixing by focusing on the concept of ownership.

Through journaling and conversations with my supervisors, it became clear that remixing material that belonged to someone else was a cause for apprehension. For example, in an entry where I reflected on the process of remixing *Star Maker*, I noted that although 'I went ahead with adding live processing to *Star Maker* […] when it came to recording the work, I started to feel uncomfortable about it'.[29] This contrasted with my experience remixing my own work.

> The process of adding electronics to *Dréimire Mhuire* was much more enjoyable than the other works. *Since Dréimire Mhuire* is my composition, I felt more free to experiment.
>
> […] With *Stung* and *Star Maker*, I was worried about offending the composers, as well as destroying their work with electronics the composers might deem

[28] Reflective Journal Entry, 05 April 2022.
[29] Reflective Journal Entry, 30 August 2021.

> as 'bad' or 'incompatible with their works'. The freedom of using my own work was that I had all the permission I needed to go crazy with the electronics.[30]

Ownership, permission, ethics—these words were constantly circulating in my head whenever I reflected on my remixes of *Stung* and *Star Maker*; however, while working on *Dréimire Mhuire*, I felt free. Again, I questioned my unease over remixing and tried to understand where these feelings came from and why I was experiencing them.

In the past, there has been a lot of controversy surrounding remixing practices. Clearly, I am not the only one to have encountered discomfort in the face of the remix. In his book on remixing, David Gunkel explains that the hesitation in accepting remixes is that they are anomalies, 'systemic problems', that cannot be controlled by the system that created them.[31] This is broken down in detail by Jeremy Barham:

> [i]n music, the digital technologies that underpin practices such as sampling, remixing, plunderphonics and mash-up render previously cumbersome processes of structural transformation and manipulation of existing (and newly created) material much easier and more accessible, potentially challenging many Western rationalist conceptions of art, and normalizing notions of, for example, hybridity, incompletion and authorial ambiguity.[32]

Despite the opposition that remixing culture has garnered in the past, Abby Waysdorf comments on the pervasiveness of remixing in popular music and culture:

> [T]oday remix is found so often as to be banal, part of music and literature, television fandom and video games, business and design. Remix is an accepted part of contemporary culture, rarely generating the sort of controversy that it did during its rise to prominence.[33]

Even so, I have yet to encounter a classical or contemporary music programme with the word *remix* printed on it. This may be because the composer's score is often treated as

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[30] Reflective Journal Entry, 03 October 2020.
[31] Gunkel, David J.: *Of Remixology: Ethics and aesthetics after remix* (Cambridge, MA: MIT Press, 2016), 142.
[32] Barham, Jeremy: 'Not Necessarily Mahler': Remix, samples and borrowing in the age of Wiki', *Contemporary Music Review*, 33/2 (2014), 128–147.
[33] Waysdorf, Abby S.: 'Remix in the Age of Ubiquitous Remix', *The International Journal of Research into New Media Technologies*, 27/4 (2021), 1129.

sacred in the sphere of Western classical music. Remixing highlights that compositions are indeed alterable. This challenged my original view that '[c]omposition in contemporary classical music is generally a process that ends with the score' and '[s]ometimes, the process is extended further when the composers and performer collaborate.' [34]

In a journal entry, I examined the distinction between composition and performance, as well as the area in between:

> Performance is when the composition is realized in time for an audience (even if that audience is not here as it happens, like with recorded music).
>
> But what about the space between the score and the performance? And what happens when the performer re-opens the compositional process by adding something new to the work? (or removing something).
>
> Or is the compositional process never truly finished? If a composer writes a piece for performers to play, it is realized again and again with ever subsequent performance. There is never a 'last' performance because there is always the possibility that someone will perform the work again in the future.
>
> When someone like me comes along and remixes the composition into something new, it is like a new branch starting to grow on a tree that will never stop growing.
>
> I am now questioning the notion that a compositional process ends with the score. The score is merely a point in which the composer hands the work over to the world to finish. But it will never be finished. The composer is handing the work over to the world to contribute to. It will be shared many times and it will change depending on who is contributing.[35]

If I were to take the perspective that the composition does not end with the score, back to the time that I remixed *Stung* and *Star Maker*, I wonder if I would have experienced the same sense of guilt. As Waysdorf has argued, remixing is everywhere around us in the contemporary world:

> In a 'participatory' media culture, where it is expected for a user of media to also make media, remixing content is one of the main ways to participate. Professional DJs release new remixes to acclaim and mainstream success. Memes fly across the Internet at all levels. Even the structures of digital life, from social media to search engines to professional documents, are made in

[34] Reflective Journal Entry, 03 October 2020.
[35] Reflective Journal Entry, 03 October 2020.

> a system based on what Manovich (2008) called 'deep remix', meaning that everything made with computers can be moved to another piece of software (or another function of the same software) and annotated, edited, or otherwise altered, by (nearly) anyone.[36]

Perhaps in the future, remixing in contemporary classical music will become more conventional.

6.4 Relationship with Technology

My relationship with technology has had its difficulties. As we all know, many things can go wrong when working with technology and I have had no shortage of technological problems to solve. For instance, the following journal entry demonstrates a frustration I encountered early on with Live:

> My goal was to explore Ableton and Max for Live as creative enablers, but right now I am actually finding them to be creativity killers. For the past half hour, I have been trying to use the Looper Audio Effect in Ableton Live 10. For whatever reason, I cannot hear what I am recording into the Looper, making it impossible to experiment with looping. I can record and then play back my recording without the Looper effect, but as soon as I try to record into the Looper, I am not able to hear what I have recorded. I tried to Google solutions to my problem, but to no avail.[37]

I encountered issues such as not getting any sound out of the speakers, resulting in me forfeiting a performance. On another occasion, I did not have the cords plugged in properly, causing the electronics to only emanate from one speaker during a concert. Despite these trials and tribulations, I have learnt a great deal from working with technology. In a comment on one of my reflective journal entries, my supervisor Dr Paul Roe made an interesting observation about my relationship with technology:

> Throughout your research I've had a sense that the technology could point a mirror back towards yourself. To invert. The amplification brought about by technology provides an opportunity to turn our attention inward. It seems like a contradiction but when we examine things we need to see outside and inside-the poles if you like. I sense this research continues to be a journey

[36] Waysdorf, 'Remix in the Age', 1129–1130.
[37] Reflective Journal Entry, 08 February 2018.

> within with the technology providing the impetus to consider what's important-movement, gesture, expression et al.[38]

Adopting various technologies into my practice, such as software like Ableton live and hardware like the SABRe sensors, has provided me with new opportunities and endless artistic possibilities. Not only do these technologies extend my clarinet practice beyond the capabilities of my instruments, but they also impact my musical identity.

6.4.1 The Influence of Instruments on Identity

In the past, changes to my musical identity were often caused by learning a new instrument. Over the last twenty years, I have shifted between identifying as a pianist, a clarinettist, or a bass clarinettist. My identity has always been strongly connected to the instruments that I perform on.

> Performance is a big part of my identity. For many years, I have strongly identified as a performer, or as a performing musician. In fact, I have been performing for so long that I barely have any memories that pre-date my first few performances. I started performing as a young child, first on piano and then later on flute and clarinet. My musical identity has fluctuated to allow room for various instruments to come and go. Most recently, my identity is now tied stronger to the bass clarinet than the clarinet, but I am sure this will not always be the case.
>
> The sensors were a new addition to my practice, similar to how the bass clarinet was new to me 6 years ago. In both circumstances, the new object caused a shift in my practice and to my identity.[39]

The addition of sensors to my practice was akin to taking up a new instrument. The newness and unfamiliarity of the sensors shook me out of my normal routine. This was like my experience learning the bass clarinet during my master's degree. The bass clarinet, a new object, gave me entry into a new community with new possibilities. For example, the repertoire for bass clarinet is completely different than for clarinet. Since most bass clarinet music is contemporary, bass clarinettists tend to become specialists in contemporary music. After taking up the bass clarinet, I also became attracted to the

[38] Roe, Paul, e-mail message to author, October 2020.
[39] Reflective Journal Entry, 08 April 2022.

world of contemporary music and this caused shifts in my practice, which I wrote about in my master's thesis.[40]

Similarly, the SABRe sensors offered me entry into new communities, such as SABRe, Ableton Live, and Cycling '74. I learned how to programme and became comfortable using music technology in performance. The fear that something could always go wrong with music technology never faded, but I gained confidence in solving technical problems on my own.

Without the sensors, playing the clarinet or bass clarinet is already complicated. My posture, the way I hold my instrument, breath control, tongue position—all of these and more affect the sounds that come out of my instrument. By placing sensors on my instrument (clarinet or bass clarinet), my relationship with my instrument instantly becomes more complex. The sensors add another layer to this because moving the bass clarinet now also affects the electronic sounds.

> Originally, I was seeking integration of technology into my practice. What I didn't foresee was that this would actually influence me to start considering my practice as one where the body and mind are connected and integrated. [… M]y previous practice did not include consideration of the body in more than a mechanical role (purpose of controlling the instrument). But when physical movement changes non-clarinet sounds (electronic processing) the body becomes more noticeable (from performer's perspective). This leads to an increased self-awareness and an internal debate over planning movements to get a certain type of processing or to move naturally and embrace the indeterminacy of the electronics.[41]

Although I have always been aware of my body when playing an instrument, I had never focused on it as anything other than as a means of sound production. This all changed with the addition of the sensors (yaw, pitch, and roll) to my instrument.

> When the sensors are on my clarinet and change the results of the electronic sounds, I become ultra-aware of my movements. I even think I move differently when the sensors are on. I think I become more careful about how

[40] Barz, Marcella: 'A Contextual Analysis of Solo Bass Clarinet Music by Irish Composers' (MMus diss., Dublin Institute of Technology: 2017).
[41] Reflective Journal Entry, 06 January 2021.

> I move, rather than being blissfully unaware in a non-sensor performance. If I programme the piece well, then I don't feel inhibited by the sensors, but rather careful in the sense that my body has become an instrument. When I am programming a new piece and testing out the sensors, there are often times I feel things are out of control. Or the other side of things is I can feel that my movements make no difference whatsoever to the resulting electronics. This is more often the case.
>
> If my body becomes an instrument with the sensors on the clarinet, then as the programmer I am something like an instrument maker. Perhaps this is another way to look at programming – instrument design?[42]

With the sensors on my instrument, any movement could cause something to happen in the electronics and this is precisely why the sensors enact change. Not just a change between myself and my instrument, but also between my mind and my body.

> I am planning my movements in real-time. I am reacting to what I hear, but also evaluating how a movement will 'go' with upcoming musical material. If I think there will be a clash, or the sounds will build too much (become too loud), then I will avoid moving in the direction that would create an undesirable result. On the other hand, if I liked the way something sounded because of how I moved, then I have to decide if I want to make that happen again, or savour it as a 'rare' effect.
>
> With the sensors, I become more careful about my physical movements. I think the sensors require me to be more present. I can't rely as much on muscle memory or zombie states.[43]

By 'zombie states', I was referring to a sort of cruise control mode of performing. In a sensor performance, if I zone out, even for a split-second, it could have consequences on the electronics. I need to be constantly aware of my position in my performance space so that I can use the sensors as an extension of my instrument. The sensor box may just be an object, but its addition to my clarinet and bass clarinet challenged me to reconsider my tendencies as a performer.

[42] Reflective Journal Entry, 01 October 2020.
[43] Reflective Journal Entry, 01 October 2020.

6.5 Collaborative Discoveries

One reason I chose to remix compositions by Feery and Lyons is that I already enjoyed performing their works. With an ever-increasing amount of new music, I wonder if some bass clarinet works may be lost in the masses.

> In a time where new music is being cranked out into the world all of the time, there is a constant flow of new content. New works are supported, praised, and encouraged. But what happens to the old ones? By repurposing existing repertoire, these works are not forgotten.[44]

There is often funding for the premieres of new works, but not necessarily for subsequent performances. Remixing contemporary classical music provides an opportunity to re-perform works in different contexts. For example, if I were to perform *Stung* in Northern Ireland, I would surely want to perform with the composer; however, if I were to perform it anywhere else, I would prefer my remixed version for sensors. Similarly, I could perform the original versions of *Star Maker* or *Dréimire Mhuire* in any room, but if I were to perform somewhere with speakers, I would opt to perform the electronic versions. Why is this the case? Connection is one word that comes to mind and this is directly linked to my environment.

> I am most inspired by my environment. I have chosen to work primarily with music by Irish composers or people who live in Dublin. I feel there is so much music in the world and the choices are endless, but I have connections to people in my environment. If I have met with a composer, I am more likely to work on their music because I feel there is a connection there. I also have this idea of 'recycling' music. Instead of always looking for the next new thing, why not explore compositions with a history and recontextualize them in the present.[45]

Collaborating with Frank Lyons and Yue Song on new works was not so much a search for the new, but a search for connection.

[44] Reflective Journal Entry, 07 October 2020.
[45] Reflective Journal Entry, 07 October 2020.

6.5.1 Collaboration with Lyons

> When I started to learn bass clarinet music, I met some of the composers in Ireland. Instead of feeling intimidated by this, I felt that knowing what the composers looked like, how they walked and talked, and the way they communicated with those around them gave me some implicit understanding of the score. It also provided me with inspiration, emotion, and meaning.[46]

My experience with collaboration so far is that the connection between the people involved will ultimately impact the quality of the work. As bass clarinettist Harry Sparnaay admitted in an email to Paul Roe, '[f]or me personally it's very important what I feel for the composer as a person too. When he is a very nice guy I'm willing to give more than for a terrible person!'[47] I was introduced to Lyons through Roe. Knowing that Lyons and Roe had previously collaborated together (on *Stung*), having worked on *Stung* with Roe, and having performed *Stung* with Lyons all fed into my collaboration on *Hex 2*. I sensed that I was part of a developing legacy of bass clarinet playing in Ireland, and this made me feel invested in learning *Hex 2*.

Lyons wrote *Hex 2* for me after I remixed *Stung* for SABRe sensors and performed it in Zurich in February 2019. We met once to go through *Hex 2* in Belfast in June 2019 where Lyons explained his concept for his series of compositions (see section 2.5). During this meeting, we went through the score and I asked plenty of questions to clarify my understanding of the notation. I also played through the score with the soundtrack to get a feel for the different sections. I absorbed a lot that day, all of which undoubtedly filters into how I approach *Hex 2*. The location, the view from the window, Lyons' disposition and choice of words are all stored away in my memory. This is similar to what Roe discovered from collaborating with several different composers:

> Each time I play these pieces I have embedded in my memory and imagination each composer's gestures, movements and oral cues. In particular I

[46] Reflective Journal Entry, 04 April 2022.
[47] Roe, Paul: 'A Phenomenology of Collaboration in Contemporary Composition and Performance' (PhD diss., University of York: 2005), 217.

> discovered the importance of the visual in gaining a deeper understanding of musical intent.[48]

In particular, I picked up on Lyons' open-mindedness. When I perform *Hex 2*, I have a sense of ease because I feel like I have the freedom to explore the composition differently every time.

6.5.2 Collaboration with Song

In the third year of my research, Chinese composer Yue Song and I agreed to collaborate on a series of short works for bass clarinet and live electronics (see section 2.6). Up until this point, I had only worked with the SABRe sensors independently and I was unsure how to introduce them to another person. In the first two years of my research, I had developed a particular way of working with the sensors, but I did not want Song to feel obliged to adopt my style.

The COVID-19 pandemic delayed the start of our collaboration, but the easing of public health restrictions in the summer of 2020 allowed us to meet so that I could show Song what I could do with my bass clarinet. We went through the basics of bass clarinet playing, as well as a lengthy list of extended techniques. Following this workshop, Song completed the first three bass clarinet scores in quick succession. After the second lockdown in 2021, we were finally able to meet at the university and work together to create the live processing.

For each piece, I learned the bass clarinet part first and then recorded it or played it in-person for Song to hear. At this stage, I was able to flag any difficulties in the bass clarinet part and suggest changes. For example, the score for *Dovetails* was edited at least five times. Once I could play the bass clarinet part sufficiently, we developed a process for adding the live electronics. Typically, Song would send me a score with audio effect ideas marked in and this would initiate our first rehearsal, where we tried out different audio

[48] Roe, 'A Phenomenology of Collaboration', 217.

effects. Our second meeting was usually after the programming was complete, to test out the electronics and to make any changes if something did not sound quite right. Often, we met three or more times to make minor adjustments.

While working on the live processing for *Above Dublin*, I taught Song how to use my setup (Live and the SABRe sensors) so that she could change between different audio effects as I played excerpts from her score.

> One of the benefits with working with a composer is that they are able to sit behind the speakers and listen to the bass clarinet and the effects. When I am working alone, I rely on video and audio footage to hear the blend between the clarinet/bass clarinet and effects. While working with Yue, I was able to teach her how to swap between different audio effects so that she could do it while I was playing excerpts from the score. This really saved us a lot of time when choosing which effects to use.[49]

Although it was helpful for Song to be able to control my setup in rehearsals, it would not have worked well in performance:

> [T]he sheer number of audio effects used in Yue's pieces, coupled with the quick changes from one effect to another mean that it would be difficult for a second person to control them, as we discovered while rehearsing the effects one day.[50]

I did not expect Song to adopt my approach to using the sensors when I already had two years of experience using them.

> In some ways, collaborating with someone is like starting over with the SABRe sensors. The amount of knowledge I have developed working with these sensors and the accompanying software (Max for Live and Ableton Live) cannot be transferred to my collaborator, even during an extended period working together. Instead, they can develop their own knowledge of working with the sensors by working with me.[51]

Additionally, I was interested in Song's ideas and was curious to see how she would approach the combination of bass clarinet and sensors. My attitude towards our collaboration was open-minded and that we could both learn from each other.

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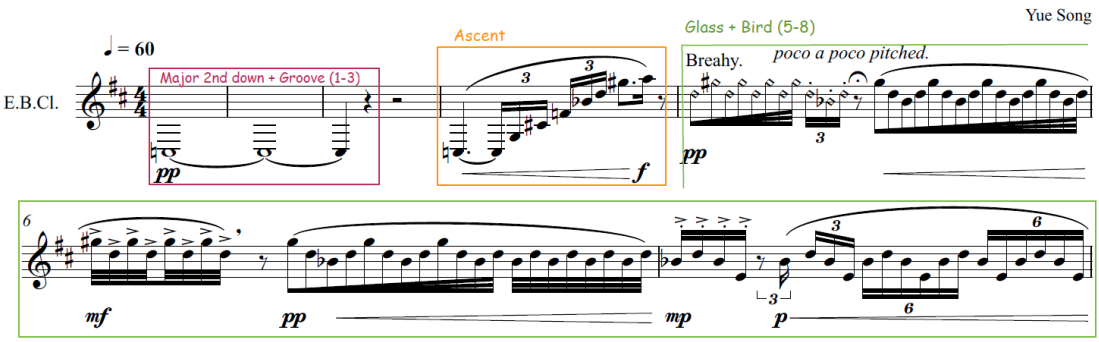
[49] Reflective Journal Entry, 24 June 2021.
[50] Reflective Journal Entry, 21 February 2022.
[51] Reflective Journal Entry, 08 September 2021.

> By the nature of collaboration, there is also little point in trying to do things my way because then I am not learning from my collaborator. […] Interestingly, I ended up coming up with new approaches to using the sensors and programming that I probably could not have if we had never worked together.[52]

Song's approach to the electronics was to assign audio effects to particular areas in the bass clarinet score. Example 28 shows how Song notated the audio effects. The audio effects are specified by coloured boxes, the name of the audio effect, and the bar numbers where the effect should be active. This required me to programme the sensors so that they could be navigated through in a sequence, similar to how I set up the patch for *Stung*; however, the difference with Song's works is that the audio effects are predominantly static, without any change to their parameters.



Example 28: Song, *Unstoppable Spirals*, 1–7

By using the sensors to navigate through a sequence of effects in the score, I had to use planned movements to trigger each scene, so I programmed it in a way that did not require me to move outside of my usual range of movement; however, it was difficult to programme anything with such a small range of movement so I was forced to make bigger movements as a result.

> Recently, I've been working on one of Yue Song's compositions for bass clarinet and electronics. She asked if I could do certain effects in specific places in the score so I've been trying this out. What this has made me realize though, is that my range of normal/habitual physical movement is quite limited, especially with the bass clarinet.

[52] Reflective Journal Entry, 08 September 2021.

> So I videoed myself playing one of her pieces [*Wandering Consciousness*] and then I watched it back. It felt while playing that I was being over the top with my physical movements. When I watched the video back, I was shocked by what I saw. It didn't look at all the way it felt. It wasn't over the top. Actually, I thought it would be ok in some places if I moved even more! This got me thinking that my range of movement could be limited by my habitual gestures and movements.[53]

Up until my collaboration with Song, I had been using the sensors to generate a more indeterminate result with the electronics (the soundworld approach, for example). Aside from my interest in variability (see section 3.2.1), I had purposefully avoided placing audio effects in specific locations in the score because I was worried my movements would become unnatural if I used the sensors in a choreographed manner.

My reaction to the video proved this was not the case and raised the question of whether natural movements even exist when playing the clarinet.

> I don't think playing the clarinet is an inherently natural activity. The use of a mechanical instrument already sets clarinet playing in a different category to singing. I could describe my habitual clarinet sound, but I could not do the same for my natural clarinet sound. Does such a thing even exist?
>
> Although playing the clarinet is not a natural human activity, the physical movements required to play the clarinet can feel natural.[54]

Although I had strong aesthetic ideas that influenced my use of the sensors, collaborating with Song was an opportunity to question my own aesthetics.

6.6 Conclusion

> During this research, I have noticed that using the sensors […] caused me to re-evaluate my own views on what a performer does. I wanted to use the sensors, but very little repertoire existed for them [back in 2018]. So why didn't I just commission composers to write for me? Why did I remix *Stung* and *Star Maker* and compose my own work?
>
> I think I have always had a deeper desire to be more involved in music creation. Although it is difficult to admit, I was unsatisfied with being a performer before this project took shape. And I noticed people in the bass clarinet community, in particular, were composing their own music and arranging music for bass clarinet. So I was influenced by others as much as my

[53] Reflective Journal Entry, 19 April 2021.
[54] Reflective Journal Entry, 28 September 2020.

> own desire to do more as a performer. I wanted to be more involved and more creative.[55]

Learning to use the SABRe sensors and integrating them into my practice expanded my view of what it means to be a performer and allowed me to explore my own aesthetics. The vast amount of creative possibilities that the sensors afford encouraged me to understand technology on a deeper level, to improvise, to remix, to compose, and to collaborate.

Significantly, the sensors were a catalyst for changes to my musical identity. The decision-making that was required to programme the sensors for performance encouraged me to look inwards. I no longer identify singularly as a performer, but also as an improviser, programmer, remixer, and composer (although the last one is a contentious point).

> Am I a composer? Even if I have only composed 1 work? […] I still feel hesitant to consider myself a composer. Part of it is that I prefer words like *creator* and *maker*. It gives a more 'hands on' connotation, whereas composition tends to sound much more academic or cognitive.[56]

At the beginning of this research, I sought to escape the restraints of fixed electronics by using the sensors to manipulate live electronics; however, after some time I did feel like the sensors created their own set of restraints. Although the live processing afforded me freedom of time, the sensors caused me to become careful of my every movement, either to manipulate the audio effects or to not trigger the wrong ones. With this experience behind me, I do not find that live electronics are necessarily better than fixed electronics, rather they are different mediums altogether.

[55] Reflective Journal Entry, 04 April 2022.
[56] Reflective Journal Entry, 06 January 2021.

CHAPTER SEVEN: FINAL THOUGHTS

7.1 Summary of Research

My original research questions set me on a path to study the relationship between performers and music technology. I was particularly interested in interactive technology and how using it could enact change in my own practice. To answer my research questions, I prepared performances of nine compositions for clarinet or bass clarinet and the SABRe multi-sensor device. This included collaborating with two composers, remixing two existing works, and composing my own work. For all nine pieces, I created Live Sets and Max for Live patches in Live for the live processing.

My aim was to integrate the SABRe sensors into performance so that I could interact with the live electronics, and this guided my programming decisions. While creating the Max for Live patch for *Stung*, I realized how important it is to consider the human aspect of using technology in performance. I pursued answers to questions such as *how will the sensors connect the physical environment to sound*? By doing so, the body became central to my considerations.

How the performer moves their instrument around the performance space can either determine which audio effects become active or inactive, or modify an audio effect's parameters to change its sound. The sensors, the instrument, and the body of the performer become one entity that interacts with the live electronics. With the sensors attached to the performer's instrument, the performer becomes a conductor of sorts, using the instrument to communicate with an orchestra of electronics. The sensors are like the conductor's baton, signalling the entrance of particular electronic instruments and ushering out others. As the conductor, the performer acts as the main artery of the orchestra by keeping a plethora of electronic instruments united and in time.

Although this analogy is helpful, it is not perfect. Having a conductor suggests that the movements of the sensors are always pre-planned, but this was not the case. For the first four compositions, I programmed the sensors in a way that allowed for unplanned movements and indeterminate results; however, when collaborating with Yue Song on her compositions, it made more sense to plan movements because the type and location of the electronics were decided in advance.

These two approaches to the electronics resulted in two very different performance experiences. With indeterminate electronics and unplanned movements, my movements were improvised and guided by what I heard. With Song's works, I planned and practised movements ahead of time in order to facilitate the activation of audio effects. Both approaches were engaging and interactive because the live processing reacted to the sounds of the live instrument. Unplanned movements are less stressful in one sense because there is no right or wrong way to interact with the audio effects. On the other hand, planned movements can be practiced and provide the performer a degree of certainty as to how the electronics will sound.

Through the decision-heavy stage of programming, I often asked myself *what is the purpose of the electronic sounds*? To me, it was important to consider the meaning behind the electronics because they should not simply create a smattering of sound effects just to show off what the technology can do. This brought the relationship between the mind and body into focus. I asked *how do my intentions affect the visual aspect of performance*? To achieve integration of the sensors in performance, I considered how the internal affected the external. I took regular videos of myself practising and realized that my perception of my performance does not always line up (visually) with reality.

By working with the SABRe sensors, my attention shifted away from the musical score and my viewpoint on performance expanded. Because I wanted to perform with the

sensors, I remixed existing works, collaborated, and composed. This afforded me new perspectives on performance and made me question the usefulness of being labelled as a 'performer'. Throughout this research, I have been considering the term 'artist' as an alternative because it is broader; however, upon further reflection, I have concluded that just because I am a performer does not mean that I cannot also be other things.

7.2 Contributions

The primary aim of this research was to investigate new music technology and its impact on my performance experience; however, this thesis goes beyond an investigation of technology and tracks how I interacted with my own thoughts, feelings, and experiences about performance and how this subsequently affected my practice. Although much of this thesis centres on my use of technology, the integration of journal entries into the main text reveals the intricacies of musical identities, the performer's mind-body relationship, and the relationship between performers and composers.

Throughout this thesis, I have demonstrated that reflective journals are a valuable tool for analysing artistic processes. My reflective journal, which contained over 20,000 words, was an incredibly beneficial resource for analysing my artistic journey. By maintaining a reflective journal for a period of four and a half years, I developed an awareness of my musical identity and aesthetics, and questioned preconceived notions about performance. It enabled me to express my ideas and concerns on paper, consequently encouraging me to search for solutions. The journal is also a record of my research activities and reading it back allowed me to understand where my ideas came from and how they developed over time. I was able to track changes to my practice and acknowledge how this was enacted. I would encourage other researchers to maintain their own reflective journals as I have exhibited how vital it is for understanding the artistic process.

This research has shown that using music technology can empower performers to expand their practices. Over the past few years, many performers have remarked to me (after watching me perform) that they find technology too unreliable or frustrating to use. When I started this research, I was also a beginner and had little experience using music technology. Although I experienced a steep learning curve with Ableton Live, Max for Live, and the SABRe sensors, I gained confidence by solving technical problems. This enabled me to experiment in Max for Live, broadening my practice and inspiring me to try remixing, improvising, and composing. This thesis provides many examples of how I solved technical problems with no prior experience using sensors, Live, and Max for Live; this demonstrates that, through problem-solving, performers with little experience using technology can improve their relationship with technology and expand their practice at the same time.

Throughout the thesis, I have illustrated several different approaches to using the SABRe multi-sensor and remote with Live. These developments include using scenes to switch between different settings, which uses the Master Counter setup in Max for Live; the soundworld approach to navigating audio effects in performance, which employs Live's Chain Select Editor; the modification of audio effect parameters through the creation of sensor boundaries; and the use of return tracks to ensure the continuity of sound during scene changes.

Finally, this thesis is accompanied by nine works for clarinet or bass clarinet, live electronics, and the SABRe multi-sensor and remote. Of the nine works, there are two remixes of existing compositions, six collaborative works, and a composition of my own. I created Live Sets and Max for Live patches for each piece, exhibiting various approaches to using the SABRe sensors.

The first Live Set and Max for Live patch was for *Stung*; in addition to the patch being overly complicated and untidy, the main issue was that switching between audio effects

caused the live processing to cut out. This was remedied after I developed the soundworld approach for *Dréimire Mhuire*'s Live Set and patch; my solution to this problem was to use return tracks to route the live processing, allowing sound moving through the DAW to fade out, even after the audio effects had been de-activated. Another successful outcome of the soundworld approach was utilizing Live's Chain Select Editor to navigate through a plane of audio effects. This proved to be easy to negotiate in performance, especially for indeterminate electronic works such as *Dréimire Mhuire* and *Hex 2*, but it was also necessary to implement Song's effect ideas.

7.3 Where to From Here?

The benefit of the SABRe sensors is that multiple people can purchase and use the same sensors.[1] Works composed for SABRe sensors have a higher chance of surviving if multiple people use the sensors, but there are a few potential barriers to the transmission of these compositions to other performers.

At SABRe Day in 2018, the only performer who solely used the SABRe software was Stephen Vermeersch. All the other performers used other software programmes in correlation with the SABRe software. This may prevent performers from learning compositions that require a specific type of software that they do not have. For example, all the compositions that are discussed in this thesis require Ableton Live 10 and the SABRe software; if another performer wanted to learn any of these works, how could it be made accessible to them?

One area that I did not have time to explore is the use of sensors to control, manipulate or create live visuals, potentially in Jitter. This could easily be the subject of another doctoral dissertation and would lend itself well to collaborations with visual artists. Similarly, another area with potential is the use of sensors to navigate a game-like

[1] For a list of works for SABRe sensors, please see APPENDIX K: LIST OF COMPOSITIONS FOR SABRe SENSORS.

environment. At SABRe Day in February 2018, Marij van Gorkum demonstrated the possibilities of this by navigating through a game with the SABRe sensors. This was interesting to watch and is another area that could produce exciting collaborations, possibly between performers, visual artists, and game designers.

At the International Clarinet Conference in Belgium in 2018, I witnessed a chamber music group perform together with SABRe sensors. Chamber music with two or more performers using the SABRe sensors has the potential to be a rich, yet complex area of research.

Ideally, all the future research directions suggested here would be investigated through artistic research. This would allow other performers, composers, music technologists, and electronic engineers insight into how the sensors are actually used.

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ChagallMusicOfficial: ‘Chagall - Sappho Song live performance with mimu gloves’ (16 February 2015), accessed 20 May 2022, https://youtu.be/Ks19HI3r2yQ.

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TEDx Talks: ‘Mi.Mu Gloves Chagall Performance | Chagall van den Berg | TEDxAmsterdamWomen’ (29 November 2016), accessed 20 May 2022, https://youtu.be/-aAGGRTxC0s.

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Centre for New Music and Audio Technologies: ‘Downloads’, https://cnmat.berkeley.edu/downloads.

Cycling ’74: ‘How to make a double tap(click) button for monome’: https://cycling74.com/forums/how-to-make-a-double-tapclick-button-for-monome.

Cycling ’74: ‘LOM – The Live Object Model’: https://docs.cycling74.com/max8/vignettes/live_object_model.

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Sensor Augmented Bass Clarinet Research: www.sabre-mt.com.

APPENDICES

APPENDIX A: *STUNG*, COMPOSED BY FRANK LYONS

STUNG

(2010)

for

Bass Clarinet and Live Electronics

by

Frank Lyons

(Commissioned by Paul Roe)

STUNG
(2010)
for
Bass Clarinet and Live Electronics

Introduction
A B C D E
I
II
III
IV
V
VI
Coda

First performance given by Paul Roe (bass clarinet) and Frank Lyons (live electronics).

Performance Notes

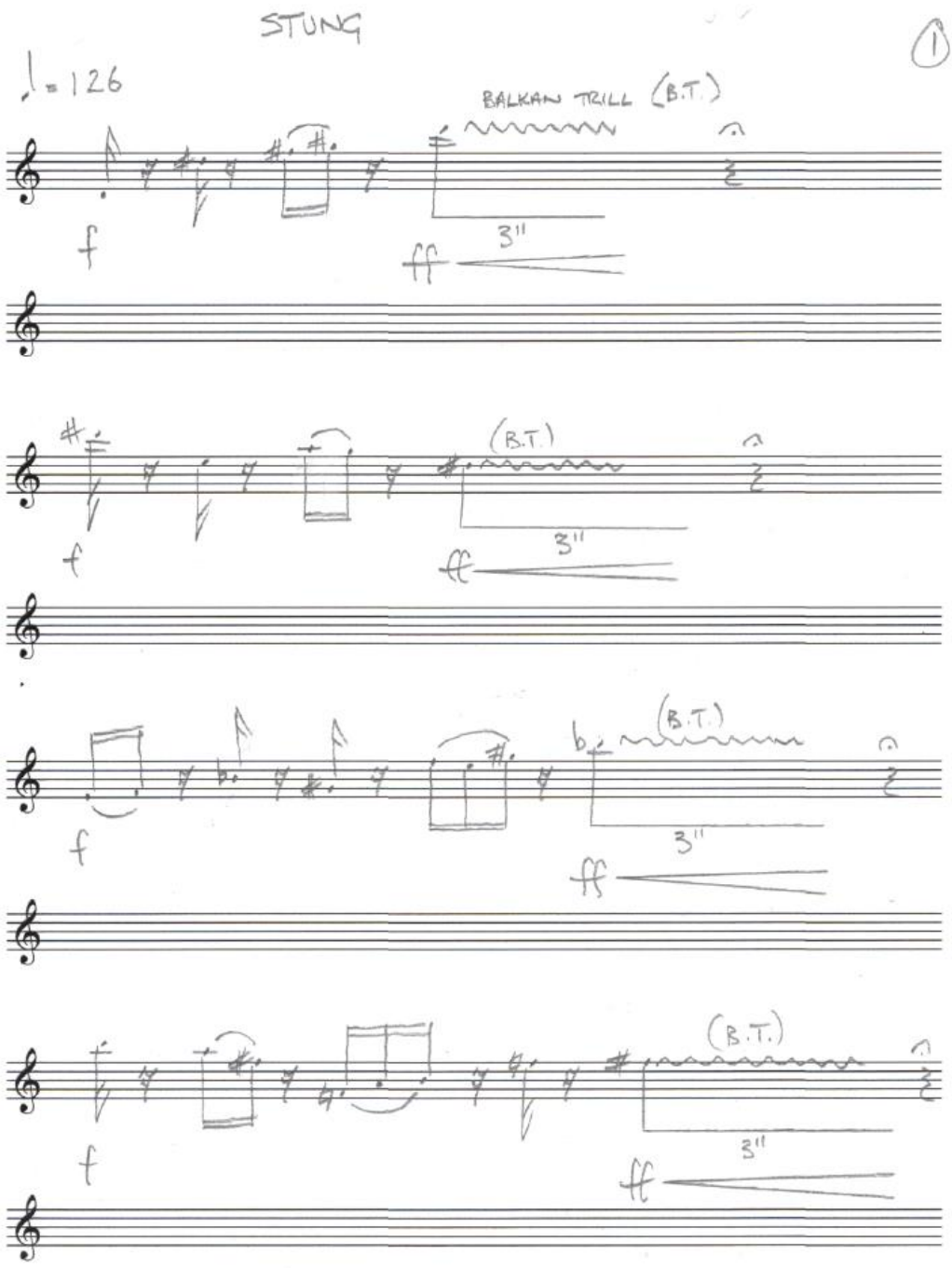
The ordering of the sections is at the discretion of the performer(s) with the following stipulations:

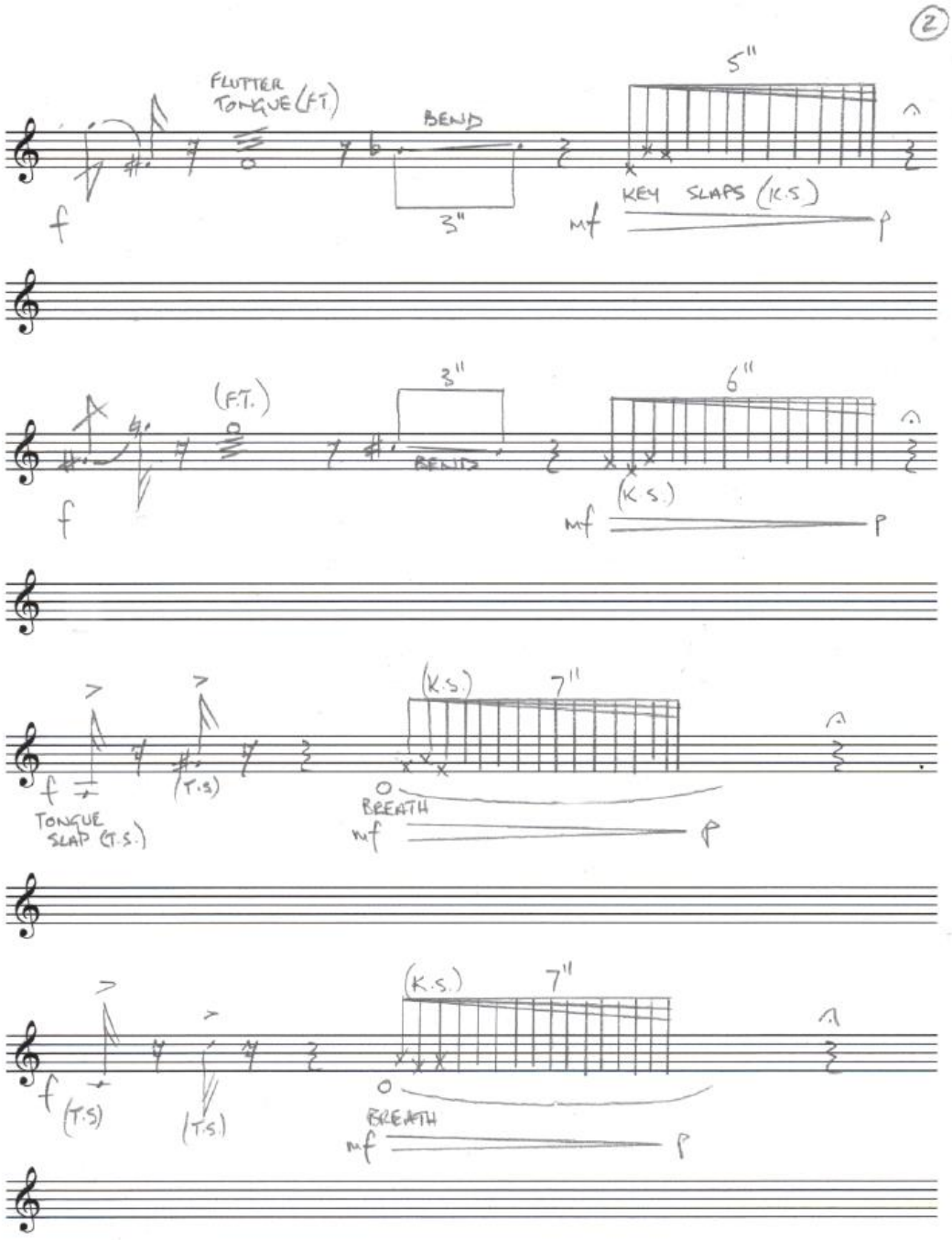
The introduction should be followed by a numbered section alternating with a lettered section ending with the coda.

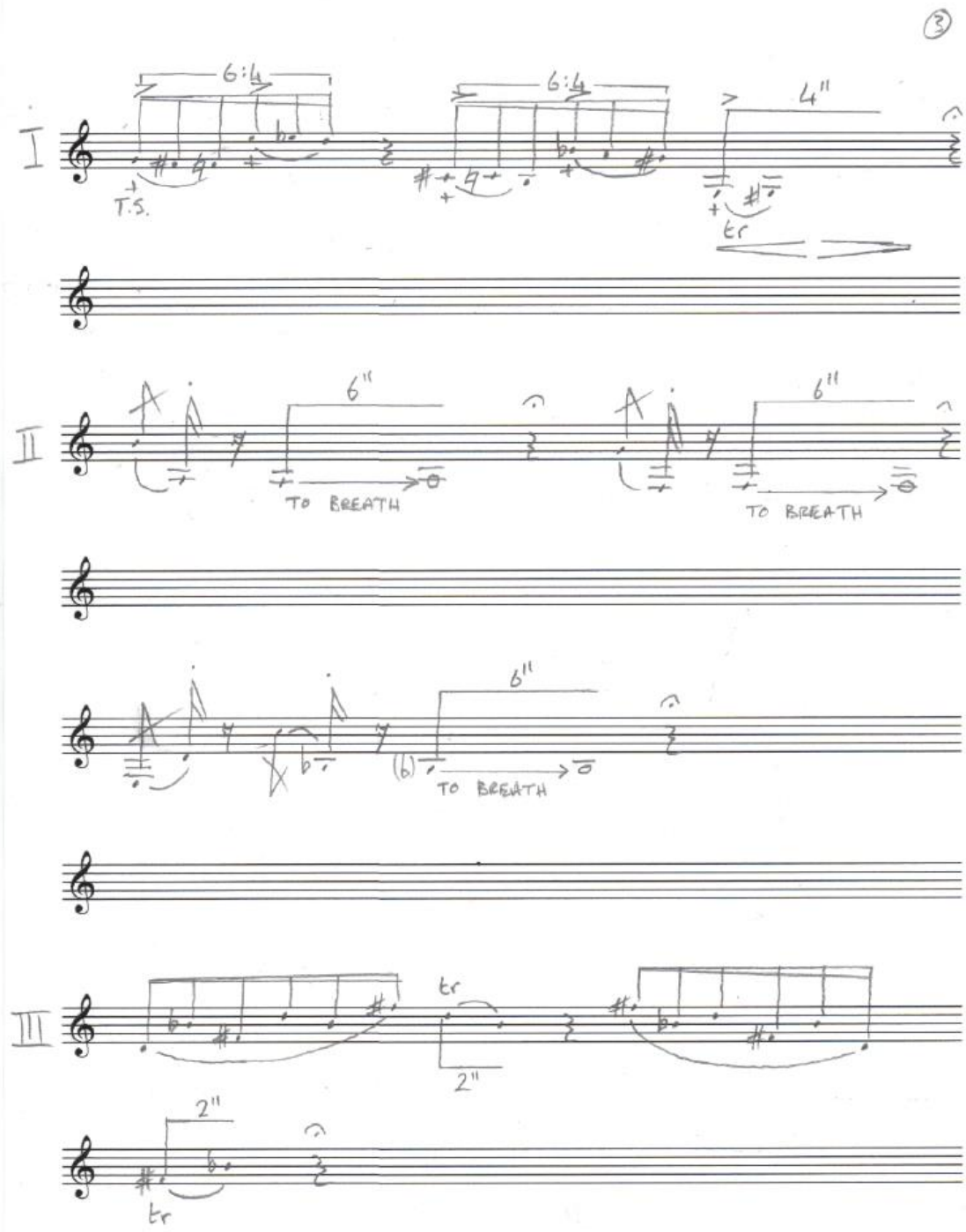
The live electronic processing (Ableton Live Patch) may be controlled by the bass clarinettist or by a separate performer.

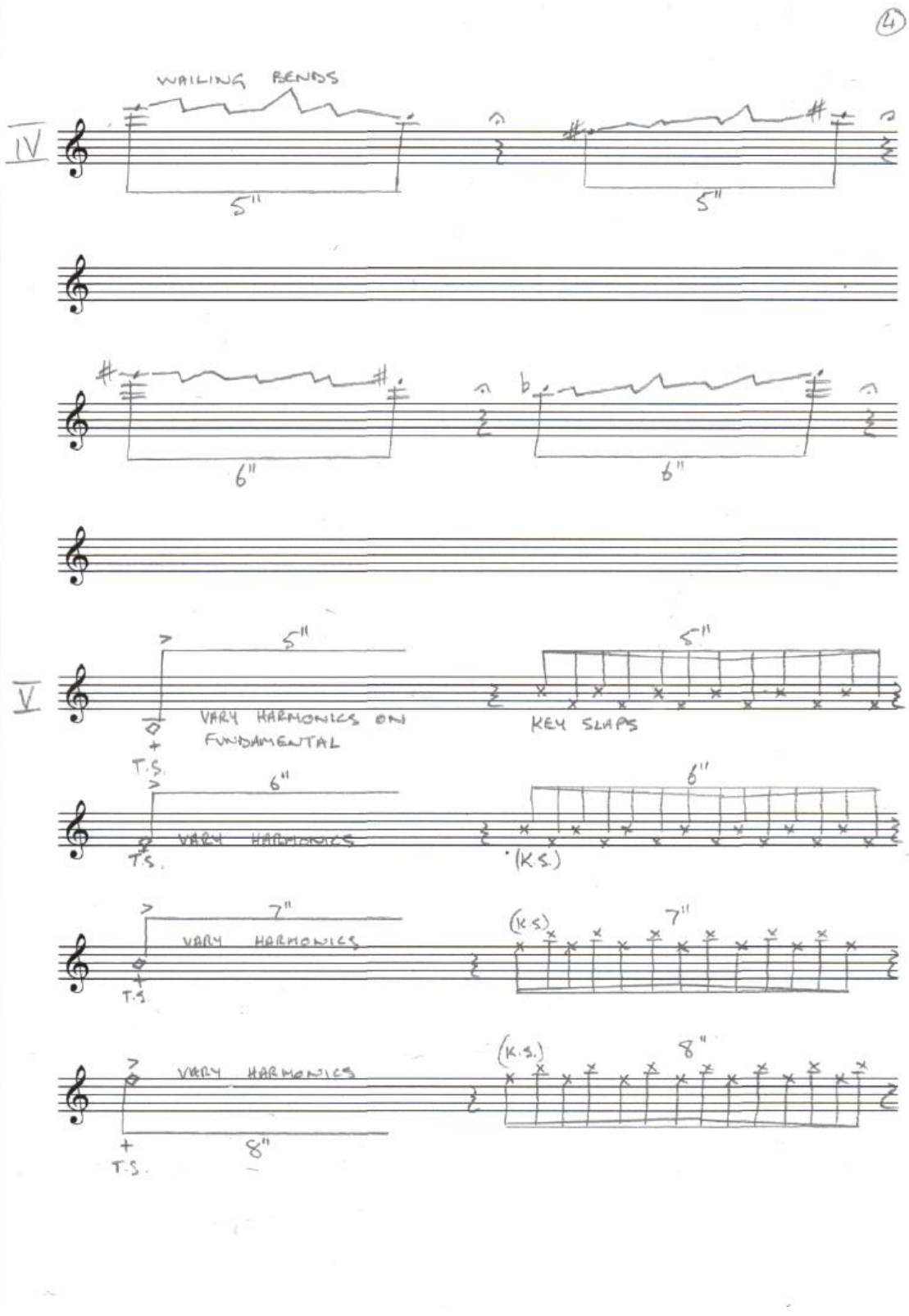
The different types of processing, including granulation, delay, chorus, filtering etc., may be used in a freely improvised way.

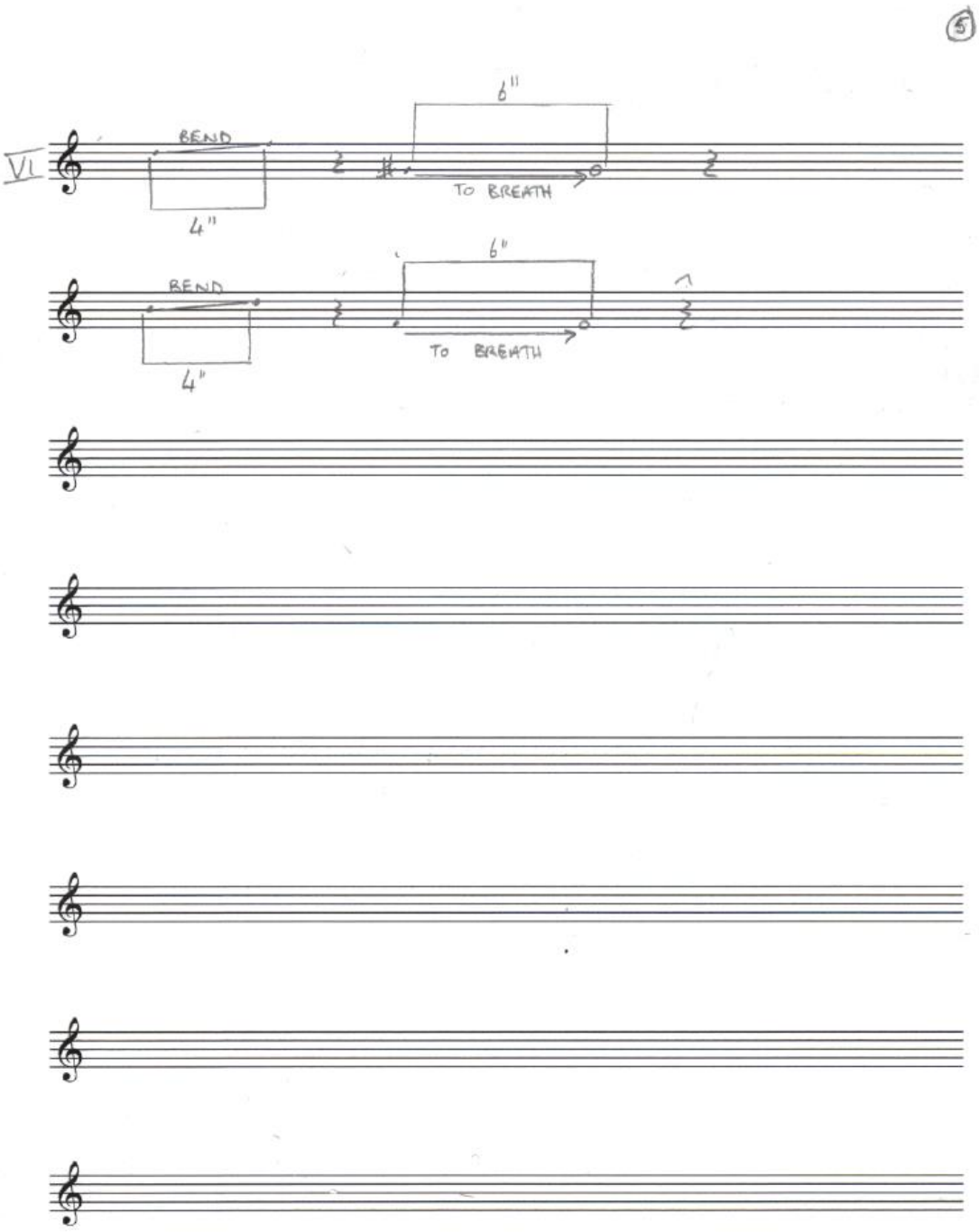
The processing should be quite subtle and discreet in relation to the volume of the bass clarinet which should be amplified.

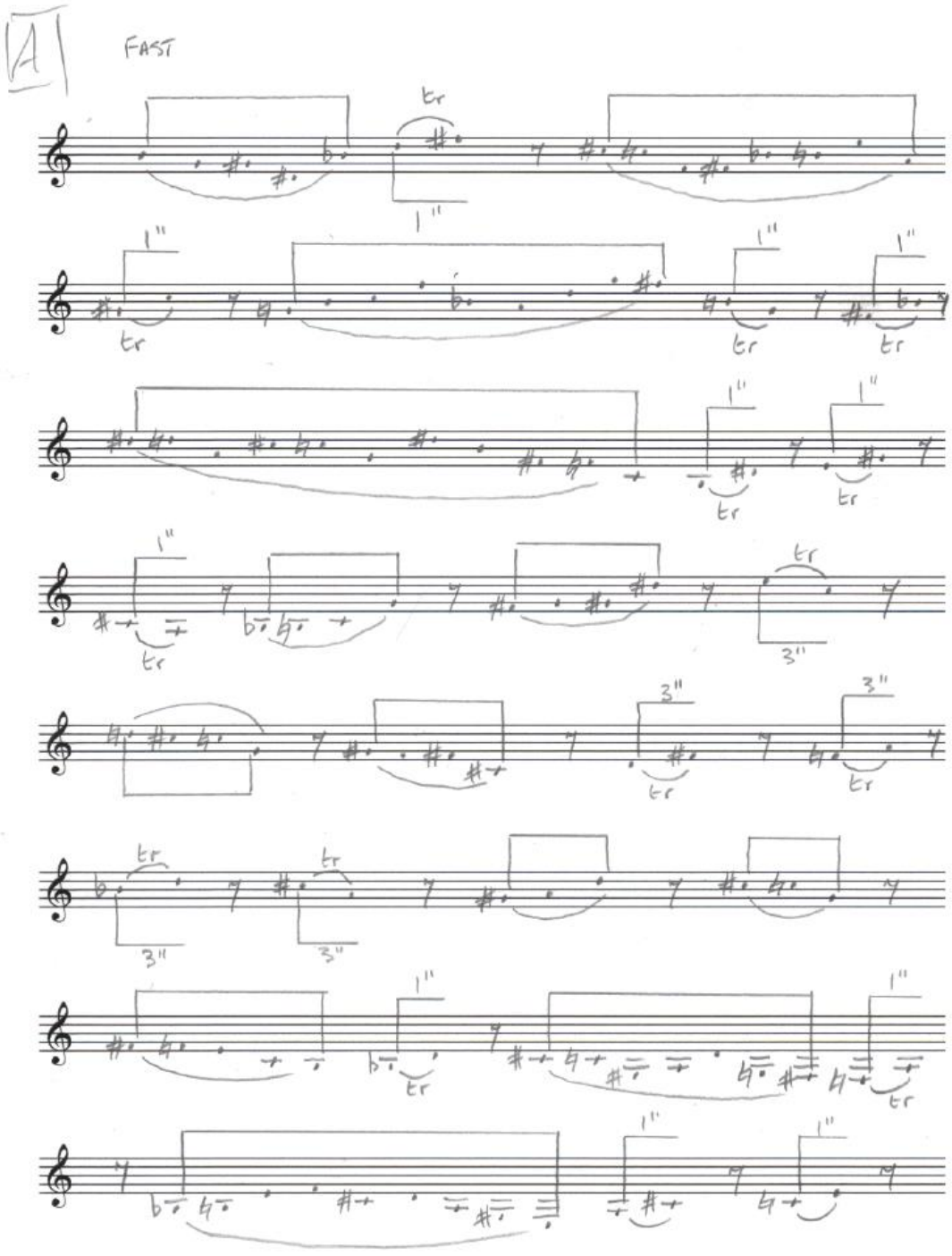

STUNG
1
♩ = 126
BALKAN TRILL (B.T.)
f
ff
3"
(B.T.)

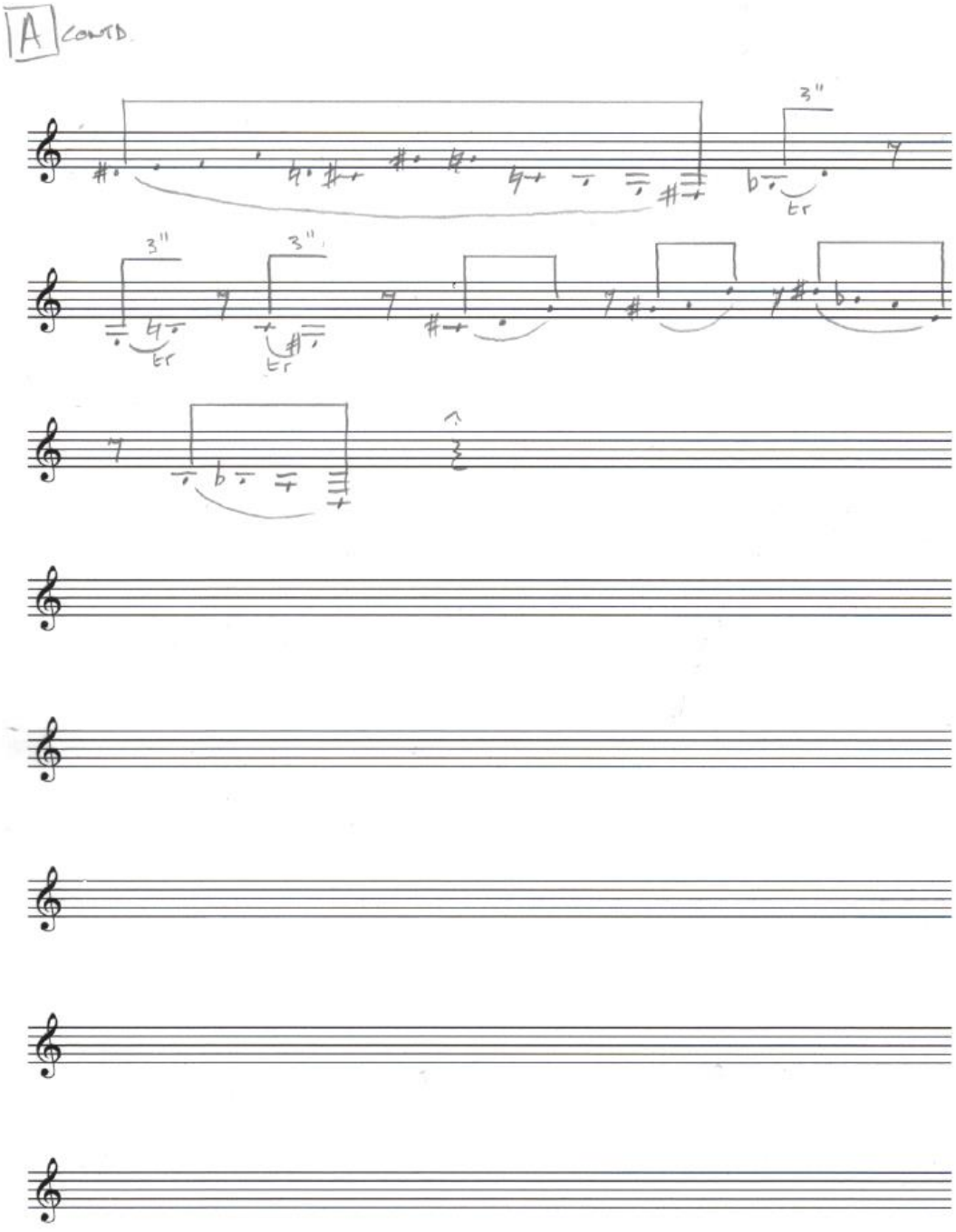

2
FLUTTER TONGUE (F.T.)
BEND
5"
3"
KEY SLAPS (K.S.)
f
mf
p
(F.T.)
3"
6"
BEND
(K.S.)
TONGUE SLAP (T.S.)
(T.S.)
7"
BREATH

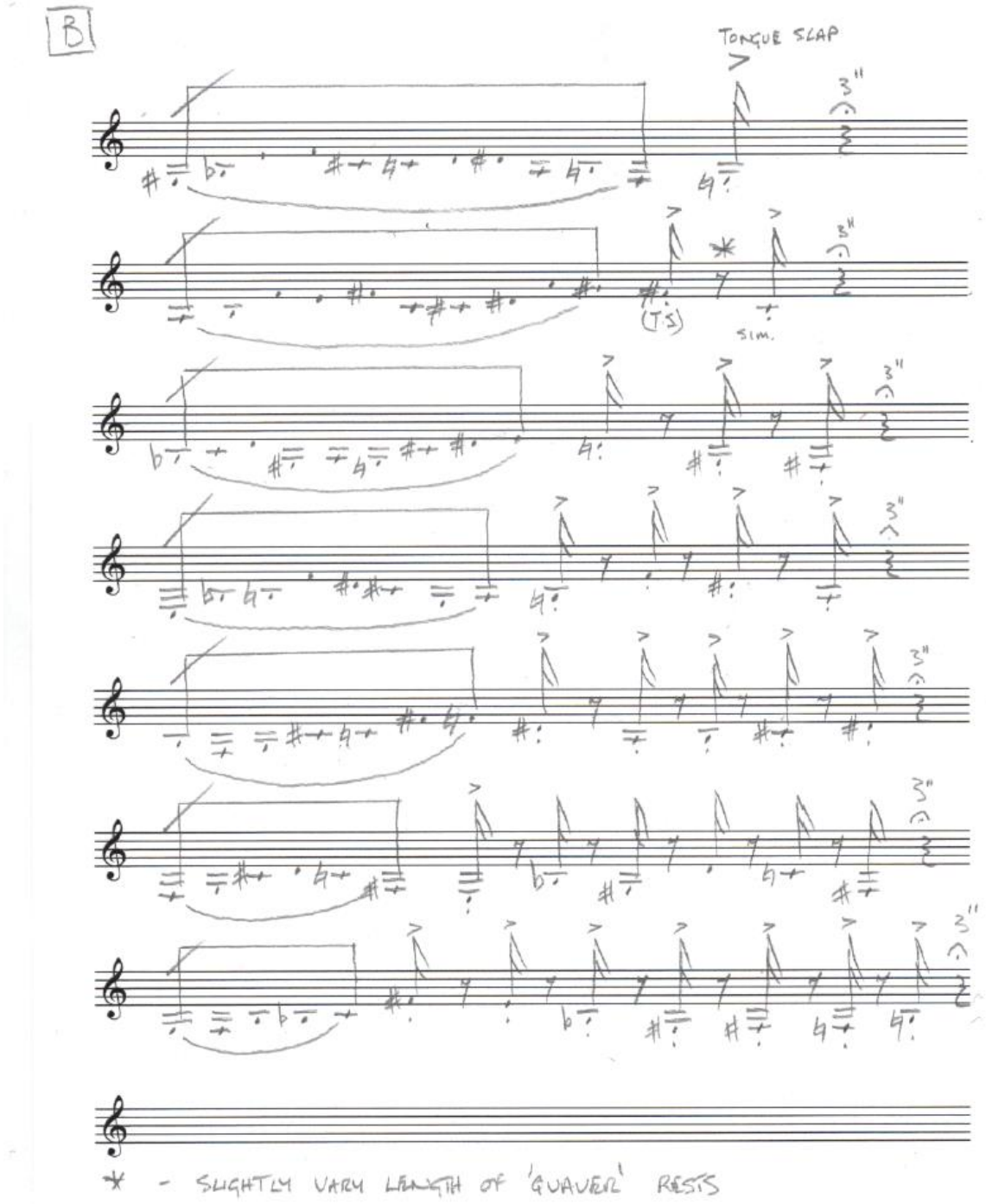

3
I
6:4
6:4
4"
T.S.
tr
II
6"
TO BREATH
6"
TO BREATH
6"
TO BREATH
III
tr
2"
2"
tr

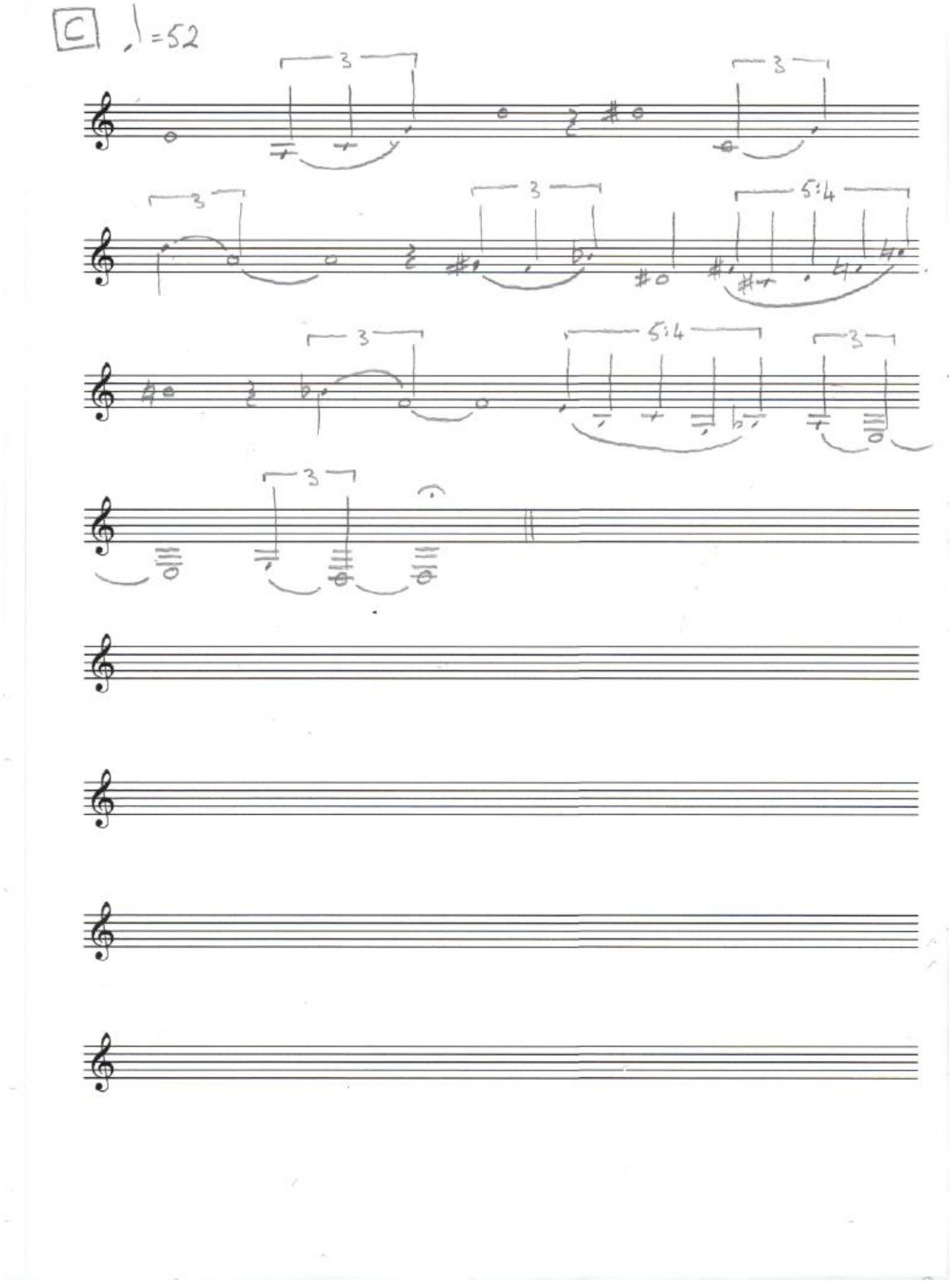

WAILING BENDS
IV
5"
5"
6"
6"
V
5"
5"
VARY HARMONICS ON FUNDAMENTAL
KEY SLAPS
T.S.
6"
6"
VARY HARMONICS
T.S.
(K.S.)
7"
7"
VARY HARMONICS
T.S.
(K.S.)
8"
VARY HARMONICS
8"
T.S.

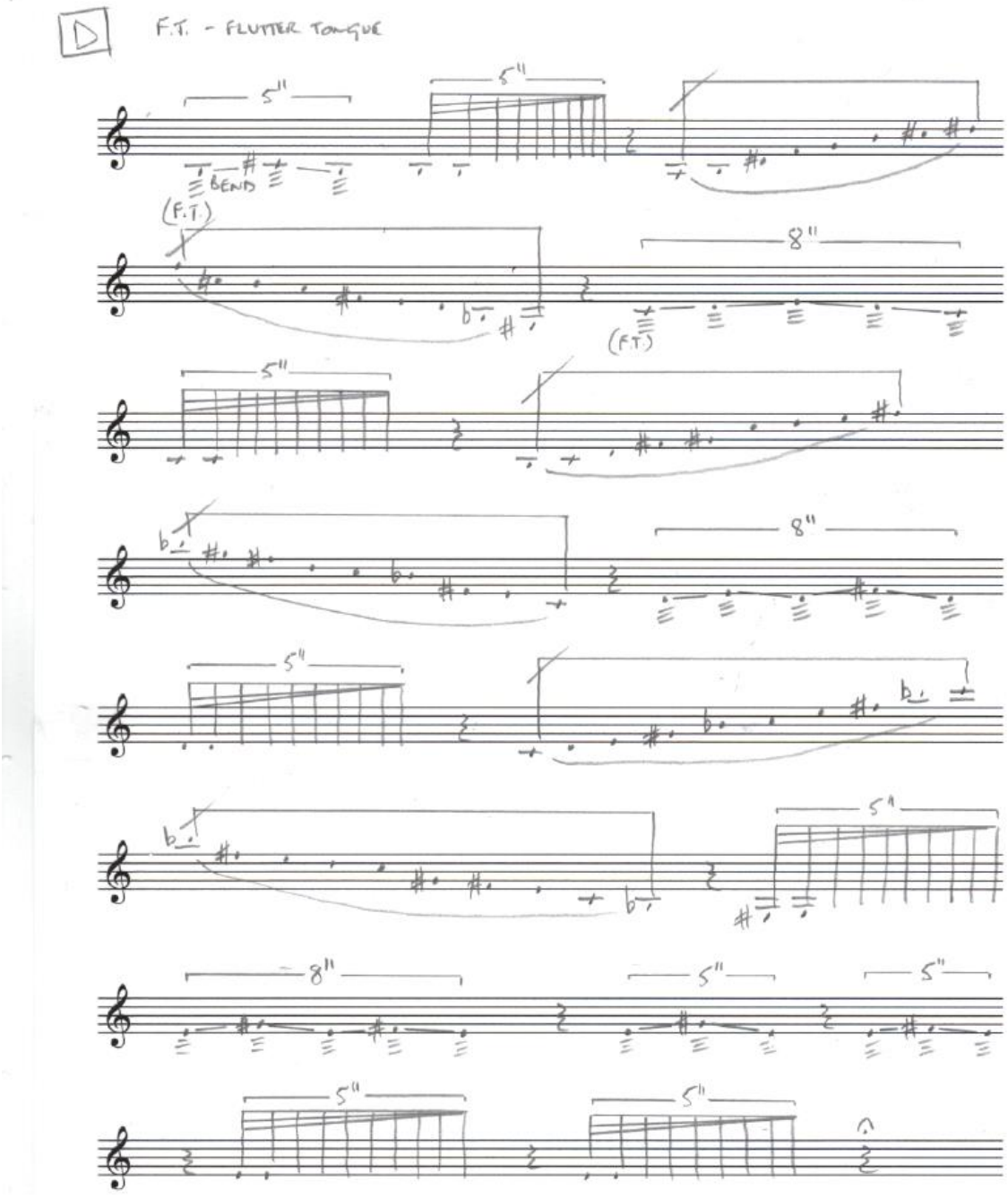

5
VI
BEND
4"
6"
TO BREATH
BEND
4"
6"
TO BREATH

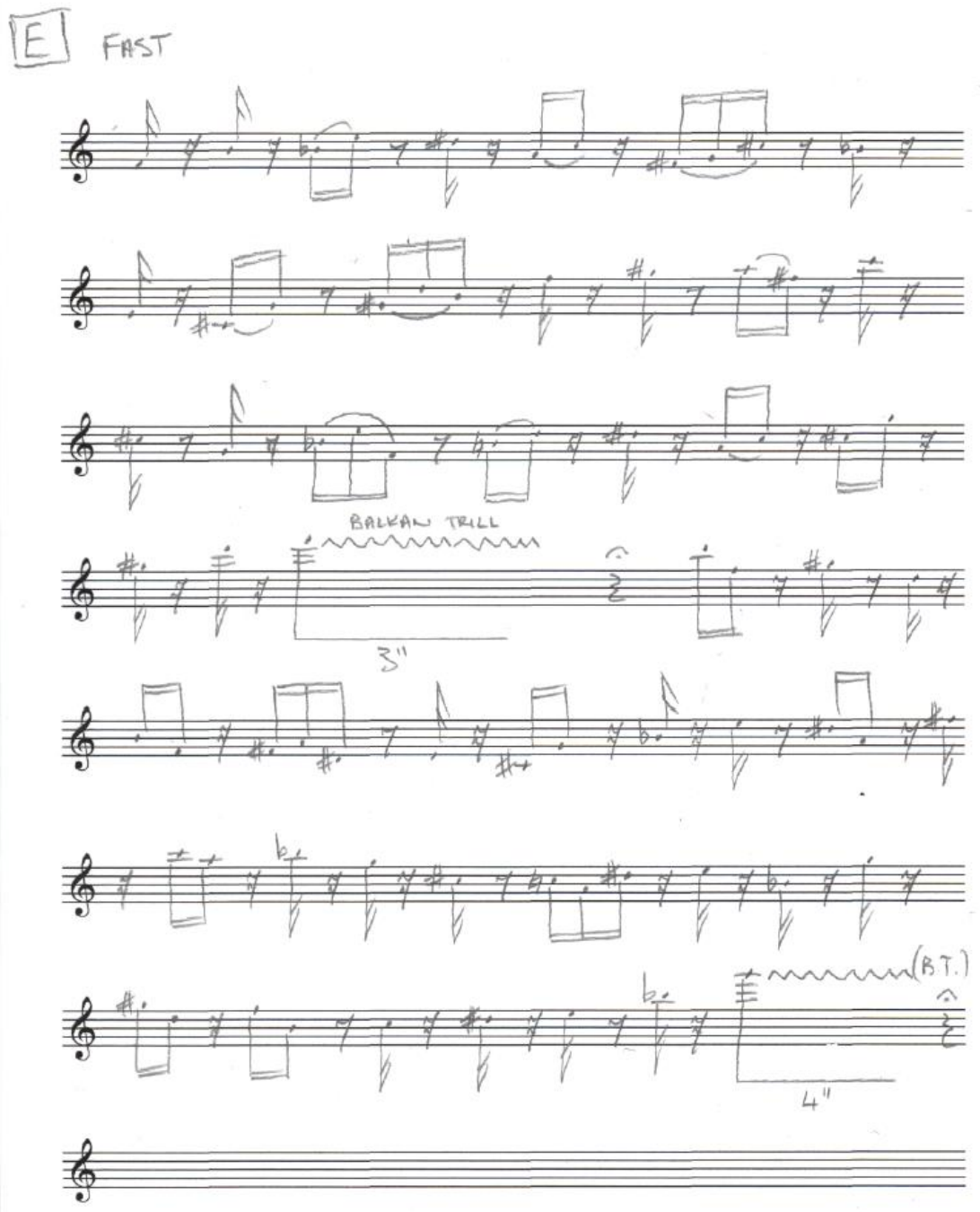

A
FAST

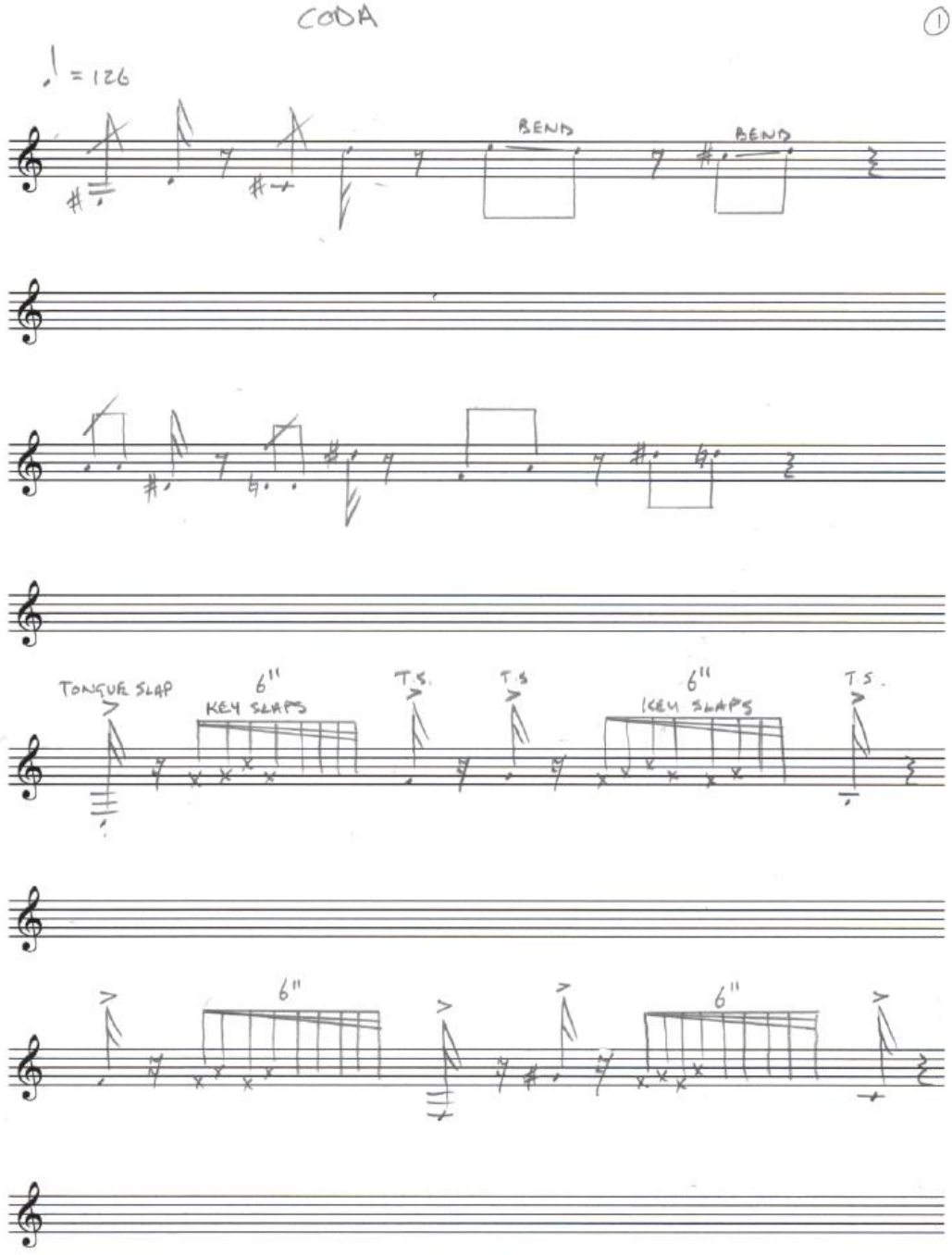

A cont'd
3"
3"
3"
tr
tr
tr

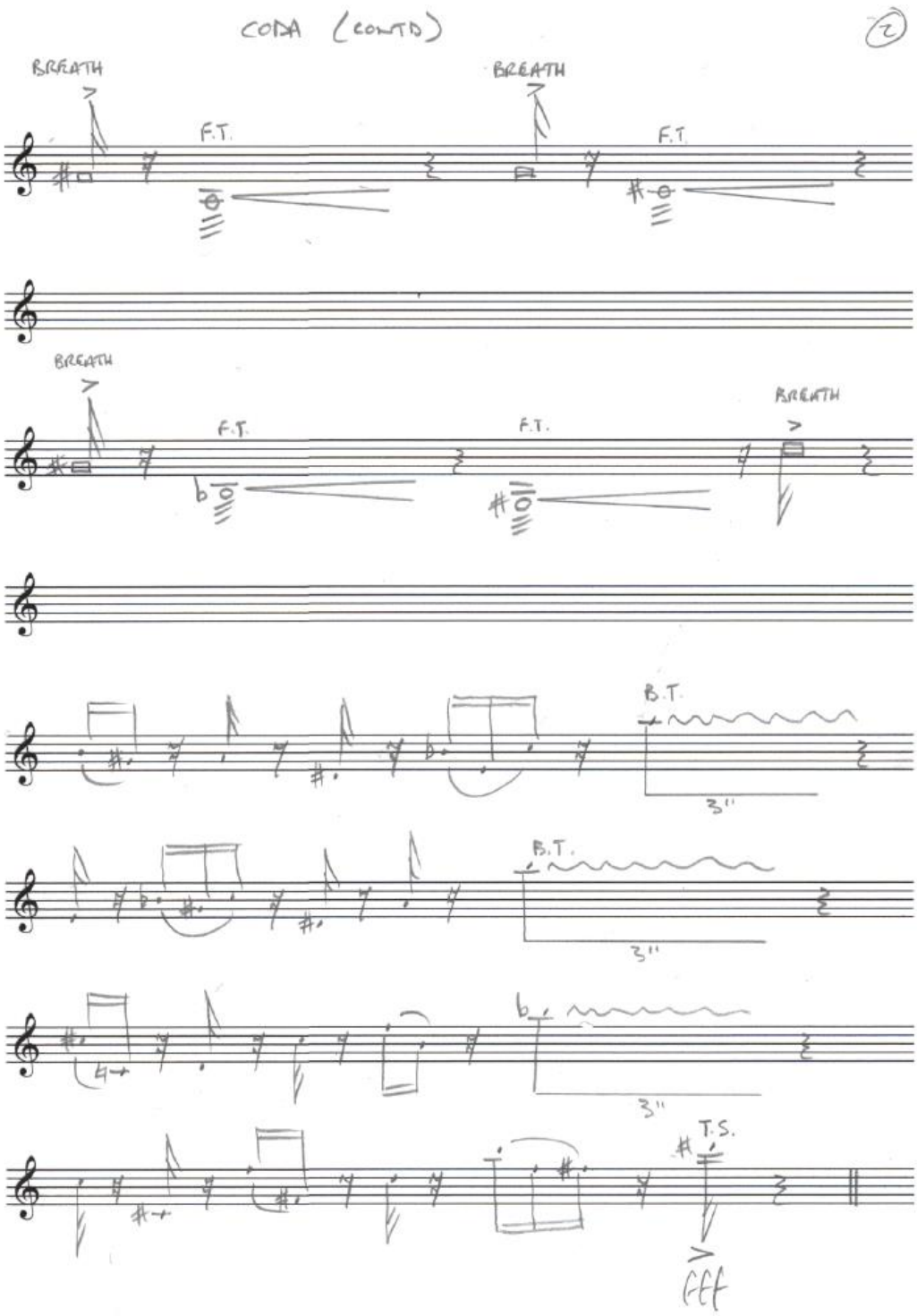

B
TONGUE SLAP
3"
(TS)
SIM.
* - SLIGHTLY VARY LENGTH OF 'QUAVER' RESTS


C
♩=52
3
3
3
3
5:4
3
5:4
3
3


D
F.T. - FLUTTER TONGUE
5"
5"
BEND
(F.T.)
8"
(F.T.)
5"
8"
5"
5"
8"
5"
5"
5"
5"


E
FAST
BALKAN TRILL
3"
(B.T.)
4"


CODA
1
♩ = 126
BEND
BEND
TONGUE SLAP
6"
KEY SLAPS
T.S.
T.S.
6"
KEY SLAPS
T.S.
6"
6"


CODA (CONTD)
2
BREATH
F.T.
BREATH
F.T.
BREATH
F.T.
F.T.
BREATH
B.T.
3"
B.T.
3"
4
3"
T.S.
fff

APPENDIX B: STAR MAKER, COMPOSED BY AMANDA FEERY

Quinquennial

In 2010, I wrote *Rattle*, a memory piece about my clarinet lessons, particular the elements of the lessons I was least excited about – work on intonation, scales, melodious studies, and removing erroneous breaks and squeaks. Five years later, I thought I would continue the memory trail and go back to my earliest lessons, when I wasn't allowed to play any melodies until I managed to get an actual sound and pleasant tone out of the clarinet. *Star Maker* deals with the battle between weekly lessons, instrumental technique and a child just eager to have a bit of mess around with a brand new instrument. I'll write another piece in 2020 but I'm not sure where in the memory trail that will lie.

1. Star Maker - 4'
2. Rattle – 4'30"

Performance Directions – Star Maker

Dyad Multiphonic – a pure sounding multiphonic. The pitches I've written in the score are based on Harry Sparnaay's multiphonics in his book, which he said would be the most stable. There might be other pitches that are more effective, so feel free to use different pitches where the multiphonic is indicated.

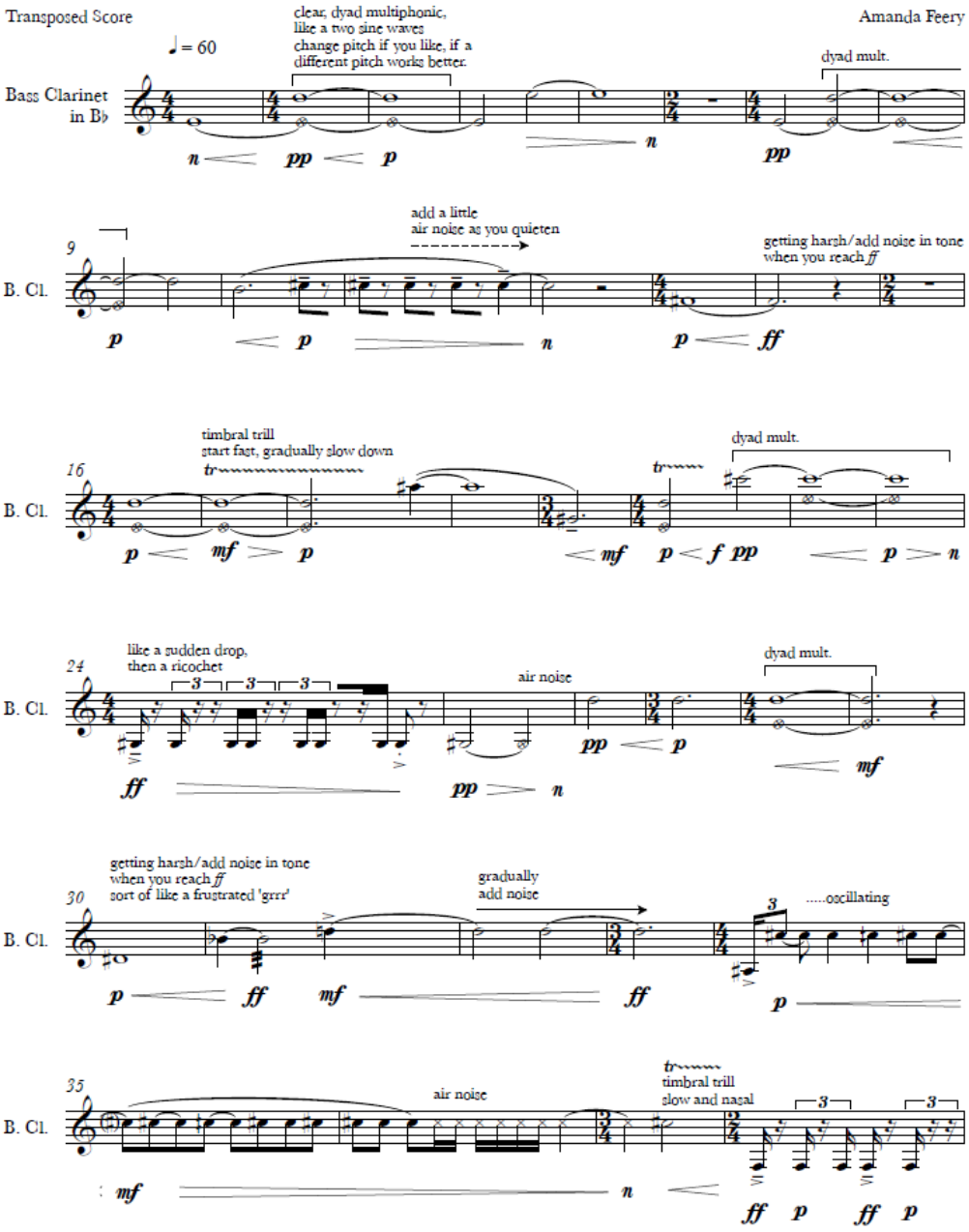
Performance Directions – Rattle

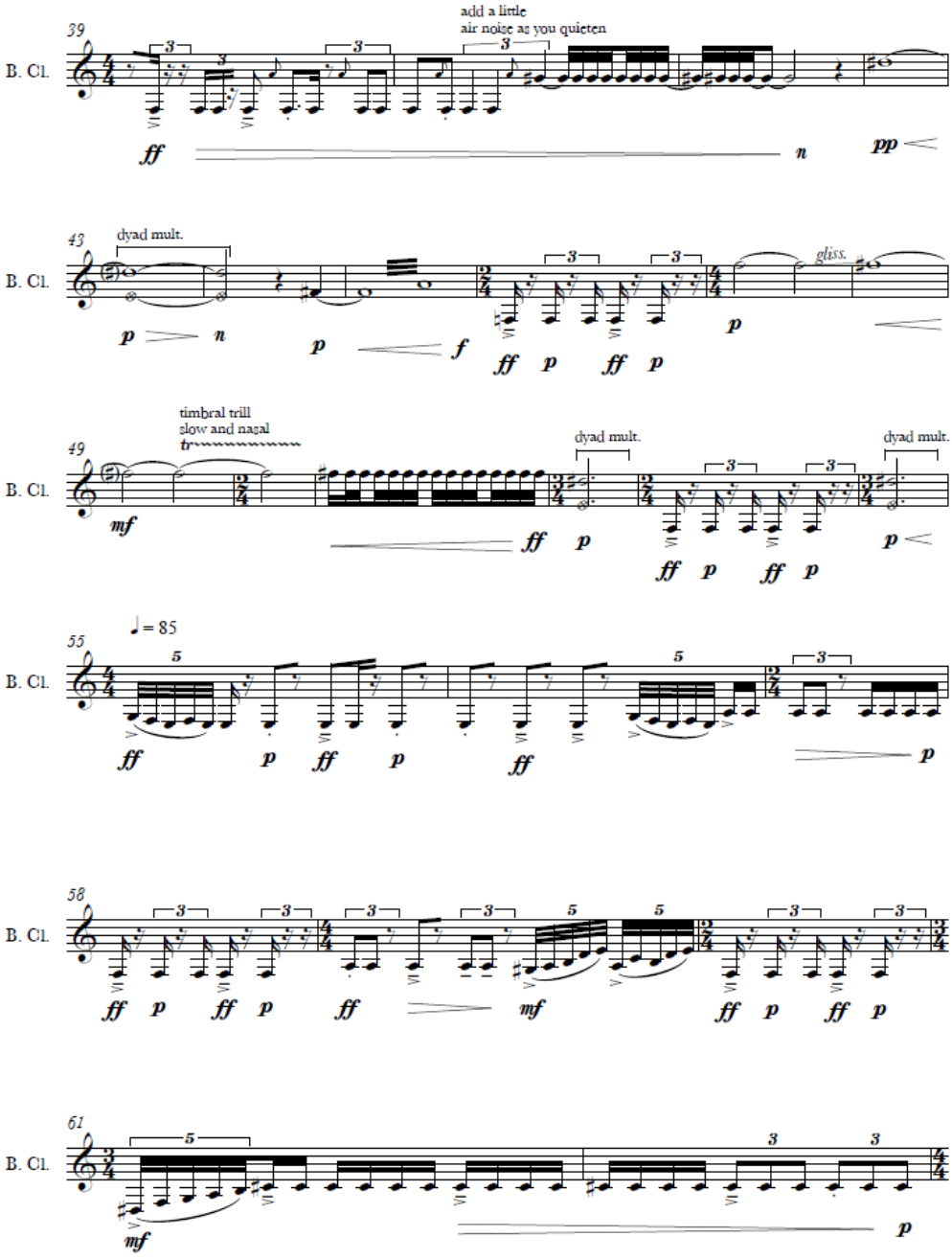
ad lib. sections – play with quick ascending-descending passages, building up to a vocal, screaming quality (think climax of a sax solo).

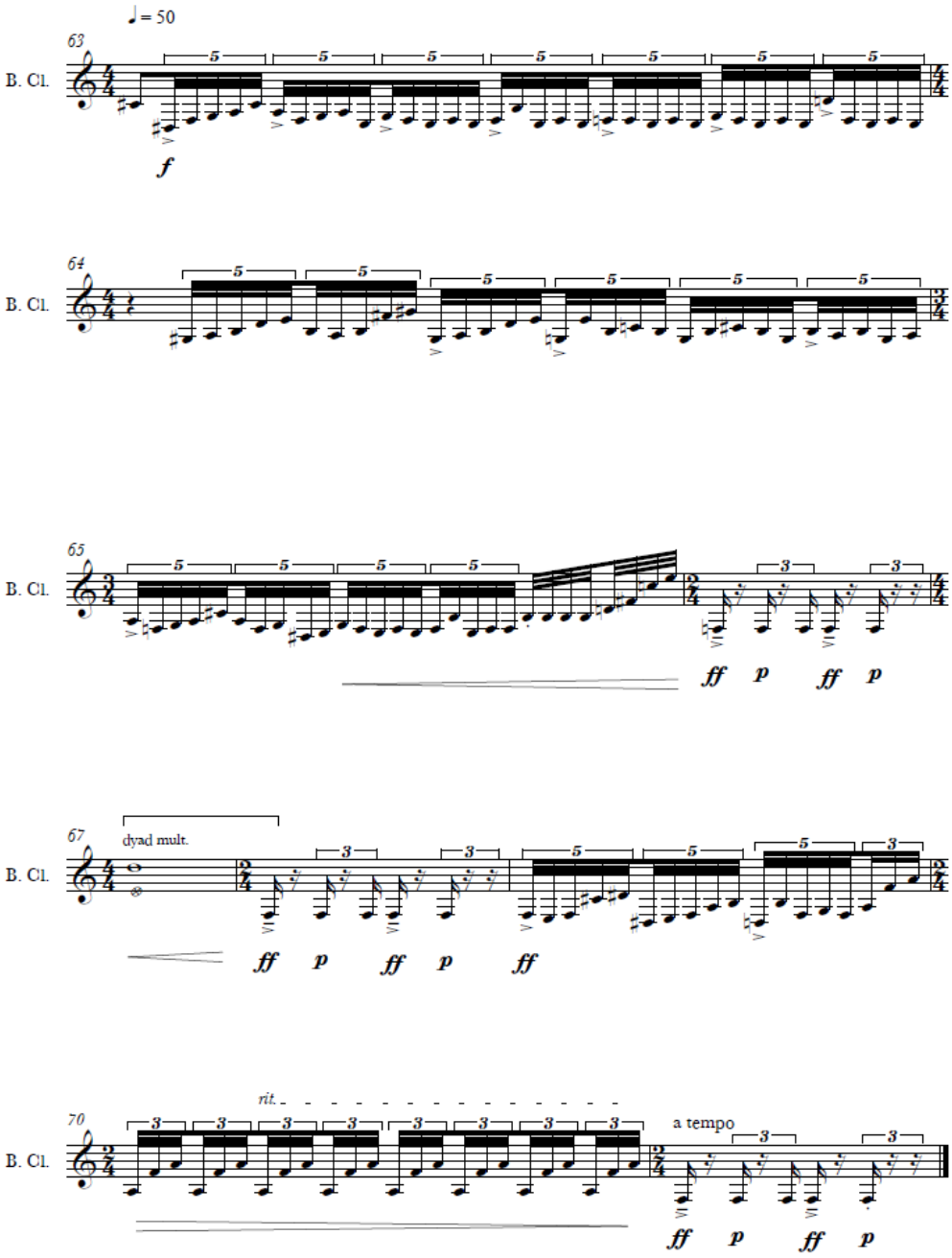
Multiphonic 1 – Noise – a complex multiphonic that sounds almost electronic. If other pitches work better or are more stable here, that's fine.

Multiphonic 2 – Dyad – a more pure sounding multiphonic, including a pitch either lower, or higher than the notated pitch. Again, if other pitches are more stable/clearer, that's fine.

Star Maker


Transposed Score
Amanda Feery
♩ = 60
clear, dyad multiphonic,
like a two sine waves
change pitch if you like, if a
different pitch works better.
dyad mult.
Bass Clarinet
in B♭
add a little
air noise as you quieten
getting harsh/add noise in tone
when you reach ff
B. Cl.
timbral trill
start fast, gradually slow down
like a sudden drop,
then a ricochet
air noise
getting harsh/add noise in tone
when you reach ff
sort of like a frustrated 'grrr'
gradually
add noise
.....oscillating
timbral trill
slow and nasal

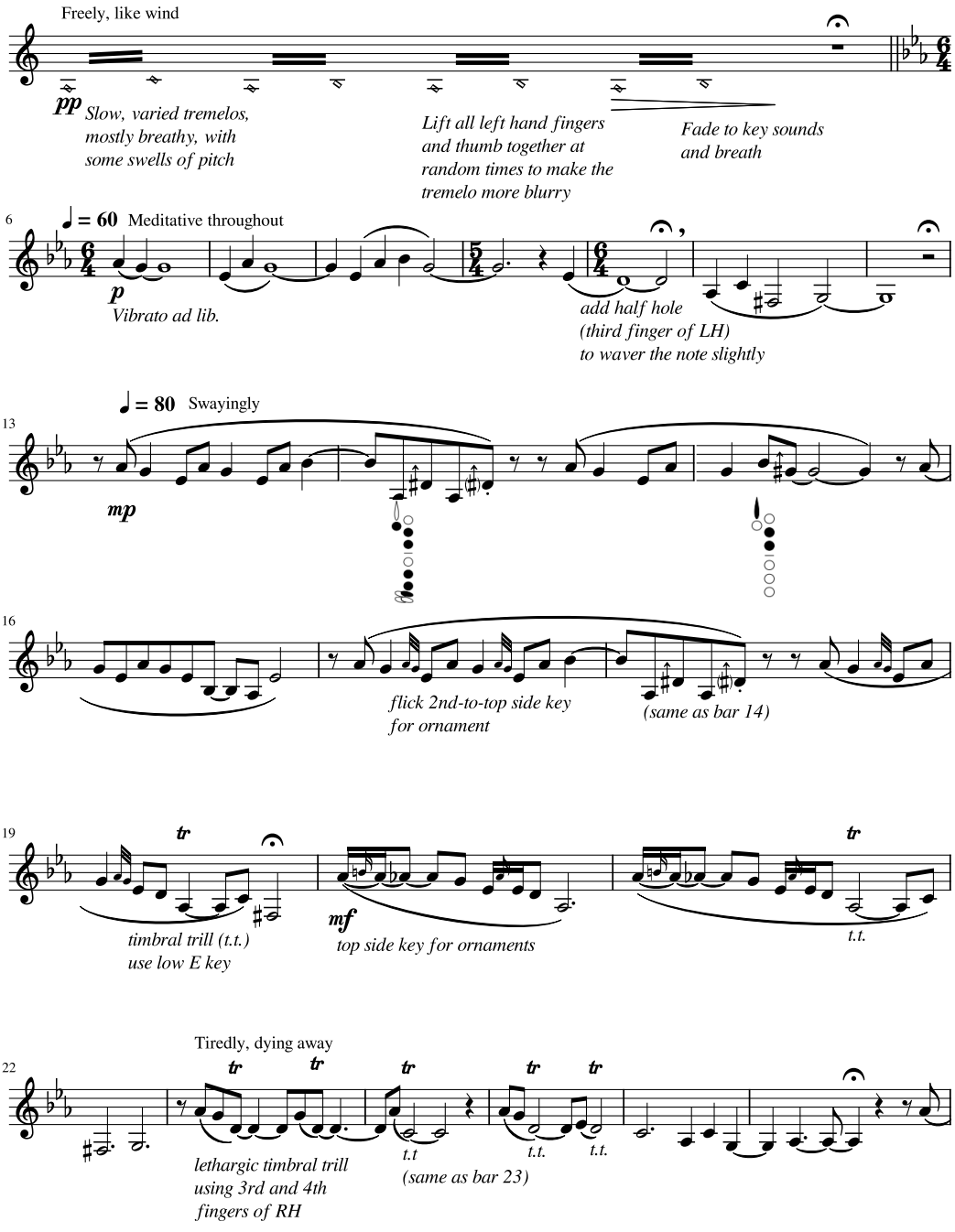

39
B. Cl.
add a little
air noise as you quieten
ff
n
pp
43
B. Cl.
dyad mult.
p
n
p
f
ff p ff p
p
gliss.
49
B. Cl.
timbral trill
slow and nagal
tr
mf
ff p
dyad mult.
ff p ff p
p
dyad mult.
55
B. Cl.
♩ = 85
ff p ff p ff
p
58
B. Cl.
ff p ff p ff
mf
ff p ff p
61
B. Cl.
mf
p

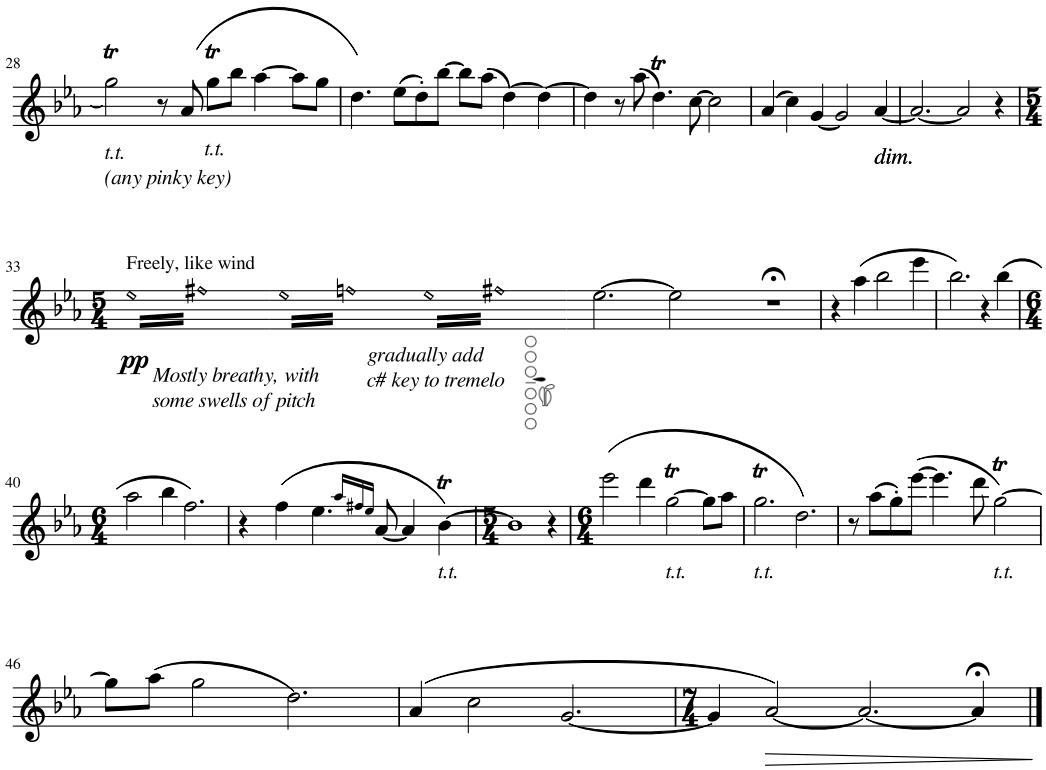

♩ = 50
63
B. Cl.
f
64
B. Cl.
65
B. Cl.
ff p ff p
67
B. Cl.
dyad mult.
ff p ff p ff
70
B. Cl.
rit.
a tempo
ff p ff p

Dréimire Mhuire

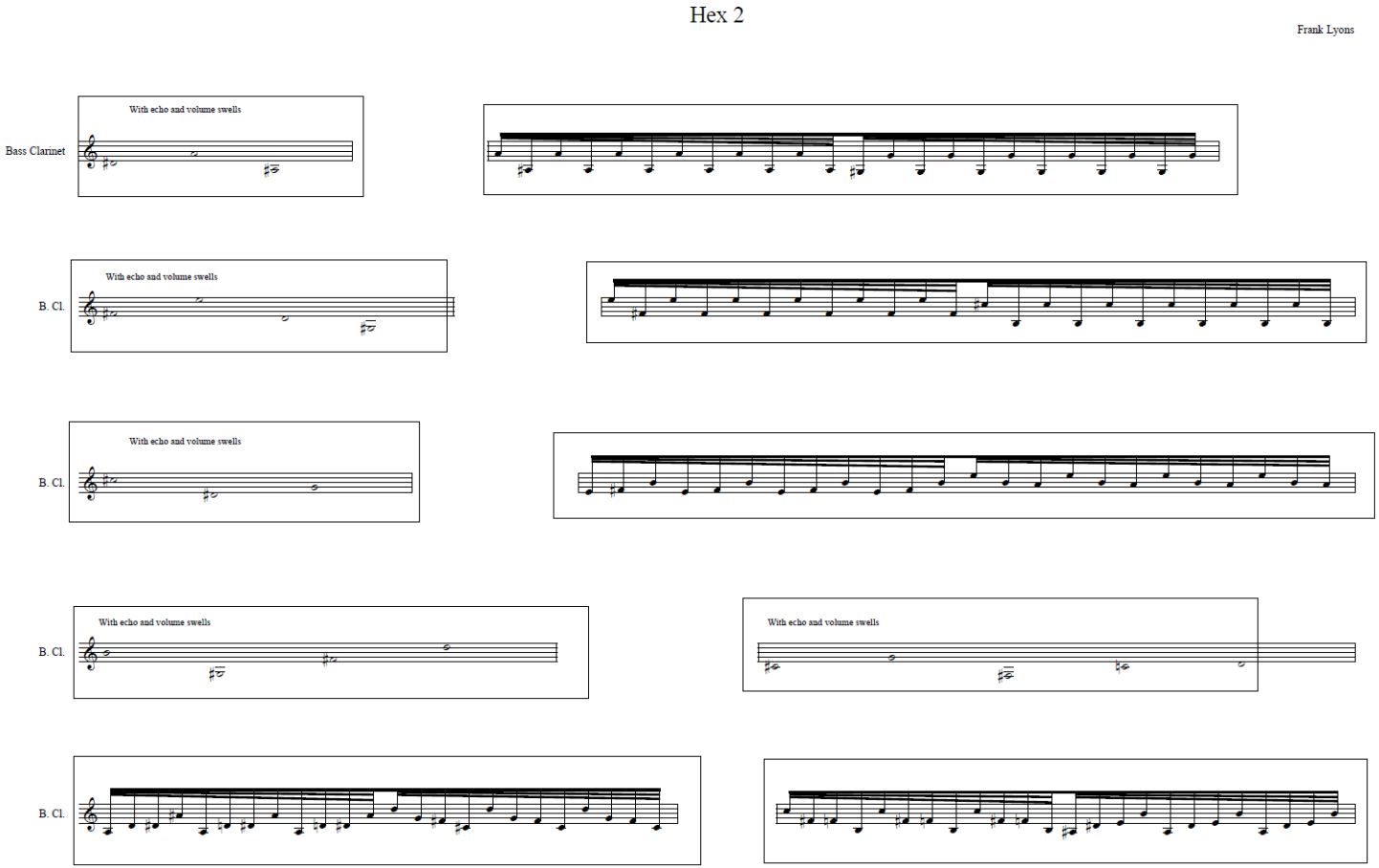
for solo clarinet

Marcella Barz
August 2020



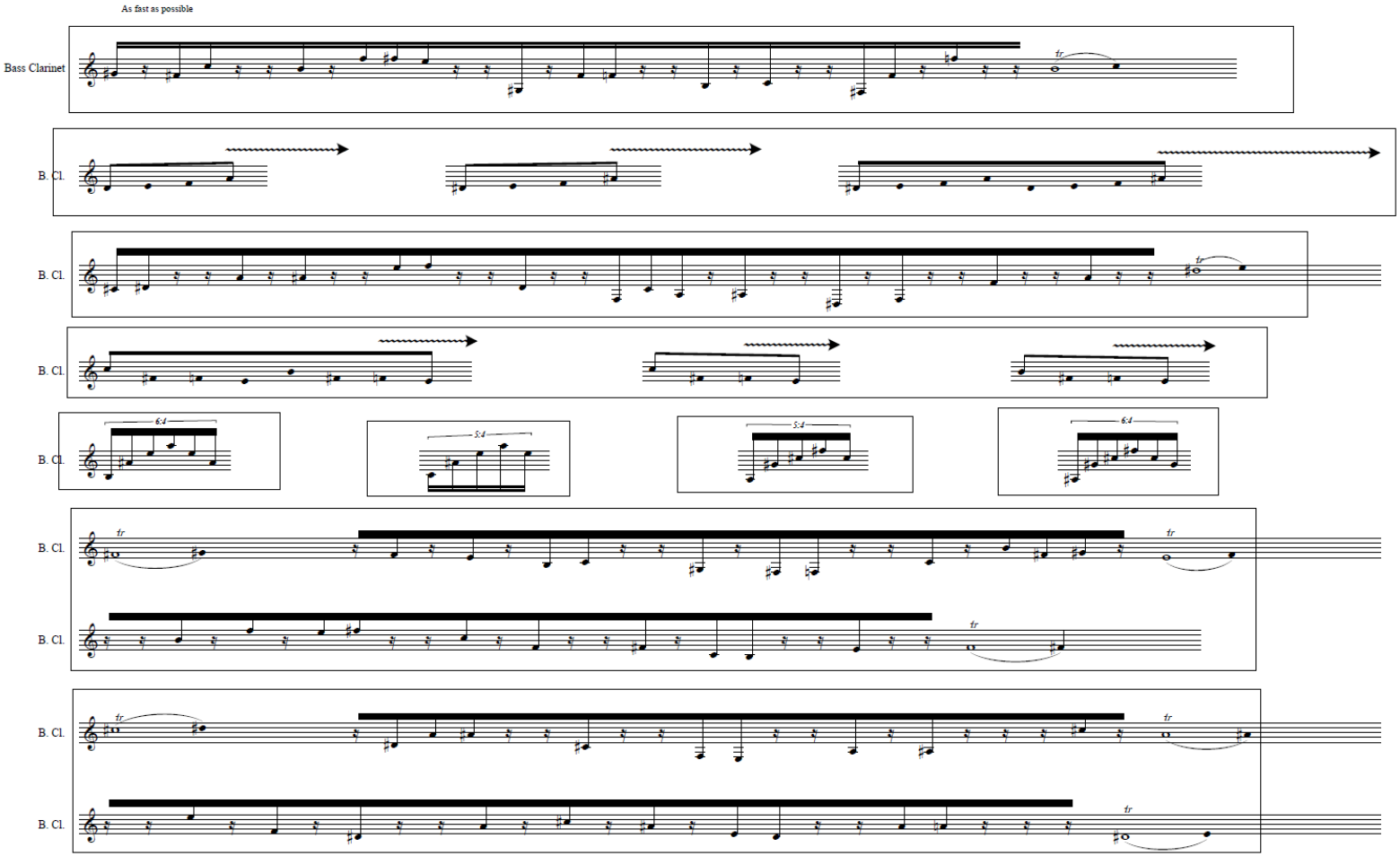

28
tr
tr
t.t.
(any pinky key)
t.t.
dim.
33
Freely, like wind
pp
Mostly breathy, with
some swells of pitch
gradually add
c# key to tremelo
40
tr
t.t.
t.t.
t.t.
t.t.
46

APPENDIX D: *HEX 2*, COMPOSED BY FRANK LYONS



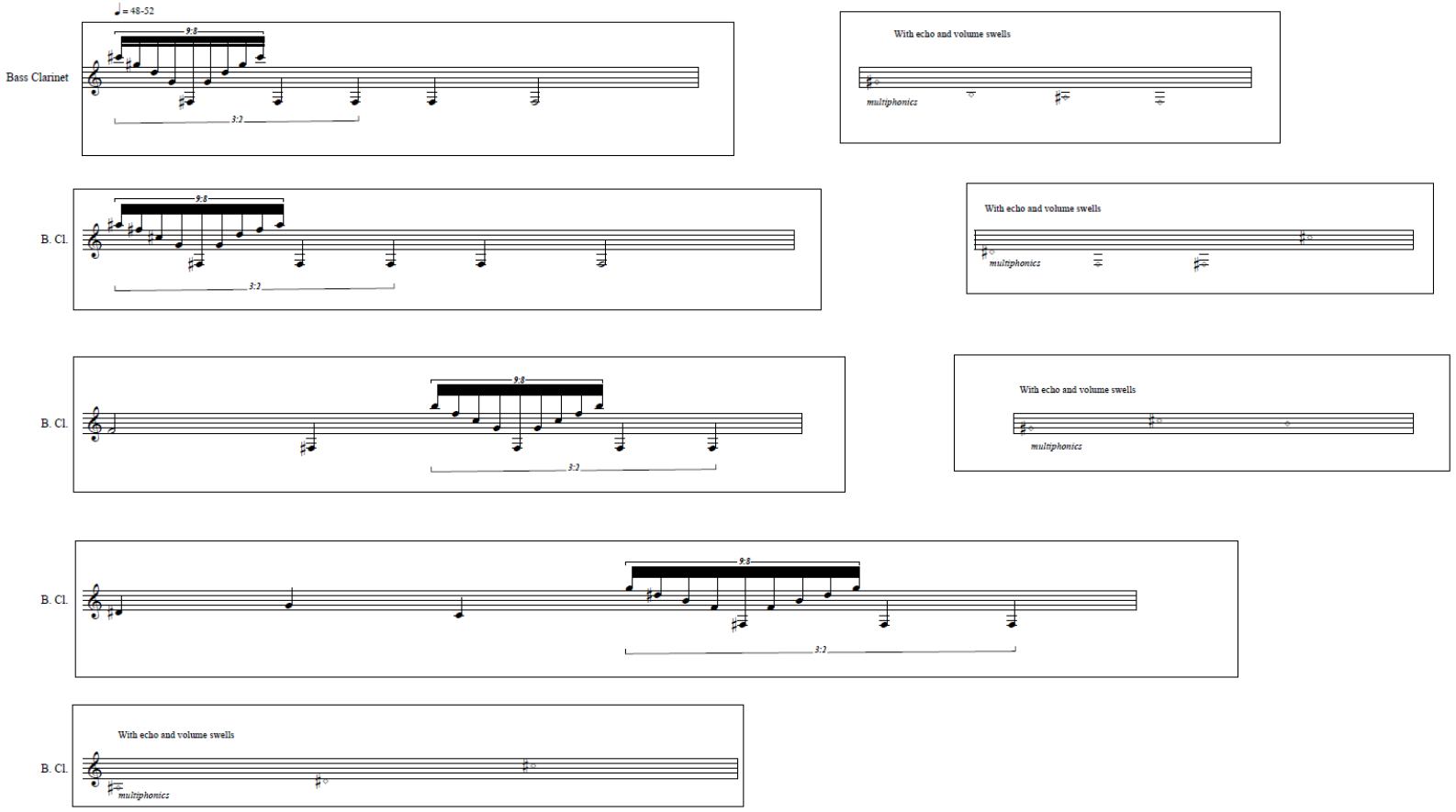
Hex 2

Frank Lyons



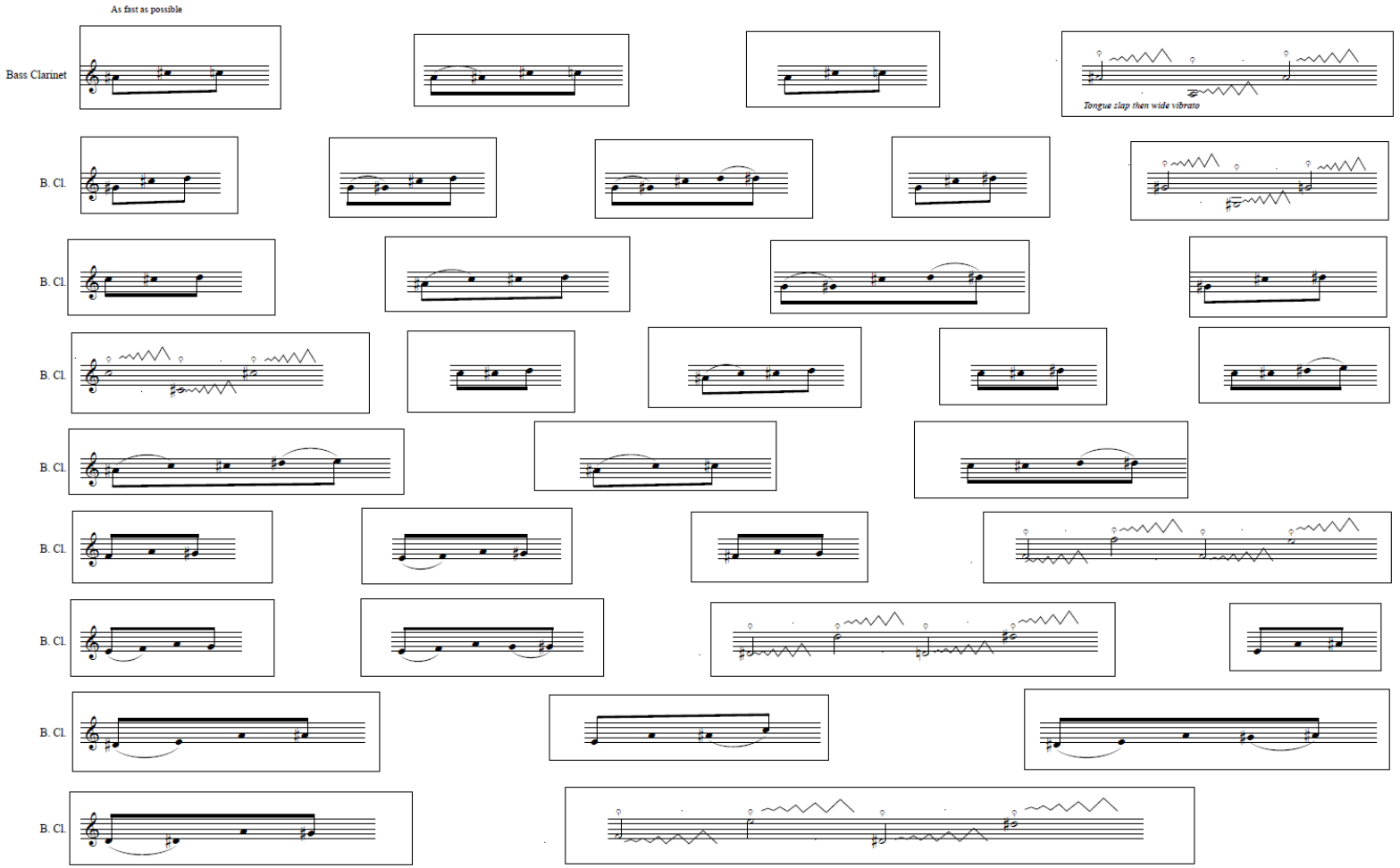
Hex 2

Frank Lyons



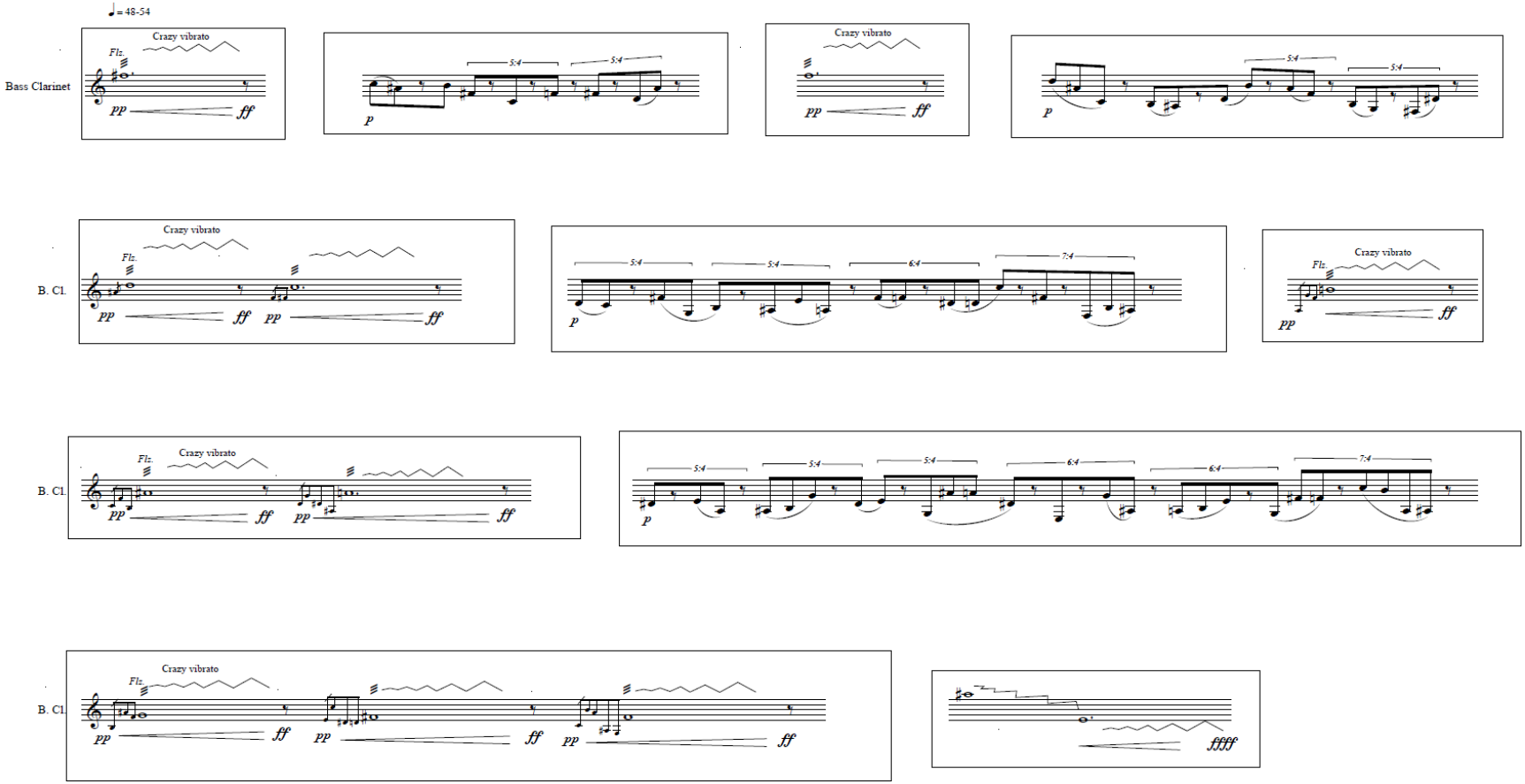
Hex 2

Frank Lyons



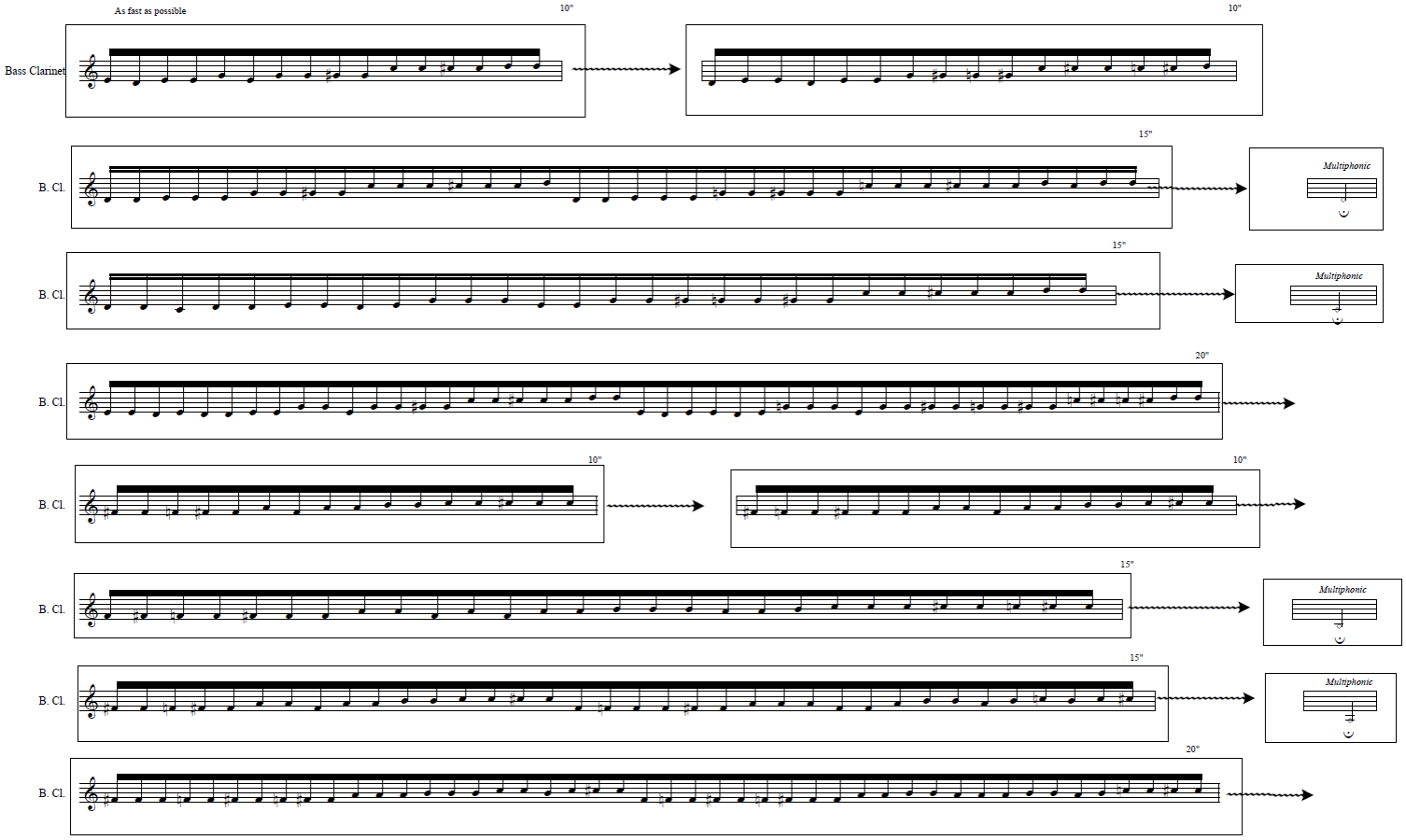
Hex 2

Frank Lyons

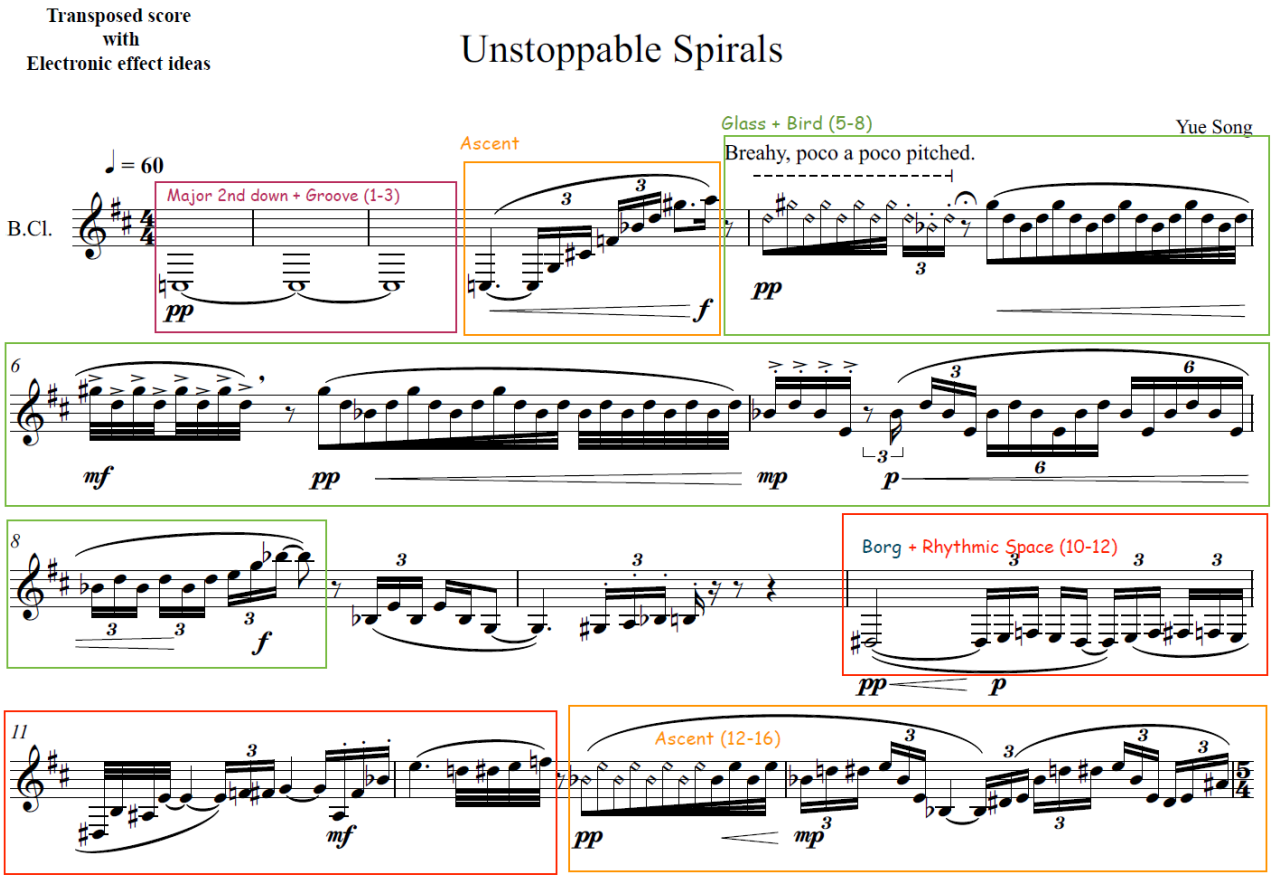


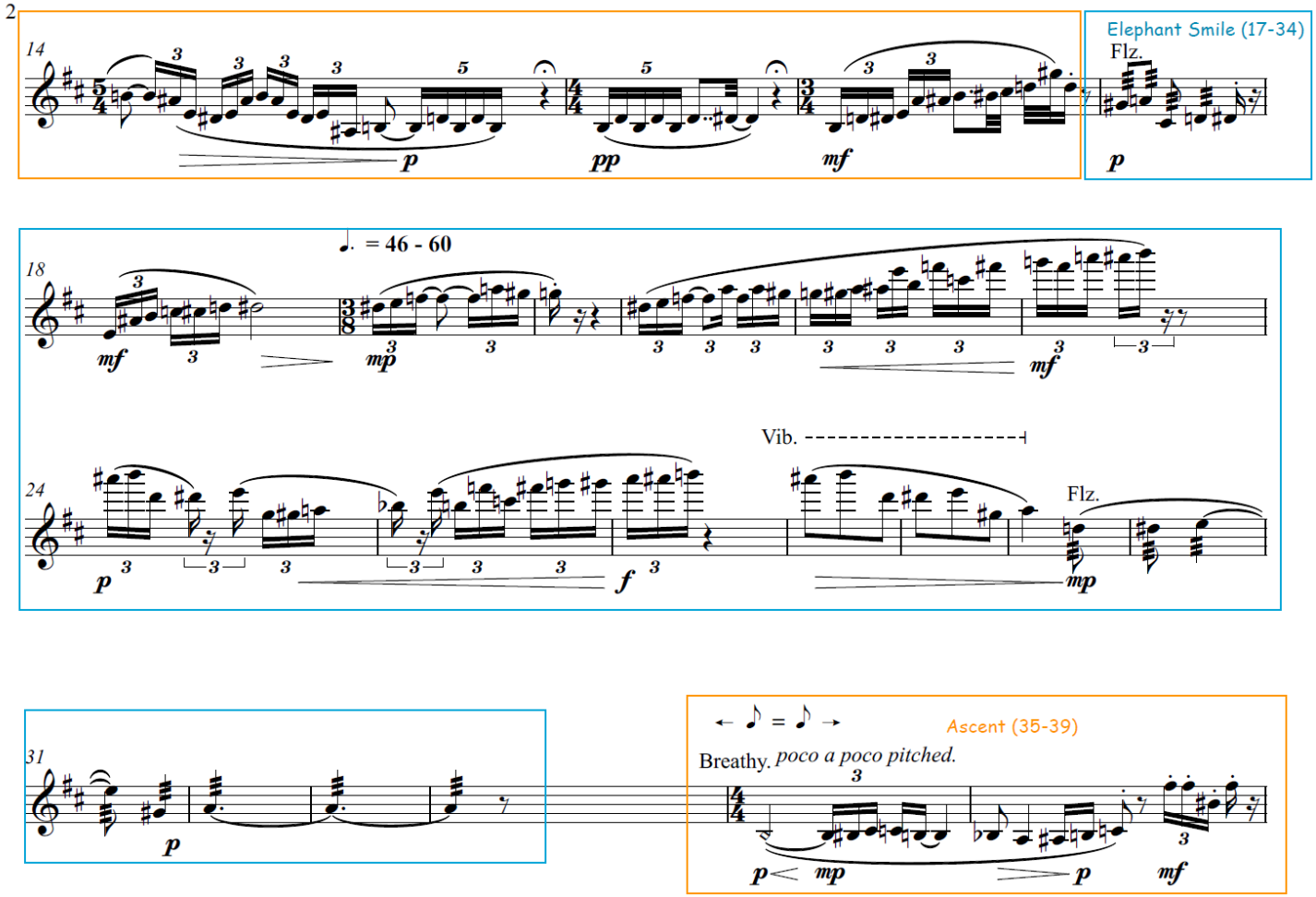
Hex 2

Frank Lyons



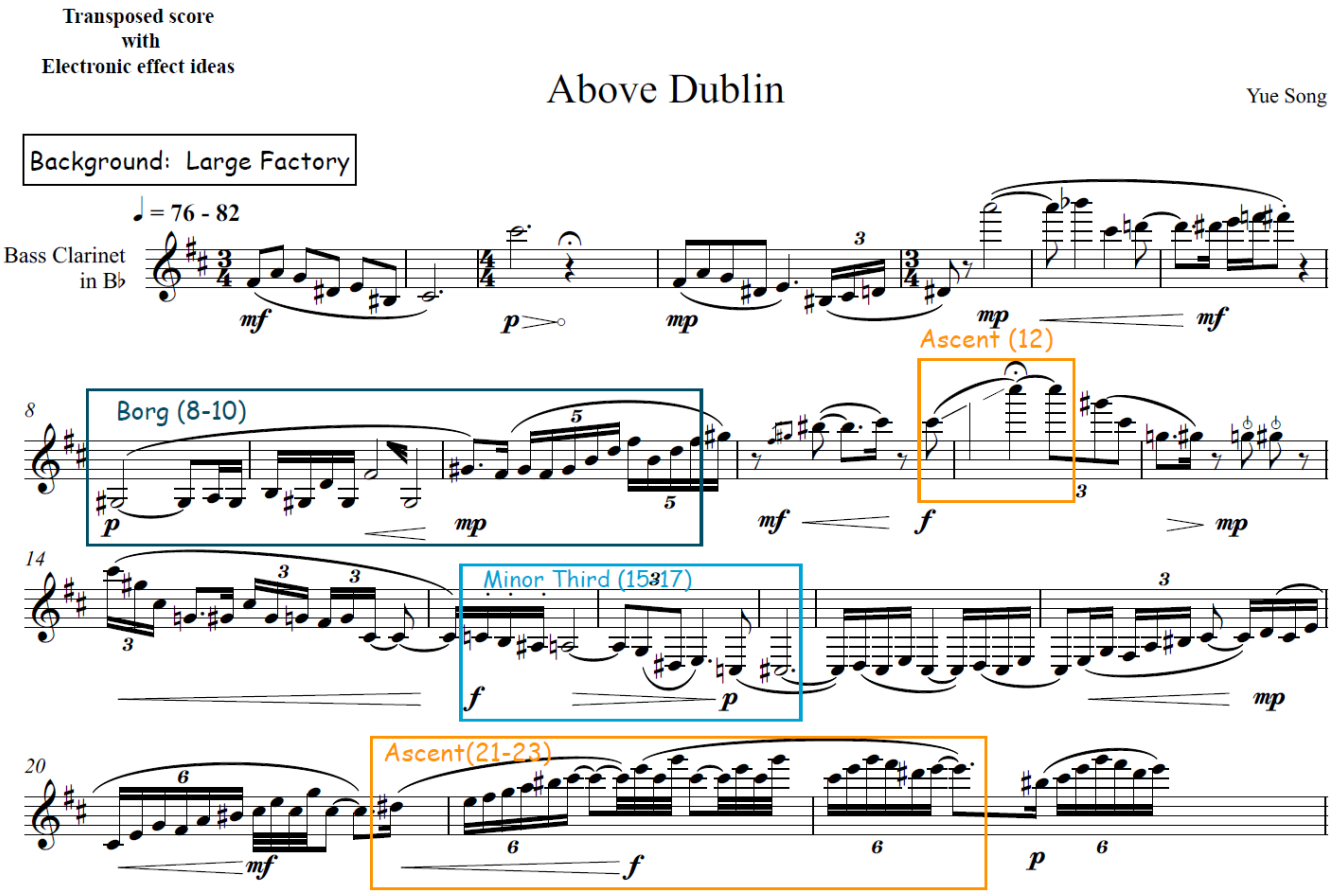
APPENDIX E: *UNSTOPPABLE SPIRALS*, COMPOSED BY YUE SONG




2
14
p
pp
mf
Elephant Smile (17-34)
Flz.
p
18
♩. = 46 - 60
mf
mp
mf
24
Vib.
Flz.
p
f
mp
31
p
Ascent (35-39)
Breathy. poco a poco pitched.
p
mp
p
mf

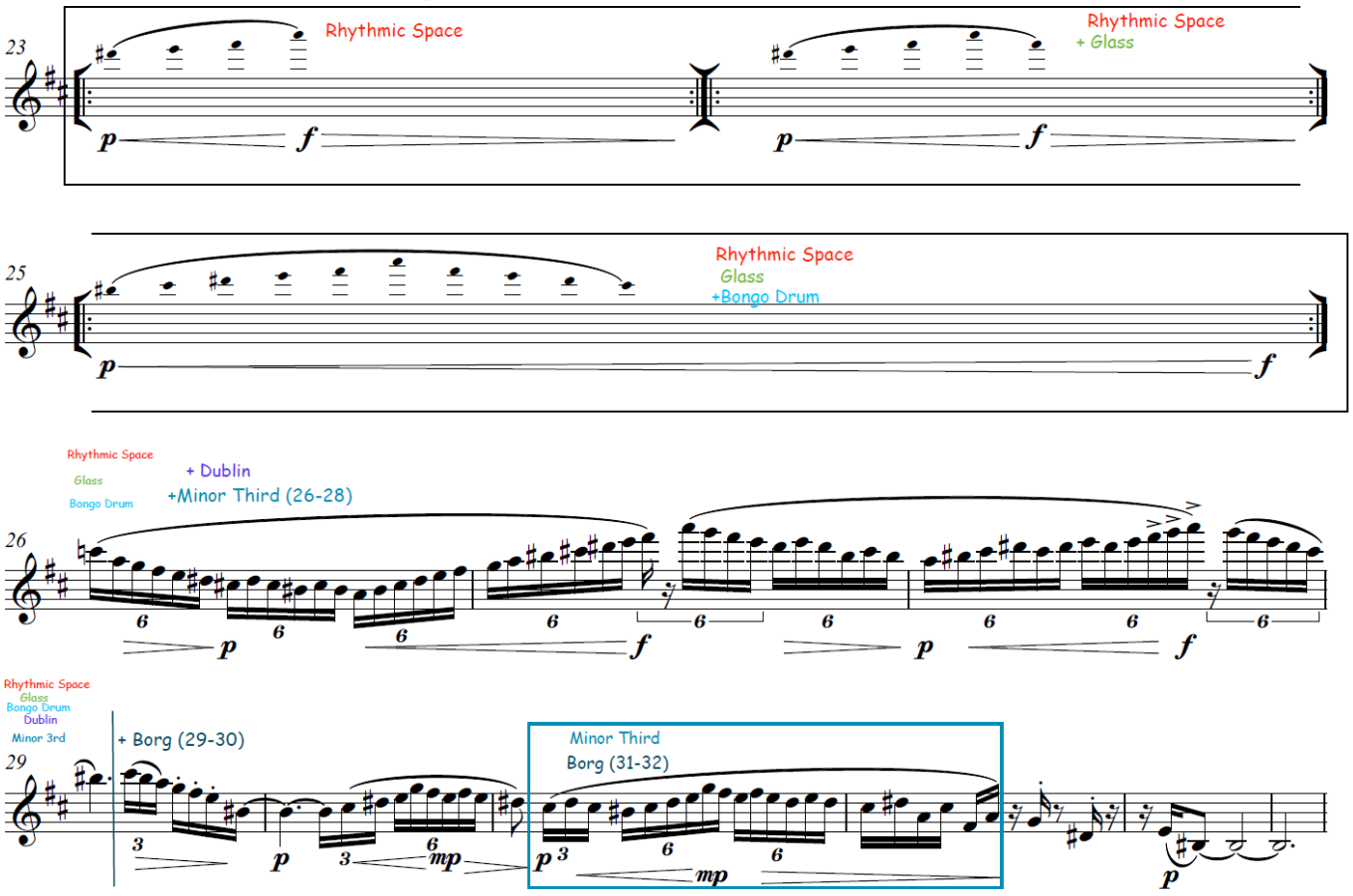

37
Flz.
p
mp
mf
Minor 3rd up (40-47)
f
41
p
mf
mp
44
Squeak.
8va
mf
f
ff
48
Major 2nd down + Groove (48-53)
mp
pp
f

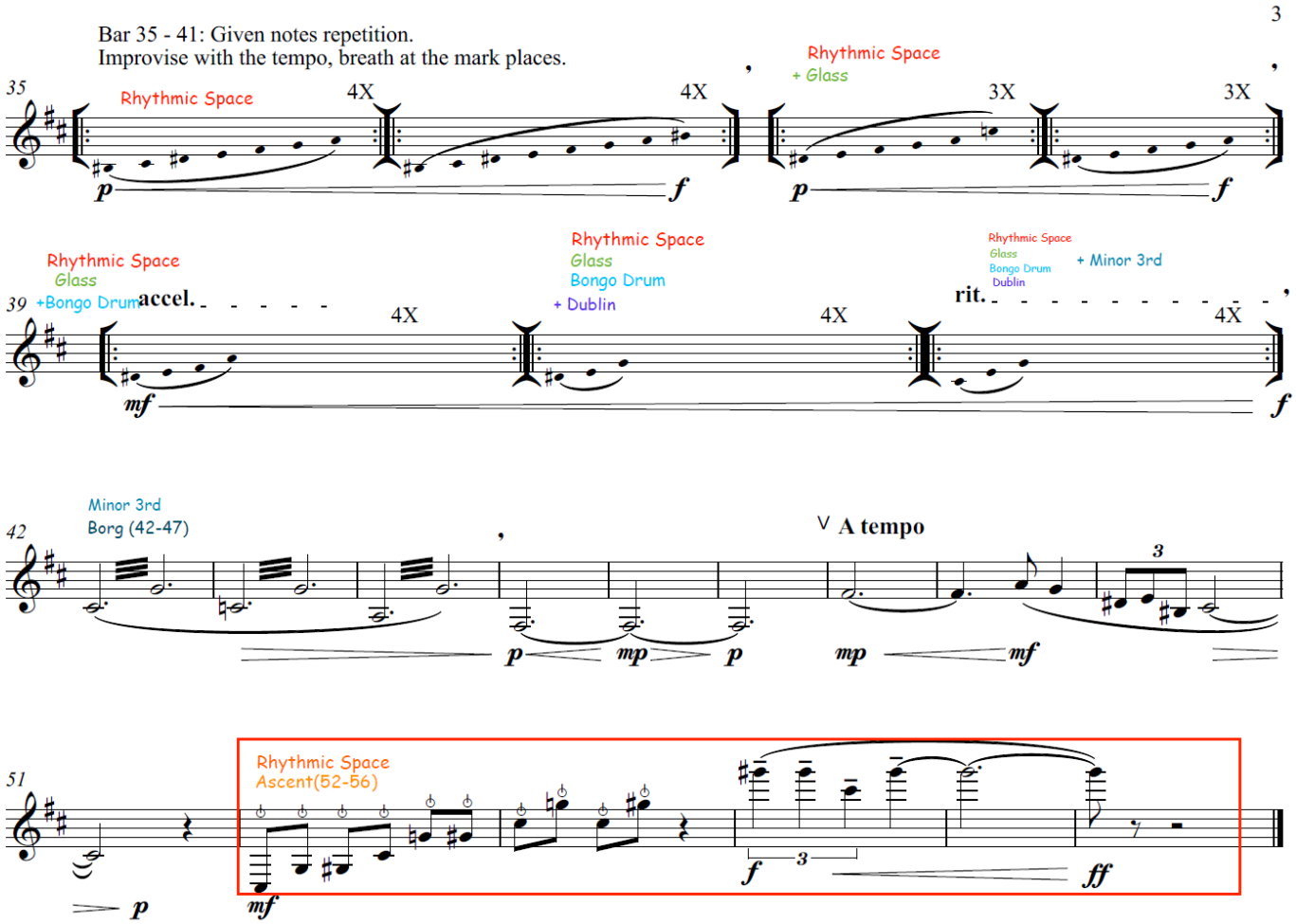
APPENDIX F: *ABOVE DUBLIN*, COMPOSED BY YUE SONG



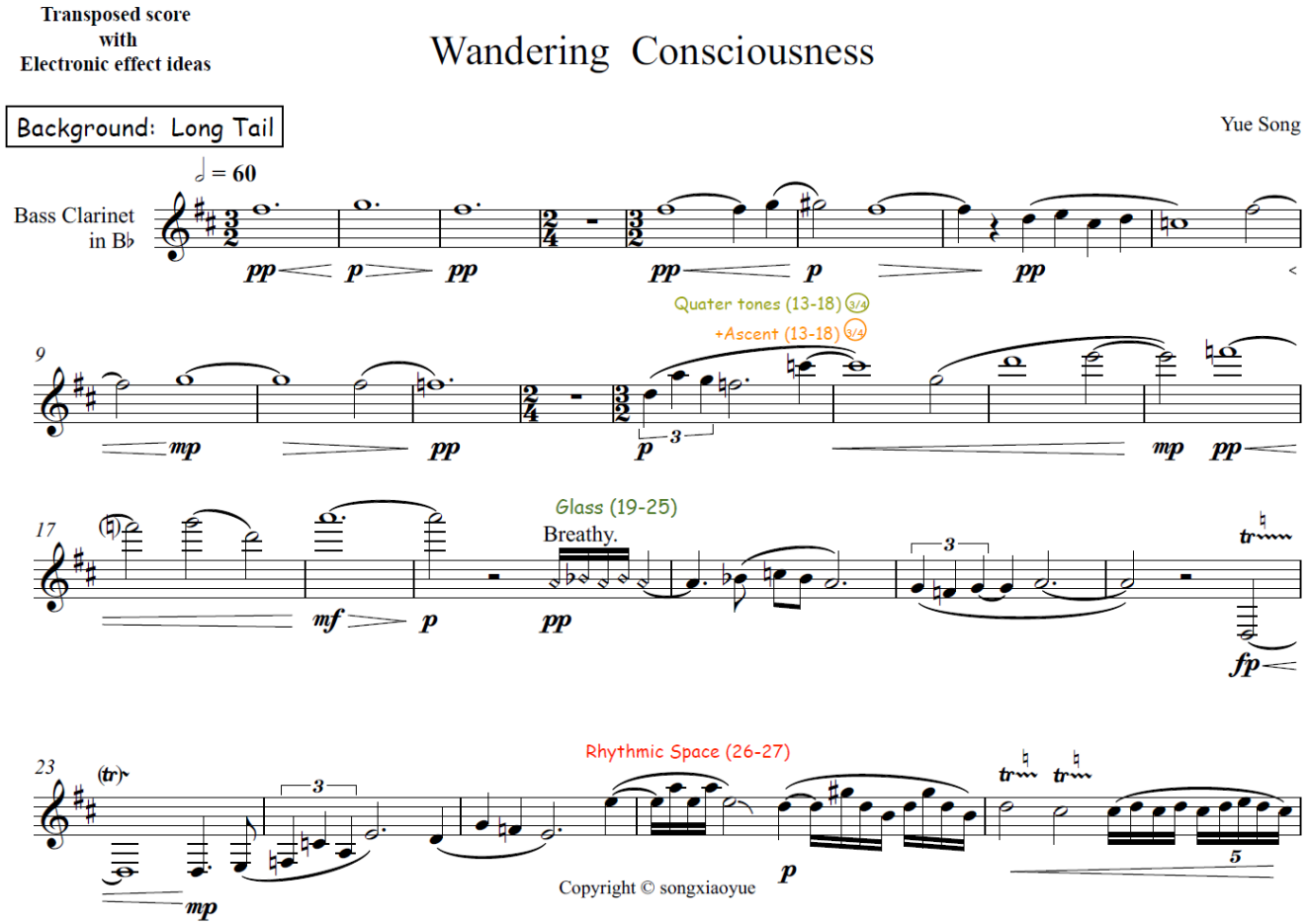
2

Bar 23-25: Given notes repetition in one breath.
Each bar starts slowly to as fast as possible.

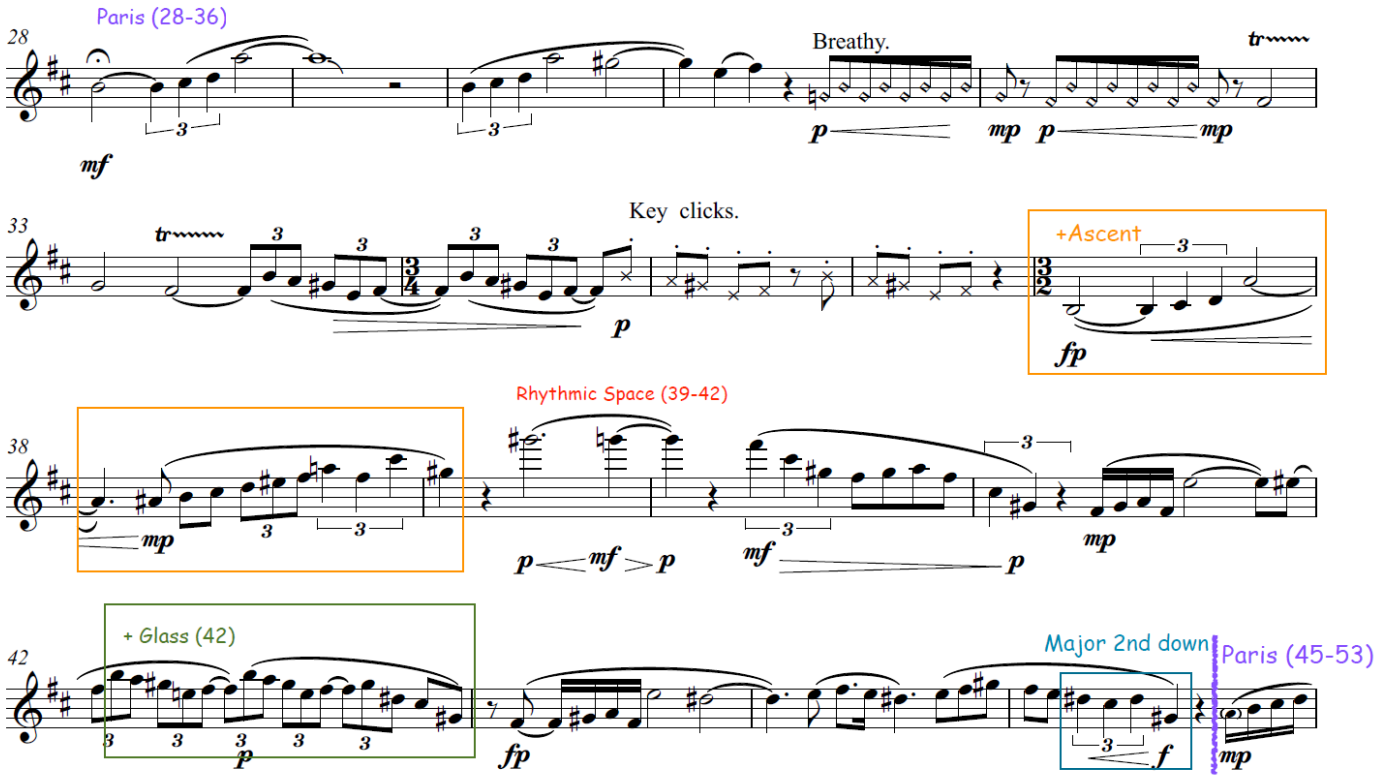


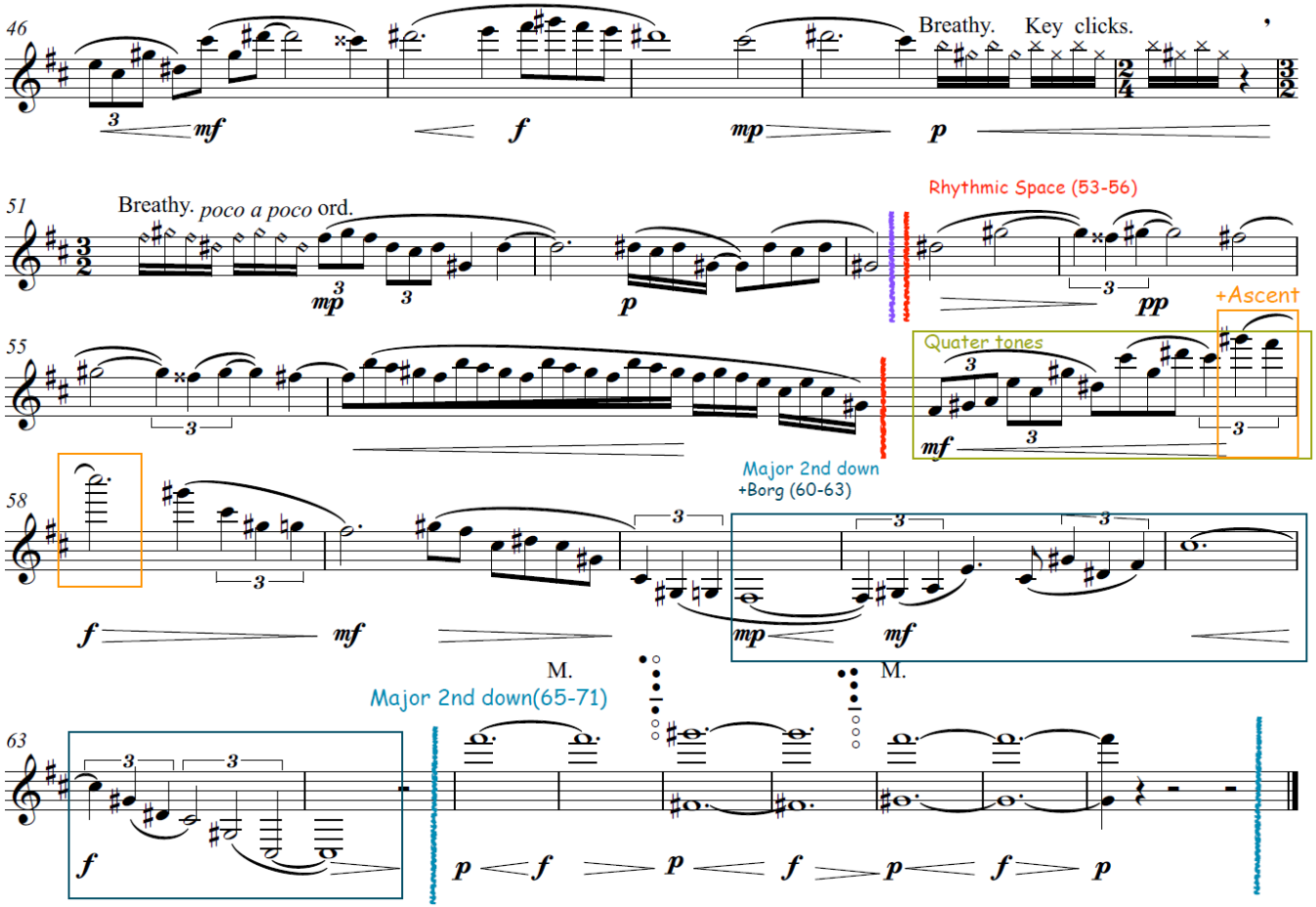

Bar 35 - 41: Given notes repetition.
Improvise with the tempo, breath at the mark places.
3
35
Rhythmic Space
4X
4X
p
f
Rhythmic Space
+ Glass
3X
3X
p
f
Rhythmic Space
Glass
+Bongo Drum
39
accel.
4X
Rhythmic Space
Glass
Bongo Drum
+ Dublin
4X
Rhythmic Space
Glass
Bongo Drum
Dublin
+ Minor 3rd
rit.
4X
mf
f
Minor 3rd
Borg (42-47)
42
A tempo
3
p
mp
p
mp
mf
Rhythmic Space
Ascent(52-56)
51
p
mf
f
3
ff

APPENDIX G: *WANDERING CONSCIOUSNESS,* COMPOSED BY YUE SONG

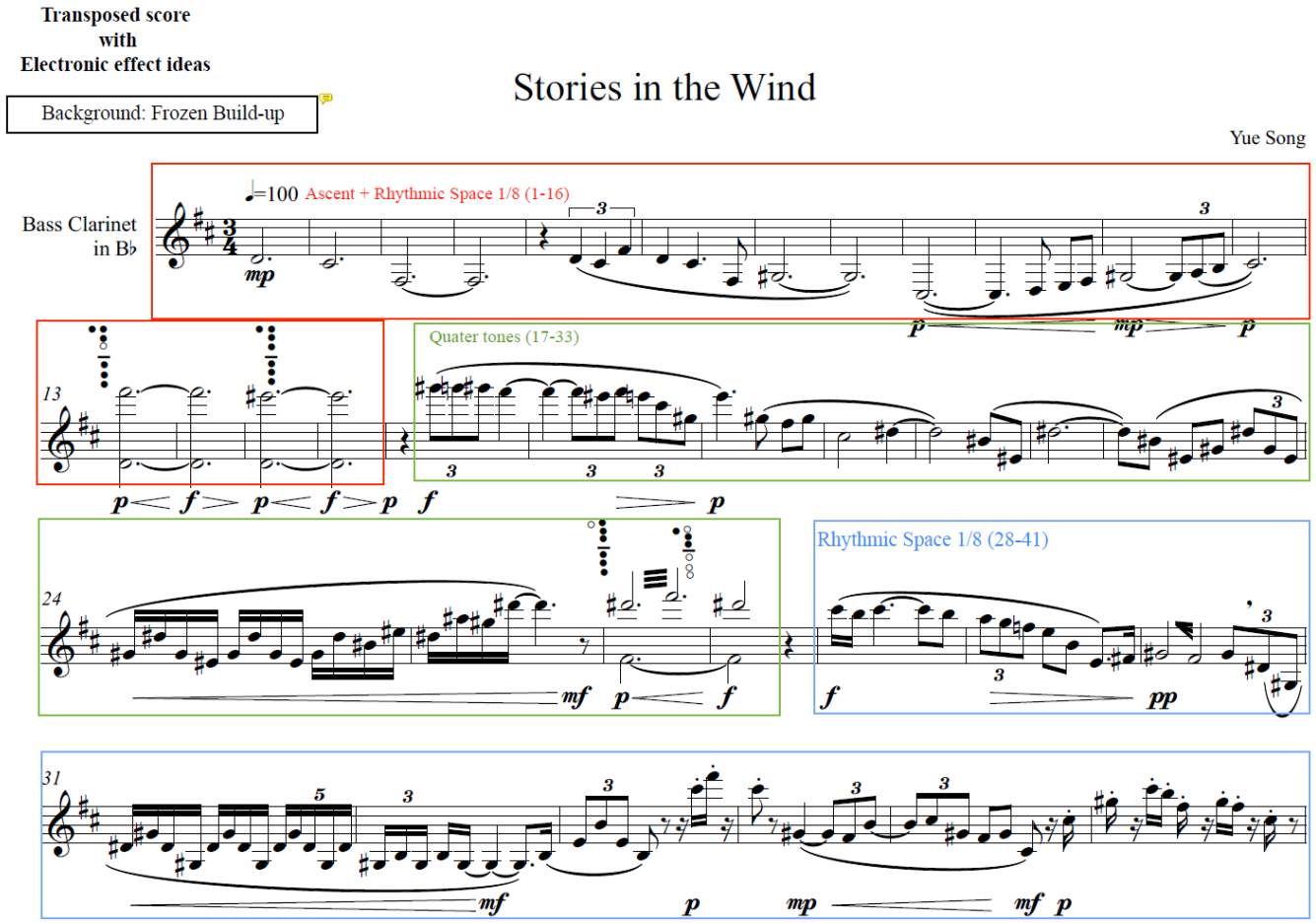


2

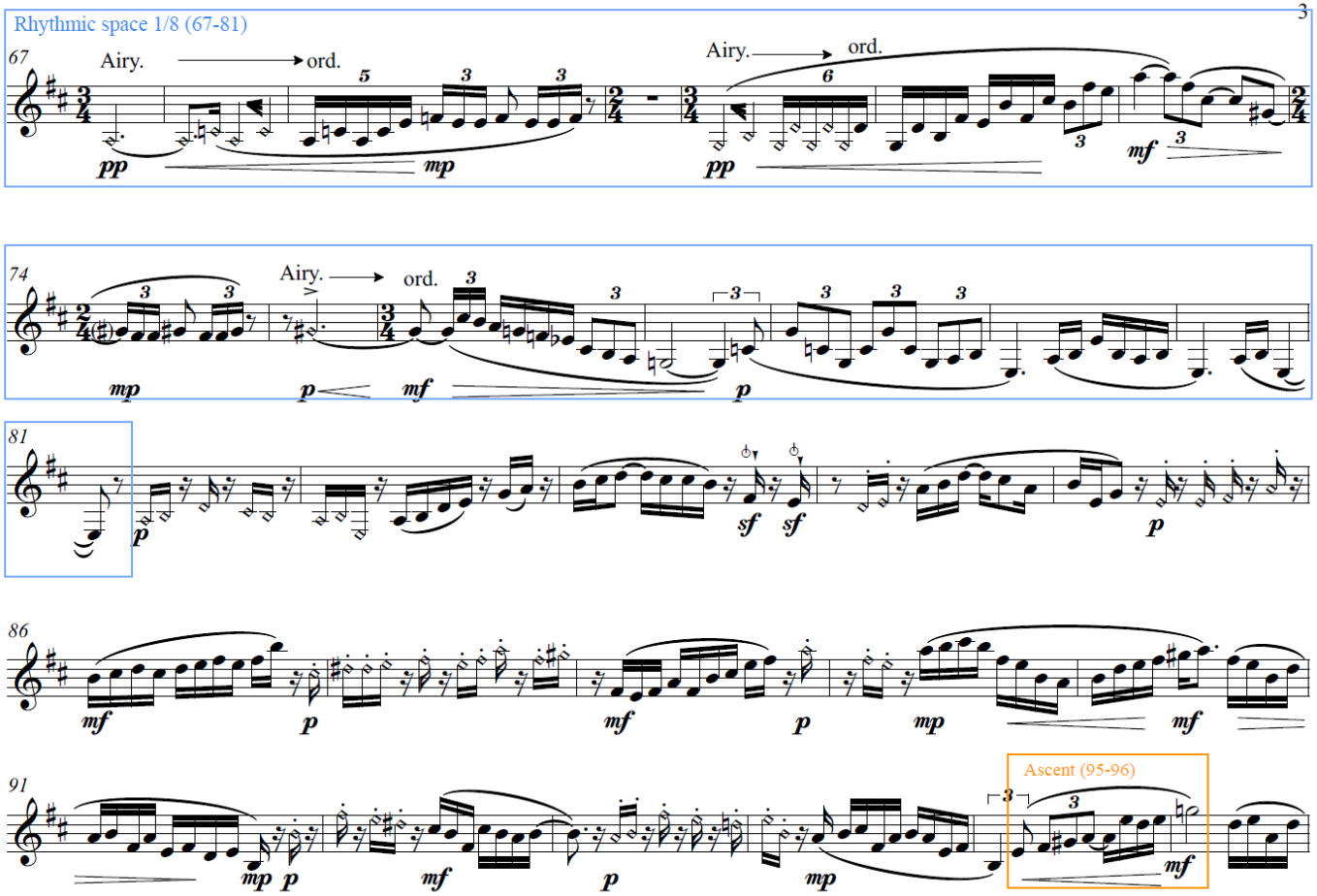

Paris (28-36)
28
Breathy.
mf
p
mp
p
mp
33
Key clicks.
p
+Ascent
fp
38
Rhythmic Space (39-42)
mp
p
mf
p
mf
p
mp
42
+ Glass (42)
p
fp
Major 2nd down
Paris (45-53)
f
mp


46
Breathy.
Key clicks.
51
Breathy. poco a poco ord.
Rhythmic Space (53-56)
+Ascent
55
Quater tones
58
Major 2nd down
+Borg (60-63)
M.
M.
Major 2nd down(65-71)
63

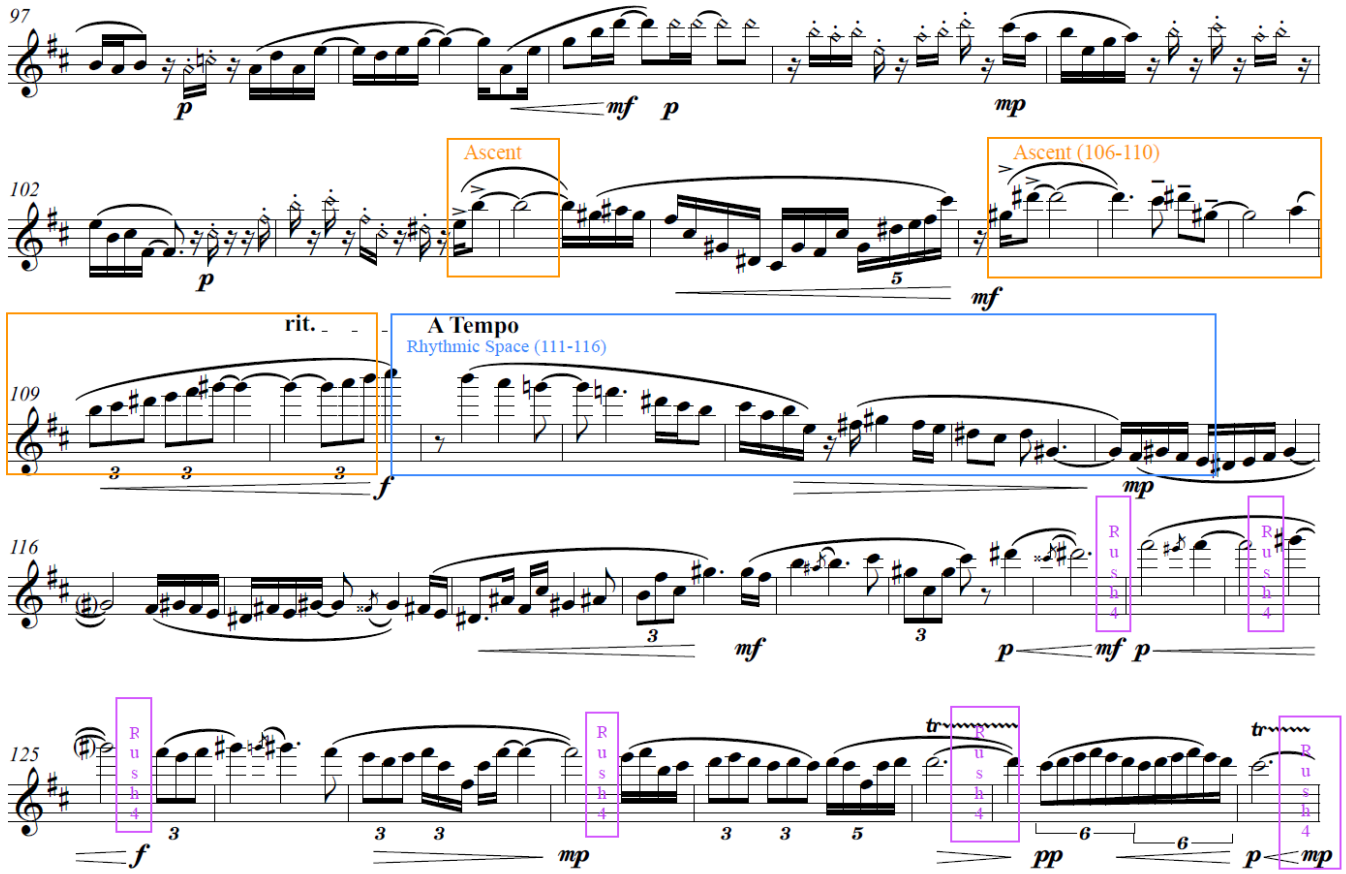
APPENDIX H: *STORIES IN THE WIND*, COMPOSED BY YUE SONG




2
37
mf
p
mp
42
Ascent + RS (43-52)
mf
p
mf
48
p
p
mf
p
mf
54
f
61
p
f
p

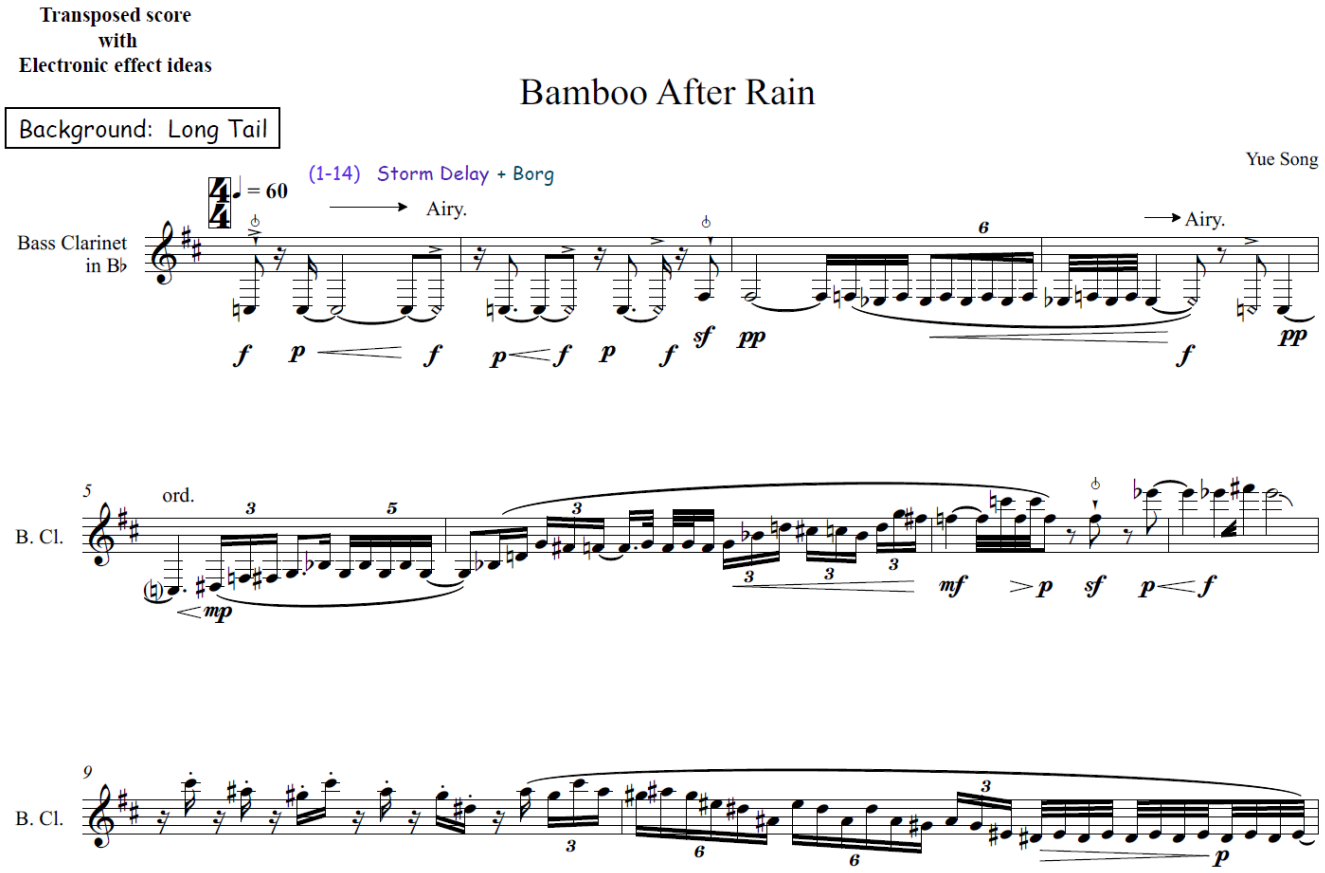

Rhythmic space 1/8 (67-81)
3
67
Airy.
ord.
Airy.
ord.
74
Airy.
ord.
81
86
91
Ascent (95-96)

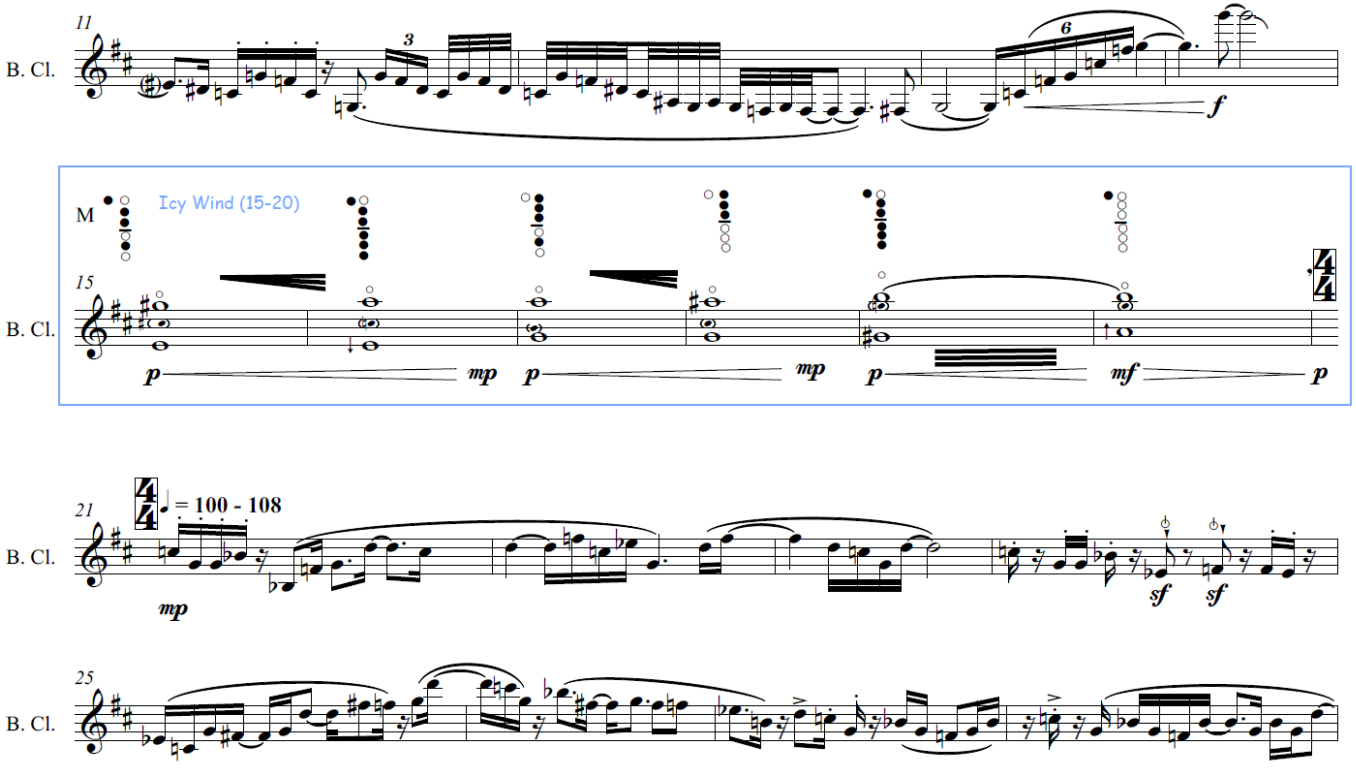
4

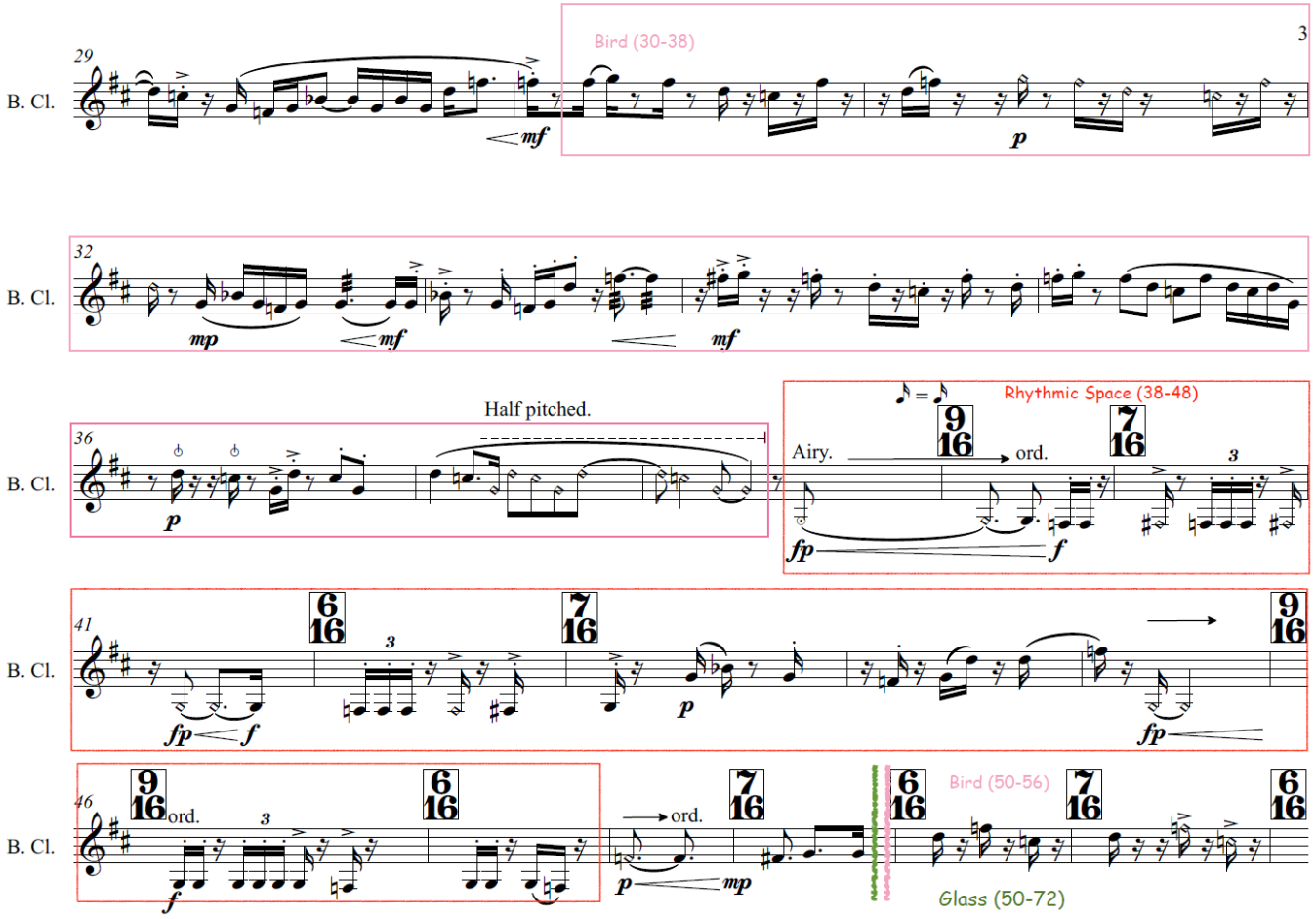

97
102
Ascent
Ascent (106-110)
rit.
A Tempo
Rhythmic Space (111-116)
109
116
125
Rush
tr


133
(tr)
pp
mp
p
mp
p
Rush
140
mp
Rhythmic Space (142-147))
pp
mp
pp
mp
pp
mp
mf
Quater tones
(148-159)
pp
149
mf
f
156
p
Minor third (160-166)
*M
*M
*M
p
f
p
f
p
f
p

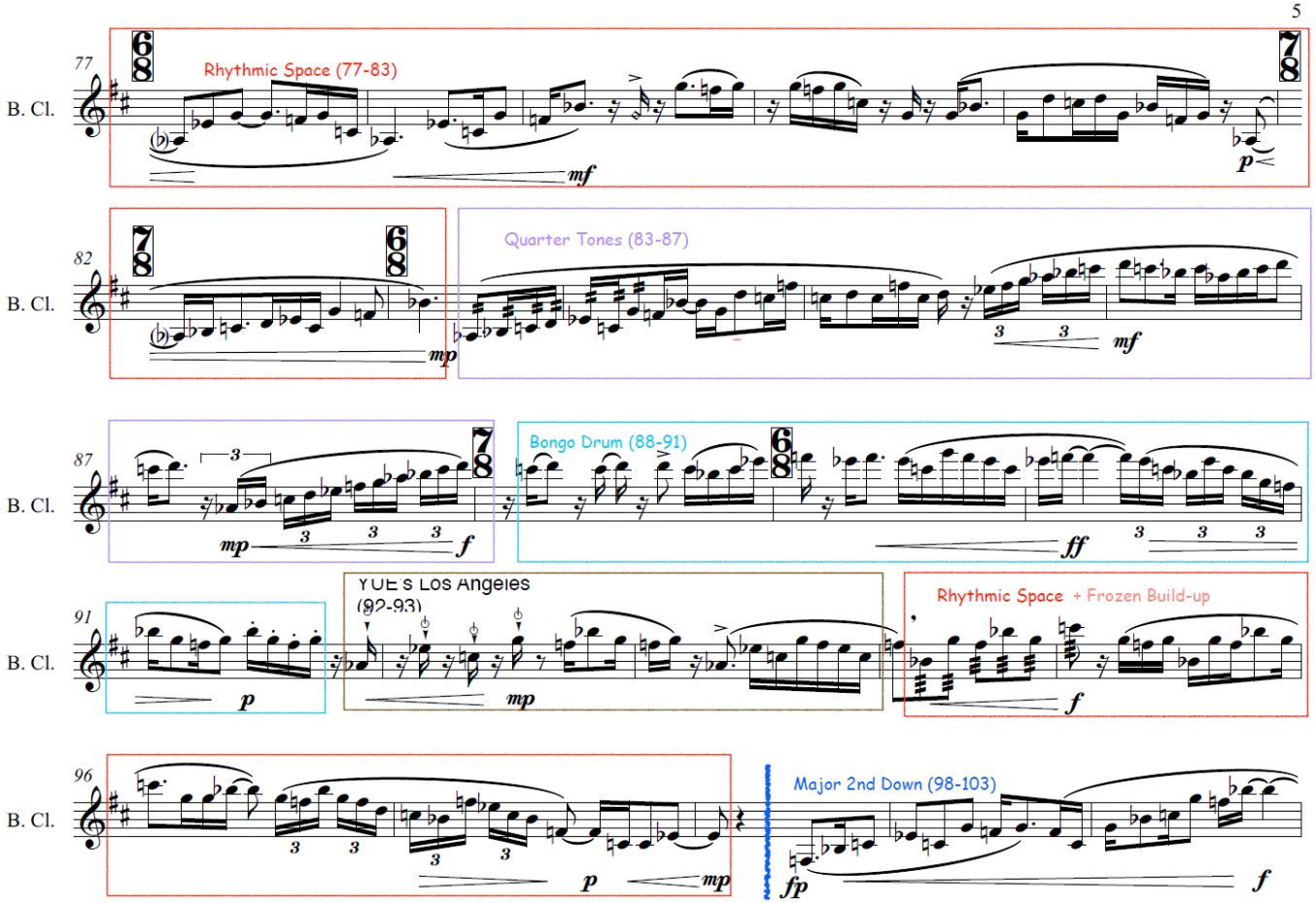
APPENDIX I: *BAMBOO AFTER RAIN*, COMPOSED BY YUE SONG

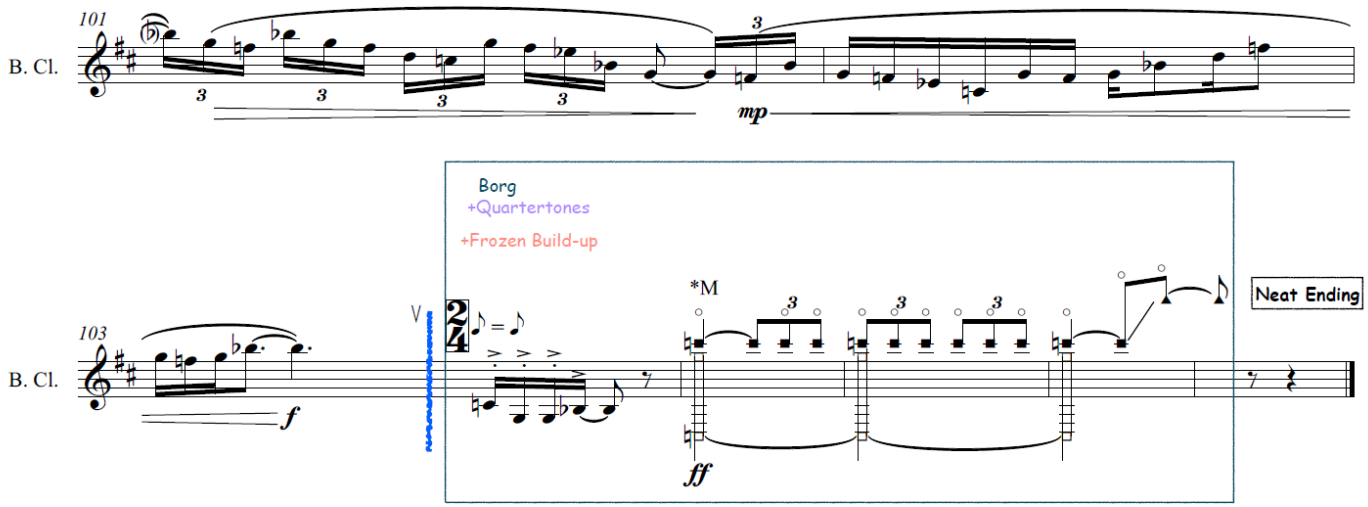



11
B. Cl.
3
6
f
M
Icy Wind (15-20)
15
B. Cl.
p
mp
p
mp
p
mf
p
21
B. Cl.
= 100 - 108
mp
sf
sf
25
B. Cl.


B. Cl.
29
Bird (30-38)
3
mf
p
32
mp
mf
mf
Half pitched.
36
p
Rhythmic Space (38-48)
Airy.
ord.
fp
f
41
fp
f
p
fp
46
ord.
f
ord.
p
mp
Bird (50-56)
Glass (50-72)


52
B. Cl.
fp
mf
58
B. Cl.
p
sf
p
62
B. Cl.
mf
sf
67
B. Cl.
+ Borg
p
72
B. Cl.
Ascent (72-76)
mp
fp
mf
mf
fp


77
B. Cl.
Rhythmic Space (77-83)
mf
p
82
B. Cl.
mp
Quarter Tones (83-87)
3
3
mf
87
B. Cl.
3
mp
3
3
3
f
Bongo Drum (88-91)
ff
3
3
3
91
B. Cl.
p
YUE'S Los Angeles
(92-93)
mp
Rhythmic Space + Frozen Build-up
f
96
B. Cl.
3
3
3
3
p
mp
Major 2nd Down (98-103)
fp
f


101
B. Cl.
mp
Borg
+Quartertones
+Frozen Build-up
103
B. Cl.
f
V
*M
ff
Neat Ending

APPENDIX J: LIST OF PERFORMANCES WITH SABRe SENSORS

Date	Composition	Composer	Occasion	Location
February 2019	*Stung*	Frank Lyons	SABRe Day 2019	Zurich University of the Arts, Zurich, Switzerland
February 2019	*Stung*	Frank Lyons	TU Dublin/Intel Partnership Event	North House, Grangegorman, TU Dublin
February 2020?	*Stung* *Star Maker*	Frank Lyons Amanda Feery	Artistic Research Perspectives Seminar	TU Dublin, Rathmines
4 June 2020	*Stung* *Star Maker*	Frank Lyons Amanda Feery	Contemporary Music Centre Ireland Salon Series	Online
17 September 2020	*Dréimire Mhuire*	Marcella Barz	Versioning the Future?	Online
15 December 2020	*Hex 2*	Frank Lyons	YouTube Premiere	Online
September 2021	*Stung* (abridged version) *Star Maker* *Dréimire Mhuire*	Frank Lyons Amanda Feery Marcella Barz	Doctors in Performance Conference	Tallinn, Estonia
27 March 2022	*Bamboo After Rain*	Yue Song	Perform_Live Festival	National Concert Hall, Ireland
25 April 2022	*Hex 2*	Frank Lyons	Artistic Research Days	Recital Hall, TU Dublin Grangegorman
26 April 2022	*Bamboo After Rain* *Above Dublin*	Yue Song	Artistic Research Days	Concert Hall, TU Dublin

	No. 1 *Wandering Consciousness* *Stories in the Wind*			Recital Hall, TU Dublin

APPENDIX K: LIST OF COMPOSITIONS FOR SABRe SENSORS

Composer	Composition	Instrument(s)	Composition Year
Laurie Altman	*Singularities*	Clarinet, bass clarinet	2018
Laurie Altman	*Sonic Drifts*	Bass clarinet	2014
Jacopo Baboni-Schilingi	*De la nature du mythe*	Bass clarinet	2017
Jacopo Baboni-Schilingi	*New beginnings*	Bass clarinet	2014
Marcella Barz	*Dréimire Mhuire*	Clarinet	2020
Alex Buess	*SKUTO*	Bass clarinet	2013/2014
Raul Castro	*eight hours*	Clarinet	2019
Marko Ciciliani	*Time Machine*	Bass clarinet and video	2012/2013
Ricardo Climent	*s.laag*	Bass clarinet and game audio	2016/2019
Marc Estibeiro	*Open Borders*	Bass clarinet	No Date
Amanda Feery (remixed by Marcella Barz)	*Star Maker*	Bass clarinet	2015/2020
Gleb Foulga and Marij van Gorkum	*Churn*	Bass clarinet	2019
Oliver Arcos Joan Jordi	*Dibuixos invisibles*	Soprano saxophone	No Date
Thomas Kessler	*Berceuse*	Bass clarinet	2017
Thomas Kessler	*Is It?*	(Arr.) Soprano saxophone	No Date
Frank Lyons	*Hex 2*	Bass clarinet and soundtrack	2019
Frank Lyons	*Stung*	Bass clarinet	2010/2019
Matthias Mueller	*Camerino-Suite*	Clarinet Quartet (E-flat clarinet, B-flat clarinet, bass clarinet, and contrabass clarinet)	No Date
Matthias Mueller	*Confluence*	Bass clarinet and dancer	2018/2019
Matthias Mueller	*deuxième rhapsodie en bleu*	Clarinet and orchestra	2018

Matthias Mueller	*Evolution 2.0*	Bass clarinet and percussion ensemble (4 players)	2017
Matthias Mueller	*Improvisation for SABRe 1*	Bass clarinet	No Date
Matthias Mueller	*SABRE Suite*	Clarinet	2018
Matthias Mueller	*Sailing*	Clarinet	No Date
Alastair Penman	*Layers*	Alto saxophone	No Date
Alastair Penman	*SABREtooth*	Alto saxophone	No Date
Katharina Rosenberger	*nodes*	Bass clarinet	2011/2013
Yui Sakagoshi	*Motion Experiment II* – improvisation with SABRe	Saxophone	No Date
Yui Sakagoshi	*Sound and Silence*	Soprano saxophone – on a text by Toru Takemitsu	No Date
Martin Schlumpf	*Dawn*	Bass clarinet and orchestra	2012
Martin Schlumpf	*Puzzle*	Bass clarinet	2011
Uduman Sohrab	*Out of the darkness the envelops*	Contrabass clarinet	No Date
Yue Song	*Above Dublin*	Bass clarinet	2020
Yue Song	*Bamboo After Rain*	Bass clarinet	2021
Yue Song	*Stories in the Wind*	Bass clarinet	2021
Yue Song	*Wandering Consciousness* for bass clarinet	Bass clarinet	2020
Yue Song	*Unstoppable Spirals*	Bass clarinet	2020/2021
Miroslav Spasov	*Idiosyncrasies*	Contrabass clarinet and electronics	No Date
Hans Tutschku	*Interlaced 1*	Bass clarinet	2014
Hans Tutschku	*Neues Werk*	Bass clarinet and live video	2012/2013
Stephan Vermeersch	*Kinetic Clarinet*	Clarinet and live video	2020
Stephan Vermeersch	*Lîla 2.0*	Bass clarinet	2019
Stephan Vermeersch	*Monologue!*	Bass clarinet	No Date
Stephan Vermeersch	*Moves*	Bass clarinet and live video	2021
Stephan Vermeersch	*SABRe Dance*	Bass clarinet	2019

Stephan Vermeersch	*Sounds!*	Bass clarinet and live video	2019
Tom Williams	*Weighed Down by Light*	Contrabass clarinet and xed Media	No Date