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The Manifestation of Human Agency

Designing the Hybrid Guitar for the Humanisation of Digital Composition and Performance

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Abstract

This research presents an exploration of personalised humanised approaches to performing and controlling digital music, as well as encapsulating human presence and feel in digital musical performance tools. Specifically, this involved the development of a hybrid guitar instrument with integrated hardware and software components, to produce an instrument that serves simultaneously as a digital controller for computer-generated sounds and as a conventional guitar. Blended practices of guitar and digital music instrument techniques utilise pre-existing skills and musical background as effectively as possible and provide opportunities to transfer skills from one domain to the other.

This thesis outlines the practices and methods used to develop the instrument accompanied by a portfolio of compositions and software. The portfolio of compositions consists of four solo electronic pieces, as well as one piece that includes an instrumental ensemble. The compositions demonstrate and evidence the practical applications of the software and instrument while addressing their relationship to the key theme of ‘humanisation’. The work examines a broad range of topics such as recycling virtuosity; using the guitar as a sound source and digital controller; simulating human imperfection and behaviours in software; improvising with composed material in real-time; extending and augmenting human control; liveness and the visibility of human agency.

To discover an approach for a bespoke physical instrument and software environment, this thesis reviews some existing practices, literature and research. In addition, it explores considerations of compositional and performative methods that allow guitarists to control and improvise with digital compositions in real-time, as well as computer improvisation methods that aid in the interpretation of compositions. This

exploration contributes novel control and interaction methods for digital environments that are useful for enhancing and exposing human agency.

The research is linked to recent developments and thinking in electronic music, touching on areas such as augmented instruments, New Instruments for Musical Expression, controllerism, virtuosity and mastery, tactile feel, expressivity, mapping strategies and interactive environments. This research project adopts Donald Schön's theory of reflective practice to illustrate the advantages of these approaches for guitarists, composers, improvisers and digital musicians at large. While contributing knowledge to the field through a suite of software tools, compositions, control strategies and the design of the hybrid guitar instrument, presented through discussion, diagrams and video documentation.

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Finally, thanks to my family for their love and unwavering support, my parents Gerard and Alice Canny, sister Aisling, and brother Adrian.

Declaration

I declare that this thesis was composed by myself, that the written and practical work contained and discussed herein is my own, except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

Nicholas Kirk Canny
Edinburgh
14th December 2021

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Chapter 1 Introduction

The thesis, writings and recordings present my exploration of a personalised humanised approach to performing and controlling digital music, as well as encapsulating human presence and feel in software. This includes a broad range of topics such as the recycling of virtuosity (Tremblay and Schwarz, 2010); using the guitar as a sound source and digital controller; encapsulating human imperfection and behaviour in software; improvising with composed material in real-time; extending and augmenting human control; utilising acoustic and digital methods; liveness in electronic music and making human agency visible. These topics have been addressed using guitar, digital interfaces, Ableton Live and custom software created with Max/MSP to play as a solo performer. However, the instrument is transferable to ensemble settings when used in a limited capacity.

This is a reflective research project that adopts Donald Schön's theory of reflective practice (Schön, 1983). Consequently, my research was a process of reflection-in-action and reflection-on-action to reach a practicable outcome. This felt like the most pragmatic way to approach this research as I am working with a new instrument, compositions and performance methods that were developed to achieve personal musical goals. Schon's reflective model enabled me to investigate and consider this work throughout its development and describe what I have learned from carrying out this research. This process involved problem setting and solving, as I addressed and solved problems through practice-based research to determine an optimal outcome that utilised my knowledge base and experiences. For example, reflection-in-action helped to address problems with the instrument, while reflection-on-action enabled

me to devise solutions by observing myself and other people's practices. This allowed me to put the hybrid guitar into practice, experiment with it in real-time to learn from the experience and following this, spend time reconsidering the situation and evaluating what the ramifications of my design decisions were for the music and performance. Thus, the contributions of this research are demonstrated through what I have learned by investigating and reflecting on practice-based research.

The contributions of this research include new methods for integrating guitar and digital controllers, approaches to improvised, flexible routing and processing of composed material, and a suite of software devices for automating control, processing audio and generating musical material together with compositions that demonstrate the methods and software. The hybrid guitar system consists of guitar mounted and floor based Musical Instrument Digital Interfaces (MIDI) (see Figures 1.1 and 1.2) that control a customised Ableton Live session that includes original Max for Live devices that provide additional affordances. Specifically, I utilised the Keith McMillen SoftStep, Livid Guitar Wing and Fishman TriplePlay MIDI controllers. The Guitar Wing and TriplePlay attach to the body of the guitar. The Guitar Wing has pads, sliders, buttons, switches and an accelerometer, whereas the TriplePlay allows for the conversion of the guitar’s sonic output into MIDI information. The SoftStep is a foot controller which is placed next to my guitar pedals close to where I am situated during performances. It has ten gesture-sensitive pads that register pressure and position, which can be used in numerous ways.

Figure 1.1: Performance setup at Audio Mostly conference, displaying guitar, Guitar Wing, TriplePlay, laptop and audio interface.

Figure 1.2: Performance setup at Audio Mostly conference, displaying SoftStep.

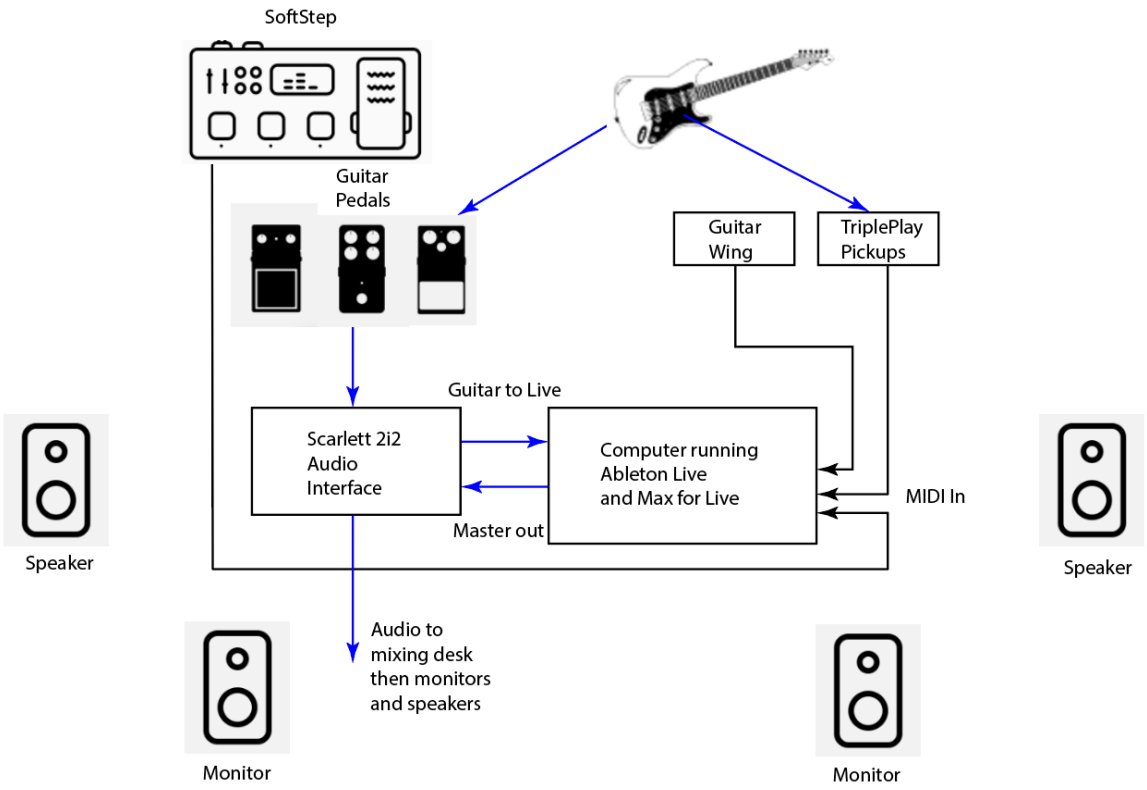


Figure 1.3: Stage layout and signal flow. Audio in blue and MIDI in black.

I create most of the compositional material before performances by recording and arranging compositions in Live's arrangement view; however, I occasionally use live guitar to contribute additional material. To improvise with this material during performances, I use the digital layer of the hybrid guitar to control audio effects and MIDI instruments; vary the instrumentation and track routings; and perform software instruments on the note-based level, allowing me to play the roles of composer-conductor-instrumentalist. My bespoke Max/MSP software focuses on improving these aspects of Live and enhancing my control capabilities through the creation of novel audio effects and routing capabilities; MIDI instruments; and complex mapping strategies that allow me to control multiple audio effects simultaneously (see 7.3). The software was designed with guitar technique and improvisation in mind, to recycle virtuosity and create a participatory environment. To achieve the latter, much

of the software incorporates indeterminate methods that vary compositions and human actions.

The scope of this research is broad, as it explores the topics of electronic instruments and controllerism; hybrid instruments; composition and improvisation; control strategies; and software design, any of which could have been PhDs within themselves. This research is necessarily broad as humanisation incorporates these other topics; therefore, it was important to address them through the lens of humanisation. I also felt this would provide more of a contribution to knowledge for electronic musicians who engage with these other topics. Musicians can learn how to apply these methods since I comprehensively document the integration of the hardware, software and compositions (see Chapters 7 and 8).

1.1 Motivations

I carried out this research as there was a knowledge gap with regards to using the guitar as a digital controller. I became aware of this in 2017, having performed electronic music for the preceding two years, I realised that I was not making full use of my skills: physical and mental. Furthermore, there was something lacking with the engagement of the instruments I was using at the time. Initially my research was closely aligned with that of augmented instrumentalists, concerning the expansion of the guitar's capabilities; however, I realised this would make it difficult to perform structured and multi-layered compositions. Thus, this research explores strategies for playing the guitar and controlling complex compositions simultaneously.

Prior to my research, I was performing with Ableton's Push, Keith McMillen's SoftStep and guitar. I controlled digital compositions using the Push while occasionally incorporating live guitar with added audio processing using the SoftStep. Although this proved useful, the Push was encouraging me to work in particular ways, thereby constraining my creativity and personality. Furthermore, there was a disconnect

between the guitar and Push, as there was no crossover in how I used and interacted with these devices. Thus, switching between instruments was disturbing the flow of my performances. Furthermore, there was a lack of spontaneity that was exacerbated by the fact that when using the Push, it was necessary to navigate between its various modes, switching between performative and operational activities. I was not satisfied with how this came across to audiences, as there was inactivity and activity that did not produce auditory outcomes. This was misleading as when gesture-sound relationships were occurring, audiences may think I was carrying out operational tasks.

I also missed the complexity of the guitar, where interaction with the instrument sometimes resulted in mistakes or unintentional body movements that changed the course of a performance. Furthermore, I had become so familiar with the guitar that my actions had become partially unconscious, relying on the intelligence of the muscles and the mind-body connection I had developed. These factors were lacking in my interaction with the Push, therefore, I felt I had not mastered the instrument and the performance experience was less enjoyable.

The way I designed the composition environment was also creating problems, as its impact was tending towards music that was predictable and precise. Although this necessitated the need for me to improvise to vary the composed material, it did not influence how I improvised, making performances less spontaneous. Moreover, the composition environment produced no surprises that required awareness and responsiveness. Thus, the music always sounded similar, which made performing the same material less interesting in the long-term. Moreover, I feared that audiences would realise that I was not actively interacting and responding to the computer part. Much like John Ferguson (see 6.4.3) and George Lewis (see 5.4.1), I wished to create a computer environment that participated in the musical discourse.

Having reflected on my previous experiences of playing guitar in a jazz ensemble, I concluded that I could adapt these methods to the computer to create an ensemble feel in solo electronic music performance. This led me to the concept of humanisation which involved the creation of an instrument and environment that resulted in human and computer improvisation and spontaneity. My intention was to encapsulate some of the complexity of human musicians' playing in software, such as microinteraction and variation. This facilitated control and delegation by letting me be more flexible in determining the role I played while movement and improvisation continuously occurred in aspects of the environment where control was delegated to the computer.

Bell (2018) suggests that oftentimes, "the overall experience of an instrument is contingent on whether the design of the system is compatible with users' pre-existing ways of conceptualizing and making music". There were many aspects about the design of Live that did not correlate with my conceptual view of making music. For example, the linear mapping strategies Live offered could not produce the complexity I desired, therefore, throughout this research I developed software that overcame such problems.

The outcome of this research is not entirely philosophical or technological, as it has allowed me to create a unique musical outcome and performance experience. Although the style of music was not of primary importance, I composed in a broad range of styles as I wanted to develop an instrument and environment that was versatile and applicable in various contexts. Thus, the music contained in this portfolio takes influence from glitch, electronica, ambient, EDM, pop and techno. However, I have applied a jazz aesthetic preference and ensemble feel throughout the entire portfolio.

1.2 The Fundamental Objectives of this Research

- To create a personal approach in electronic music through the design of a complex composition and performance software environment that can be controlled effectively using the guitar
- To develop and explore approaches for guitarists to control and improvise with digital compositions in real-time
- To discover ways of performing digital music that improve the experience of both performer and audience, extending and augmenting human control while allowing for the visibility of human agency
- Creating an ensemble experience in solo electronic music performance through the development of software that contributes to the realisation of the music

1.3 Research Questions

There were two overarching questions in my research. These are broken down into more specific sub-questions.

1) How can the hybrid guitar be used to control digital compositions intuitively?

- What is the value of guitar technique versus novel Digital Musical Instrument (DMI) technique in the control of digital compositions, and how can these be combined and applied effectively by controlling certain aspects of an environment?
- How does designing a complex or simple DMI affect the performance experience? For example, how do different mapping strategies change the outcome for both performer and audience? What are the advantages of designing an instrument for flexibility or mastery of a specific area?
- What does the hybrid guitar provide that a separate guitar and DMI could not?

- Is it beneficial for a guitarist to maintain gesture-sound relationships when working with digital controllers and software? For example, how can the guitar's sonic output be used to control digital music?
- How can the hybrid guitar be designed to enable a balance in challenge and frustration that facilitates flow states?

2) How can human agency and presence be incorporated into a digital performance environment built around pre-composed material to improve the performance experience?

- What humanising techniques enhance a performer's awareness and interactions to better facilitate flow states?
- How can a humanised digital composition and performance environment incorporate some of the interaction and spontaneity found in an instrumental jazz ensemble? For example, designing digital compositions and computer methods that encourage improvisation and result in an instrument that reacts inconsistently.
- When composing and improvising with computers, is it beneficial to add human nuances and physicality to create a convincing piece? For example, the physical limitations of the muscles, which when playing acoustic instruments result in space, imperfection and microinteraction.

1.4 Contributions of this Research

The concept of humanisation was not an original idea, as this builds upon the work of others (see Chapter 2). This research provides new insights into how performers, particularly guitarists, can improve their sense of control and interaction with digital environments while displaying liveness and human agency. I have extended the concept of humanisation to software, by advocating for the encapsulation of personal knowledge and human behaviours. To cover this topic, this research illustrates

approaches practitioners may take when working with electronic instruments, highlighting those that are useful for humanisation.

The development of the hybrid guitar is a contribution in itself. Hybrid instruments have been explored by others, especially within the New Interfaces for Musical Expression (NIME) community. However, I work with popular electronic musical styles which are underrepresented in the NIME community and academic DMI communities more generally. Furthermore, I use commercial software and hardware, rather than the bespoke approaches commonly found within academic circles.

I also present these ideas in a broad style of music, jazz influenced electronica, that is not often discussed in practical terms in academia, which has allowed me to apply an academic approach to commercial software and popular electronic music, something that is uncommon with this type of research. In doing so, I expand the capabilities of commercial software and create new uses for commercial hardware. This makes my research accessible to both those working inside and outside of academia since these methods can be applied by those using Live and commercial interfaces, or bespoke software and hardware. The integrated use of adaptable commercial devices may suit musicians more than creating something bespoke and presents new opportunities for combining the functionality of devices.

There were many other aspects to this research, including the design of software environment; composition and improvisation method; as well as control strategies and performance skills, all of which are contributions in themselves. This encompasses the following topics:

- Computer assisted music generation
- Digital composition and improvisation
- Recycling virtuosity and mastering DMIs
- Innovative signal routing methods
- Novel mapping strategies

- Converting expressive human control into indirect computer control
- Audio and MIDI effects for compelling sound design
- Effective design and use of digital controllers
- Blending acoustic and digital practices

1.5 Structure of the Thesis

This section describes the structure of the thesis, providing a rough overview of the topics addressed in each chapter.

1: Introduction describes my motivations for carrying out this research and explains what the contribution to knowledge is.

2: Overview of Humanisation describes foundational perspectives on this topic and addresses the relevant literature. This provides contrasting views on topics such as liveness, physicality, computer precision, the encapsulation of knowledge and personality, as well as generative and autonomous environments.

3: Electronic Instruments and Controllerism discusses the motivations for creating new instruments and the challenges that can arise when doing so. I consider the designs of electronic instruments, comparing the value of different interfaces and interaction methods. I address the controllerism movement, which has influenced my research, as these practitioners use novel controllers that allow them to get away from their laptops and display liveness.

4: Hybrid Instruments and the Role of Humanisation examines the field of augmented/hyper/hybrid instruments, as these practitioners use traditional instruments in the digital domain to make use of pre-existing skills and techniques. I explore the various approaches one can take to evaluate how to transition to a hybrid instrument practice while exploiting the positive aspects of traditional and digital instruments.

Following this, I discuss my motivations for using the hybrid guitar and its relationship to humanisation.

5: Composition and Improvisation discusses how my research combines elements from these disciplines while addressing the value of improvisation with regards to humanisation. I also describe forms of improvisation that humans and computers can engage in, acoustic and digital, as well as how compositions and technology can be designed to facilitate improvisation and a participatory environment.

6: Control expounds the various control strategies one may adopt, which involves mapping strategies, affordances and constraints, as well as human and computer agency. With regards to humanisation, this is important, as the functionality and control methods one implements influence the experience of both the performer and audience, as well as determining how much of an influence a performer has over their environment.

7: Assembling the Software and Hardware Components of the Hybrid Guitar discusses the functionality of the tools, addressing my motivations and rationale for designing the software in this manner. I discuss the general use, as well as my personal implementation for the purpose of composition, improvisation and humanisation. Following this, I discuss the design of the hardware, rationalising my choice of controllers and the functionality I assigned them, with a focus on how I recycled virtuosity. I also describe how I gained proficiency with the hybrid guitar and made skill perceivable to audiences.

8: Portfolio of Compositions and Technical Documentation describes the compositions and how their design reflects the themes discussed throughout this thesis. I dissect how these pieces work in collaboration with the hybrid guitar, including how their design facilitated human and computer improvisation, and the

playing of specific roles. I also reflect on the performance experience, explaining why I made certain decisions to produce compelling and humanised performances.

9: Conclusion reflects on this research, highlighting the topics that have been discussed in each chapter and how these link to address the overarching theme of humanisation. I explain the outcomes of this research, the contribution to knowledge, and suggest possible further research.

Chapter 2 Overview of Humanisation and Jazz

2.1 Introduction

This chapter gives an overview of humanisation and jazz as it relates to this research, providing insight into the field and explaining my perspective on these topics. I will address the topic of humanisation in different sections, making human presence visible during performances, and incorporating human presence and musical preferences in technology. Both topics play a vital role in the humanisation of digital music. The former allows a performer to improve their sense of control and display liveness to audiences. While the latter allows a musician-programmer to encapsulate personality, knowledge and human feel into technology. Although a jazz approach is not essential for humanising performances, incorporating jazz methods into the software encourages interaction that enhances humanisation. Furthermore, humanisation is about creating a system that reflects a personal practice. As my background is rooted in improvisation, I considered humanisation from a jazz perspective.

2.2 Defining Jazz Practices in my Research

> "Jazz is not a musical form; it is a method of treatment. It is possible to take any conventional piece of music, and 'jazz it.' The actual process is one of distorting, of rebellion against normalcy" (Spaeth in Gridley, Maxham and Hoff, 1989).

I take a similar perspective as I do not consider the style of music to be essential, rather I define jazz as any music that embraces improvisation and spontaneous decisions as its core values. Solo improvisation is often an important aspect of jazz

that involves one musician taking a lead improvised role within an ensemble during specific sections, in a personal and expressive manner while other musicians play the role of accompanist, providing a foundation for solo improvisation while playing off the soloist's ideas. This was important in my research as I wished to play the roles of both soloist and accompanist at different times.

Within solo improvisation, mistakes and unpredictable instrument behaviours act as a source of interaction, pushing performers into unexpected directions. Solo improvisation can offer more experimental possibilities as a performer is not bound by other player's aims and contributions. For example, in my practice performing jazz standards in a solo context allowed for drastic deviation from a composition's harmony as I was not clashing with an ensemble outlining the predetermined harmony. I strived to create an environment that contributed ideas while adhering to a predetermined form, thereby maintaining each composition's unique identity, and allowing me to take a lead improvisational role.

2.3 Defining Humanisation

My notion of humanising involves the visibility of human agency and improving interaction with technology through the encapsulation of human characteristics and interactivity that reflect a personal practice and musical background. This is important regarding my work with the hybrid guitar and composition environment, as I developed these in response to these considerations to situate myself as a primary agent within a digital composition and performance system: visually and sonically.

The Cambridge Dictionary (Proctor, 1995) definition of *humanise* is to "make something that is not human seem like a person, or treat something that is not human as if it is a person". This is achieved by imbuing the "qualities, weaknesses, etc. that are typical of a human, in a way that makes you more likely to feel sympathy for them". The other definition the dictionary uses is to make "something less unpleasant and

more suitable for people". The Chambers dictionary (Donald, 1997) defines humanising as a way "to render human or humane; to soften; to impart human qualities to; to make like that which is human or of mankind".

These definitions are useful for clarifying the broader meaning of humanising, as the term is not directly associated with music or the use of technology. It is, however, a pertinent issue for digital practitioners as music technology can benefit by being designed in a way that is relatable to people. Embedding human qualities, weaknesses and imperfection into the technology and performances facilitates this (see 2.5.3). This research focuses on designing the hybrid guitar around pre-existing skill and vocabulary to control a bespoke digital environment, as this creates an instrument that is easier to master in a personal sense. The research is still of benefit for other guitarists and those wanting to improve interaction and audience experience with DMIs more generally. My intent is to make performances accessible to audiences by providing visual and auditory experiences that are comprehendible.

In my research, the concept of humanising involves a variety of topics and methods, which can be subdivided into the following four overarching themes and underlying topics:

1) Liveness

a. Placing the human as the central agent in a digital system: visually and sonically
b. Noticeable actions with fixed gesture-sound relationship
c. Embodied interactions
d. Displaying navigation and wayfinding
e. Control that is nuanced and expressive
f. Control and delegation/surrender
g. The struggle between liveness and perfection, choosing what to control and when to act

h. Manual or autopilot, delegation, supervision, direct manipulation and inhabitation
i. Applying a mental model of the guitar to digital processes

2) Extending and augmenting human control

a. Recycling virtuosity to accelerate mastery
b. Mapping strategies for different levels and purposes
c. Replicating an acoustic instrument: nonlinear behaviours and full-body experience
d. Utilising the intelligence of the mind and muscles
e. Playing multiple roles: composer-conductor-instrumentalist
f. Tools for sound sculpting
g. Customising the level of complexity, finding a balance between challenge and frustration
h. Achieving flow states

3) Encapsulating knowledge into the software

a. Human characteristics and imperfection
b. Creating an improvisational partner through computer variation that influences outcome
c. Indeterminate processes that contribute to liveness, by keeping the music novel, thereby requiring performer awareness and responses
d. Creating personal music, sound design, MIDI instruments and audio/MIDI effects

4) Humanisation in composition and improvisation

a. Microinteraction
b. Meso improvisation
c. Macro improvisation

d. Motivic development
e. Human and computer agency, scripted or improvised actions
f. Control over computer improvisation
g. Interpreting compositions, leaving or making space
h. Playing or programming

My research takes influence from Peter Furniss, who based his thesis on a “humanised augmented practice of the clarinet” (Furniss, 2017, p. 16). His humanised practice places the “performer(s) at its centre, not in dominion over other people and elements, but as essential decision-makers in the act of presenting musical material, appropriately empowered within a community of interconnected influences” (ibid.). The approach Furniss devised enabled him to feel in control onstage, develop a personal sound, as well as display liveness and embodied relationships.

Although my research has its similarities, especially with regards to liveness and displaying human agency, my focus is mainly on using the guitar as a digital controller, rather than extending the sonic capabilities of the instrument. I wished to feel in control onstage by not having to rely on other people; however, in my research this meant negating the need to perform with acoustic musicians to create complex compositions with human feel, variation and imperfection. Furniss was concerned with not having to rely on sound engineers and/or technical co-performers.

To further address the topic of humanisation, the following sections examine relevant literature with regards to the display of visual liveness through gesture and embodied interaction, as well as the encapsulation of knowledge to incorporate human personality and feel that displays an auditory sense of liveness. The encapsulation of knowledge is a vital consideration for those endeavouring to improve the experience of the performer, particularly indeterminate and interactive methods. Although it is beneficial for a performer to have an instrument that is intuitive and playable, computer techniques that vary compositions during performance keep the

music new and exciting. Therefore, I placed equal importance on these two over-arching themes through the development of a system that is interesting for both performer and audience.

2.4 Making Human Agency Visible During Performance

This section discusses the challenges faced by digital practitioners wishing to display human agency through gesture, providing the paradigm of acoustic instruments as a useful reference.

2.4.1 Liveness

Liveness can have different meanings for different people; however, simply put it implies a musician is physically or virtually present for an audience to see in real-time. For example, Philip Auslander defines it as “the kind of performance in which the performers and the audience are both physically and temporally co-present to one another'' (Auslander, 1999, p. 60). This does not refer to human action or decision making, meaning that an electronic musician could simply set the music in motion, and this would still be considered live.

In this research, displaying liveness through human action was essential, yet this proved problematic for me in the past, as DMIs are often less visually oriented than acoustic instruments, which prevents audiences from gaining an insight into a performer's process. This is because most acoustic musicians’ gestures are visible to audiences, for example, with percussive instruments the correlation between action and sound is transparent and understandable. Paradiso and O'Modhrain discuss how acoustic instrumentalists can exploit “a mental model that the audience has of the instrument’s action-to-response characteristics, allowing virtuosity to be readily appreciated” (Paradiso and O'Modhrain, 2003, p. 4). According to John Croft for digital musicians to achieve liveness it is important to follow two underlying principles:

- The performer's gestural input should always be met with an immediate and fitting response from the instrument (e.g. a large input gesture should result in a loud or accented sound).
- The instrument should itself have some degree of internal consistency that makes it possible to learn how to control the system and makes its sound recognisable. (Emerson and Egermann, 2017 p. 365)

Displaying liveness through human gesture and considering the spectators point of view has become a central concern for some DMI practitioners, exacerbated by the fact that unlike acoustic instruments they can "have no physical-world connection to the kind of sound produced" (Bin, 2018, p. 63). This is a phenomenon Miranda and Wanderley (2006) describe as control dislocation, meaning that the materials DMIs are made from can be unrelated to the sounds they produce or how they are played. Croft suggests instruments can engage audiences "in a way that cannot be accounted for in terms of the sound alone: the difficulty, the impossibilities, the encounter with limits, the finitude of the instrumental performance resonates with wider human experience" (Croft, 2007 p. 62).

Many DMI researchers and communities, such as NIME, are now striving to produce instruments that make use of noticeable human agency and gesture. Miller Puckette (1991, pp. 65–69) suggests that digital performers who solely push a button to set the music in action are not demonstrating how the music is made. In this case "all we learn about the music is what our ears can tell us" (ibid.), which raises the question if listening is the only requirement to fully understand the music, why would the performer even need to be present?

In jazz, displaying liveness can be important in a musical group setting, as this shows that the musicians are communicating with one another. However, an introverted state of playing is common in digital music as instruments often only suit the needs of a particular performer. Unlike acoustic musicians who are constantly engaging with

each other to play synchronously, cue different sections, and give the music structure, many digital musicians do not need to physically engage with their instruments to accomplish this.

Another challenge when designing DMIs is the extensive possibility for variation and customisation, if a DMI does not follow a well-known paradigm it becomes harder for an audience to relate to and comprehend. Paradiso (1999) suggests this is exacerbated when performers use hidden interfaces or implement advanced automation and mapping strategies that can result in slight gestures producing complex outcomes. In comparison to many acoustic instruments where direct control over the entire instrument is a natural affordance, with DMIs totality of control may be impractical, meaning performers will need to decide what to control or delegate to the computer.

Acoustic instruments have the benefit of being nonlinear and unstable, for example, when a drummer strikes a snare and then instantly repeats this action the sound will differ when the snare is still vibrating following the first action. Miranda and Wanderley (2006, p. 16) suggest beginners must learn to deal with nonlinear behaviours, while competent players have become so accustomed to these particularities they become unconsciously ingrained in their playing**.** Although audiences may not be consciously aware of these nonlinear behaviours, the immediate hands-on control required from the musician will be apparent. Conversely, many DMIs are not designed in this way, which can render them less visually oriented. The nonlinear and inconsistent nature inherent to acoustic instruments makes them hard to learn yet results in more "freedom of expression found in extended playing techniques" (ibid.). These extended techniques contribute an additional sense of liveness, as a musician can be seen and heard interacting with the instrument in an unconventional manner.

Hunt and Wanderley (2002) conducted a study in which they discovered DMIs that were challenging were found to be more enjoyable and have long-term appeal. The

more challenging DMIs used in this study replicated aspects of acoustic instruments, as they used complex mappings that required multiple actions and limbs to play. Additionally, it was necessary for the user to exert a certain amount of energy into the system to produce the desired sounds. This correlates to Mihaly Csikszentmihalyi (1990, pp. 48–70) concept of flow, which occurs when humans are totally absorbed in a task and consequently experience deep happiness. Attaining this state demands that an activity is “challenging yet well-matched to the participant’s skill level, and a sense that the activity itself is intrinsically rewarding” (ibid.). To facilitate this, DMIs should be challenging yet not to the point that they frustrate users. This concept can also be applied to audiences trying to understand the music and actions of a performer.

Caleb Stuart proposes that displaying human agency is not essential as audiences of laptop music should not expect a physical spectacle, as performances can instead exist entirely on an aural plane (Stuart, 2003, p. 62). Moreover, Jon Hassell (Shapiro, 2000) claims that displaying instrumental expertise has become difficult as sampling culture and hidden electronic processes are becoming ubiquitous. Consequently, audiences are only looking for the result, and do not need to understand the underlying processes. They may be equally impressed by a composer who sampled music from a record as compared to one who spent years crafting every detail of a composition (ibid.).

The complexity and lack of physicality inherent to many DMIs can make it challenging to achieve the liveness found with acoustic instruments. However, it is worth attempting to incorporate liveness and human control as this can result in imperfect blemishes, which many people enjoy going to concerts to witness (Collins, Shedel and Wilson, 2013). Furthermore, not all music is meant to be exactly reproduced, for example, improvisational music strives to create something spontaneous and new (ibid.). Andrew Hugill (2019) raises the point that although technology can extend the capabilities of humans, it has no freedom of choice. However, some would argue

whether some software, such as George Lewis' Voyager (Lewis, 2000), have this freedom of choice. In most cases, human decision making is vital for humanisation, even if this is occasionally setting processes in action, as this demonstrates to an audience that the performer is making choices to assert their conceptual view of what the piece should be.

Most technology alone cannot display musical presence; however, technology can be a powerful tool to enhance and expose human agency. For example, algorithmic techniques can be effective tools for leading performances into the unknown, which may cause a performer to react and make spontaneous musical decisions. Margaret Morse states that a system that “interacts” can provide an additional sense of liveness, as audiences can see this interplay occurring and a computer's persona emerging (Morse, 1998 p. 15).

2.4.2 The Struggle Between Liveness and Perfection

Collins, Schedel and Wilson (2013) suggest that with the advanced recording and editing capabilities computers are capable of today, it has become difficult to recreate music in real-time that is as polished as the original recording. This made me consider how I could combine the perfection of premade elements, with human and computer improvisation that contributed imperfection and liveness. Thus, this research evaluates how performers can manipulate composed and pre-recorded material during performances to benefit the music and display liveness (see Chapter 8).

Another intriguing capability DMIs provide is the possibility of sound sculpting, which can result from a disconnection between gesture and sound. Sebastien Lexer (2012, p. 45) compares this to a painter working with a canvas, then stepping back and reflecting on their decisions. This is relevant to DMIs as it is not always necessary to engage physically with the instrument to produce continuous sound, meaning a performer can step away for an extended period. In some cases, a performer may

prefer the progression of the music without their input and, therefore, must determine whether to sacrifice their musical preferences for the sake of incorporating liveness. Furthermore, as computers can carry out techniques that humans are not physically capable of (Dobrian and Koppelman, 2006, p. 279), sometimes it is worth delegating tasks that require virtuosic physical abilities to the computer and compositional stage, as this could result in a better outcome.

This research examines the implementation of both consistent hands-on control and sound sculpting, which is accomplished through a methodology that utilises the hybrid guitar to enable the playing of multiple roles during performance: composer-conductor-instrumentalist.

2.4.3 The Intelligence of Physicality

Physicality can be overlooked in DMIs, as computers are designed around our cognitive abilities; however, when designing DMIs it is possible to incorporate physical energy in addition to cognitive energy. These forms of activity are interconnected, making it pertinent to consider the interaction occurring between the physical and cognitive. Brian Eno believes this transition from the physical to mental is not desirable, as even though muscles are not reliable, “they represent several million years of accumulated finesse”, and “musicians enjoy drawing on that finesse (and audiences respond to its exercise), so when muscular activity is rendered useless, the creative process is frustrated” (Eno, 1999). When designing the hybrid guitar, I considered how to utilise touch while transferring the intelligence of the body acquired from guitar playing to new digital controllers (see 7.8).

Hugill suggests that physicality can be incorporated by designing the software around the affordances and expressivity of the controller (Hugill, 2019). For example, Michel Waisvisz’s, The Hands*,* which was designed around the affordances of the body, to place the human as an essential agent within the environment. Waisvisz strived to

achieve a link between action-sound, as his intent was for physical and mental effort to be clearly recognisable to audiences (Bellona, 2017).

Joel Ryan (Ryan, 1991) suggests that effortlessness is often desirable with technology; however, this does not always apply to musical instruments. DMIs can be designed to be physically difficult to play and still produce desirable musical outcomes, as is the case with acoustic instruments which take years of practice to develop competency. Although acoustic instruments have continuously been modified over the past centuries, these improvements were not about reducing physicality, but rather improving the timbre, accuracy, and ranges of the instruments (ibid.). According to Ryan, physicality has always remained essential because:

> "effort is so closely related to expression in the playing of traditional instruments. Effort maps complex territories onto the simple grid of pitch and harmony. And it is upon such territories that much of modern musical invention is founded" (ibid.).

The loss of physicality is discouraging from a humanistic perspective; however, spreading our energy into the cognitive domain has the potential to offer new forms of human creativity (Keislar, 2011). This is especially the case with digital composition, where non-physical techniques have created entirely new forms of musical language and possibility. However, Keislar (ibid.) points out when it comes to performance, transferring energy into the cognitive domain results in insufficient humanistic qualities.

The use of embodied interactions is a concrete way for a performer to display physical control with intent, which allows performers to communicate effectively (Butler, 2014). Embodied interactions also allow a performer to control technology guided by their perceptions, coupling physical actions to audible results. Owen Green (2011) suggests that interaction with digital technology can be embodied, such as when a

performer uses a slider to adjust an equaliser as they are continually guided by their auditory sense.

These embodied interactions are easier to accomplish by carrying out “a desired transfer of physical energy into a sound-producing device, usually achieved by incorporating more nuanced, continuous forms of control” (Emerson and Egermann, 2020, p. 315). Doing so, provides performers with a practical method of synchronously utilising physical and mental energy, as both become necessary to carry out successful actions. However, this form of interaction is not always desirable as performers may instead wish to set certain processes in motion or engage in macro control.

The role of human agency and gesture in digital performance is something that often must be intentionally designed into a DMI. When software is designed around the affordances and expressivity of the controller and human, it has the potential to improve interaction and help audiences better understand the role of the performer in the creation of the music.

2.5 Incorporating Human Presence into Technology

This section discusses the incorporation of human feel, interaction and personality into technology, providing another dimension of humanising to a digital environment. Although this form of humanisation is less visually oriented than the display of human agency through gesture, it still has the potential to improve the experience of audiences and influence how performers control and interact with digital music.

2.5.1 The Encapsulation of Knowledge and Personality

According to Magnusson, technology comes with “programmes of action, manuals of behaviour, and political and sociocultural constructions, including aesthetic tendencies” (Magnusson, 2009, p. 170). Users can accept or reject some of these scripts

but often they are hidden from us, thereby preventing the attainment of personal musical goals (ibid.). For example, Digital Audio Workstations (DAWs) tell users that copying and pasting material is perfectly normal, often resulting in overly repetitive music (ibid.). It is pertinent to question what knowledge our instruments contain and whether this is constraining our personal goals. To achieve this, it is necessary to understand how “things ‘contain’ knowledge? How do we write our knowledge into artefacts, and how do we read that knowledge from them?” (ibid., p. 171). In my research, I considered what knowledge was present in Live, and how I could alter this to suit my needs. This led me to study Live’s application programming interface and how Max for Live could be used to achieve my musical goals (see 7.3.4).

The development of music software is a form of composition that encapsulates the maker's musical idiolect and provides a way to share musical ideas in a non-performative sense (Bown, Eldridge and McCormack, 2009). Many new developments come from experimental forms of music, in academic and commercial circles (ibid.). In these circles, the development of the software plays a pivotal role in the development of the music and, therefore, artist-programmers are commonplace (ibid.). I found it useful to study the work coming from experimental artist-programmers, such as Patrick Marschke (see 3.9.1), as this helped provide ideas for my system.

With regards to personality, Hugill (2019) suggests the identity of acoustic musicians is intrinsically linked to their instrument, for example, a guitarist or saxophonist. The development or adoption of digital technology allows a performer to create a unique identity. Magnusson and Hurtado suggest this is a crucial difference for many people, as it is necessary “to ‘mold oneself’ to an acoustic instrument, whereas a digital instrument can be created to suit the needs of the user” (Magnusson and Hurtado, 2007, p. 3). This could be considered an affordance of technology as users can customise their setups based on their physical and mental abilities; however, this presents a dilemma for audiences trying to understand DMIs.

2.5.2 Human Presence in Generative and Autonomous Systems

The encapsulation of knowledge is of particular importance when dealing with generative and autonomous systems that contribute to the music on an equal footing as the performer. Affording the capacity to embed decision making and interaction into an environment allows the computer to demonstrate an additional sense of liveness. This encourages and enhances how a performer physically interacts with the environment, but more noticeably it adds human characteristics to the music that reflects the composer's personality.

Acoustic musicians must deal with the encapsulation of knowledge; however, they are able to choose the people in their ensemble, which provides ample choice with regards to instrumentation, musical style, and technical abilities. Although software is customisable, it does not have this depth of human instrumental experience and style pre-programmed in, for example, there are few plugins that have the human feel and interactive capabilities of a jazz drummer. Some digital practitioners have designed bespoke software to have this reign of choice, for example, George Lewis' Voyager is designed to deal “with the nature of music and, in particular, the processes by which improvising musicians produce it” (Lewis, 2000, p. 33).

2.5.3 Encapsulating Human Physicality and Imperfection

The precision computers provide is an asset as it allows performers to create music that would not be possible to physically produce (Keller, 2004). However, this precision comes at a cost, for example, Kramer suggests sequencers lack the minute variation and imperfection that is present in a human's playing and, therefore, can seem cold and lifeless (Kramer, 1988).

Some electronic musicians have taken a humanised approach, especially in genres where groove and rhythmic feel are defining characteristics of the music, such as hip hop. The humanising methods of J Dilla have been hugely influential on hip hop and

electronic musicians more generally. Dilla was known for the rhythmic characteristics of his sampled drum patterns, which were physically created in real-time using an MPC (Diaz, 2018). This way of working produced drum parts that were purposely un-quantized, resulting in “imperfect and offbeat patterns” (ibid., p. 13).

Some styles of digital music have rejected human physicality, instead choosing to utilise the inhuman characteristics of technology, for example, glitch music focuses on the imperfections of computers rather than humans. Kim Cascone suggests failure “has become a prominent aesthetic in many of the arts in the late 20th century, reminding us that our control of technology is an illusion, and revealing digital tools to be only as perfect, precise, and efficient as the humans who build them” (Cascone, 2000, p. 13). New techniques “are often discovered by accident or by the failure of an intended technique or experiment” (ibid.).

Although human and inhuman imperfection produce different musical outcomes, the idea behind these concepts is similar. David Zicarelli suggests "failure tends to be far more interesting to the audience than success” (ibid.). Thus, failure was an important topic in this research, as I strived to create an environment that occasionally resulted in failure and unexpected outcomes. This can provide an additional sense of liveness, as failure could be perceived by audiences when it necessitates a response from the performer.

According to Joanna Demers “listening to electronic music constitutes an act that is fundamentally different from how listeners have been used to hearing Western art music for the previous five centuries” (Demers, 2010, p 15). When using an inhuman sequencer to trigger acoustic drum samples, audiences may compare this to a human drummer, and unconsciously recognise it lacks human feel. If this same sequence were used to trigger entirely electronic drum samples, there would be no human comparison to make. This was an important consideration as I explore both human and inhuman characteristics and sounds.

This research pays attention to incorporating a sense of human physicality and imperfection into the digital environment to give it human feel, without the need to physically engage with every aspect of the environment. Constant variation played a pivotal role in this, which included the subtle imperfections in the timing and velocity (see 7.5.1), as well as the continuous, unpredictable evolution of sounds and melodic lines (see 7.6.1).

This section discussed how humanising a digital environment can benefit from the encapsulation of knowledge; this can take many forms, such as the incorporation of human feel and imperfection or the use of generative and autonomous techniques to create an improvisational partner. Humanisation can also be achieved through encapsulating a performer's processes and musical preferences, allowing an artist-programmer to have more influence over the outcome.

2.6 Summary

This chapter provided an overview of humanisation and described the role of jazz as it relates to this research. I separated the topic of humanisation into two different sections, making human presence visible during performances, and incorporating human presence and musical preferences in technology.

The former section discussed the challenges musicians face when learning and performing with a DMI. To improve the overall experience of digital music it can be useful for a performer to display liveness, which may necessitate the application of certain approaches, such as a causal relationship between action and sound. Furthermore, I discussed the incorporation of nonlinear behaviours, as well as the utilisation of the intelligence of the muscles. These methods have the potential to facilitate mastery, allowing performers to have embodied interactions while drawing upon the finesse that muscular activity is capable of. In this research, to humanise the performance experience I designed an instrument that allowed me to recycle

virtuosity (see 7.8), as well as software that extended and augmented my physical capabilities (see 7.3).

The latter section discussed the possibility of encapsulating knowledge into a digital environment that reflects the personal musical preferences and background of the musician-programmer. The use of computer processes that vary compositions and how an instrument reacts enhances a performer's experience, and encourages interaction, thereby, contributing to liveness. Furthermore, processes can be designed to add human emotion and feel to digital music, which certain styles of music benefit from. In this research, I encapsulated personal knowledge that allowed me to manipulate live guitar and recorded material in my own unique way (see 7.4), as well as developing computer methods that added human feel and variation during performances (see 7.5 and 7.6.1).

Humanising a digital system requires that thought be given to both the physical instrument and computer environment. Thus, the following chapters discuss the diverse types of designs and approaches other practitioners have taken to discover a useful framework.

Chapter 3 Electronic Instruments and Controllerism

3.1 Introduction

This chapter discusses the motivation for creating new instruments and the challenges faced in putting them to useful musical ends. These topics are explored through an evaluation of approaches taken with certain electronic instruments and controllerists, with a particular focus on computer interfaces. I discuss the value of utilising interfaces based on acoustic instruments compared with novel electronic interface designs that aim to overcome the limitations set by following the acoustic paradigm. Furthermore, I explore instrument design in relation to humanising performances, such as the strategies applied in controllerism. This movement strives to make human presence visible during performance by using instruments that enable dramatic gestures and the visualisation of software, and moreover, human expression and embodied interaction.

3.2 Motivations for New Instruments

Andrew McPherson suggests the following motivations for developing new instruments:

- We make instruments because we want to make music.
- To study how people interact with technology to learn interesting things about the relationship between humans and technology.

- Because doing it well is a really hard problem – designing an instrument that people want to play and become familiar with over an extended period of time. (McPherson, 2020)

McPherson suggests there are currently too many instruments being developed, which is “outpacing our ability” to put them to “detailed musical ends” (ibid. 19’25”). I take this to mean instruments that have been mastered by an individual or community, as well as those that offer novel approaches that can be intriguing to audiences. This chapter reviews electronic instruments that I feel result in striking music and engaging performances.

As the design and interaction methods of electronic instruments are distinct from acoustic instruments, it is necessary to question what mastery of electronic instruments even means (Paradiso and O’Modhrain, 2003). Dobrian and Koppelman suggest that mastering an instrument is accomplished when a performer can “call upon all of the capabilities of that instrument at will with relative ease” (Dobrian and Koppelman, 2006, p. 279). This is complicated by the fact that DMIs can entail working entirely in a compositional rather than a performative, interactive manner. This research looks at instruments that cover the spectrum of composition and performance, and those that facilitate a humanised interaction between the two.

Eno (2010) suggests the history associated with acoustic instruments comes with cultural conventions that influence the music we make and determine the techniques we use. Conversely, digital designers can create new instruments that are never a finished product, which can incorporate novel sounds, interaction methods and a variety of cultural references. This can present challenges, as “the level of shared understanding about a traditional instrument, such as the piano, is far more significantly developed and uniform than that of any post-digital technology” (Ferguson, 2016, p. 129).

This lack of culture could be considered an asset as there is no need to reference to any specific tradition, therefore, electronic instruments impose fewer limitations, which offers new possibilities and forms of creative expression. However, this can make it harder for electronic musicians to build familiarity with their instruments (Eno, 2010). According to Eno, the acoustic guitar is a “strange instrument, it's very limited and it doesn't sound good” (ibid.), nevertheless, people spend years building relationships with these instruments which results in compelling music.

With regards to DMIs, advances in technology have led to the rapid expansion and evolution in synthesis and control capabilities (Kurzweil, 2000). For this reason, DMIs are constantly changing, and long-term relationships rarely develop. Eno (2010) suggests things are changing as synthesizers that react inconsistently are being built, which require musicians to learn to deal with these inconsistencies. For example, modular synthesizers are imperfect systems, the slightest adjustment of a knob can change the sounds of an entire environment in an unpredictable manner. This forces performers into a negotiation with their instruments, which can result in the instrument leading a performance into unknown territory. This research explores methods that make a human-computer relationship necessary and evident (see 7.6.1). To achieve this, I wanted an instrument with a life of its own, thereby influencing my decisions, which led to methods that varied the instrument’s behaviours (see /media/Touchpad-GestureRecorder.mp4 3’36”).

It can be beneficial for designers to expand on the capabilities and qualities of pre-existing instruments. This evolution can be seen in grid controllers, for example: ever since Roger Linn developed the MPC[1], other companies have continually released products that follow this paradigm, allowing users to exploit existing techniques. There is an abundance of controllers that have developed around Live with similar designs and functionality, utilising pads, knobs and sliders.

[1] See https://www.rogerlinndesign.com/about/about-museum for technical information.

My research pays particular attention to the methods of augmented/hybrid/hyper instrument practitioners as they utilise the pre-existing wealth of culture, knowledge and technique present in acoustic instruments. These instruments can also offer innovation as designers can incorporate novel digital methods in the hardware and software. This is valuable when a musician is already proficient with an acoustic instrument, as it could take years to develop the same level of competence with a DMI. James Gibson (Gibson, 1979) describes this process as perceptual learning as our knowledge of the world is influenced by past generations.

When addressing the motivations behind the development of new instruments it is important to note that instruments are as vital to the compositional process as the writing of the music, often requiring a composer to work in particular ways. Acoustic instruments have unique affordances and constraints which make each instrument more suitable for specific roles within an ensemble. There are exceptions, for example, the bassist Jaco Pastorius would often take a lead rather than supporting role (Tremblay, 2020), which is uncommon for the bass. When it comes to digital technology, the link between interface and composition is even more tightly coupled, as the interface can be designed around the composition and vice versa. Furthermore, designers can choose what role a digital instrument or software will play. This was something I considered in my research as I strived to replicate the feel of a jazz ensemble in the software (see 7.4.1).

Further motivations that are relevant to humanisation are highlighted by Emerson and Egermann (2020). They conducted a study to ascertain the motivations electronic musicians might have for designing novel instruments and how this relates to the situations these musicians work in, whether that be an academic or club setting (ibid.). They highlighted the following motivations:

- M1: Wanting a more embodied experience when performing and producing electronic music.

- M2: Wanting to make the activity of performing electronic music more interesting to audiences.
- M3: Wanting to develop new sounds or timbres.
- M4: Wanting to build responsive systems for improvisation. (ibid., p. 2)

Emerson and Egermann (ibid.) suggest that those working in club settings will likely be more concerned with greater embodiment and improving audience experience, whereas academics are often more driven by the desire to explore new musical frontiers. Since I work in both club and academic settings, all these motivations are relevant to my research, especially since I consider all of these to be methods for humanisation. Emerson and Egermann suggest that M1 and M2 are methods for humanising computer music, while M3 and M4 allow for artistic exploration. However, I also consider M3 and M4 as humanising techniques as they allow for personal sounds and approaches, as well as providing new experiences for audiences.

Finally, McPherson (2020) suggests that although designers intend their instruments to be used in certain ways, people will interpret instruments differently depending on their musical goals and values. Sometimes the most compelling approaches will be unanticipated, therefore, “creating an instrument is not solving a problem, it is engaging in an ongoing conversation” (ibid.).

3.3 MIDI Guitar Instruments

The development of hexaphonic pickups and pitch extraction circuitry led to the development of polyphonic guitar synthesizers, such as Roland’s GR500, which relied on pickups and a separate synth module (Paradiso, 1998). During the mid-80s other DMIs based on the guitar, such as the SynthAxe[2], were developed which relied on two sets of strings with sensors that detected finger positions. These instruments

[2] See https://www.rorguitars.com/blogs/news/the-synth-axe for technical information.

were adapted by many guitarists, such as Allan Holdsworth and Pat Metheny, who applied them in a jazz context to experiment with new sounds, leading to new styles of jazz.

Advancements in technology have led to the development of devices that can be retrofitted to the guitar to convert analog signals into MIDI with little latency (Menzies, 1999), for example, the Roland GK-3 and TriplePlay pickups. These devices have the advantage of letting guitarists carry out non-invasive augmentations, turning their guitars into an analog and digital hybrid with vastly different output streams, which offer guitarists new possibilities. For example, Christopher Willits uses Roland GK-3 pickups on his composition Heart Connects to Head (Willits, 2010), to play an arpeggiated software-based synthesizer while simultaneously processing the guitar's sonic output (Kirn, 2014). I would consider this a multi-instrumentalist approach, as Willits manages to produce most of the piece using this method.

MIDI pickups are useful in the context of my work with the hybrid guitar as they transform the guitar into a sound source and digital controller, offering many new possibilities. Although MIDI pickups do not offer the same continuous expressive capabilities as the guitar, other MIDI devices can be used in combination with the guitar (see 7.3.3), thereby offering a range of different interaction methods.

An example of a commercially produced hybrid guitar is Rob O'Reilly's Expressiv MIDI Pro[3]. This guitar incorporates a fretboard scanner which transforms the strings and frets into velocity sensitive switches, and an XY trackpad that is similar in design to Matt Bellamy's augmented guitar, Manson MB-1[4]. Although these guitars are similar in design to my instrument, they are advertised as a way to play synthesizers

[3]See https://www.rorguitars.com/products/expressiv-midi-pro for technical information and demonstration videos.
[4] See https://www.musicradar.com/reviews/guitars/manson-guitars-mb-1-standard-matt-bellamy-signature-guitar-241595 for technical information.

or control audio processing being applied to the guitar, rather than manipulating digital compositions.

In my research, MIDI pickups provided the primary way of recycling virtuosity; however, I used them to perform inharmonic glitch-based material, thereby using conventional interaction methods in an unconventional manner (see /media/MIDI-Guitar.mp4 2’57”). With the growing popularity of DAWs, many other interfaces have emerged, therefore, the following section examines controllerism, as these practitioners utilise interfaces that are purposefully designed to control digital compositions.

3.4 Controllerism

This section discusses the controllerism movement, as I consider this to be an important development in digital performance in recent times, prioritising musicians to have a high degree of control over music, with human expression and embodied interactions. I shall explore the new instruments and methods controllerists are applying that have been intentionally designed around music technology.

3.4.1 A Humanising Performance Method

As computers became commonly used instruments in the early 2000s, controllerism permeated modern live performance as practitioners searched for methods to overcome the challenges faced in performing digital music (Crooke, 2018). However, it was not until 2007 that Matthew Moldover first coined the term, describing it as “the art of manipulating sounds and creating music live using computer controllers and software” (Golden, 2007, p.58). Controllerism covers a wide spectrum of digital performance; however, there are two distinct modes of performance that it can refer to, which Blanes defines as:

- The art of manipulating pre-existing music contained in computer storage or computer software in a live setting using controllers, as can be observable in digital live Dub mixing, digital Turntablism and digital Djing.
- The art of playing a controller as one would a musical instrument, thus playing improvised or orchestrated music in a live setting using said controllers to manipulate sound sources such as software programs, virtual-instruments, samplers and the like (Blanes, 2017, p. 41).

Even though controllerism has only recently been widely embraced, this style of performance can be associated with early DMIs, such as Akai's MPC. The aims of controllerism also predate the era of digital technology as it correlates to the performance practices of early dub practitioners, such as King Tubby and Lee 'Scratch' Perry. These musicians used mixing consoles to allow for the real-time mixing and processing of their music, creating alternate tracks in the process (Knowles and Hewitt, 2012).

Considering composition and performance methods is important with regards to humanisation. Complex compositions with limited human control and input during performance can result in lacklustre experiences for audiences. Conversely, the virtuosic use of controllers with little thought given to the controlled material can result in music lacking in structure and complexity. I explored instruments and approaches used by controllerists in this thesis (see 3.9.1, 3.9.2 and 5.6), with a focus on those that are effective at controlling compositions. They provide examples of practical approaches for humanising a digital environment and, therefore, the hybrid guitar has been influenced by these musicians.

3.4.2 The Relevance of Controllerism

Controllerism provides new instruments and performative techniques and is a useful way for musicians to establish a unique identity around their practice. Moldover

created this term to establish an identity for himself and develop a thriving community in the process. This made it easier to describe what he does to an audience, “I'm a controllerist, and that's my controller, I use it to manipulate sounds on my computer, just like someone playing a musical instrument” (Golden, 2007, p. 58).

With regards to my research, controllerism is not the main contribution, rather it is the style of performing digital music that is most relevant to my research. Controllerism's ethos is reminiscent of my jazz instrumental and digital practice, as it allows the improvisation of compositions in a live setting. Controllerism also strives to make human presence visible during performance, which is a critical aspect of this research.

Although grid, knob, slider and button controllers are the basis for instruments used by controllerists, augmented instruments have been used by some practitioners. Moldover himself initially relied entirely on the use of MIDI controllers, but at a later stage incorporated the guitar, which made him realise his controllers were lacking the expressiveness found with traditional instruments (Moldover, 2015). This led him to develop new controllers that replicated this expressiveness and augment his guitar to utilise the best aspects of the guitar and MIDI controllers. This allowed him to expand the guitar's sound palette and build upon his technical abilities[5] (ibid.).

3.5 A New Kind of Instrument

These instruments provide new affordances that are based around digital composition and performance strategies. Although some instruments provide the ability to play melodies, harmonies and rhythmic material directly using gestures, this is often not the primary goal. This note-based approach is no longer necessary, instead

[5] See https://www.youtube.com/watch?v=Hu4U3VG1U1I for video demonstration of how Moldover uses the Guitar Wing to extend the capabilities of the guitar and vocals while simultaneously controlling pre-composed percussive material.

performers can concentrate on the control and processing of audio effects and macro events.

There are some notable controllerists, such as Deantoni Parks, who have mastered the direct control over software instruments. Although this approach offers more possibility for improvisation with the immediate sound, it is challenging for a solo performer to produce an elaborate composition with multiple instruments entirely in real-time to the same degree as an ensemble of acoustic musicians or when working with pre-recorded material. As a result of these developments, the role of improvisation has changed, as these new methods are gaining widespread acceptance witnessed “by the popularity of Ableton Live in laptop circles” (Eigenfeldt, 2007, p. 4).

Another critical factor that makes these instruments unique is their purpose has resulted in production technologies, studio and performance tools becoming similar: live recording, editing and processing of music (Kjus and Danielsen, 2016). Recent technology has resulted in the advancement of studio techniques, and the creation of new conditions for performing this music on stage, thereby, converging these practices (ibid.). As this intrinsic link exists, it is possible to play the roles of composer-conductor-instrumentalist, a topic that is explored in this research with the hybrid guitar.

3.6 The Advantages of Modern Interfaces

A vital affordance of many modern controllers is the visualisation of software through coloured grids and graphical interfaces, allowing users to get away from their laptops. D’Errico suggests that in “an attempt to heighten the sense of physicality and direct manipulability when working with seemingly intangible software, producers and DJs have increasingly integrated button-based hardware “Controllers” into their creative workflows” (D’Errico, 2016, p. 25). The dramatic gestures these controllers allow can

result in performers exerting more energy into an environment. Interaction with touch sensitive pads allows performers adjust the intensity of their gestures to suit the needs of the music, resulting in dramatic and dynamic gestures throughout a performance to incorporate variation and articulation, a prime example of this being Darlington (see 3.9.2).

3.7 Challenges Faced by Controllerists

Controllerism is an effective approach for controlling digital compositions in a performative manner, from the perspective of the performer and audience. However, there are challenges which this research highlights and aims to overcome in the design of the hybrid guitar and environment. From personal experience, I had difficulty navigating a complex environment using an all-in-one controller, such as Ableton's Push, as these interfaces require a performer to switch between modes to control various aspects of an environment, which can momentarily take a performer out of a musical mindset. There are controllerists who overcome this by using multiple controllers with individual tasks or automating the functionality of an all-in-one controller throughout a performance. For example, Kieran Hebden's setup[6] incorporates a mixing desk, SoundBite looper, laptop running Live being controlled using a grid-based Monome, and another laptop running Cool Edit, being controlled and processed using a mouse and Boss SP-303. Each of these controllers has a specific functionality and role, meaning he knows how each device will react.

I felt it necessary to control the environment in an intuitive manner to achieve a continuous musical mindset, therefore, I took a similar approach as Hebden. To successfully perform and interact with an intricate digital environment, I explored the use of complex mapping strategies (see 7.3.2), which extended human agency and physicality. However, as it was impractical to control the environment in its entirety,

[6] See https://www.youtube.com/watch?v=9KIvnLBF7vU for Keiran Hebden's demonstration of his performance setup.

this research developed strategies for delegation, automation and indeterminate computer parts (see 7.6.1).

3.8 Hybrid Instruments and Controllerism

Although hybrid instruments fit within the category of controllerism, they are not commonly used. It is worthwhile considering the benefit of these instruments and whether this is dependent on the individual in question. I was a competent guitarist before becoming a controllerist, therefore, it seemed wise to apply these skills, even if they needed to be adapted to suit the alternative goals of controllerism.

There are many MIDI controllers available today designed to be used in combination with the guitar, for example, Moldover experimented with guitar augmentations for many years before using this knowledge to design the Guitar Wing (see 7.8.1) with Livid Instruments. This allows guitarists to benefit from his experience with previous incarnations of augmented guitars, such as his prototype the Robocaster, which incorporated all the possible sensors Moldover believed would work in combination with guitar (Moldover, 2015).

Although certain MIDI controllers are easier to use in combination with the guitar, it was still necessary for me to acquire proficiency with MIDI controllers. However, the application of MIDI pickups allowed guitar technique to be used for tasks that required the most physical abilities, while other tasks benefited from the visualisation of software, thereby making MIDI controllers the suitable option. This subdivision of tasks and application of relevant skill is what makes the hybrid guitar a viable approach, yet for controllerists with little traditional instrumental skill, this will not be as valuable. Although still advantageous in certain regards, the time it takes to become competent with a traditional instrument might not be worthwhile for many musicians. This research will still be of value to all controllerists, as the resultant humanising methodology applies to digital controllers and software more generally.

3.9 Case Studies

The following case studies examine two controllerists that are using digital interfaces and software in ways that are beneficial for humanisation and performing digital music.

3.9.1 Case Study #1 Patrick Marschke Integrating a Digital Controller into Drum Practice

Patrick Marschke is a controllerist who recycles virtuosity and blends acoustic and digital techniques[7]. Marschke is a percussionist, composer and electronic musician who strives to merge these disciplines. One way he accomplishes this is with the addition of a Roland SPD-sx sampling pad[8] to his drum setup, thereby allowing him to control melodic and harmonic sampled material, to accomplish one-man band performances. Marschke can work with pre-prepared material and improvise with this in real-time using bespoke software made with Max/MSP. The bespoke software allows for the encapsulation of personal knowledge, which Marschke uses to merge his compositional and improvisational methods in compelling ways. This involves delegating tasks to the computer to provide a rich source of interaction and inconsistency in how the instrument behaves.

[7] See https://www.youtube.com/watch?v=6NR4kc-LbDQ for performance video and https://www.youtube.com/watch?v=HM9w7bKB9xw&t=301s for video demonstration.
[8] See https://www.roland.com/uk/products/spd-sx/ for technical information.

Figure 3.1: Patrick Marschke's performance setup, drum Kit and Roland SPD-sx.

Marschke makes constrained use of the Roland SPD-sx, as he has designed his software around the device's six main pads, and rarely uses any of the other buttons and knobs. This is an effective way to recycle virtuosity as he can use drumming technique to trigger these pads, all of which he has designed to produce different outcomes. Two of the top pads trigger the same sample every time they are hit, yet with different durations. The three bottom pads incorporate computer movement, as Marschke takes a loop and subdivides it, generally into 7 or 9, because when he is playing in 4/4 it has an interesting "displacement thing to it" (Marshcke, 2017). The computer then moves through these subdivisions every time the pad is hit, meaning every drum hit triggers a different sound, until it returns to the beginning of the loop. To differentiate these three pads, each triggers the samples with different durations while one pad contains a reverb for a sustained ambience. Finally, one of the other top pads can be used to change the samples being triggered, which provides a way to change between different sections of a composition.

Marschke has also designed a tempo matching algorithm that allows him to play a pattern and have this looped indefinitely by the computer. This feature is useful for exclusively focusing on drums while still having ongoing digital material in the background, providing a solid foundation for drum improvisation. Marschke's software also incorporates randomisation, as it is possible to have the computer move through samples randomly rather than sequentially, thereby providing inconsistency. Another way the instrument affords flexible improvisation is through audio processing, as Marschke can spontaneously add delay, reverb and equalisation during performance.

With regards to humanisation, Marschke's approach contributes to liveness through a causal relationship between gesture-sound. This is partially distorted by computer movement which provides a source of intrigue for audiences, yet does not change the outcome to the point that actions become unrecognisable. Liveness is maintained by triggering samples using drum technique, as this lets audiences apply a mental model of drum practice to the digital controller.

Marschke's approach justifiably offers more liveness than my own, as he triggers most of the material. I did not replicate this as I knew it would be impractical to reproduce my compositions in real-time in this manner. I took influence from Marschke, by designing computer processes that captured and repeated human actions (see 7.3.2), allowing me to have continuous movement in aspects of an environment while turning my attention elsewhere. I also integrated digital controllers by exploiting guitar technique and delegated tasks to the computer to provide a source of interaction and inconsistency in how the instrument behaved. I occasionally use Live's Simpler in a comparable manner to Marschke, subdividing loops and performing these using MIDI guitar, to incorporate direct control over sampled material in an improvised manner (see 7.8.3). At times, this included the use of computer inconsistency, using randomised MIDI effects or my Touchpad Gesture Recorder's bounce function (see 7.3.3).

3.9.2 Case Study #2 Alfred Darlington 'Daedalus' The Plunderphonic Button Pusher

Darlington is an example of a controllerist who relies on pad controllers to make and perform his music. The advantage of pads is that they can be controlled more effectively using the hands in comparison with other types of controllers, as a pad can be controlled using one finger, whereas a knob takes multiple fingers to operate (Fleisher, 2014). Darlington uses Monome controllers in combination with the software mlr[9], loading a variety of samples into the software and using one Monome for live playback, cutting and recording pattern gestures, and another smaller device to control levels and turn on/off audio processing. His performances generally involve plunderphonics, sampling and remixing other people's music, yet the way he manipulates and combines material in numerous ways, results in music that is distinct from the source material.

Darlington tailors his approach to the audience by facing his equipment towards them so his actions can clearly be seen. Making his performances are visually oriented, which is enhanced by his constant activity. As the smaller Monome device has an inbuilt accelerometer, it also allows Darlington to control audio effect parameters using embodied interactions. He strives to incorporate spontaneity into his performances as he wants to go on a journey with his audiences while trying "to stay as present as possible" (ibid.).

Darlington was influential in my decision to use pads, as they were easier to manipulate, especially when playing guitar (see 7.8.1). Furthermore, he made me consider how one should go about staying present during performances (see 5.4), as well as incorporating improvisation to interpret the compositions in a way that was

[9] See https://llllllll.co/t/mlr-norns/21145 for technical information.

unexpected to myself and audiences. Finally, I also strived to create an environment that required activity (see 8.6) and an instrument that made this visually apparent.

3.10 Summary

This chapter discussed the motivation for new instruments through an appraisal of early electronic instruments and controllerism. Putting new instruments to detailed musical ends presents challenges. I evaluated potential problems and solutions, such as incorporating inconsistency leading to deeper relationships. Furthermore, I questioned the need for a community to develop around an instrument so that knowledge and experience may be shared.

I explored the controllerism movement as this has been critical in digital performance in recent times. This allows musicians to establish an identity around their practices while composing and controlling digital music in entirely new ways, including deconstructing and remixing compositions. Furthermore, this chapter covered the humanisation of performances by controllerists who use instruments that provide an insight into the performer's actions and the underlying digital processes through gesture and the visualisation of software. I briefly discussed how augmented instruments fit within controllerism. The following chapter discusses this in greater detail and outlines the role of the hybrid guitar concerning humanisation.

Chapter 4 Hybrid Instruments and the Role of Humanisation

4.1 Introduction

This chapter addresses the field of augmented/hyper/meta instruments, which allow musicians to expand upon their instrumental practices, using digital technology. To address this, I will discuss the motivations of augmented instrument practitioners to ascertain the value in their approaches, for example, the utilisation of gesture and tactile feel. Furthermore, I will discuss how one can transition effectively to a hybrid instrumental practice by utilising the positive aspects of traditional and digital instruments, as well as the spare bandwidth a traditional instrument provides. Finally, I will describe my motivations behind the use of the hybrid guitar as a digital controller and sound source while explaining how it helped me humanise and improvise with compositional material.

4.2 Augmented Instruments

Augmented instruments can be defined as either acoustic or electric instruments that have been modified through the attachment of sensors, providing control over digital audio effects and synthesis processes which extend the instrument's sonic possibilities (Thibodeau and Wanderley, 2013). Other terms that apply to this type of instrument include hybrid, hyper and meta. Although the goals of these instruments may differ, in principle many of the underlying concepts remain the same. Bowers and Archer suggest despite the different names, there are "recurring themes, [such as] rich interactive capability ... detailed performance measurement ... engendering of complex music ... and expressivity and virtuosity" (Bowers and Archer, 2005, p. 6).

The term that is most relevant to my research is hyperinstruments which comes from Tod Machover. His project's motivation for creating hyperinstruments was to find “a way to combine what advanced technology can do in a recording studio or a MIDI studio with the spontaneity and human communication of live performance” (Machover, 2011). Similarly, the hybrid guitar was designed to perform compositions that were written in a non-real-time studio environment with the intention of altering them in real-time. Another motivation lies in the fact that the instrument serves two distinct purposes: musical sound production source and digital controller. Similarly, Lauren Hayes uses the term hybrid piano, suggesting it emphasises “the integration and importance of both the acoustic and digital components”.

The motivations of some augmented instrument practitioners are strongly associated with the utilisation of gesture. Augmenting an instrument is a process that takes “traditional instruments and augments them by adding sensing technologies that offer access to aspects of the instrumental gesture” (Essl and O’Modhrain, 2006, p. 286). Hayes (2013, pp. 502-503) suggests that to exploit the gestures of a performer, instrument designers must pay careful attention to the physical energy of the performer and the information drawn from this. To facilitate this, Hayes (ibid.) argues against designing an instrument that is easy to play and instead designing an instrument that allows for a continuous embodied experience. During performances this has the potential to offer “new forms of embodied knowledge and competence” (ibid., p. 503). With consistent practice over a sustained period “these negotiations lead to a more fully developed relationship with the instrument, and to a heightened sense of embodiment, or flow” (Armstrong, 2006, p. 6). I strove to design an instrument that resulted in a continuous embodied experience, as well as software that made effective use of this form of control (see 7.3.2).

The analysis of gestures to expand the capabilities of the instrument and control the composition environment (see 7.8.1) was a consideration throughout this research; however, this was not the primary goal. Instead, this research prioritises methods for

the synchronous application of guitar and DMI gestures and techniques, and for these to be equally comprehensible to an audience. Accomplishing this required a review of ergonomic solutions that allowed for the successful integration of MIDI devices, making simultaneous interaction with the guitar and MIDI controllers more straightforward (see 7.8).

4.2.2 Transitioning to an Augmented Instrument

The adaptability of technology is an asset when augmenting an instrument, as commonly found “computer input devices, such as joysticks and graphics tablets, are sophisticated and inexpensive enough to work in musical contexts” (Cutler and Robair, 2000, p. 1). In recent times, commercial music companies have been producing a wide variety of digital controllers and sensors which are compact and light enough to be attached to the bodies of acoustic instruments, such as Keith McMillen's QuNeo[10]. This provides musicians with a vast array of devices and different techniques to apply to their instruments.

Thibodeau and Wanderley suggest the benefits from augmenting instruments comes from the great expansion in technical and sonic capabilities which are gained without having to dispose of the time-consuming practice that went into learning an acoustic instrument (Thibodeau and Wanderley, 2013). However, it is important to consider how to achieve all these new capabilities “without hindering the acoustic level’s sonic possibilities and playing technique” (Lahdeoja, 2008, p. 54).

Although performers need to adapt to new sensors and functionality, this transition can be seamless if the sensors are designed around a musician's pre-existing performance technique. It is, therefore, important to design the technology around the affordances and constraints of a particular instrument as some have more spare bandwidth than others (Cook, 2001). I take this to mean the extra cognitive and

[10] See https://www.youtube.com/watch?v=HM9w7bKB9xw&t=301s for technical information.

physical capacity available to expend. Although some instruments lack spare bandwidth, designers find solutions to these common limitations, an example being Keith McMillen's K-bow[11], an augmentation of the violin bow that tracks the gestures and movements of the bow. This is an ideal augmentation for the violin as the instrument requires the use of both hands and lacks significant sustain. This prevents musicians from intermittently operating non-gestural sensors unless they are operated using their feet.

The electric guitar is already an augmentation, which has allowed it to be intrinsically connected with technology over the past few decades. Guitarists have experimented using “effects, pedals, amplifiers, and more recently computers” (Lahdeoja, 2008, p. 53), allowing the guitar to stand out “as a pioneer instrument in the area of acoustic–electronic hybridization” (ibid.). The guitar has plenty of spare bandwidth as the picking hand is not always necessary when guitarists play legato or sustain notes. The affordances of MIDI pickups make the guitar one of the few instruments that can acquire similar functionality as MIDI keyboards, without having to sacrifice the feel of the instrument.

Guitarists can move their instrument and body without hindering technique, allowing for the effective application of gestural sensors. An example of this is Morreale, Guida and McPherson (2019) Magpick, which is an augmented guitar pick designed for expressive control. This is non-invasive as it does not require hardware to be physically installed onto the instrument, and it does not interfere with a guitarist's technique, which helps to maintain a performer's playing style and flow.

Hans Tammen's, Endangered Guitar[12], is an example of the effective use of digital technology to expand an instruments' capabilities. Tammen takes a similar approach to many prepared guitar practitioners as he plays his guitar as a tabletop instrument,

[11] See https://www.keithmcmillen.com/labs/k-bow/ for technical information and video demonstration.
[12] See https://tammen.org/Endangered-Guitar for technical information and video demonstration.

allowing him to work “on sonic progressions by completely obliterating traditional guitar playing techniques” by using “both hands independently” (Tammen, 2017). However, Tammen's approach to altering the sound of his instrument relies far more on custom built software in Max/MSP, than it does on extended technique and physical augmentations. As Tammen describes it, the interactive “software “listens” to the guitar input, to then determine the parameters of the electronic processing of the same sounds, responding in a flexible way” (ibid.). This approach of using an instrument's sound as a controller is unorthodox as most digital controllers, such as joysticks, light beams, sensor pads and motion trackers, do not actually produce any sound themselves.

Although Tammen has not physically installed hardware controllers on his guitar, he uses an infrared proximity sensor, iPhone accelerometer and Leap Motion controller. He situates one proximity sensor in front of himself to turn on and off specific routines which he controls by moving his head in proximity to the sensor. His use of an iPhone is inventive as he uses it as a guitar slide while using the device's accelerometer data to control the electronic processing. Tammen's overall approach focuses on working with sound, timbre, rhythm and dynamics instead of melody and harmony, as he describes the “main purpose is to organize sound in time” (ibid.).

Trond Engum is an example of another guitarist that strives to extend the capabilities of the guitar’s sonic output. Engum uses a phone attached to his guitar, located just below the guitar strings to control software[13]. Interestingly, his approach often departs from the conventional action-sound relationship of the guitar, which he accomplishes using a variety of processing effects (Kjus and Danielsen, 2016). This produces a delay between action-sound, which Engum believes makes it “hard for both audience members and co-musicians to understand what’s coming” (ibid., p. 332). This produces an expansion of the instrument’s capabilities while transcending

[13] See https://www.youtube.com/watch?v=yl6H8vnOHOM for video demonstration.

established action-sound relationships. In my research, I wanted a mixture of conventional and non-conventional guitar action-sound relationships (see Chapter 8), providing some insight into how the instrument works while leaving a degree of mystery to instil intrigue.

When John Bowers designs a performance environment, he strives to have a “varied set of musical resources” which he structures “as an arena for activity, a performance ecology” (Bowers, 2002, p. 57). For Bowers “musical resources cross boundaries of technical idiom (acoustic, electronic, mechanical, computational), yet are used in conjunction and juxtaposition with each other” (ibid.). This approach is based on multiple forms of interaction and, therefore, displays varied forms of machine interactivity. This is important with regards to hybrid instruments as they cross these boundaries. I adopted a similar approach to Bowers, as I wanted an instrument with a varied set of musical resources that enabled fluid activity with a diverse skill set: acoustic, electronic and digital (see 7.7 and 7.8), that could be used in conjunction.

4.3 The Advantages of the Hybrid Guitar and its Relationship to Humanisation

Hybrid instruments offer performers the ability to take the positives inherent to digital and acoustic instruments and develop strategies for overcoming any limitations. Hugill carried out a study on the attitudes of musicians to determine the positive and negative features of these instruments (see Figure 4.1).

Musicians' attitudes to acoustic and digital instruments

Acoustic - Positive	Acoustic - Negative
Tactile feedback	Lacking in range
Limitations inspiring	No editing out of mistakes
Traditions and legacy	No memory or intelligence
Musician reaches depth	Prone to cliché playing
Instrument becomes second nature	Too much tradition/history
Each instrument is unique	No experimentation in design
No latency	Inflexible - no dialogue
Easier to express mood	No microtonality or tunings
Extrovert state when playing	No inharmonic spectra
Digital - Positive	**Digital - Negative**
Free from musical traditions	Lacking in substance
Experimental - explorative	No legacy or continuation
Any sound and any interface	No haptic feedback
Designed for specific needs	Lacking social conventions
Freedom in mapping	Latency frequently a problem
Automation, intelligence	Disembodied experience
Good for composing with	Slave to the historial/acoustic
Easier to get into	Imitation of the acoustic
Not as limited as tonal music	Introvert state when playing

Figure 4.1: Based on Hugill (2019). Positives and negatives of acoustic and digital instruments.

Augmented instruments are generally designed to expand the technical and sonic capabilities of acoustic instruments. I would argue that using the guitar as a digital controller is an expansion of the instrument's capabilities in a broader sense. It is helpful to look at this from the perspective of the computer which is an instrument in itself that is augmented using the hybrid guitar, as an interface and live sampling source. Approaching the computer in this manner lets guitarists situate themselves

as primary agents within a digital composition and performance system: visually and sonically.

The hybrid guitar also provides an alternative way of performing digital music and allows for the development of new strategies for exploring composed material (see 7.5.2). Although it is still necessary to adapt to new controllers, guitar technique can be applied in situations requiring a high level of skill, such as playing software instruments.

Another motivation behind the use of the hybrid guitar lies in the fact that interaction with the instrument naturally results in humanising techniques. The use of live improvised guitar lets audiences exploit an existing mental model of the guitar, allowing a performer to display liveness, physicality and embodiment. When live guitar is used as source material for digital processes, it allows for the exhibition of real-time agency with respect to production technology, providing an understanding of the correlation between the original and processed sound. Although this research focuses heavily on the exploration of pre-recorded material, the methods employed to control and process this material and live guitar are the same. I felt this useful for providing audiences with a greater understanding of the digital processing being applied to the pre-recorded material.

4.4 Sound and Discovery

According to Martin Heidegger, when interacting with tools one mainly focuses on the activity rather than the tool itself (Souza, 2017). Ability to act comes from familiarity with the tool, rather than knowledge of it (Winograd and Flores 1986). Similarly, when playing musical instruments, musicians mainly focus on the music, rather than the instrument, which is useful for achieving flow states. This is especially true in the case of competent musicians who have achieved an understanding and awareness to the point that their actions become mostly unconscious.

Although this is generally useful, guitarist Kurt Rosenwinkel found that his knowledge of the guitar was negatively affecting his relationship with the music. Rosenwinkel explains, “I felt like I knew too much about what I was doing and not hearing the music directly” (ibid., p. 88). This meant Rosenwinkel fell into predictable patterns which prevented him from hearing the music properly. Souza (ibid.) suggests this involves perceptual and conceptual habits, as the auditory-motor connections Rosenwinkel developed resulted in his knowing the outcome of actions. To overcome this, Rosenwinkel altered the guitar’s tuning, which made him rely less on the habits he had formed, allowing him to develop a new relationship with the guitar based on sound and discovery.

Similar methods could be adopted using MIDI pickups rather than an altered tuning (see /media/MIDIGuitar.mp4 5’19”). When used in combination with software this allows for the customisation of the sound each note on the guitar produces, which affords more possibilities as any sound can be used. In my research, this allowed the guitar to play a significant role in the performance of glitch material (see 7.5.2) while utilising the instrument’s tactile feel.

4.5 The Importance of Tactile Feel

Hayes (2014, p. 57) argues that “within the area of digital and electronic instrument design, the focus is overwhelmingly directed towards methods for yielding input data, with minimal attention given to the feel of the instrument for the performer, and the instrument-performer relationship”. This is important as Claude Cadoz (1988) suggests that feel provides a way for musicians to apprehend and be fully conscious of an instrument. An instrument's feel helps musicians develop complex motor patterns and a deeper relationship with their instrument, which encourages flow states. Furthermore, tactile feel makes visual engagement less necessary for

experienced users, demonstrated by the fact that competent acoustic musicians can sight read notated music while negotiating the instrument through muscle memory.

As a professional guitarist who had already achieved a deep relationship, the act of playing the guitar had become unconscious, requiring little focus and thought. I felt this would enable the simultaneous use of the digital augmentations, which could be enhanced through the ergonomic layout of the instrument (see 7.7 and 7.8), thereby allowing me to navigate the digital environment without the need to engage with the laptop. Hayes suggests this is a central concern when using augmented instruments as reliance on a laptop screen can be “distracting and interrupt the sense of absorption in the task at hand. When this occurs for the performer, the audience are likely to perceive it too” (Hayes, 2014, p. 55).

When designing an instrument and software I considered which digital processes benefit from tactile feel. For example, triggering an algorithmic process may not, whereas performing melodic and harmonic material may, since a musician can use muscle intelligence to control this material with finesse.

4.6 Summary

This chapter discussed the embedding of a humanised instrumental background and personality into the control of digital compositions. This allows a performer to display personality and decision-making in a physical sense while interaction with an environment that encapsulates personal knowledge enhances this. A performer can therefore improvise with a traditional instrument to achieve sounds, techniques and a relationship with the instrument that would otherwise not be possible. This is especially the case when bespoke software is designed around the augmented instrument's expressive capabilities and the playing style of the performer. This research presents the advantages and challenges of these approaches and makes

a comparison to commercial digital controllers and DMIs more generally, including hyper/augmented/meta instruments, as well as NIME.

Chapter 5 Composition and Improvisation

5.1 Introduction

Throughout this research I explored an approach to music creation and performance that is influenced by my jazz background and strove to explore compositions in an improvisational and interactive manner. There appear to be fewer resources for learning digital improvisation compared with instrumental styles such as jazz, where there are predefined formats and methods that improvisers can study. Attempting to design a system for the exploration of compositions can be overwhelming because digital technology creates new possibilities in composition and improvisation by providing an abundance of techniques, control methods and forms of interaction.

To address this, I shall discuss the different forms of improvisation and interaction musicians can engage in, paying particular attention to those that are important for humanisation, and those that provide a useful framework for digital performers. I shall explore the challenges of developing an improvisational language and collective atmosphere, and opportunities to purposely make space for improvisation and interaction when composing. In my research, the improvisational language was influenced by jazz instrumental and digital practitioners. Working with arranged compositions and interactive environments can make it difficult for performers to incorporate improvisational input. I shall discuss how composers can design environments to enable improvisation, for example, creating situations for playing or programming.

With regards to the hybrid guitar, performance scenarios become more complicated, as it is possible to play multiple roles: composer-conductor-instrumentalist. I had to give more thought as to which sections of a performance should be scripted or

spontaneous, as composed and improvised parts can also be applied to live guitar and its audio processing. It is also possible for the computer to play a role in the improvisation of the guitar's audio processing and MIDI sampling.

5.2 Defining Composition and Improvisation

This section gives an overview of composition and improvisation, discussing the challenges faced when combining these practices, for example, learning an improvisational language and creating an environment for collective engagement. This helps situate my research within the field of composition and improvisation, as well as understanding what skills are useful for digital comprovisation.

5.2.1 Situating my Practice - Comprovisation

Composition and improvisation were not mutually exclusive in this research, therefore, the term 'comprovisation' was useful for describing my approach (Kim, 2018). Jin-Ah Kim suggests this approach draws on the "contingent moment of performance" and a "context-independent system of rules or scores" (ibid., pp. 1-2). Comprovisation allows musicians to combine the "structuredness, seclusion and controllability" of compositions, with the "openness, singularity and coincidence" of improvisation" (ibid.). Although blending these practices can be challenging, it is achievable since they rely on the same "musical structures and models" (ibid.).

Improvisation has been defined as the real-time instantaneous creation of musical works without prior preparation, commonly while interacting with other musicians or an audience (Bailey, 1993). Composition is a non-real-time process that allows for deep reflection, as well as the ability to make corrections and produce multiple drafts of a piece until the desired outcome is attained. A middle ground is taken by jazz practitioners, as many forms of improvised music include composition.

Prevost (1995) suggests that when jazz is over composed it can lose its identity as there is no space for improvisation. Conversely, when composers include sections that rely on improvisation, this is no longer entirely their composition and they must acknowledge the improviser's contribution (ibid., pp. 73-74). It could also be argued that compositions that rely overly on improvisation lose their identity. Thus, this research was concerned with keeping these identities intact, which was accomplished through a selective approach to human improvisation and a computer part that helped maintain compositional structure.

5.2.2 Learning an Improvisational Language to Engage Audiences

Levin proposes there is value in improvisation, as it allows a “performer to assimilate a language and bring it alive” (Levin in Bailey, 1992), rather than regurgitating ideas precisely which can become mundane for performers and audiences in the long-term. Consequently, improvisation is important to humanisation, as it provides new experiences for performers and audiences that may not occur from listening to a recording or an entirely scripted performance. This connection between performer and audience also influences musical decisions which contributes to liveness, for example, a subdued audience may result in a performer taking more conservative decisions.

In this research, I strived to adapt jazz techniques and learn from controllerists that use hardware and software to improvise. Digital approaches can involve the use of melodic, harmonic and rhythmic material, or manipulating spectral material and using computer processes to augment what is physically possible. This was important to consider in my work with the hybrid guitar as the instrument allows for both instrumental and digital techniques, making it useful to evaluate how these could be used in combination. This amalgamation of instrumental and digital practices has the potential for the creation of diverse and personal language for a hybrid instrumentalist.

When working with computers, it is useful to consider how the computer can encourage improvisation and a collective language. To address this, the following sections discuss various improvisation and interaction techniques by considering the jazz ensemble paradigm, the setting of roles and leaving space for human physicality and improvisation.

5.3 Forms of Improvisation

This section discusses the various forms of improvisation and interaction performers can engage in, with particular attention paid to jazz ensemble improvisation and the translation of this paradigm into the digital domain.

5.3.1 Understanding Improvisational Circumstances

George Lewis suggests there are four factors improvisers must deal with, including:

- Agency – the way you can affect a piece in order to make a difference
- Indeterminacy – dealing with unexpected situations and being prepared for this
- Analysis – taking into account what is happening or is going to happen, so you know how to react
- Choice – deciding upon which course of action to take (Lewis, 2016).

Having a thorough understanding of these factors is beneficial as it makes improvisers aware of the capabilities and options at their disposal, helping one deal with indeterminacy and taking decisions without hesitation. Human and computer agency can both produce indeterminacy to help create an improvisational environment. In my research, unpredictable digital processes can act as an improvisational partner by providing a source of ideas and direction, as well as capturing and altering live guitar (see /media/AsynchronousLooper.mp4 3’15”).

Many terms in this section refer to instrumental group interaction, yet are relevant for describing the improvisation that occurs within solo digital performance, and differentiating between the numerous ways performers can improvise and interact. Digital technology also provides many new improvisational possibilities, including remixing pieces, manipulating spectral material and triggering events. However, digital environments can lack affordances for improvisation unless these are purposely designed. In this research, I explored the types of improvisation that were interesting to me and considered whether they should be carried out by the computer, performer or both. The following sections discuss the forms of improvisation and interaction that were most applicable to my research.

5.3.2 Microinteraction

According to Givan, the microinteraction inherent to acoustic traditions involves the "tiny adjustments in tempo, dynamics, pitch, and articulation that musicians make while playing together" (Givan, 2016, p. 8). These adjustments are often so minuscule they cannot be "quantified by standard western notation" (ibid.), meaning musicians need to apply these based on their experiences, preferences and perception of ensemble dynamics. Timing and maintenance of the beat is a subtle practice; however, it is central to performances, as it allows competent performers to incorporate "connotations of stability, intensity, and swing" (Berliner, 1994, p. 968). Hugues Panassié suggests that the qualities of jazz music are mainly found in these microinteractions and the collective groove that occurs as a result (Givan, 2016).

When it comes to digital music this form of interaction is not always present, especially with regards to temporal microinteraction, as unlike humans, technology can sustain a fixed tempo throughout performances without the need for spontaneous interaction. Practical approaches to microinteractions are explored in a range of ways in this thesis, for example, in Chapter 7, which includes descriptions of my PolyrhythmicHumanisedStepSequencer (see 7.5.1) and MIDI guitar setup (see

7.5.2). Furthermore, as the feel and relationship of the drum and bass parts can be critical in establishing a groove, techniques such as sidechain compression were employed to create interaction between these instruments.

5.3.3 Meso Improvisation

Givan describes another form of improvisation and musical interplay, called motivic interaction (Givan, 2016), also referred to as ‘call and response’. This is commonly found throughout improvised music, occurring when musicians repeat each other's melodic, rhythmic and harmonic ideas. Often musicians will expand upon each other's ideas instead of replicating them precisely, resulting in continuous back and forth exchanges between musicians. Givan suggests these “sorts of dialogic exchanges clearly manifest real-time social communication” (ibid., p. 11).

This form of improvisation is arguably the most recognisable, which seems logical as George Lewis suggests “listening turns out to be different from just hearing – the only way you know if you're being listened to is by the response” (Lewis, 2016), and motivic interaction encapsulates this. This form of interaction can differ with digital systems, as performers have the option of motivic interactions based on spectral and live sampling manipulation, as well as audio processing.

Although complex two-way interaction was not a top priority in this research, many of the humanising techniques were designed to give the impression of these behaviours (see 7.4.1). The lack of interactivity from a computer is not always a negative, granted it is interesting to have musical exchanges for performers and audiences. However, it is also interesting to have the computer ignore or go against the performer, which is something George Lewis (2016) employed in Voyager. In my research, I attempt to create an environment that is participatory, where the computer influences my decisions.

Motivic development relates to motivic interaction, as it involves the repetition and evolution of ideas, but does not always involve interaction. Motivic development is important for composition and improvisation, being a useful tool to keep listeners engaged. Perception is predominantly focused on motives, as we comprehend the larger structure of compositions based on their relationships (Pike, 1971). Listeners understand music by relating what they have heard to what they are going to hear, as “without memory there would be no music” (Levitin, 2007, pp. 162-163). Motivic development lets listeners deduce clear-cut relationships; however, it is beneficial to modify motives to engage and challenge the memory of audiences (ibid.).

This is likely why sequences are a common jazz technique, allowing improvisers to repeat melodic and rhythmic phrases at different pitches to match the harmony (Levine, 1995), thereby repeating material in an ever-changing manner. Development can ensue solely using rhythm (ibid.), which is applicable to my practice, as I utilise methods that do not directly alter melodic material, such as panning and equalisation. It can be harder for audiences to understand how performers are controlling these processes, which is why I felt it necessary to design an instrument where repeated gestures could produce similar outcomes, as this provides relationships in actions.

Another technique that can be used in combination with motivic development is delayed anticipation, as ideas do not have to be repeated sequentially, a motive can be played at the beginning of a piece and returned to at a later stage. Huron suggests this technique further engages audiences, as when there is uncertainty about the timing of events “we must raise arousal or attention levels in advance of the earliest anticipated moment when the event might happen” (Huron, 2006, pp. 9-10). This makes audiences more aware of other aspects of a performance.

Considering the value in motivic development, it was incorporated into the design of the digital environment and control methods. Performances sometimes involved a strategy of motivic development which combined joint human-computer agency (see

7.6.1). Delayed anticipation was achieved with computer processes that recorded motives and repeated them at a later stage (see 7.4.1). These strategies have the benefit of being less predictable for the performer, which can improve engagement by encouraging an approach based on control and surrender (see 6.4.3). When engaging in these techniques, it is useful to consider the prospective audiences to tailor performances to their reactions, as some enjoy a higher degree of repetition than others. There is no ubiquitous standard (Middleton, 1990), with certain genres, such as pop and techno, incorporating more repetition than others.

5.3.4 Macro Improvisation

Macro improvisation involves the arrangement of a composition, intensity levels and ensemble roles. Macro improvisation provides many options for performers, for example, changing the intensity of a piece can be accomplished through varying the dynamics, level of dissonance or rhythmic content: density and metric modulation. Improvising with a composition's arrangement offers flexibility, as sections can be played or combined as the performer sees fit. Some formats need to be adhered to to provide compositional structure and identity, for example, jazz improvisation generally starts and ends with the thematic melody. This may not always be necessary, as in certain instances the element of surprise provides a better outcome for an audience.

Ensemble roles can be improvised in numerous ways, including how many instruments are playing at any given time and the role of each instrument, for example, outlining the harmonic structure or taking a lead melodic role. Gabriel Solis recounts that Thelonius Monk preferred drummers “who played solid, traditional time”, rather than playing complex busy parts (Solis quoted in Givan, 2016, p. 7). Monk probably preferred less busy drummers, as this provides more space for others to improvise. However, some jazz musicians prefer rhythm sections that take a lead role as this can provide ideas and surprises.

Givan suggests that at times jazz musicians are better adhering to their "conventional ensemble roles without immediately responding or otherwise adapting to one another's spontaneous flights of inspiration" (ibid., pp. 7-8). This was important in my performances, as I have lots of opportunities to improvise, yet I realised these should not always be acted upon. When designing my digital environment, I took a mixed approach, at times having the computer improvise heavily while at others clearly outlining the composition's form (see Chapter 8).

With regards to DMIs, it is useful to consider the roles taken by the performer and computer, as well as how these roles complement rather than clash with one another. I needed to be aware of the indeterminate computer contributions, for example, what register they were in, as this allowed me to contribute meaningful improvisation. This was critical, as visible gestures alone will not humanise performances since the sonic content of these gestures needs to be discernible from the rest of the music.

5.4 Creating an Improvisational Environment

This section discusses the creation of environments that allow for structured composition and improvisation. Addressing this issue required an exploration of the possible applications of human and computer agency, as well as the options for leaving space for improvisation.

5.4.1 Human and Computer Improvisation

Todd Winkler suggests when it comes to human and computer performance the following strategies can be employed:

- Predetermined score + predetermined computer sequences
- Predetermined score + indeterminate computer actions
- Performer improvisation + predetermined computer sequences

- Performer improvisation + indeterminate computer actions (Winkler, 1998, p. 292)

This research is concerned with the latter three approaches, as some degree of improvisation was a requirement for the exploration of compositions. An example of a system based on performer improvisation and predetermined computer sequences is Martin Parker's 'gruntCount', much like a musical score the composition moves through sections, the rate being at the discretion of the performer. This is achieved using an envelope follower, allowing the computer to be controlled by the "player by being pushed through a map of interleaved presets with each sound (or grunt) the player makes" (Parker, 2010, p. 6). As the computer's role does not require physical control (ibid.), it leaves the performer to focus on their playing whilst listening and reacting to the composed environment. This situates the performer as instrumentalist and conductor within the system, as the density of their playing controls the arrangement of the digital sequences. Although the computer part is predetermined, it is difficult for a performer to keep track of the density of their playing, therefore, the piece may result in unanticipated outcomes.

Parker's intent was to "engender a rich and credible musical co-action that meaningfully addresses a compositional engagement with the liveness and spontaneity of improvised performance" (Furniss, 2018, p. 106). This system could be likened to jazz standard performance, where a performer can practice improvising over a predetermined melody, harmony and arrangement.

Conversely, systems such as Lewis' Voyager incorporate human improvisation and indeterminate computer parts that bear resemblance to free jazz. Lewis's software was designed to have a "separate, recognizable personality that participates in the musical discourse on an equal footing with the human players" (Rowe, 1994, p. 79). This means that every decision taken by the computer has "consequences for the music that must be taken into account by the improvisor" (Lewis, 2000, p. 36), giving

the software as much input over the structure of the piece. However, Voyager is incapable of adhering to a predetermined compositional form, as Lewis suggests the system could not improvise over jazz standards as competently as well-trained improvisers, as it has a mind of its own[14] (Lewis, 2016).

Lewis' approach has the advantage of enabling a performer to be experimental with their ideas, as they are not constrained by a computer part outlining a predetermined form which could result in the performance going into unknown directions. However, some performers may feel constrained by this lack of compositional structure which could hinder their creativity and cause them to play more reservedly to give coherence to the material.

I determined that it is unnecessary for these roles to be fixed, for example, a human or computer part can be mostly predetermined with certain sections relying on randomness. Additionally, it can be at the performer's discretion to select how the computer part reacts, giving human improvisational control over whether the computer part will improvise or perform predetermined sequences (see 8.6).

This research explored methods for creating situations for both eventualities, mainly through human guidance over the digital environment, letting the performer decide which sections display compositional structure and human control or experimental improvisation and chaotic outcomes (see Chapter 8). This aids in the humanisation of a digital environment as the computer's outcome is partially controlled by the performer, thereby, adding another sense of human control over the environment. This is a form of human control that is noticeable, as it can be used as a primary method for adding tension and release throughout performances (see 8.6). In my

[14] See http://repmus.ircam.fr/nika/improtek for an interactive software capable of following a compositional form.

research, computer improvisation can result in experimental outcomes, therefore, it is noticeable whenever I set these processes in action.

5.4.2 Interpreting Compositions and Leaving Space

> “Jazz tunes are great vehicles. They are forms that can be used and reused. Their implications are infinite” (Lee Konitz quoted in Berliner, 1994 p. 191)

As Konitz suggests, it is possible for compositions to be improvised in infinite ways. Jazz standards provide a useful framework as they provide a rough guide that must be interpreted by the performers to create something compelling. Digital composers can use indeterminate software as improvisational tools to generate spontaneous ideas, thereby providing a rough guide as performers will only partially comprehend the outcome. At the other side of the spectrum, composers can use studio techniques to formulate polished compositions performed with exactness.

Within the context of malleable digital environments, it is possible to develop strategies to make space for improvisation when composing or during performances. Composers can create excess material, yet only use a fraction of this. When doing so, performers should consider how to keep a composition's identity or spontaneously create something new. For example, my composition Technophobia (see 8.6) lacks structure and is extremely variable, yet the consistent sound design and performance methods give it a distinct identity. Much can be learned from popular jazz standards. When performing these pieces, it is conventional for musicians to start and end with the melody while engaging in solo improvisation in between, “within the piece’s cyclical rhythmic form” (Berliner, 1994, p. 192). This demonstrates the composition that is being performed and soloists can further this by referencing the melody.

Modal compositions provide an alternative framework for improvisation, as unlike Broadway standards, they are harmonically fixed and consist of one or two repeating

chords (Porter, 1985). I found this useful to explore in my research, as this approach could be applied in sections of a live set that involved the exploration of groove based, experimental digital sounds, rather than strict harmonic and melodic structures. This also works well with digital processes that do not specifically focus on melodic and harmonic material, for example, instruments and effects that produce microtonal outcomes. This framework allows improvisers to drastically vary compositions and engage in techniques such as playing outside the current scale/harmony, superimposition being one of these methods.

To accomplish these different approaches the software and control methods were designed to be adaptable to suit modal or harmonically structured compositions. The application of these contrasting approaches was intended to keep audiences engaged as it goes against expectations since the musical landscape is ever-changing. This also keeps performances interesting for me, as it requires different interactions and control methods, calling for either constrained or experimental improvisation (see Chapter 8).

Another aspect of ensemble roles involves complementing other people's playing, achieved through staying out of their vertical and horizontal space (Berliner, 1994). Vertical space implies the melodic and frequency ranges of instruments, whereas horizontal space involves rhythmic density, as if one person is playing densely this leaves little room for others to do so (ibid.). With digital music, it is equally important to consider spatial and timbral space. My software (see 7.4) allows me to improvise with pitch, timbre, density and spatial content, which can be applied flexibly to suit a given moment. Working in this way facilitates interaction, as instruments can exchange ideas in different spaces, for example, suggesting a motive or chord that is above or below the soloist provides ideas but does not disturb or take the focus away from them (ibid.).

Motivic interaction leaves space, as when the computer was playing the role of accompaniment or repeating my ideas, it allowed me to develop new ideas without audiences becoming overwhelmed by a lack of repetition. In this research, developing a group dynamic and mentality in the system was vital. To accomplish this, I utilised an instrumental ensemble paradigm to draw upon my background. Much like a jazz ensemble, instruments were created with predetermined, complementary roles and space. This was based on a solo improvisation format, providing opportunities where most instruments leave considerable space so that a soloist can take a lead improvisatory role. With regards to the hybrid guitar, the role of a soloist involves playing live guitar or manipulating digital sounds and processes, which provides more options and room to manoeuvre.

5.4.3 Leaving Space Through Playing or Programming

Leaving room for interpretation can be achieved by designing an environment that requires musicians to search for the desired sounds during performance. Butler (2014) discusses the divide between playing versus programming, as not pre-programming equipment can be useful for encouraging improvisation. He gives the example of Pacou, who uses various vintage devices including a Roland TR-909 drum machine that he prefers not to program before performances (ibid.). Pacou must search for sounds during performances, resulting in spontaneous experimentation and unpredictable outcomes. Butler suggests the way Pacou plays instruments in a live setting is the same as how he programmes instruments in the studio, therefore, “an essentially compositional action (“programming”) becomes suffused with the qualities of an improvisational, performative behavior (“playing”)” (ibid., p. 128).

It could be argued that extensively planning performances is the detriment of improvisation as performers can follow a predetermined path. It is tempting to follow this path, having spent so much time crafting a composition in the desired manner.

Performers may fear that deviating from this path will produce an inferior outcome. However, following a predetermined path lacks external input which can be problematic. For example, Sender Berlin will purposely perform with incomplete compositions allowing him to finish pieces during a performance to evaluate the audience's reactions and determine what works well within his live sets (ibid.). This allows performers to bring compositional process to the stage, giving an insight into these processes, and making the audience and performance space central in the creation of the music. Pacou suggests this approach adds qualities of liveness through “hands-on control and the uniqueness of the event” (ibid., p. 151).

The following are some examples of aspects of a performance that can be pre-planned:

- Arrangement of a composition and set
- Melodic, harmonic and rhythmic material
- Mixing – volume, space, location, width and depth
- Audio and MIDI processing
- Points of tension and release
- Instrumentation – sounds, textures and roles
- Density
- Tempo
- Role of performer and computer

According to Jin-Ah Kim, “the design, to bring about improvisation by the efforts of the participating musicians, results in inhibitions; any one musician may feel obligated to improvise” (Kim, 2018, p. 4). This seems logical as excessively planning improvisation goes against its purpose, that of spontaneity and free choice. In my research, I created a rough performance plan (see Chapter 8), providing options for improvisation with room for interpretation. I strove to find a balance between composition and improvisation so that when improvisation did not ensue the environment still produced interesting outcomes.

5.5 Case Study #1 The Party Van Improvisation Environment

An environment that correlates with my own, is Rodrigo Constanzo's The Party Van[15], which "is a live performance patch with dozens of modules and dsp effects covering a wide range of sampling, processing, and synthesis techniques" (Constanzo, 2011). Constanzo lists the following features:

- A variety of samplers/loopers oriented towards live performance
- Granular, concatenative, and convolution based synthesis on recorded buffers
- Buffer-based and real-time audio analysis used to dynamically generate intelligent presets
- Input/output effects
- Input stage convolution and amp simulation
- 8-bit sampler/looper based on the ciat-lonbarde Cocolase instrument
- Virtual CD skipping module based on "The Chocolate Grinder"
- Concatenative synthesis module based on "C-C-Combine"
- Attack-based sampling and triggering of effects (ibid.)

Constanzo uses this to perform with digital synthesis or work with recorded material, with which he can flexibly improvise, using a Monome to control audio effects. The environment allows Constanzo to delegate tasks to the computer in either determinate or indeterminate ways, which he can decide when to put in motion. This allows Constanzo to play acoustic instruments while the computer varies material and contributes ideas that influence his playing.

The capabilities of this environment reflect my own regarding the processes available and their application. The way Constanzo uses other instruments, such as the drums, in combination with the software and controllers is like how I apply the hybrid guitar.

[15] See https://rodrigoconstanzo.com/the-party-van/ for technical information and video demonstration.

One of the main differences between our practices lies in the fact that I work with more pre-prepared material, including MIDI clips, automation and recorded audio. Although Constanzo's environment is capable of this, he generally produces audio material for manipulation during performances. This is useful for bringing the studio processes to the stage, yet takes time to feed material into the environment to attain complex outcomes.

5.6 Case Study #2 Jon Hopkins' Electronic Music Performance Practice

Performance Setup

Hopkins arranges his compositions in Ableton Live's session view, which for variety includes a mix of loops and stem loops, both "one-shot things", as well as "longer things" (Hopkins, 2010). He can then control these using a Livid CNTRL:R, a pad-based device that includes sliders and knobs. This allows him to play the role of conductor by bringing in and out different loops and instruments, which he achieves by triggering loops with the pads and controlling the volume of tracks with the sliders. Hopkins' improvisation does not rely much on Live for audio processing, instead he employs external hardware in the form of Kaoss Pads (KPs) and Pioneer DJM-900 Nexus Mixer. This allows him to send instruments from Live to these devices for live audio processing and mixing, allowing him to carry out "sampling and looping and all kinds of crazy sounds" (ibid.). His arrangements in Live leave space for improvisation, which makes it necessary for him to engage in live control and programming (see 5.4.3) to achieve compelling outcomes.

Hopkins has a set signal flow which helps structure his improvisation, with bass and riffs going into one KP, melodies and atmosphere into another and drums into another, all of which go into the Nexus. However, he sometimes sets up KPs in com-

bination, sending drums into one KP which then go straight into another one, allowing for dual processing. Occasionally, Hopkins will “put one at the end to control the master” (ibid.) to process an entire composition. The flexibility of the KPs enables the application of different methods to each aspect of an environment, as the device contains an abundance of effects and affords the ability to switch between these quickly. In addition, the Nexus, has four channels each with audio effects, including filter, crush, noise, space, dub echo and gate/comp, thereby allowing for further processing.

The interactive capabilities of the KP makes it ideal for improvisation, as you can “simply swirl your finger around the pad until you find the sound you want, and then you can either freeze the setting or modulate it further by stroking and prodding the pad as you please” (McNamee, 2011). According to Eno, the KP provides a way to utilise the intelligence of the muscles, as you can “start playing with sound itself, with its physical character” (ibid.).

Performance Commentary

In this performance[16], the arrangements of his compositions Breathe This Air and We Disappear (2013) seem fairly set, as Hopkins rarely uses the Livid controller to trigger loops; instead, his improvisation is based on live processing and mixing. In this commentary, I will discuss the first composition and point out a few key actions and outcomes while relating these to the topics discussed throughout this thesis.

To create a build at the start of the piece, Hopkins uses the Pioneer at 1’10” to add shimmering reverb to the vocals, which he gradually turns up until the bass comes in at 1’30”, creating a peaceful atmospheric crescendo. When the bass comes in, he turns his attention to this aspect of the composition, using the KP on his right to add

[16] See https://www.youtube.com/watch?v=n8fsMcMY2do&list=FLeLxu9I2kIQh-vkaOffyWOg&index=10 for performance video.

distortion, delay and beat repeat. This allows for motivic development, as he uses the KP to vary the repetitive bass part, yet not to the point that it becomes unrecognisable. He achieves this by applying microvariations to the bass, momentarily turning on/off effects and quickly changing between these while continuously adjusting their parameters with the XY pad, resulting in an ever-changing bass part.

At 1’50”, he brings in drums using the Pioneer, and begins manipulating this using the two KPs on his left. Hopkins mainly uses the middle KP to sample and loop incoming drum patterns, allowing him to record a pattern, slice it up and switch between slices, which sometimes results in tiny segments being repeated. He then sends this into the other KP on his left to add audio processing. This allows for extensive real-time control while using the composed drum part as source material to spontaneously create new ideas. Much like a human drummer, his improvisation produces constant variation while adhering to a consistent groove. This approach also allows for macro improvisation, as Hopkins can take segments of a composition from one section and transfer them into another section. Furthermore, this can be used to control the intensity and density of the drums, by creating sparser or denser drum parts that can either be repetitive or ever-changing, and of varying durations.

At 2’28”, using a knob on the Pioneer, he turns on a resonant filter processing the bass and gradually reduces its spectral contents and dynamics, before turning the filter off at 2’32”, which immediately reintroduces the bass. This creates contrast and gives the impression of a new section, as without these interventions the bass would remain a prominent element of the composition, resulting in less development. He carries out a similar action at 3’02”, except this time applied to every instrument. This allows him to play the role of conductor by changing the arrangement and intensity level.

At 3’08”, he uses two KPs to synchronously manipulate the drum and atmospheric parts. This involves the use of a delay and pitch shifter, with the incoming signal muted so that only the effects can be heard. This produces variation in the rhythmic and spectral contents, momentarily adding triplets followed by out-of-time patterns that did not exist in the composed part. This enables the real-time application of microinteractions, adding a loose, imperfect feel to the drums. This adds tension and release, as it sounds out of context with the rest of the piece, momentarily adding tension until he resolves it a few seconds later by turning off the effect, thereby returning the drums to the original tempo and feel. In moments like these, the gesture-sound relationships are apparent, as when he disengages with the KPs the effect immediately turns off, making touch a requirement to achieve this outcome.

At 3’28”, he again removes the bass while applying drastic reverb to the vocals and atmospheric part, which allows him to bring the intensity down and transition into the next composition.

Performance Summary

Hopkins is skilled at creating tension and release through improvisation, which he does by controlling the density and dynamics of instruments, as well as changing the general atmosphere throughout his performances. This is useful as otherwise the composed material would remain at a consistent level of intensity, which would get mundane. His live control results in a different outcome from the composed version with regards to micro/meso/macro structure, yet he manages to maintain the composition's identity.

Most of Hopkins’ improvisation involves adding microinteractions, as he carries out tiny and momentary adjustments in tempo, dynamics, pitch and spatial contents of the individual instruments. The nature of his performance setup allows him to apply these techniques to multiple instruments simultaneously. Interestingly, this means that many of Hopkin’s actions do not produce prolonged outcomes, as only in some

instances does he leave audio processing on for sustained durations. This contributes to liveness, as touch is often a requirement for there to be an outcome. Furthermore, his performances are immersive since he engages in a full-body experience with continuous switching between controllers that have interconnected outcomes. This approach lends itself to experimentation, as the intricacy of this performance would be challenging to script. It is, therefore, likely that many of the outcomes are unanticipated, with mistakes that influence the outcome and lead to in-the-moment decisions.

Hopkins' approach is dissimilar to Darlington's (see 3.9.2), who mainly improvises by changing the arrangement of loops, with minor attention paid towards audio processing. Hopkins occasionally samples and chops up loops to create new material; however, this is a focal point of Darlington's improvisations. Hopkins' compositions are more structured as they have a set form, whereas Darlington spontaneously combines various source material to create ideas. Hopkins' approach bears resemblance to Rodrigo Constanzo's software (see 5.5) as both focus on the use and adjustment of various audio effects that can be used in combination to create complex outcomes.

My performance practice resembles Hopkins', as I structure compositions in Live in a similar fashion and then engage in improvised audio processing and mixing to vary the micro/meso/macro structure (see Chapter 8). Furthermore, my compositions require real-time control to create engaging music, with varying density, dynamics and intensity levels, as well as interesting microvariations.

There are some fundamental differences in our approaches, for example, I have incorporated flexible routings into my software, allowing me to change the signal flow during performance (see 7.3.4 and 7.6.1). Furthermore, the use of MIDI guitar provides me with more direct control over source material using guitar technique (see 7.5.2). Finally, I have developed complex mapping strategies, as well as gesture

recording and indirect computer control which enhance my physical actions (see 7.3.2 and 7.3.3). This lets me control more of the environment with less physical input and convert direct control into indirect computer control.

5.7 Summary

Compared with instrumental jazz, digital improvisation is still not widely discussed. It can be more challenging to learn, even when transitioning from a jazz instrumental practice, as digital music can incorporate novel approaches. This chapter suggested that much can be learned from instrumental forms of improvisation, specifically their methods for composing and planning for improvisation. Alternatively, I have suggested methods that can be acquired from the practices of electronic musicians and controllerists who bring studio techniques to the stage.

There are challenges that digital improvisers must successfully navigate to produce outcomes that maintain both compositional and improvisational identities. These include the development of personal and collective improvisational languages achieved through the acquisition of necessary skills, as well as fostering engagement with an environment that is open to influence and exchange. It is useful to consider the role of the human and computer since they are equally capable of performing either scripted material or improvising. Therefore, this chapter considered the approaches other practitioners have taken and attempted to address the spectrum of what is possible with digital comprovisation. This research points to the fact that these approaches can be flexibly adapted when designing the environment or during performance.

The topics discussed in this chapter helped situate my research and revealed improvisation methods that were advantageous with regards to the hybrid guitar; humanisation; and playing the roles of composer-conductor-instrumentalist. I shall

further address how I have implemented this in the following chapters while referring to many of the terms discussed here.

Chapter 6 Control

6.1 Introduction

The control strategies one implements are central to humanising as it has a direct effect on the experience of both the performer and audience, influencing the display of liveness, physicality, embodied interactions and the likelihood of flow states. Control strategies are intrinsically linked to compositions, which require performers to determine how to map their interfaces to composition environments. This is of particular importance when using hybrid instruments as they provide a wide array of affordances and control strategies to choose from. It can be beneficial to determine whether to develop distinct affordances and control strategies for individual devices or the entire instrument. Thus, the topics of agency, mapping strategies, affordances and setting constraints played a significant role throughout this research.

6.2 Agency

John Bowers identifies numerous ways in which performers engage with digital music environments, including “delegation, supervision, direct manipulation and in-habitation” (Bowers, 2002, p. 57). This can vary in complexity as live control can “run on a continuum from a single press of a button to initiate playback, to in-the-moment fine control of all aspects of the music, at a human gestural rate” (Collins, Schedel and Wilson, 2013, p. 512). There are pros and cons from operating at either side of this spectrum, from the performer and audience perspectives. Whereas the former allows for the exact realisation of a composer’s intentions, the latter enables the performer to engage in continuous real-time human improvisation.

It is useful to consider the contrasting roles of composer-conductor-instrumentalist in thinking through approaches to the control of a hybrid performance system. Certain tasks can be more suitable for automation versus real-time human decision making, whereas certain control strategies can make human control more effective and comprehensible. Collins, Schedel and Wilson suggest various methods that digital performers can implement, including “shared control by multiple human musicians, computer artificial intelligences designed for concert situations, mixtures of manual control and autopilot” (ibid., p. 513).

Human and computer agencies both have roles to play within digital composition and performance. Human agency enables performers to display presence and musical choices guided by their aesthetics, while utilising computer agency can help a solo performer produce complex multi-layered material. Owen Green argues that computers “exhibit agency by apparently making skilled human action peripheral where once it was central” (Green, 2011, p. 140), yet as we continue to designate tasks to machines, new skills arise in the process (Ingold, 2000, p. 332).

The type of skills required from a performer is dependent on their approach since performances can vary from intensely rehearsed pre-planned actions to spontaneous in-the-moment decisions. Whereas the former requires extreme precision and an awareness of compositional structure, the latter necessitates improvisational skills to adapt in unexpected situations. The software must also be designed to operate in these situations, with classical precision or jazz interactivity. Collins suggests that the “devisers of computer systems must themselves anticipate the sorts of freedom available” (Collins, Schedel and Wilson, 2013, pp. 513-514).

These are all critical factors to take into consideration to achieve engaging performance scenarios, therefore, the “manifestation of human agency in electronic music is a complicated business, both for performers and any audience” (ibid.). When

considering agency, it is important to examine an environment's affordances, as this is what is being controlled.

6.3 Affordances

The affordances applied to a digital environment determine its complexity and influence how a performer perceives and interacts with the environment. Affordances arise from how a person perceives the possibilities for action in an object (Gibson, 1979). These perceived affordances will be dependent on the object and person, since the physical qualities of objects will change their interaction methods, while a person's background and goals will influence how objects are perceived (ibid.). This is particularly the case with musical instruments, for example, a drummer will likely perceive a grid-based controller as a drum sampler, whereas a DJ will see it as a tool for remixing music. Dobrian and Koppelman (2006) note that, although an instrument can be designed to afford expression, a performer still must master the instrument for expression to occur. For this to occur, designers should make affordances perceivable and understandable for its users.

6.3.1 Transparency of Affordances

Alexander Bell (2018) suggests that an environment must be simple for its affordances to be equally transparent. Designers can make compromises with their environments, limiting the affordances so that they are effective for a particular purpose (Norman, 1998). This is made evident in Ableton's Push, as the interface mainly affords performative capabilities by designing the interface around the software's session view. Although the company could have incorporated control over mixing capabilities in the arrangement view, as Graham Pullin suggests, it can be useful to limit the number of features to improve the overall experience (Pullin, 2009). When designing my instrument, I set constraints on affordances to make them equally transparent and improve the performance experience (see 7.2 and 7.8).

Designers can make specific affordances more transparent, suggesting actions to users while providing further options upon deeper exploration. I applied this in my environment by developing mapping strategies for various levels and purposes (see 7.9). Another way to achieve this is a modular approach, where users can choose and combine various aspects of an environment to create unique affordances. I employed this in my research, using Live and Max/MSP in a modular manner, as seen with my GlitchGenerator software (see 7.6.1). The software tools and affordances developed in this project have been made with my compositions and performance practice in mind. However, they may be of use to others in similar or different contexts.

6.4 Setting Limitations

6.4.1 The Purpose of Setting Constraints

Magnusson discusses how “affordances and constraints in musical instruments are two sides of the same coin, but with a change of focus where affordances point to features that make things possible and constraints define the limits of the possible'' (Magnusson, 2010, p. 71). A key difference comes when designing DMIs, as in their case, it is at the behest of the user to set constraints. When dealing with commercial DMIs with the provision of more affordances than required, users can limit themselves by determining which affordances are useful. The opposite is true with programming-oriented environments, such as Max/MSP, as designers may take a bottom-up approach to setting constraints, since building an environment from nothing requires one to know when to cease applying affordances. However, in both instances setting constraints enables users to “engender an identity, a musical world that is simple, intuitive, and direct” (Magnusson, 2010, p. 70). This aids in the development of a musician's awareness and mastery of the limitations that have been imposed.

In my case, as I was using a commercial software, I had to select the affordances Live provided that were useful to me and determine how I could overcome any constraints by designing new affordances using Max/MSP (see 7.2). However, I needed to know when to cease applying affordances to create a system that was intuitive, learnable and facilitated flow states (see Chapters 7 and 8).

6.4.2 Freezing an Instrument's Development

To fully comprehend an instrument's affordances and constraints, it may be necessary to freeze its development, especially in the case of DMIs as they are in a state of perpetual evolution. This mutability and lack of limitations can be troublesome, as if musicians do not freeze their instruments at some point, it is difficult to achieve mastery (Magnusson and Mendieta, 2007). Freezing an instrument's development allows a user to “engage with the instrument and learn about its expressive potential through experience” (Magnusson, 2010 p. 65), thereby building “an embodied tacit knowledge of the system” (ibid.). This was a central concern for Michel Waisvisz and his instrument, The Hands[17] (Bellona, 2017), which he spent years developing through three hardware versions. Rather than continuously redesigning the instrument to overcome any challenges, Waisvisz would freeze development for a substantial period and struggle with the instrument, thereby learning to exploit its limits (ibid.). I applied this method to my instrument to better understand its affordances and constraints, as well as determine how it could be improved upon during each stage of its development (see 7.10).

6.4.3 Control and Surrender

Surrendering to technology is another way of setting limitations on control. According to Brian Eno, in recent times, humans have strived to take control of their environments; however, this is not always the ideal approach as there is value in surrender

[17] See https://www.youtube.com/watch?v=U1L-mVGqug4 for video demonstration.

(Polymath, 2011). Throughout human history, surrender was essential as humans were not capable of controlling their environments, being at the “mercy of weather, creatures, geology, geography and everything else” (ibid.). Actively surrendering, afforded humans a way to navigate their environments and “go with the flow” (ibid.).

John Ferguson achieves this by designing features into his environment that encourage real-time interaction and create a scenario where it is uncertain whether he is controlling the technology, or it is controlling him (Ferguson, 2016). To do so, he gives the computer agency, which some could argue takes away human autonomy and liveness; however, Ferguson suggests this only heightens his attention and involvement during performances (ibid.). Similarly, Maja Ratkje aims to create a situation where she is not in total control as this keeps her performances original and capricious (Kjus and Danielsen, 2016). She accomplishes this through not pre-planning performances and making the technology difficult to control as she suggests “you can use technology that is super easy to handle or extremely advanced, sometimes having full control and sometimes not at all” (ibid., p. 331).

This research explores methods for human control and creating an unpredictable environment that requires partial surrender. This is an approach for humanising digital performances, as the display of control is strongly associated with enhancing an audience's experience. Conversely, surrendering encourages performer interaction with technology based on surprise and collaboration. When considering control and surrender, mapping strategies are important, as they determine how and if one is in control of their environment. For example, extremely complex mappings may be unpredictable and require surrender, as users must accept that their actions will not result in precise outcomes.

6.5 Mapping strategies

To improve control of digital music, some would argue that mapping strategies are the most crucial factor, “as its prevalence ranges from ergonomic strategies to compositional features” (Magnusson, 2010, p. 65). When striving to extensively control complex material, it is possible to either use an abundance of controllers with simple mappings or alternatively implement complex mappings with a constrained setup. The type of mappings will impact a performer's gestures, and the audience's comprehension of the action-sound relationships.

The ability to customise mappings makes DMIs somewhat unique. Unlike acoustic instruments where the “playing interface is inherently bound up with the sound source”, a digital interface is “usually a completely separate piece of equipment from the sound source” (Hunt, Wanderley and Paradis, 2003, p. 429). With DMIs this relationship must be defined by the user to achieve their musical goals, making mappings as vital to the performance of digital music as the compositional process.

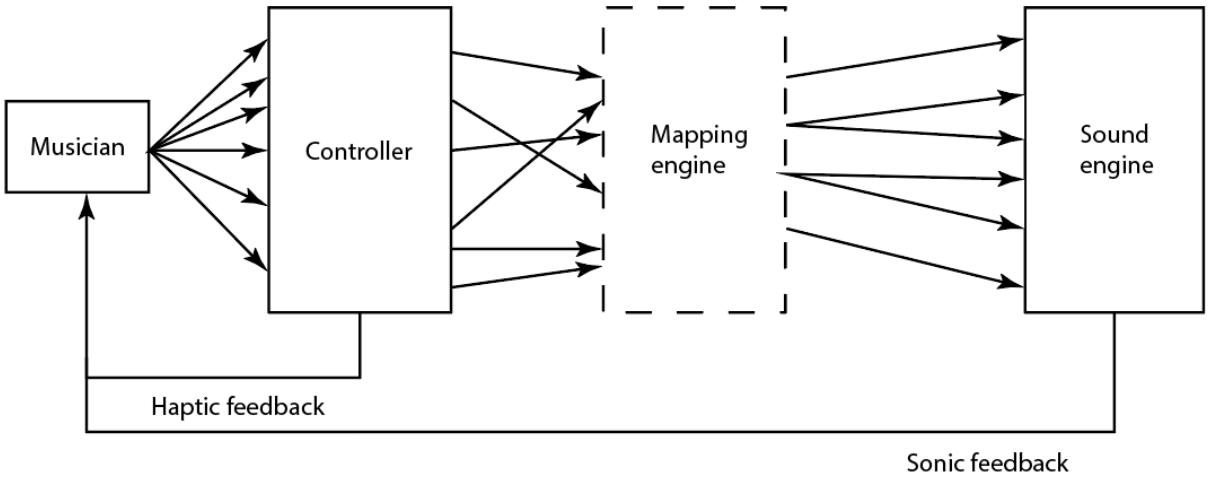


Figure 6.1: Based on Wanderley (2000). Common musical interface paradigm, with a disconnect between the controller and sound engine, with flexibility in the mapping engine which is open to change.

6.5.1 Types of Mappings

- *One-to-one*, where one synthesis parameter is driven by one gestural parameter
- *One-to-many*, where one gestural parameter may influence various synthesis parameters at the same time
- *Many-to-one*, where one synthesis parameter is driven by two or more gestural parameters (Hunt and Wanderley, 2002, p. 97).

Miranda and Wanderley (2006) suggest these three intuitive mapping strategies for digital instruments, whereas the term many-to-many can be applied to various combinations of these strategies.

This variety allows digital performers to configure the mappings between their interfaces and software environments to varying degrees of complexity, from a basic one-to-one mapping of a slider to an oscillator, to complex interconnected mappings that can become challenging for a performer and audience to comprehend. Complex mappings are incredibly customisable, for example, with divergent one-to-many mappings one slider could control one parameter linearly and another “anti-proportionally, exponentially or according to algorithms” (Lexer, 2012, p. 61). This allows users to customise how they control each parameter, to varying degrees of complexity. Conversely, convergent many-to-one strategies allow two independent controllers influence each other’s ranges, for example, “a fader controlling ring-modulation would enact different values according to the position of a second” fader (ibid.). Many-to-one strategies could also be enacted by using multiple controllers to modulate various parameters of one synthesizer.

Determining the complexity of mappings can present challenges, as complex mappings can overwhelm beginners, yet may provide better outcomes than simple mappings in certain instances (Miranda and Wanderley, 2006). Complex mappings replicate the experience of acoustic instruments which have evolved over centuries

to improve their interactivity (Hunt, Kirk and Wanderley, 2000). It is useful to study mappings that could be used to replicate the complex interrelated and nonlinear behaviours of acoustic instruments (ibid.). In the long-term, these mappings allow for a deeper relationship with DMIs that is more rewarding and embodied (Hunt & Wanderley, 2002), mainly because they require consistent engagement over an extended period for musicians to achieve physical and intellectual competence, resulting in personal approaches to interacting with DMIs. Dobrian and Koppelman (2006) suggest that one-to-one mappings allow a performer to control technology in an effective and repeatable manner, yet truly expressive actions may necessitate the use of complex mappings.

This research focuses on developing complex mapping strategies that offer flexibility (see 7.3), as this can be advantageous for improvising with elaborate compositions, allowing for more improvisational control with less physical input. My intention is not to reduce human physicality, instead actions are further extended.

6.5.2 The Effective Application of Mapping Strategies

Lexer (2012) discusses the value in these different approaches, one-to-one mappings being useful for controlling parameters independently with precision and providing the ability to easily visualise these processes using interface elements. Conversely, divergent mappings enable performers to control digital music with less physical engagement and in complex ways. For example, the implementation of “velocity controls of keyboards to mimic the complexity of the variants of acoustic sounds played in different dynamics” (Lexer, 2012 p. 40), allows performers to control velocity, attack and amplitude synchronously. Likewise, convergent mappings replicate acoustic instruments by having changes depend on various simultaneous factors, for example, “the speed of a bow, exerted pressure, and position of the string are simultaneous influences of the string sound” (ibid.). Convergent mappings are flexible as even changing one simultaneous aspect can significantly affect the sound,

while changing multiple aspects could result in an entirely different sound. These mappings also allow for a deeper embodied exploration that requires the use of multiple limbs in coordination.

Complex mappings tend to be more interesting and rewarding to the user as they can produce expressive, diverse and sometimes unpredictable results. Although one-to-one mappings are easy to learn, they are less enjoyable and not as capable of producing complex outcomes (Hunt and Kirk, 2000). Complex and cross-coupled interfaces allow users to play their instruments unconsciously, as if the body rather than the mind is guiding them (Hunt, Marcelo and Paradis, 2003). This physical connection to an instrument relates to the flow states experienced by acoustic musicians. Burzik suggests that for musicians to reach this state requires:

- A special physical contact with the instrument
- The development of a subtle feeling for sound
- A feeling of effortlessness in the body
- A playful and free-spirited handling of the material studied (Hunt, Marcelo and Paradis, 2003).

Digital practitioners may need to completely reconsider the implementation of mapping strategies, since they no longer need to rely on direct gesture-sound strategies (Magnusson, 2009). Instead, performers can control semi-autonomous processes and algorithmic techniques, as well as implementing “various complex (and even adaptive) mapping structures and contain various degrees of automation from simple looping to complex artificial intelligence responses” (ibid., p. 169). Furthermore, as DMIs allow for the separation of interface and software, a fixed relationship between action-sound is no longer required, resulting in specific gestures producing radically different outcomes (Miranda and Wanderley, 2006). This enables performers to apply different mappings strategies on every composition.

6.5.3 Navigation and Wayfinding

When deciding upon mapping strategies, it is worth considering whether these facilitate navigation or wayfinding. According to Owen Green, “the use of an equaliser” to try “to locate some specific aspect of a sound” (Green, 2011, p. 139) is a form of wayfinding. Navigation is “characterised by knowing in advance one’s destination, as opposed to simply knowing one's destination when one gets there” (ibid.). Implementing “overly simple and direct mapping strategies” tends to provide an “unsatisfactory experience in terms of the degree to which such schemes afford only navigation rather than wayfinding” (ibid.). This form of mapping militates “against skilled development” and can “give rise to breakdown more frequently” (ibid.). Wayfinding requires users to practice a DMI to acquire the skill needed to quickly find the desired sound. Green suggests “skilled practitioners will home in more quickly as they have learned to interpret the response in the sound as a guide of where to go next” (ibid.).

This is of relevance to humanisation as the type of mapping changes how a performer physically and intellectually engages with an environment. Wayfinding can be useful for improvisation, while navigation is useful when precision is required.

6.5.4 Direct Versus Indirect Control

According to Lexer, direct control encompasses performer actions that “enable intensional changes of parameters for either operational or performative control gestures” (Lexer, 2012, p. 60). A performative activity immediately affects the sonic outcome, whereas an operational activity is preliminary, and does not have an immediate effect on the sound (ibid.). Indirect control relates to events that are not controlled through a performer's actions, such as envelope following or side-chain compression (ibid.).

Although direct control offers more potential for displaying human agency, indirect control is useful for creating interesting interactions within a composition environment, allowing instruments to influence one another, much like in a human ensemble. For example, I often use side-chain compression to apply the rhythmic feel of a kick drum to other instruments, thereby, giving coherence to the various parts. This research develops methods for direct and indirect control, as well as hybrid approaches where direct control is needed to set indirect control in motion (See 7.3.1).

6.6 Summary

The design of affordances and control methods allow performers to use their interfaces to explore digital music in a way they deem desirable. The strategies one applies can have a drastic impact on how compositions are realised. This is also the case with the utilisation of human or computer control, as applying the computer in certain ways can help optimise a digital system by enhancing a performer's control and engagement. I desired an improvisational approach, which necessitated inconsistency, wayfinding and indeterminate indirect control (see 7.3) to grant interactions based on spontaneity and unanticipated outcomes.

It is useful for performers to consider how to achieve mastery and how long-term engagement will impact their relationship with the instrument. Accomplishing this may require a musician to freeze their instrument's development or continually change and expand upon its affordances and control strategies to improve interaction. Both approaches have their merits, but to gain virtuosity and intrinsically understand an instrument will likely require that the instrument only be adapted after a substantial period of engagement. The complexity of an instrument is also important to consider. Although a simple environment will be easier to learn, it may not allow for deeper exploration. For example, simple mappings may not allow for interesting interactions

between different limbs and devices that replicate the behaviours of acoustic instruments. To overcome these challenges, I designed my instrument for various levels and purposes (see 7.9).

In my work, I was already a proficient guitar player, which made it pertinent to evaluate how these skills could be used in combination with DMIs to accelerate the learning process. It was pragmatic to configure the mappings to allow for interactions between devices and detailed control over the environment using synchronous actions. When designing the instrument, I had to keep humanisation in mind, as although certain control methods could have produced better musical outcomes, they may not have displayed liveness (see 7.3.6).

Chapter 7 Assembling the Software and Hardware Components of the Hybrid Guitar

7.1 Introduction

This chapter firstly discusses the software that was developed with humanisation in mind, encapsulating a personal practice and musical background, as well as human characteristics and interactive behaviours that are reflective of my jazz practice. My intent is to facilitate interactions that result in the visibility of human agency. These methods are designed to enhance the experience of both performer and audience while encouraging human and computer improvisation to keep the music new and exciting.

Following this, I will describe the implementation of the hardware layer, rationalising my choice of controllers and the functionality I assigned to them. The controllers I utilise provide diverse affordances and interaction methods, which enable the simultaneous use of the entire instrument, a full-body experience, and a moveable instrument with dramatic gestures, thereby displaying liveness. In addition, I will describe how I apply guitar technique in the digital domain and how I utilise the digital layer of the instrument to allow for human nuance and expression.

7.2 Configuring Ableton Live for the Hybrid Guitar

Live offers a creative approach to music technology that differs from many other DAWs, which Ferguson suggests results from “the clip-launching paradigm of the session view and creative use/misuse of software instruments/audio effects” (Ferguson, 2016, p. 135). The customisation of Live, especially with the integration of

Max/MSP has allowed me to develop a personal approach that has been tailored to my proficiencies, and compositional and improvisational stylistic tendencies.

The digital controllers I utilise were designed for the guitar (see 7.7), which allows for their use in combination with guitar technique. These devices were used to control compositions that I arranged in Live. To enhance the capabilities of the controllers and Live, I created custom software in Max/MSP which extend and augment human actions, as well as provide novel ways of manipulating pre-recorded material and live guitar in an improvised manner. This allows me to control digital compositions and commercial software in a personal way that recycles virtuosity, thereby producing a different outcome than other digital controllers.

Figure 7.1: Stage setup incorporating guitar pedals.

My improvisation predominantly relies on the control of audio effects and their parameters. However, in some instances, I vary instrumentation; alter track routings (see 7.6.1); and use MIDI guitar to play software instruments (see 7.5.2). The control of audio effects is enhanced by using custom MIDI effects (see 7.3) that extend human

actions and incorporate indirect computer control. Much of my software includes indeterminate computer processes, to create an environment where decisions are influenced by the computer. The following figures (see Figures 7.2 and 7.3) illustrate the physical components of the environment and the software that I have developed.

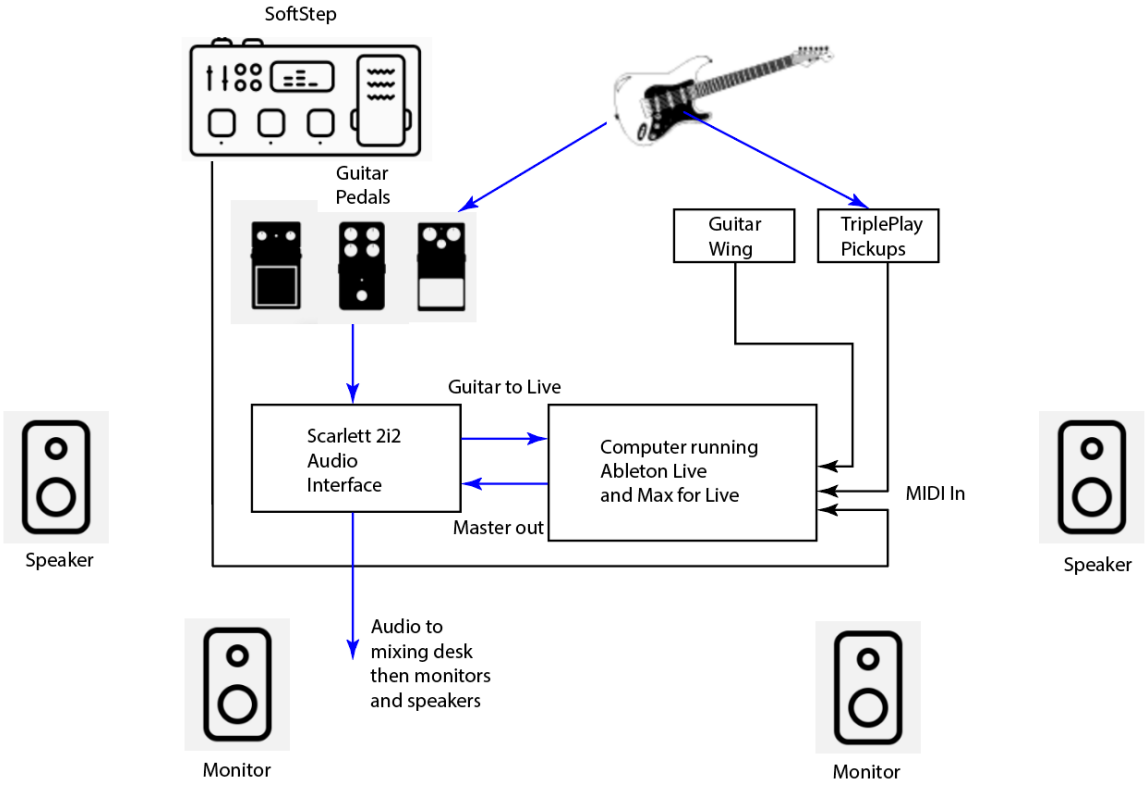


Figure 7.2: Stage layout and signal flow. Audio in blue and MIDI in black. Guitar Wing and TriplePlay attach to the guitar.

Control	Audio Effects	MIDI Processes	Other
Envelope Generator	Asynchronous Looper	Polyrhythmic Humanised Step Sequencer	Glitch Generator
Slider MultiMap	Freeze Interpolate	MIDI Guitar Setup	Use of Master Track
TouchPad Gesture Recorder	Freezey Stutter		Control Over Instrumentation
Detect Volume and Send	Timestretcher		Plugins for Computer Movement and Variation
MIDI Guitar Clip Controller			
Guitar Wing Receiver			

Figure 7.3: Methods and corresponding software.

When working with Live, initially I strived to achieve a workflow that resembled the performance practice associated with Ableton's Push. I was performing in Live's session view, which afforded the possibility of manually varying the arrangement of clips and scenes. This was not improving my performances, instead it was a source of distraction that was taking my focus away from where it was needed. Most of my compositions were highly structured, each section containing chord progressions that led into the following section, which meant that deviating from this structure often produced an unsatisfactory outcome. I was using the MIDI guitar to accomplish this task, which lacked the visualisation of software, making it difficult to remember and predict the outcome of my actions. To understand the layout of the session view I needed to look at my laptop, which I wished to avoid. Thus, I made the transition to the arrangement view[18] (see Figure 7.4) and relied on audio effects to restructure material.

[18] See https://www.ableton.com/en/manual/arrangement-view/ for technical information.

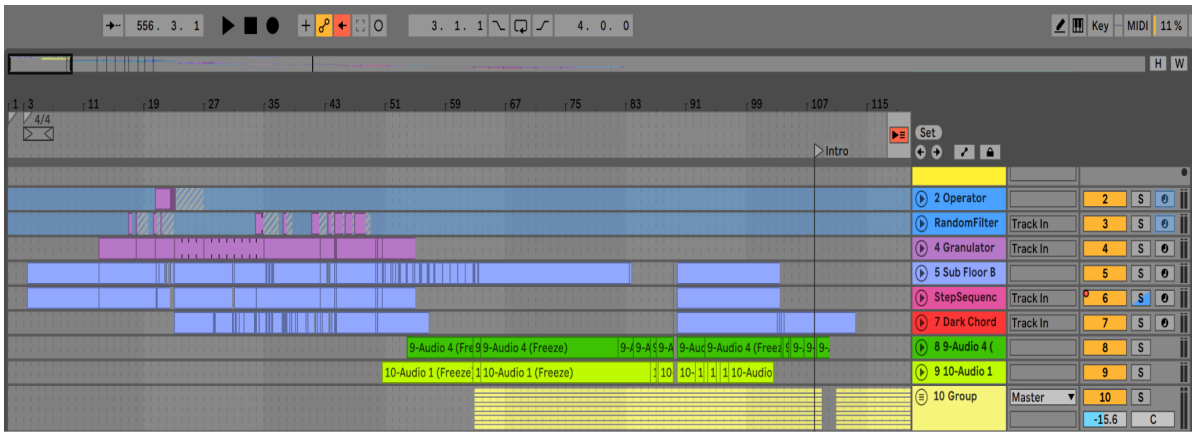


Figure 7.4: What's the Fuss? in the arrangement view.

I experimented with different processing and control methods on every composition. This offered variety, yet made it difficult to learn how the instrument behaved since it changed throughout a performance. This eventually led to a system which involved separating most of the audio processing from individual compositions, using dedicated processing tracks that every composition could be sent through (see Figure 7.5). I wished to slightly differentiate compositions, therefore, I kept some unique effects on individual tracks. To maintain some consistency in controlling these effects, I employed an approach where similar effects used the same control method. For example, I use Beat Repeat effects with different settings on each composition, yet trigger all of these using the same pad. This keeps performances interesting, as every composition requires a slight change of tactics.

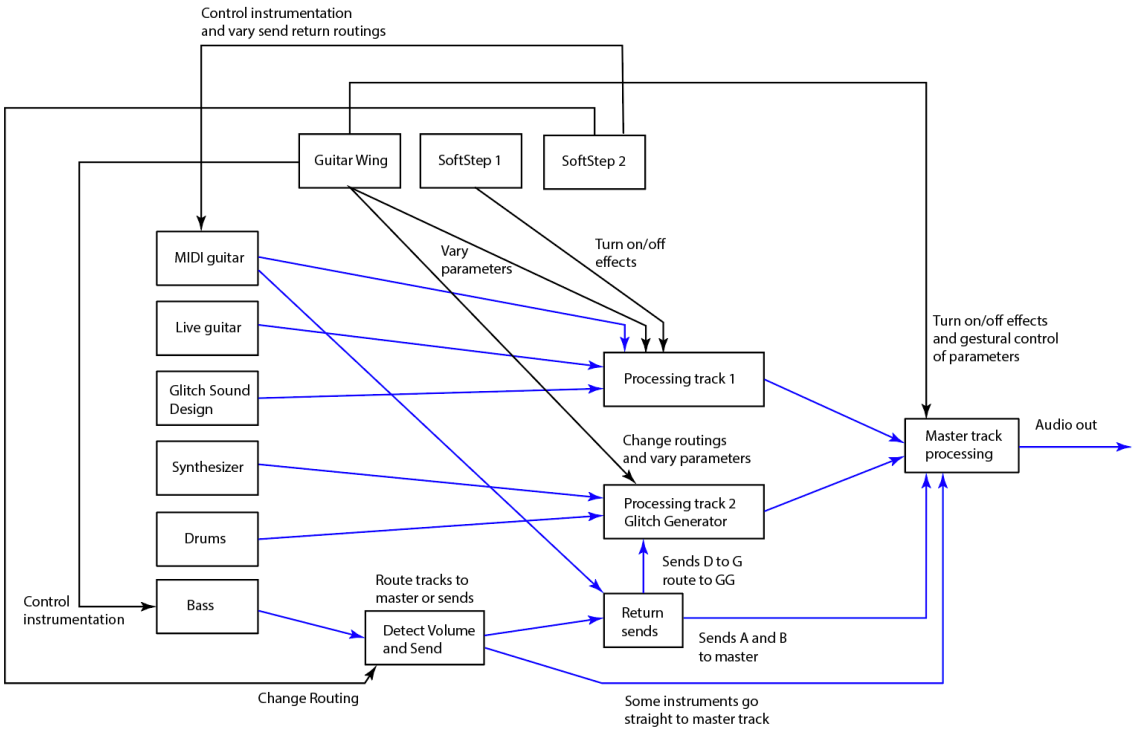


Figure 7.5: Simplified Ableton Live Workflow. Blue lines represent audio signal flow, whereas black lines represent the connections between hardware and software. Instrumentation and routing of instrumentation differ on each composition.

7.3 Software Aimed at Extending and Augmenting Human Control

This section details six Max for Live devices aimed at extending my physical abilities, allowing me to control more of the environment with less physical engagement:

- Envelope Generator (Section 7.3.1)
- Slider MultiMap (7.3.2)
- Touchpad Gesture Recorder (7.3.3)
- Detect Volume and Send (7.3.4)
- MIDI Guitar Clip Controller (7.3.5)
- Guitar Wing Receiver (7.3.6)

Some of this software was designed to help me accomplish tasks in Live that would otherwise be difficult, such as the improvised control over track routings. I often employ computer control, so I can affect the environment indirectly, setting processes in action rather than carrying out continuous control. This, in combination with the various interaction methods my software allows for using both hands and feet, enables me to multitask or carry out focused control while the computer provided movement in the other aspects of the environment.

7.3.1 Envelope Generator

Overview

This device was influenced by the artist Greg Debicki's (2017) Nice Envelope[19]. This is a time-based multi-mapping device that uses breakpoint envelopes to modulate up to eight chosen parameters within Live, which can be triggered either manually or through incoming MIDI. The envelopes can be manually set or randomly generated. During the compositional stage, it can be set up in parallel with MIDI instruments to modulate parameters and create continuous sonic movement, whereas in performance situations it can be used to alter parameters whenever the performer desires.

Max for Live patch: *`/software/EnvelopeGenerator.amxd`*

Video Documentation: *`/media/EnvelopeGenerator.mp4`*

[19] See https://woulg-related.bandcamp.com/album/nice-envelope-and-random-numbers for technical information.

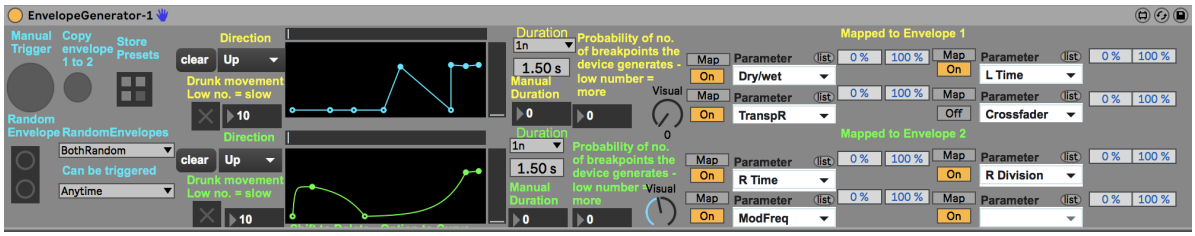


Figure 7.6: EnvelopeGenerator.

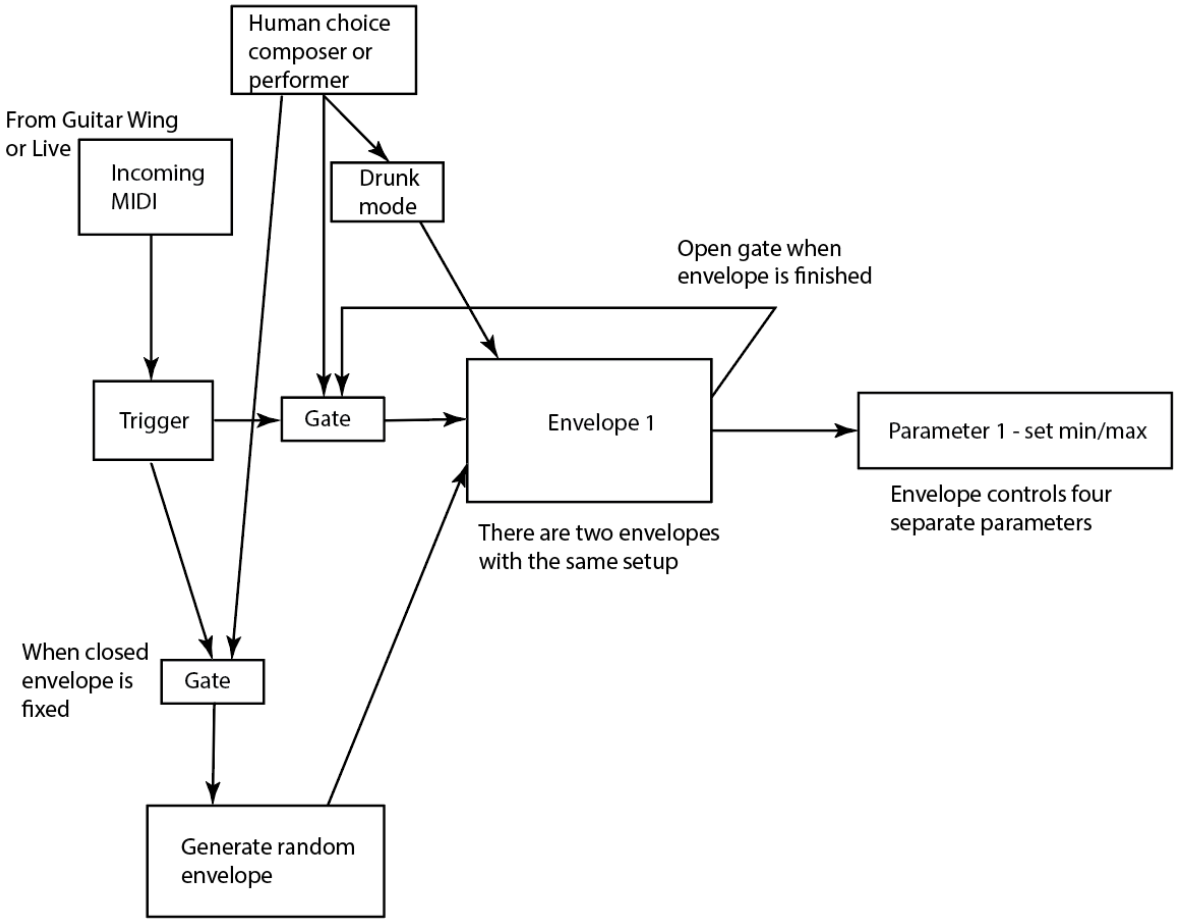


Figure 7.7: EnvelopeGenerator signal flow.

Functionality

The device can control any mappable parameter within Live, producing pre-determined or indeterminate outcomes, which can lead to subtle or drastic modulations. To achieve this, I have incorporated the following functionality:

- Trigger envelopes manually or with incoming MIDI
- Randomly generated or fixed envelopes
- Set probability for number of randomly generated breakpoints
- Zoom for writing in complex envelopes
- New envelopes can be triggered at any time or only when envelopes are inactive
- Set duration for envelopes: quantised note subdivisions or manual duration
- Scroll through envelope: up, down, or up/down
- Min/max setting to constrain parameter modulation
- Drunk mode: stepwise random movement through envelopes
- Copy first envelope to second
- Save presets

Rationale

This software addresses humanisation through the extension of human control through joint human-computer control and improvisation, allowing a composer-improviser to determine its behaviours and decide when to implement it. This device can produce unpredictable outcomes (see /media/EnvelopeGenerator.mp4 1’57”) that result in imperfect blemishes that display liveness and require the attention of a performer. A benefit of this device is that it does not require continuous control as the envelopes are initiated with a single button press, which allows a performer to engage in sound sculpting or simultaneously control other aspects of the environment.

Before creating this device, I experimented with Max for Live’s Envelope that has a similar functionality. Although this was useful, it always produced the same outcome, which I found too predictable. This led to the development of a randomisation feature in my software to automatically generate new breakpoints, whenever the device is triggered. Users can make the device more predictable by limiting randomisation to one envelope.

To allow composers to shape the delegated outcome, I made it possible to set the likelihood for the number of breakpoints that will be randomly generated and how much of an effect the envelopes have on parameters. This influences the character of the outcome, as fewer breakpoints with restricted min/max values result in subtle, gradual movement, while the opposite produces drastic, chaotic movement. Changing the outcome can also be accomplished by setting the duration, as longer envelopes produce gradual rather than swift modulations.

Although the device does not create any sound by itself, it is a powerful tool for creating compelling sound design and bringing studio techniques to the stage. As continuously varying the parameters of audio effects and synthesizers drastically alters sonic material in compelling ways, like how some composers apply automation. In doing so, this facilitates wayfinding and programming, as a performer can use the device to search for desirable sounds.

Evaluation

I program the device before performances and use a single pad on the Guitar Wing to trigger it whenever I desire drastic variation of audio effect parameters. In some instances, rather than controlling the device, I place it before a synthesizer to be triggered automatically by incoming MIDI which continuously modulates the synthesizer's parameters in synchronisation with its melody or harmony.

Figure 7.8: EnvelopeGenerator continuously modulating an Operator's parameters.

7.3.2 Slider MultiMap

Overview

This is a one-to-many mapping device that extends human control using eight envelopes which can be simultaneously controlled. These envelopes can be controlled directly using an interface, or indirectly using an inbuilt sequencer and EnvelopeGenerator.

Max for Live patch: *software/SliderMultiMap.amxd*

Video Documentation: *media/SliderMultiMap.mp4*

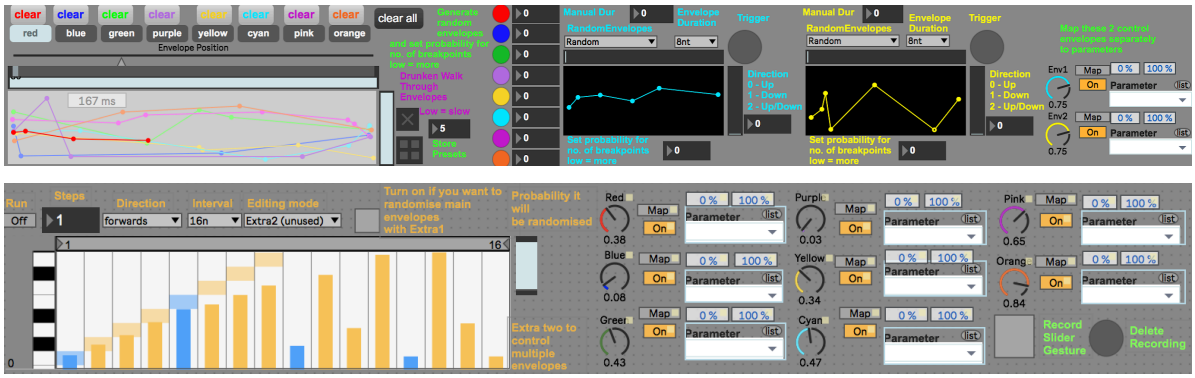


Figure 7.9: SliderMultiMap horizontal extension

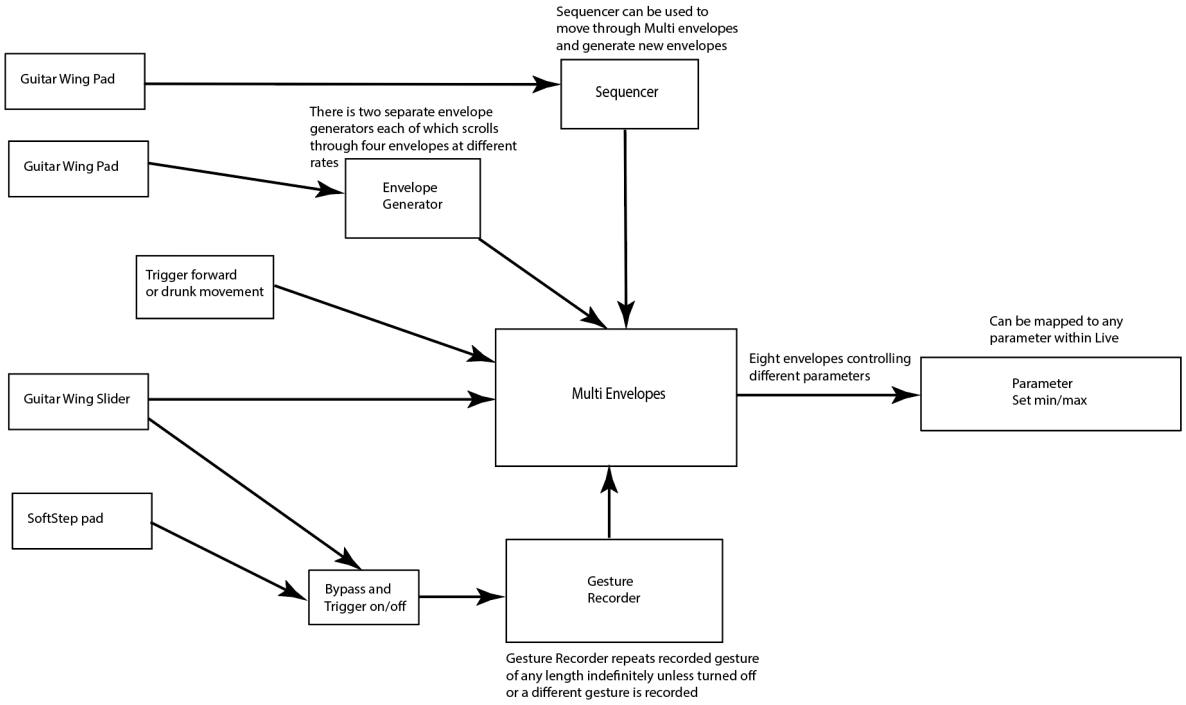


Figure 7.10: SliderMultiMap signal flow.

Functionality

The device can control any mappable parameter within Live, to produce pre-determined or indeterminate outcomes, as well as subtle or drastic modulations. To achieve this range of possibilities, I have incorporated the following functionality:

- Eight fixed envelopes customised to individual parameters
- Zoom function to create complex envelopes
- Possibility to generate random envelopes: manually or automatically
- Probability for number of breakpoints randomly generated
- Sequencer to jump to different points in the envelopes
- EnvelopeGenerator to interpolate through envelopes and modulate two other parameters within Live
- Gesture recording
- Randomly move through envelopes at specified rate

- Min/max setting to constrain parameter modulation
- Save presets

Rationale

This device addresses humanisation through real-time control and liveness, as its primary purpose is to extend and augment a performer's gestures. In doing so, it utilises the intelligence of the muscles and mind, as a performer can control numerous features relying on the finesse muscles are capable of, while the complexity this provides requires wayfinding. The device also incorporates computer processes which can be used to move through the envelopes automatically (see /media/SliderMultiMap.mp4 2'46"), allowing me to switch between manual control and autopilot. Autopilot is useful for contributing unexpected ideas and imperfect blemishes that require a performer to surrender.

At the initial stages of my research, I was using Live's mapping features. This proved beneficial when it came to one-to-one and binary mappings; however, with multi-mapping strategies I was unable to produce the complex outcomes I desired. The mappings between interface and sound engine were too linear and predictable, as a gesture would modulate all the parameters similarly.

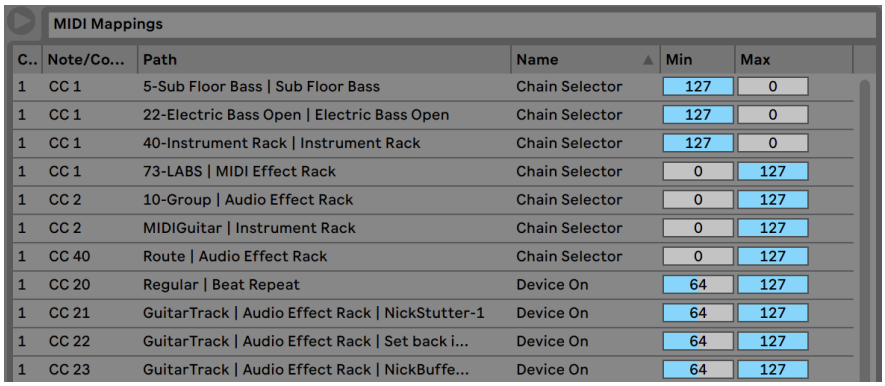


Figure 7.11: Ableton Live inbuilt mapping strategies. The min/max functionality allows for some flexibility and the possibility of inversions.

This software overcomes this problem by creating intermediary envelopes that alter the gesture-sound outcome. Depending on the envelope, a slider may act in a simple or complex manner. My intent was for intersections to emerge when using different envelopes in combination. For example, when there is a mix of parameters being controlled using drastically different envelopes, every point on a slider can differ significantly, with ever-changing interpolation between movements.

I would consider this a form of counterpoint**,** as the envelopes are controlled inter-dependently, yet their contour and rhythm are independent. This produces complex interactions that would be physically and cognitively difficult to achieve using separate controllers and Live's inbuilt mapping strategies.

Although human control was the primary goal of this device, upon reflection-in-action, I noticed I was constantly switching between devices to maintain movement in various aspects of the environment, which prevented me from mastering one aspect. I realised it would be useful to occasionally trigger movement in this device without the need for continuous control. This led me to incorporate a sequencer, Envelope-Generator and gesture recorder, which could be used to automatically move through the main envelopes when triggered. Although these accomplished the same goal, each has a distinctive sounding outcome.

The EnvelopeGenerator could be considered extending already extended control. Although manually controlling the envelopes created complex outcomes, the use of a complex time-based envelope furthered this by producing an outcome that would be difficult to physically reproduce. This is furthered by the fact I incorporated two envelope generators, each of which controlled four main envelopes separately, producing two independent yet interrelated outcomes.

The sequencer was designed to add a recognisable rhythmical quality to indirect control, as a stepwise pattern can be distinguished in its movements, which I exploit when the music needs repetition. This is useful for digital jazz sequencing and motivic

development, as the sequencer plays fixed patterns while I carry out modulations elsewhere that slightly alter the outcome.

Finally, the gesture recorder feature develops ideas presented by Rodrigo Constanzo[20] (2015), which provides a way to translate direct human expressive control into continuous indirect control. This contributes to liveness, as audiences witness the performer's initial gesture which is then repeated by the computer.

Evaluation

When I first put this software into practice, engaging in embodied interactions was difficult as the complex envelopes I was using at the time made it hard to predict the outcome of actions and be guided by my perception. Upon reflection-on-action, I realised it would be advantageous to limit the number of processes I was controlling at any given moment, so there were fewer simultaneous outcomes to predict. Another solution involved a mixture of simple and complex envelopes. Simple envelopes were easier to learn as there is less movement and variation in how they behave. Conversely, complex envelopes were challenging, as movements create more variation while subtle actions can produce drastic outcomes.

I experimented with different configurations until I discovered one that was moderately challenging, yet could be learned with consistent practice. Once satisfied, since limitations are what define most instruments, I employed the same configuration for future performances. However, the devices incorporated an envelope randomiser that could be used whenever unpredictability was desirable.

[20] See https://rodrigoconstanzo.com/2015/06/cut-glove/ for technical information.

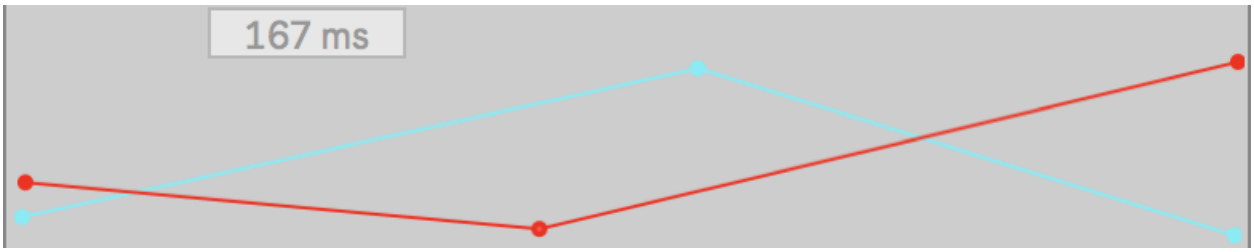


Figure 7.12: Simple and predictable envelopes.

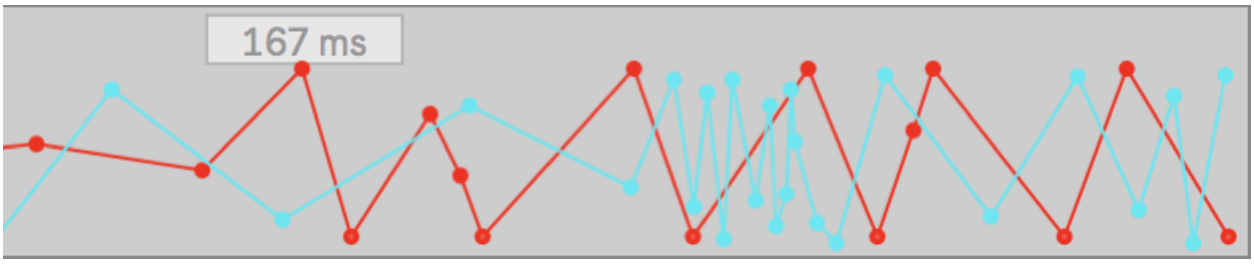


Figure 7.13: Complex and chaotic envelopes.

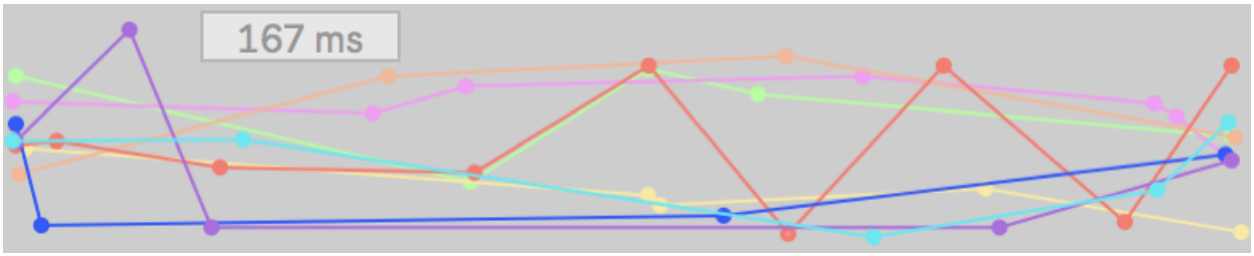


Figure 7.14: The final outcome.

This combination of envelopes worked well as it encouraged different gestures depending on the combination of envelopes that were applied at any given moment. Furthermore, each area of the slider controlling this device resulted in different outcomes, thereby affording complexity and adaptability.

Another feature that helps me control the outcome and level of challenge is the min/max functionality. I use this to constrain the effect of actions, which is advantageous when controlling certain processes. For example, when controlling a delay's feedback rate, limiting the max value prevented excessive and sustained feedback that generally did not work well. However, I kept some undesirable outcomes, as I

wanted an instrument that was able to produce what could be considered mistakes, which helped heighten my awareness and kept me engaged.

7.3.3 Touchpad Gesture Recorder

Overview

This one-to-many mapping device extends human control over a digital environment in a flexible and expressive manner. It uses the nodes object in Max/MSP, with each node mapped to a parameter, the closer the cursor gets to the centre of a node the more that parameter gets turned up (see /media/TouchpadGestureRecorder.mp4 34").

Max for Live patch: *software/TouchpadGestureRecorder.amxd*

Video Documentation: *media/TouchpadGestureRecorder.mp4*

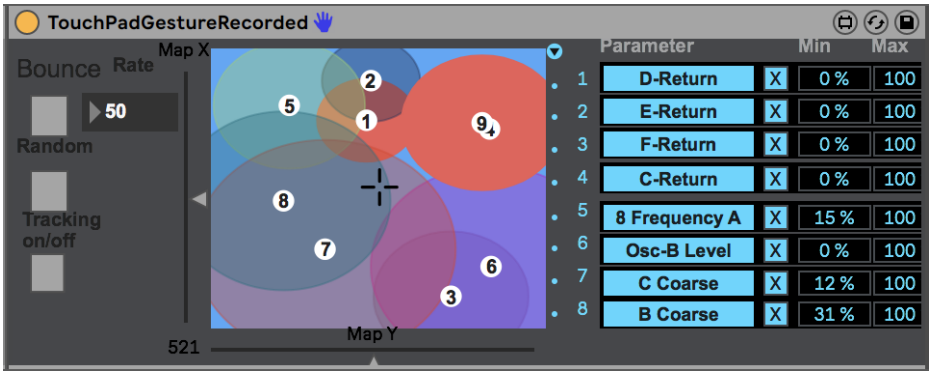


Figure 7.15: TouchpadGestureRecorder.

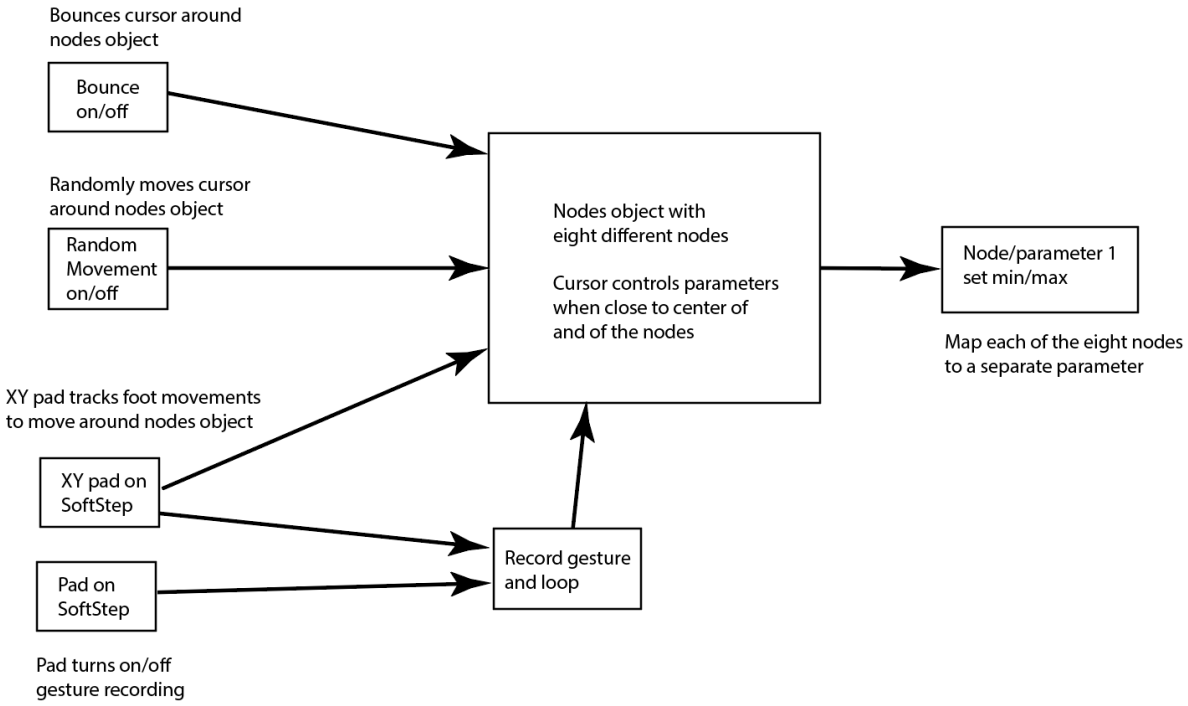


Figure 7.16: TouchpadGestureRecorder signal flow.

Functionality

The device can control up to eight parameters simultaneously while customisation involves determining the layout and size of the individual nodes, as well as the degree to which each node affects a parameter. It is possible to control the device directly or indirectly.

- Configure position and size of each node
- Bounce mode
- Random movement
- Record and loop gestures
- Min/max setting to constrain parameter modulation

Rationale

This device addresses humanisation through extended human control and liveness, as its primary purpose is to extend and augment a performer's gestures by affording the ability for expressive, continuous control, as well as recording and looping human actions (see /media/TouchpadGestureRecorder.mp4 2’10”). The device also addresses the encapsulation of knowledge through indirect computer control that can add inconsistency to software.

The outcome of this device differs from my other mapping software as control is accomplished on an XY-plane, which provides more possibilities for transitioning from point to point, with a wide selection of outcomes found at the crossover points between nodes/parameters. Since mapping operates on an XY-plane, the device requires two controllers used in combination or a single controller capable of tracking movements in different directions, such as a touchpad.

Evaluation

Initially I controlled this device with my hands and laptop touchpad, to vary audio effect parameters processing the compositions and live guitar. However, upon reflection-in-action, I became aware that I was overly relying on my hands. This was problematic in instances involving dense guitar playing, as switching between the guitar and touchpad was challenging, thereby disrupting the flow of my guitar playing. Upon reflection-on-action, I realised it would be wise to transfer skills to my feet by using the SoftStep to control the device. Furthermore, I chose to use the device to manipulate MIDI guitar, as this helped extend the sonic palette of MIDI guitar, which added another dimension to this aspect of my performances.

I wished to simulate the experience of guitar pedals by controlling digital processes individually. To achieve this, four nodes control the level of the signal being sent to the GlitchGenerator tracks (see 7.6.1), while four other nodes control synthesizer

parameters on the track itself (see /media/MIDIGuitar.mp4 3’30”). To facilitate the separate control of parameters, I dispersed the nodes around the graphical interface, with some crossover between nodes.

Upon physical disengagement with the device, I wished to revert to a predefined state. When I remove my foot from the SoftStep the cursor returns to the centre of the nodes object (see Figure 7.15). There are purposely no nodes objects placed in this position, which means all parameters will revert to zero. No sound will occur unless I play guitar, and this sound will remain constant unless I engage with the SoftStep. This was useful for liveness as it results in a full-body experience with continuous, embodied control using both hands and feet.

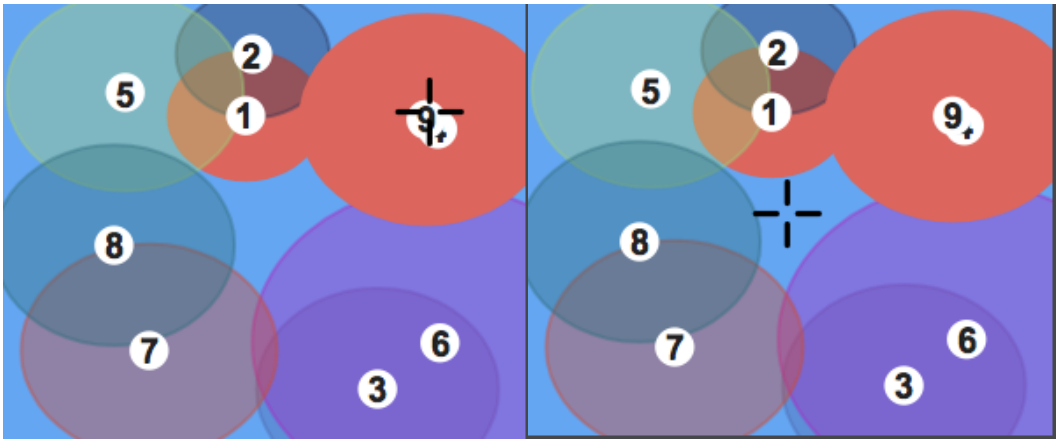


Figure 7.17: Control versus disengagement.

Although I generally control this device, some situations call for unpredictable results and for gestures to be repeated by the computer, which necessitates the use of the bounce or gesture recording features. This proved useful in moments where I was actively playing MIDI guitar and controlling compositions, yet wanted movement in MIDI guitar sounds without my input. Furthermore, the bounce feature allows for sound and discovery (see 4.4), as it continually alters the outcome of MIDI guitar.

7.3.4 Detect Volume and Send

Overview

This device allows for the spontaneous alteration of track routings, by turning a track volume down while proportionally and simultaneously turning a chosen send return level up (see /media/DetectVolumeandSend.mp4 47”). The device can control up to twenty-four tracks directly or utilise a sequencer to automatically change track routings.

Max for Live patch: *//software/DetectVolumeandSend.amxd*

Video Documentation: *//media/DetectVolumeandSend.mp4*

Figure 7.18: DetectVolumeandSend.

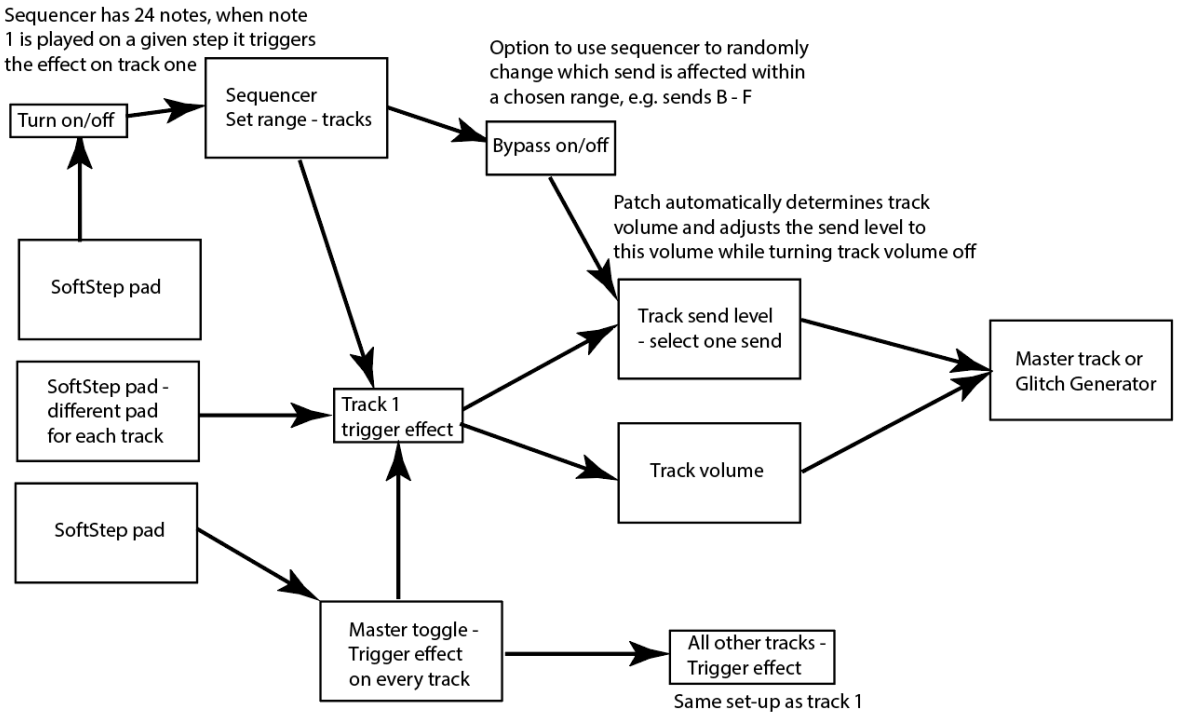


Figure 7.19: DetectVolumeandSend signal flow.

Functionality

The device can be customised to produce predictable or unpredictable responses, as well as subtle or drastic outcomes.

- Control routings of twenty-four tracks
- Master toggle, control all tracks at once
- Analyse track volumes to proportionally turn send controls up
- Designate send control on every track
- Sequencer for automatically changing track routings: stepwise or random
- Automatically change the predefined routings of tracks, within a specified range, for example, sends A to D
- Save presets

Rationale

This device addresses humanisation through the encapsulation of personal technical knowledge and the enhancement of human control through computer contributions. The motivation for creating this device resulted from my use of dedicated processing tracks (see 7.2) and the ability to route composed material to these tracks spontaneously. It proved difficult to directly alter track routings without latency, which led to a solution that involved routing audio through return tracks and then back to the processing tracks. Live already allowed for this capability; however, to achieve an entirely wet signal I needed to simultaneously turn a track's volume down and send up, proportionally. This was difficult to accomplish manually with precision and controlling every track in this manner was a waste of resources.

This device uses the computer to carry out the calculations and adjustments when triggered, which produces an entirely wet signal at the same level of the original track volume. I also incorporated a form of indirect control using an inbuilt sequencer that, when set in motion, changes track routings automatically.

Evaluation

This device blends compositional and improvisational processes. When composing, I did not wish to send every track through a processing track, as this would produce less contrast in the material. As an improviser I desired the ability to add processing to every track spontaneously. This device allows me to do so, and since it carries out precise adjustments, it enables me to be experimental with routings without audio clipping.

Direct control of this device allows for sustained changes, whereas the sequencer changes track routings in quick succession in a way that is not physically possible and provides unpredictable variation. When using the device, I mainly carried out direct control as this contributed to liveness by producing immediate and noticeable

outcomes. Furthermore, upon reflection-in-action I realised that indirect control produced too drastic an outcome for most situations, and overly distorted the composition's identities.

7.3.5 MIDI Guitar Clip Controller

Overview

This device develops ideas presented by Tom Cosm[21] (2015). It utilises MIDI to trigger clips and scenes in Live's session view. I designed this device for MIDI guitar, yet it could be applied to other MIDI instruments.

Max for Live patch: *//software/MIDIGuitarClipController.amxd*

Video Documentation: *//media/MIDIGuitar.mp4 5'48"*

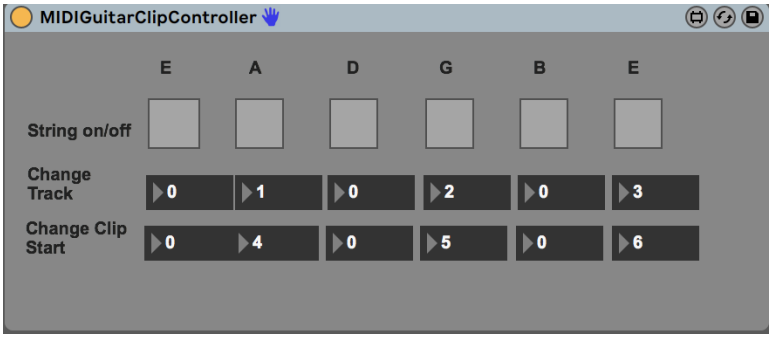


Figure 7.20: MIDIGuitarClipController.

[21] See https://www.youtube.com/watch?v=U_g680_X3bE&t=1175s for video demonstration.

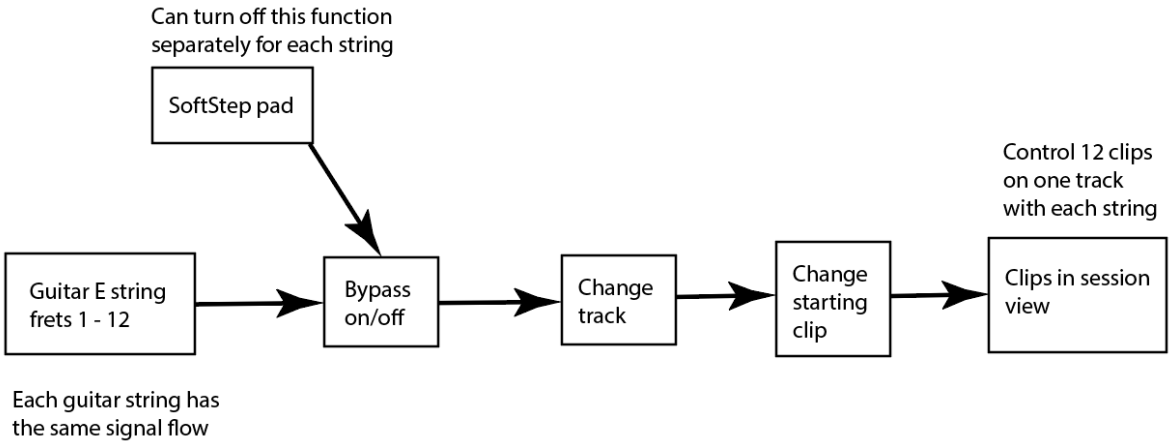


Figure 7.21: MIDIGuitarClipController signal flow.

Functionality

- Control six tracks and twelve clips on each track
- Designate the track and clips each guitar string controls
- Turn on/off this capability for each string

Rationale

This device addresses humanisation through real-time control of digital processes using guitar technique, thereby recycling virtuosity in a way that allows a guitarist to play the role of conductor by changing the arrangement of a composition. I developed this device in the initial stages of my research, to replicate grid-based controllers handling of clips and scenes in Live's session view. The device applies an instrumentalist approach to the role of arranger in digital performance, which allows musicians with proficiency on MIDI instruments other than grid-based controllers to control clips and scenes more effectively by recycling virtuosity.

Evaluation

This device proved useful in certain instances; however, the lack of visual feedback from the guitar made it difficult to control elaborate compositions. Thus, it did not play

a prominent role in performances; however, it is useful for compositions that do not have a strict harmony that needed to be adhered to (see 8.6). An interesting technique that I developed with these types of compositions involves the rapid triggering and retriggering of different clips to produce interesting breakbeat patterns with harmonic, melodic, and rhythmic material.

7.3.6 Guitar Wing Receiver

Overview

This many-to-many mapping device was designed to turn the Guitar Wing into a multipurpose controller. Using the four side switches on the Guitar Wing it is possible to switch between mappings, allowing every pad and slider to be mapped and customised to four parameters that can be controlled individually. It also lets users implement both continuous control and note on/off messages with each pad and slider, depending on which side switch is applied.

Max for Live patch: *//software/GuitarWingReceiver.amxd*

Video Documentation: *//media/GuitarWingReceiver.mp4*

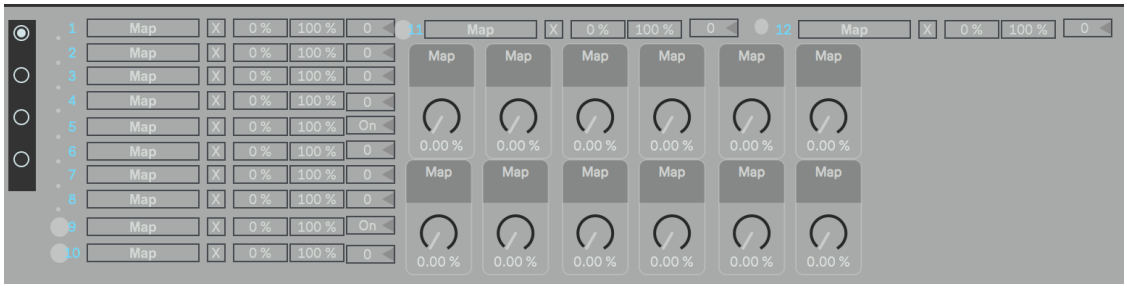


Figure 7.22: GuitarWingReceiver.

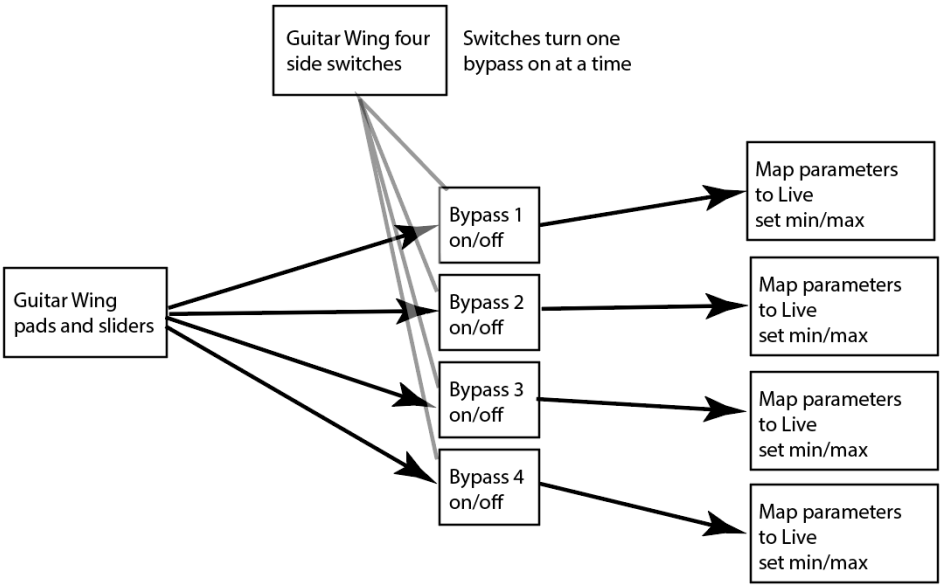


Figure 7.23: GuitarWingReceiver signal flow.

Functionality

- Quickly switch between mappings
- Min/max setting to constrain parameter modulation
- CC and note messages

Rationale

This addresses the expansion of a digital interface's capabilities, thereby extending human control while allowing for both performative and operational activities. My motivation for creating this device was to control a digital environment extensively using a limited number of controllers.

Evaluation

I did not make considerable use of this device, as I wanted to set limitations on control, and found that switching between mappings made the instrument harder to learn and play intuitively, which disrupted the flow of performances as actions became less immediate. Furthermore, it distorted the causal relationship between

gesture-sound relationships. I may use the device in the future to control my Poly-rhythmicHumanisedStepSequencer in a free jazz context.

Section Discussion

This software offered a variety of means for controlling digital technology which resulted in different physical interactions, mapping strategies and musical outcomes. These devices were paramount in extending and enhancing my control. However, it was necessary to create a digital environment that was interesting in and of itself. Thus, the next section discusses the software I developed to create a compelling environment for composition and improvisation.

7.4 Audio Effects for Improvisation and Sound Sculpting

This section details four Max for Live devices aimed at improvising with audio in real-time:

- Asynchronous Looper (Section 7.4.1)
- Freeze Interpolate (7.4.2)
- Freezey Stutter (7.4.3)
- Timestretcher (7.4.4)

My performance system uses three main streams for audio processing which could be mastered and controlled with finesse. This involved one processing track with fixed inputs, including live guitar and specific tracks on each composition; the GlitchGenerator (see 7.6.1), which contained five separate processing tracks with flexible routings; and the use of the master track to process entire compositions (see 7.6.2). To enhance these tracks, I designed the following bespoke software to provide each with a unique character and outcome.

7.4.1 Asynchronous Looper

Overview

This device is a looper that brings studio techniques to the stage, to extend the sonic possibilities of acoustic instruments and digital material.

Max for Live patch: *//software/AsynchronousLooper.amxd*

Video Documentation*: /media/AsynchronousLooper.mp4*

Figure 7.24: AsynchronousLooper horizontal extension.

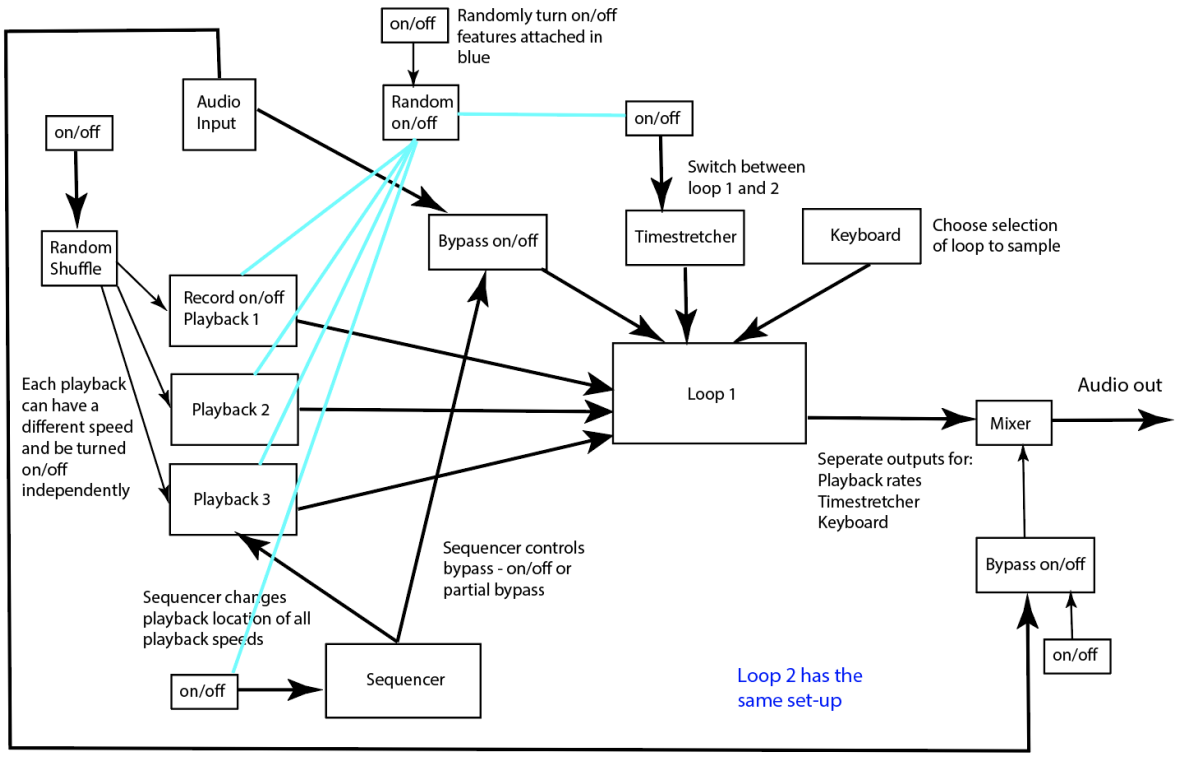


Figure 7.25: AsynchronousLooper signal flow.

Functionality

The device contains a variety of functions that can be applied as a user sees fit, including many features that Live's inbuilt Looper is not capable of.

- Generative and asynchronous capabilities
- Spectral, spatial and temporal processing
- Flexible control over recording and overdubbing
- Sequencer for automatically controlling features
- Device randomiser to automatically turn on/off processes
- Mixing of independent layers

Rationale

This device addresses humanisation through the encapsulation of knowledge, which involves embedding personal studio and performance techniques into an audio effect. Furthermore, it addresses the delegation of tasks through indeterminate computer processes that help interpret composed material and live guitar, thereby providing imperfect blemishes and an improvisational partner, which keeps performances new and exciting.

The initial inspiration for the device came from Ryuichi Sakamoto and his album Async (Sakamoto, 2017), which explores asynchronous music. Sakamoto believes this allowed him to "speak in a language which doesn't exist" (ibid.), thereby letting him do something different, as he suggests "99% of the music in this world is in sync" (ibid.). I wished to create a device that produced different music and drastically varied recorded material. Asynchronous capabilities were useful for this, as the different loop lengths create music that is ever-changing.

Although Live's inbuilt looper and session view provide asynchronous capabilities, these were difficult to control and manipulate independent layers in real-time as it would require multiple channels. This limitation led to this device, which captures incoming audio and plays it back with or without transformations. To achieve this, I utilised Rodrigo Constanzo's (2015) external Max/MSP object karma~[22], which allows for dynamic length, varispeed loops, as well as other additional features which helped me achieve my goals. I utilised six karma objects to playback sounds from two buffers, each of which can be played at different speeds/pitches and in reverse, making it possible to have six asynchronous loops occurring at once.

[22] See https://rodrigoconstanzo.com/karma/ for technical information.

I also incorporated digital techniques that emulated Oval's approach of scratching CDs[23] to create choppy and flawed outcomes that distort the original recording (see /media/AsynchronousLooper.mp4 1'45"). This involved a variable recording feature that uses a sequencer to control how audio is recorded into the buffers, resulting in choppy and sporadic recordings.

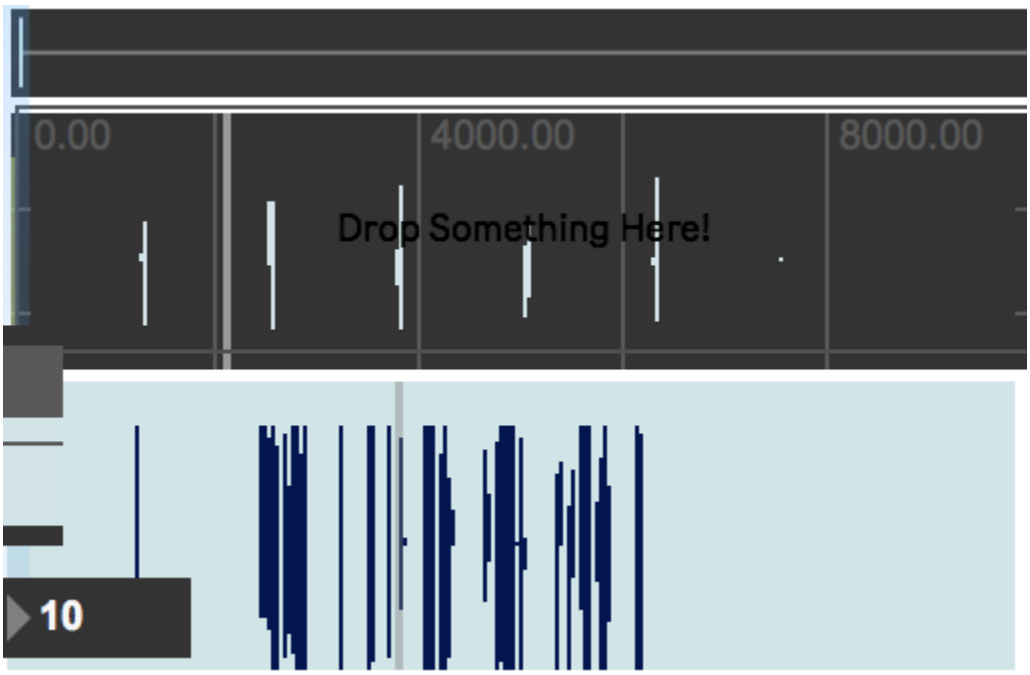


Figure 7.26: Glitch recording functionality.

I also achieved this by incorporating a buffer shuffler that uses a sequencer to quickly jump around the buffers during playback and recording (see /media/Asynchronous-Looper.mp4 1'18"). This drastically alters the looper's input and output in a repetitive or unpredictable manner, depending on the progression of the sequencer. When this function is set in motion the loops become synchronous, which is useful at times for creating coherent harmonic and rhythmic patterns.

[23] See https://pitchfork.com/features/resonant-frequency/9730-a-glitch-in-time-how-ovals-1995-ambient-masterpiece-predicted-our-digital-present/ for further information.

To further extend the capabilities of live looping, I incorporated a timestretcher, which uses Volker Böhm's (2013) object vb.stretch~[24] (see /media/Asynchronous-Looper.mp4 2'53"). I used this to timestretch one buffer at a time, with the option of switching between buffers.

Evaluation

This device has become a primary method for reconstructing incoming audio. When I first began using this device, I was controlling it manually; however, this proved difficult as there were many features. This was not benefiting performances and was taking my attention away from where it was needed. Upon reflection-on-action, I decided to implement a randomisation feature to automatically turn on/off processes for me. This produces drastic and unpredictable outcomes; therefore, I need to turn on/off the device to suit the composition. The randomisation feature was beneficial for creating motivic interactions, by transforming incoming audio while maintaining some consistency to the original recording (see /media/WeeRedBarPerformance.mp4 5'15").

7.4.2 Freeze Interpolate

Overview

This was originally a device created by Jean-François Charles (2008) which I modified to automatically capture and sustain incoming audio whenever it exceeds a certain threshold (see /media/FreezeInterpolate.mp4 2'45") using Miller Puckette's Bonk object (Böhm, 2018).

Max for Live patch: *software/FreezeInterpolate.amxd*

Video Documentation: *media/FreezeInterpolate.mp4*

[24] See https://vboehm.net/downloads/ for technical information.

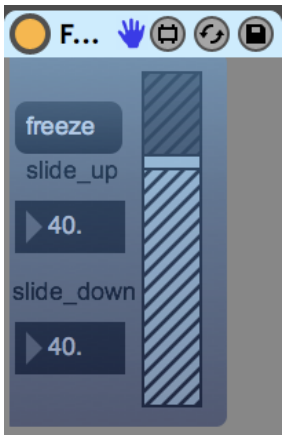


Figure 7.27: FreezeInterpolate.

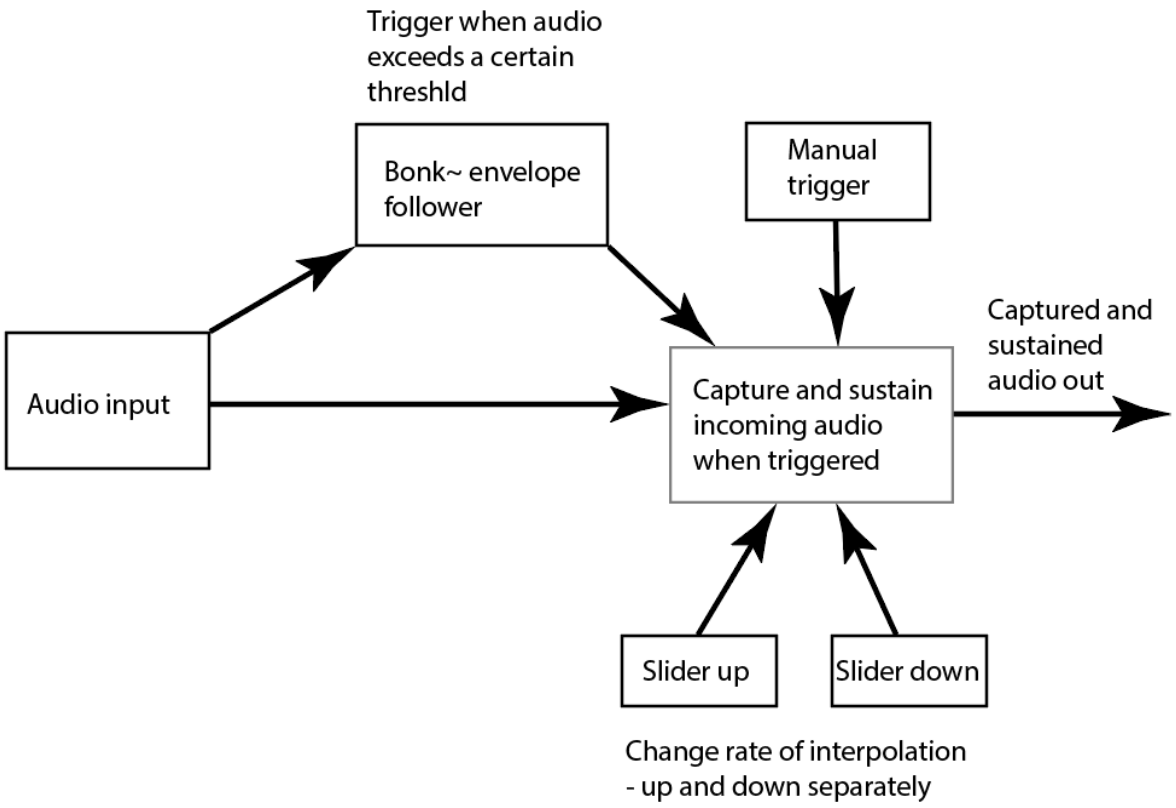


Figure 7.28: FreezeInterpolate signal flow.

Functionality

This device cannot be extensively customised by users as its purpose is singular; however, it is possible to change the way it reacts to a degree.

- Manual or automatic freeze
- Instant transition or interpolation
- Adjust rate of interpolation, separately for lower and higher frequencies
- Volume control

Rationale

This device addresses humanisation through computer delegation, as the intention was for the computer to carry out actions that normally a human would be responsible for. Although a minor modification, this was a useful tool for setting limitations on control, allowing a performer to focus on the music rather than the tool. The device is a form of joint human-computer control, as a performer must turn on/off the device when desirable, while the computer carries out indirect control when initiated.

Evaluation

I experimented with this device in various places within my session, until finally deciding to place it on the master track. This was useful for making drastic alterations, turning dense glitch compositions into ambient soundscapes. Furthermore, by using the device intermittently, it allowed me to create space if a composition was too dense, which was something I intentionally did when writing certain compositions (see 8.6) to encourage this subtractive form of improvisation.

7.4.3 Freezey Stutter

Overview

This device is a combination of Freeze (Charles, 2008) and Stutter effects, which includes envelopes that can be used to automatically vary parameters.

Max for Live patch: *software/FreezeyStutter.amxd*

Video Documentation: *media/FreezeyStutter.mp4*

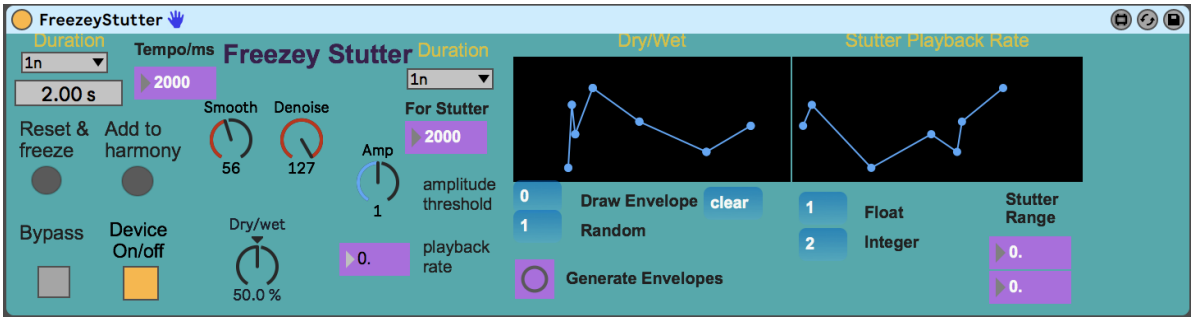


Figure 7.29: FreezeyStutter.

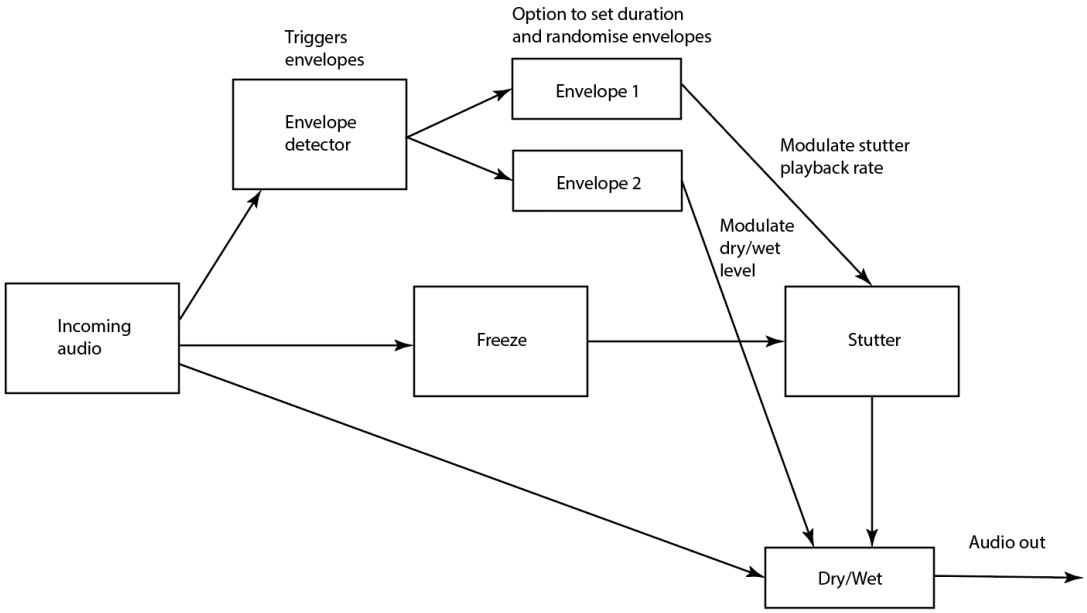


Figure 7.30: FreezeyStutter signal flow.

Functionality

- Automatically trigger freeze at set intervals
- Manually trigger freeze, deleting previous contents or building harmonies

- Modulate stutter playback rate using randomised envelope in a set range
- Modulate dry/wet control using fixed or random envelope
- Set duration for freeze and envelopes, manually set tempo or quantised note subdivisions
- Change spectral content of frozen audio

Rationale

This device addresses joint human-computer control, as the performer makes the decision as when to implement the device, yet the computer is responsible for the continuous modulation that ensues. Furthermore, this addresses the encapsulation of knowledge by bringing personal studio techniques to the stage, which create a novel sounding performance outcome.

Evaluation

I experimented with this device on individual tracks, until deciding to place it on the master track to process entire compositions (see /media/FreezeyStutter.mp4 1'28"). This was useful for drastically restructuring material, yet since the dry signal can be heard at times, a relationship can be distinguished between the original and processed sounds. Upon reflection-in-action, I realised the optimal way to apply this device was to turn it on briefly, otherwise its distinct character becomes the focal point of performances.

7.4.4 Timestretcher

Overview

This device builds upon my master's research and Volker Böhm's (2013) vb-stretch~[25] Max/MSP external. It incorporates two timestretchers and pitch-shifters

[25] See https://vboehm.net/downloads/ for technical information.

that process one loop, thereby creating a tool for temporally and spectrally manipulating material to produce ambient soundscapes (see /media/TimeStretcher.mp4 1’45”).

Max for Live patch: *software/Timestretcher.amxd*

Video Documentation: *media/Timestretcher.mp4*

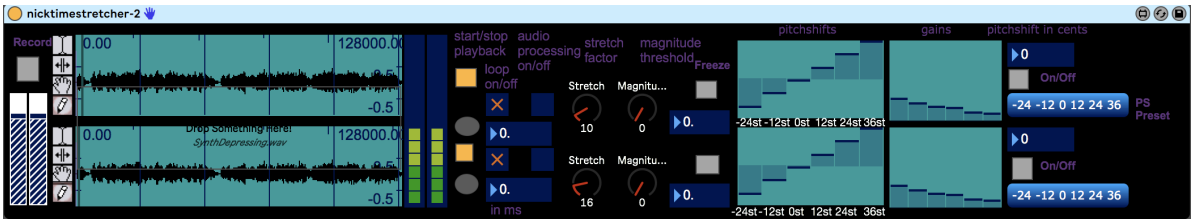


Figure 7.31: Timestretcher.

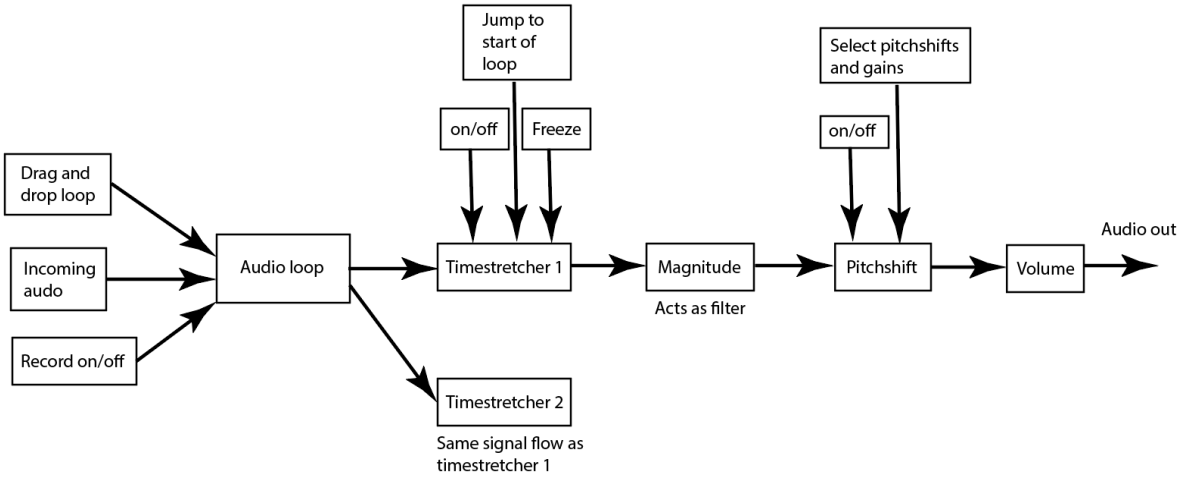


Figure 7.32: Timestretcher signal flow.

Functionality

- Record or drag audio into the device
- Set different speeds for each time stretcher
- Apply filters to time stretchers

- Freeze time-stretchers
- Add pitch shifting, six different pitches and gains

Rationale

This device addresses humanisation through the encapsulation of knowledge, which brings personal studio techniques to the stage and creates a novel sounding outcome. This extends compositional and improvisational possibilities, by providing a generative tool for creating ambient soundscapes in real or non-real-time. The everchanging nature of the device simulates an improvisational partner by providing unexpected ideas.

Evaluation

I use the device as a compositional tool, as rather than controlling it during performances, I will insert audio into the device and customise it in a particular way. The device is useful for varying compositional material, as although it acts predictably, the way I use it produces unpredictable results. From the moment I soundcheck, this device is set in motion, meaning that when I begin performing, there will be no way to predict where the device is within the sample. Thus, the outcome will be different with every performance, allowing for different realisations of the compositions.

Audio Effects Discussion

These effects create novel sounding outcomes and act as an improvisational partner through indeterminate computer processes. To insert my presence, I encapsulated some of the methods that I use in compositional and improvisational situations, which imitates the sounding outcome that could have resulted from my continuous control. The application of these effects is a form of joint human-computer improvisation. I determine when to employ them, which provides some control over the sounding outcome, yet the indeterminate computer processes provide unpredictable variation

that influences the outcome. These effects extended my sonic palette; however, it was pragmatic to have engaging sonic material and MIDI instruments that could be fed into these processes. Thus, the following section discusses the MIDI instruments that were used to accomplish this.

7.5 MIDI Instruments with Human Feel and Behaviour

This section details one Max for Live device aimed at adding human feel to MIDI drums, and the customisation of Live for the implementation of MIDI guitar:

- Polyrhythmic Humanised Step Sequencer (Section 7.5.1)
- MIDI Guitar Setup (7.5.2)

7.5.1 Polyrhythmic Humanised Step Sequencer

Overview

This device builds on ideas presented by Kasper Fangel Skov[26] (2017), to automatically add human imperfection and variation to percussive sequences in real-time.

Max for Live patch: *//software/PolyrhythmicHumanisedStepSequencer.amxd*

Video Documentation: *//media/PolyrhythmicHumanisedStepSequencer.mp4*

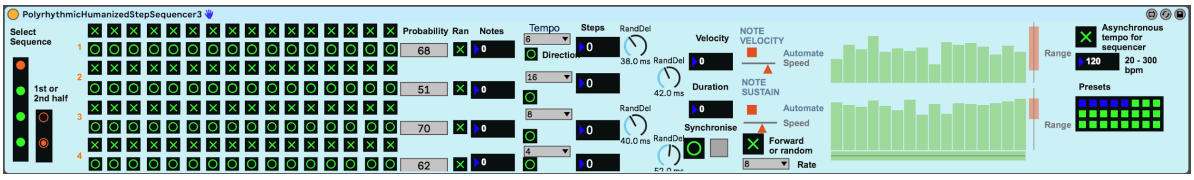


Figure 7.33: PolyrhythmicHumanisedStepSequencer.

[26] See https://www.kasperskov.dk/genstep for technical information.

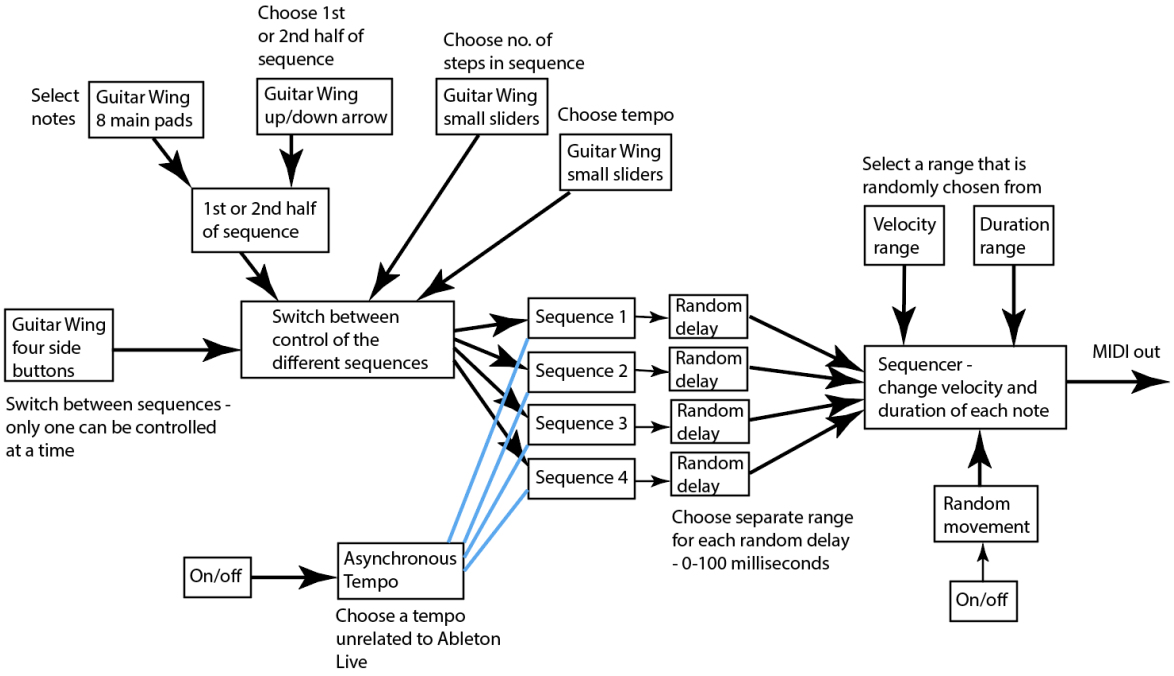


Figure 7.34: PolyrhythmicHumanisedStepSequencer signal flow.

Functionality

- Four sequences with up to sixteen steps
- Quantised or asynchronous tempo
- Set tempo and number of steps for each sequence
- Forward or random movement
- Set probability that selected notes will be played
- Apply random delay within a defined range
- Apply random velocities and durations within defined ranges
- Manually reset/synchronise sequences
- Save presets

Rationale

This device addresses humanisation through joint human-computer control in the real-time production of percussive material that incorporates human feel, imperfection and variation. Although Live allows for humanisation of MIDI material using its groove pool, it is not possible to do so in real-time. This device uses a sequencer that can be intermittently controlled in combination with computer processes that automatically add human feel and variation. This delegates tasks to the computer to create an improvisational partner that simulates a human drummer, as even when the performer does not engage with the device, every repetition of the sequences will differ.

Evaluation

When designing this device I set the limitation of four sequences, as I felt it would be difficult to control otherwise. This limitation makes it easier to switch between sequences and keep track of everything that is occurring. It also replicates a human's physical limitations, as there are only so many drums a human can play simultaneously.

Upon reflection-in-action, I realised that many of the device's features did not benefit from my control, such as varying the computer's part. Thus, I configure the computer's part when composing, which includes the degree of micro and meso variation. Thus, my performance role involves selecting notes, as well as changing the number of steps and tempo of each sequence (see /media/PolyrhythmicHumanisedStepSequencer.mp4 1'50").

The device was influenced by jazz practice, as I replicated some of the techniques competent jazz musicians engage in, such as polyrhythms, which is achievable using

sequences with different lengths and rates. This can produce ever-changing patterns, something that is not always desirable, as certain situations called for predictable, repetitive drum patterns. To suit the situation, the device makes it easy to transition between different patterns and tempos.

7.5.2 MIDI Guitar Setup

Overview

MIDI guitar was used in combination with a variety of software instruments to afford a wide sonic palette.

Video Documentation: *media/MIDIGuitar.mp4*

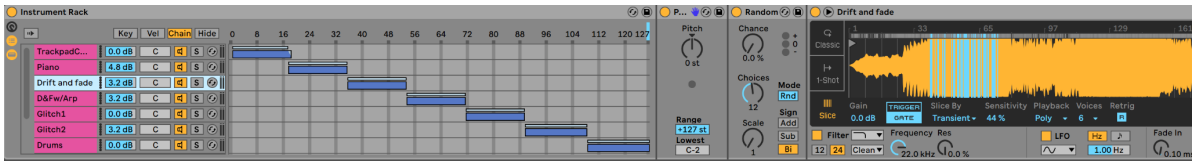


Figure 7.35: MIDI Guitar Setup.

Functionality

This setup allows a guitarist to perform digital sounds directly, which can be applied in combination with audio effects controlled using the SoftStep and Touchpad-GestureRecorder.

Rationale

This customisation addresses humanisation through the enhancement of human control over digital sounds by recycling virtuosity (see /media/MIDIGuitar.mp4 2’57”). Furthermore, it addresses liveness by allowing audiences to apply a mental model of guitar practice to digital sounds, and through the addition of human feel and imperfection that interaction with the guitar naturally provides.

Evaluation

This approach allowed for an alternative relationship with the guitar, as it changes how I interact with the guitar (see 4.4). I wanted to create a learnable instrument that I could develop a deep relationship with, therefore, I applied the same sounds when performing this portfolio of compositions. This setup also proved useful for remixing compositions in an improvisational manner, which involved placing an entire composition into Live's Simpler set to slice mode (see /media/MIDIGuitar.mp4 5'18"). This was compelling as every note on the guitar's fretboard produces a complex outcome, often containing multiple instruments.

Section Discussion

These MIDI instruments allow for the spontaneous creation of material, with human feel, expression and imperfection. This affords a higher degree of improvisation compared with working entirely with pre-composed material and contributes to liveness by directly controlling digital sounds. There were other processes in Live that allowed for the creation and variation of material, therefore, the following section discusses how I accomplished this.

7.6 Encapsulating Personal Knowledge into Ableton Live

This section details four customisations of Live aimed at enabling both direct and indirect control:

- Glitch Generator (Section 7.6.1)
- Use of Master Track (7.6.2)
- Control Over Instrumentation and Audio Effect Chains (7.6.3)
- Plugins for Computer Movement and Variation (7.6.4)

These improvisational tools are useful for adding real-time variation and movement to compositional material, at the behest of the performer, computer or both.

7.6.1 Glitch Generator

Overview

This develops ideas presented by Tom Cosm[27] (2011), who uses it as an automatic glitching machine to generate ideas. This customisation of Live's session view uses follow actions to change the routing of incoming audio and automatically modulate audio effects parameters on four processing tracks. When initiated, this can provide continuous and unpredictable movement, which a performer can partially control by deciding which processing track to route audio through (see /media/Glitch-Generator.mp4 2'30").

Video Documentation: *media/GlitchGenerator.mp4*

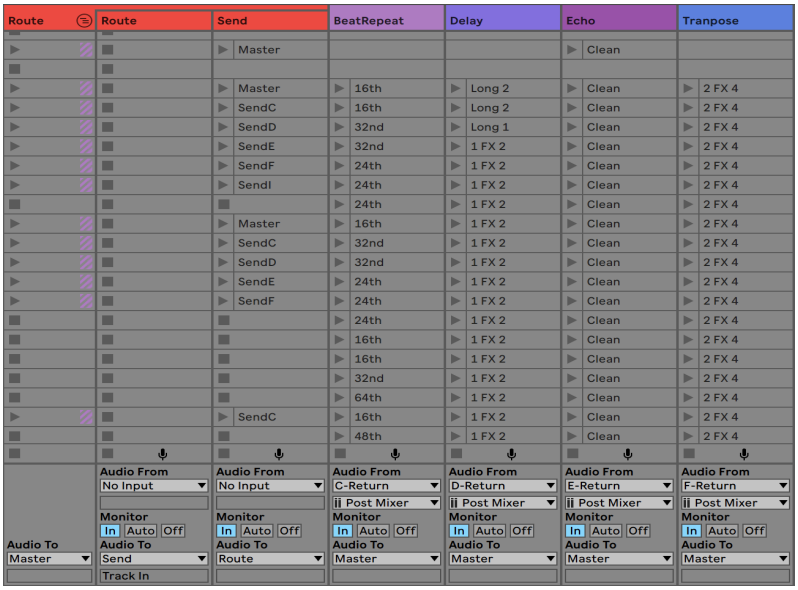


Figure 7.36: GlitchGenerator in Live's session view.

[27] See https://www.youtube.com/watch?v=Debt54sbh3s for video demonstration.

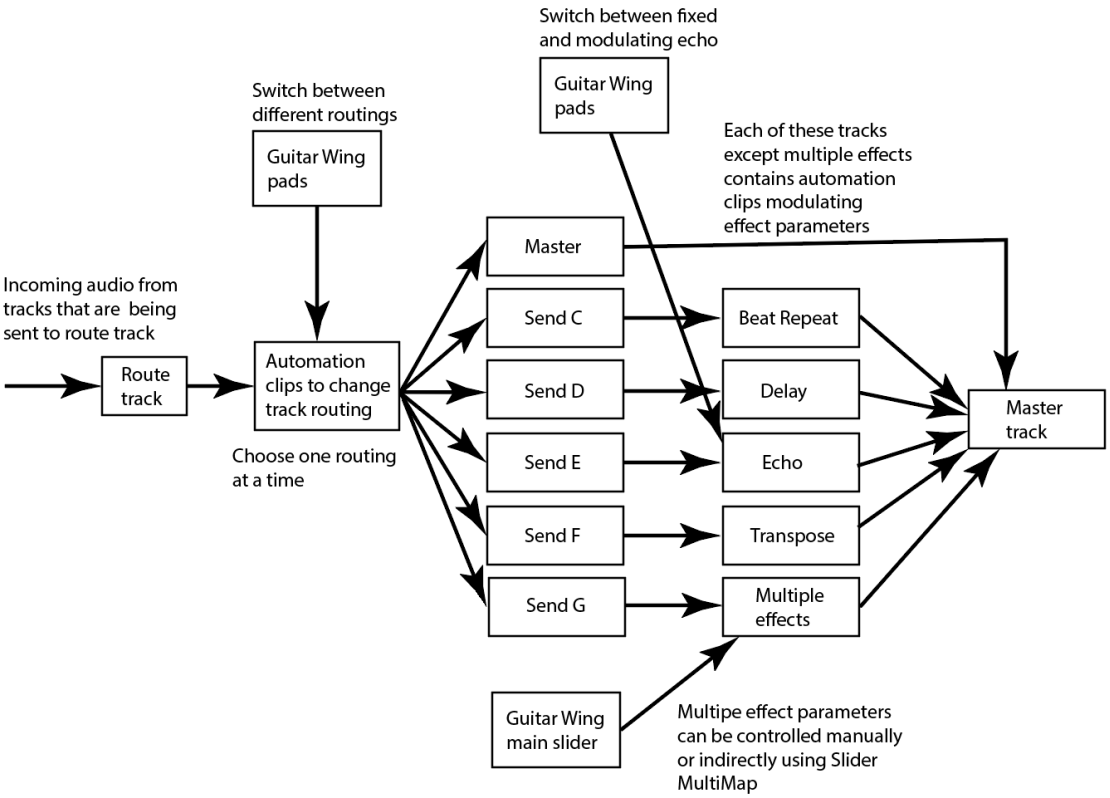


Figure 7.37: GlitchGenerator signal flow.

Functionality

- Four tracks with a continuously modulating effects: beat repeat, delay, echo and transpose
- One track with multiple effects utilising direct and indirect control
- Instantly alter the routing of incoming audio
- Optional fixed follow action on the echo track

Rationale

This addresses humanisation through joint human-computer control to create improvisational processes that provide continuous movement and spontaneous ideas. Furthermore, it addresses the encapsulation of knowledge by bringing studio techniques to the stage, as the outcome bears resemblance to how some composers

automate audio effects to create experimental sound design. Thus, the device contributes to liveness while providing a degree of mystery. Although a performer chooses the character of the overall sound and when to set the device in motion, the computer influences the outcome.

Evaluation

Initially I designed every routing with continuous computer movement. However, upon reflection-on-action following a rehearsal with a live ensemble, I realised it could benefit from some direct control. The continuous movement could become repetitive, as its character remained unchanged, meaning one could hear more of the effect than the original composition, which proved problematic for the ensemble who were following my lead. I made two modifications to rectify this. The first involved adding a fixed follow action on the echo track, allowing me to switch between fixed and continuous movement.

The second modification involved the creation of a new track containing various effects controlled directly and indirectly (see /media/GlitchGenerator.mp4 3”07”). Instead of using follow actions, I relied on two envelope followers to vary the parameters of Stutter and Bit Reduction effects. This provided slight alterations to incoming audio that depended on the volume, thereby adding unique characteristics to different sounds. This track also allowed for direct control using my SliderMultiMap software to control the parameters of Equaliser and Stutter effects, with the option of triggering SliderMultiMap’s sequencer and EnvelopeGenerator for indirect control. When using this track, I generally carry out direct control to differentiate it from the other routings.

7.6.2 Use of Master Track

Overview

I use Live's master track to manipulate material with improvised audio processing. This involved a variety of effects, including my FreezeyStutter and FreezeInterpolate, as well as Live's grain delay, beat repeat and auto pan.

Video Documentation: *media/AbletonLiveEnvironmentOverview.mp4 55"*

Functionality

- Control over density
- Spectral, spatial and temporal manipulation
- Create ambient or glitch outcomes
- Gestural control over grain delay parameters
- Indeterminate computer movement

Rationale

This customisation addresses humanisation through the display of human agency, as when altering entire composition actions have a noticeable impact. This is furthered using an accelerometer to control effect parameters in an embodied manner with a strong focus on the intelligence of physicality (see 7.8.1). Thereby, producing a causal link between gesture-sound that becomes the focal point of performances: visually and sonically (see /media/AbletonLiveEnvironment-Overview.mp4 2'14"). This also addresses the encapsulation of knowledge with indeterminate computer processes that add inconsistency to audio effects, which provides ideas and enhances a performer's engagement.

Evaluation

Through reflection-in-action, I discovered that these devices are best used sparingly, as otherwise one hears more of the effects than the composition. Furthermore, I recognised that the gestural control of the grain delay would benefit by producing a subtle outcome when the guitar is in a neutral position, and more drastic outcomes when I move the instrument's body forward and down (see /media/Studio-Recording2.mp4 50"). This made the effect easier to control and provided more of a causal relationship between gesture-sound.

7.6.3 Control Over Instrumentation and Audio Effect Chains

Overview

This customisation of Live uses the key chain selector to vary instrumentation and audio processing.

Video Documentation: *media/Instrumentation+AudioEffectChains.mp4*

Functionality

- Encapsulate multiple instruments on one track
- Encapsulate audio effect chains on one track
- Quickly transition or interpolate between instruments and effect chains

Rationale

This addresses humanisation through the display of human agency and liveness by providing a performer with control over a composition's instrumentation and audio processing (see /media/Instrumentation+AudioEffectChains.mp4). This leaves space for human improvisation, as the composer can create various sonic outcomes that the performer can implement flexibly. This could be achieved in Live's session view

using tracks with different instruments; however, this would be more challenging to control compared with my approach, as it would require turning on/off different tracks or clips, likely requiring more than one slider to achieve. My approach also provides the opportunity to interpolate between sounds, affording a wide sonic palette.

Evaluation

This approach simplified the control as I use two designated sliders on the Guitar Wing to switch between instruments or audio effects chains on every composition. This proved useful for varying instrumentation and engaging in experimental improvisation with the sound design while keeping the composition's identities intact since the incoming melodic, harmonic and rhythmic material remains unchanged. This provides contrast between compositions as I can incorporate alternative processing and instrumentation.

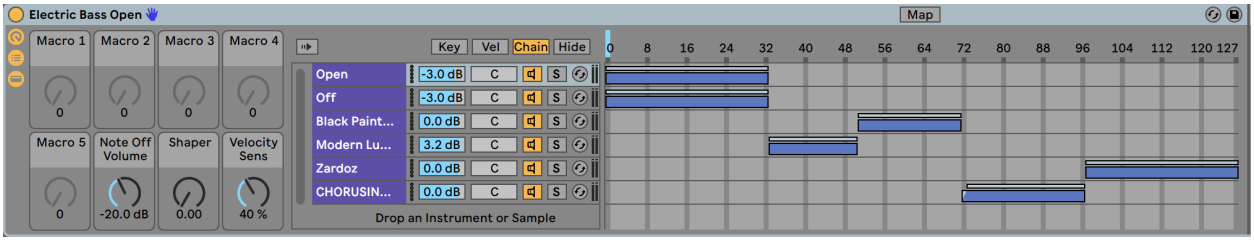


Figure 7.38: Immediate change of instrumentation.

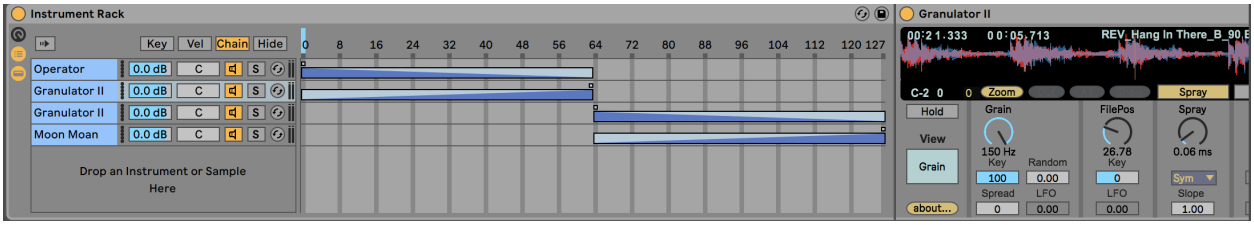


Figure 7.39: Interpolating between instrumentation.

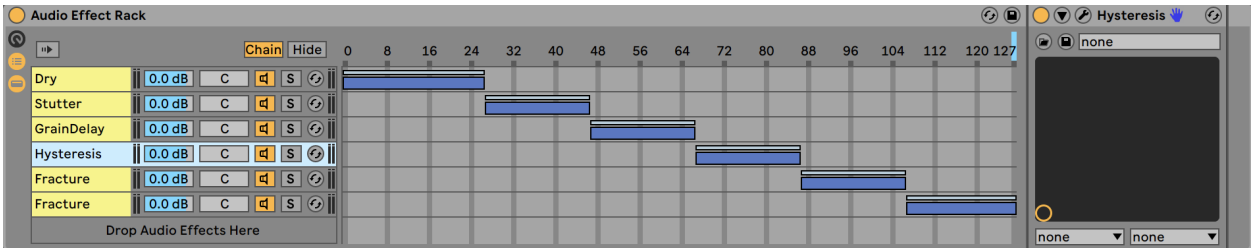


Figure 7.40: Switching between audio effect chains.

7.6.4 Plugins for Computer Movement and Variation

Overview

These plugins are useful for humanisation, as they allow a composer to design processes that produce different realisations of compositions within predefined confines.

Functionality

Beat Repeat

- Predictable or unpredictable variation
- Altering density: additive or subtractive
- Providing alternative rhythmic material

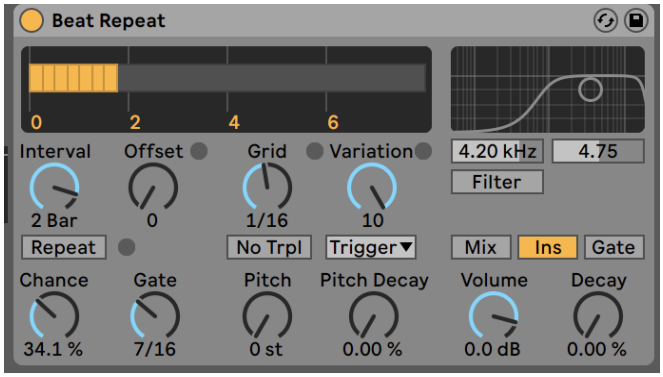


Figure 7.41: Beat Repeat set to insert mode, 34.1% chance that it will turn on every second bar.

Random

- Varying melodies, harmonies and percussion
- Set degree of variation

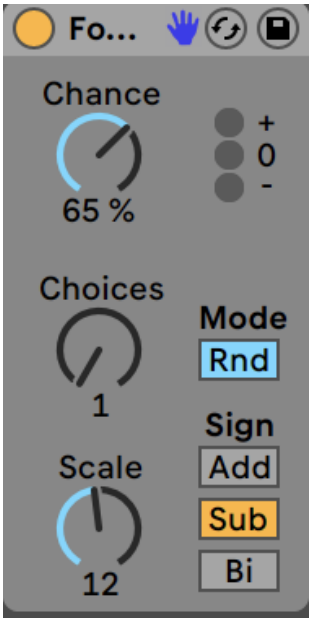


Figure 7.42: Random effect.

Velocity

- Vary velocity and density
- Subtle or drastic variation

Device Randomiser

- Randomise audio effects
- Continuous, unpredictable movement

LFO

- Randomise any parameter within Live
- Predictable or random movement

Rationale

These devices address composition and improvisation, by allowing composers to devise computer improvisation processes that are useful for humanisation as they create microinteraction and motivic development. This also provides an improvisational partner that helps interpret composed material, allowing a performer to delegate mundane tasks to achieve more focused control.

Evaluation

These devices added an element of surprise to performances, as they vary the melodic, harmonic and percussive material, as well as the velocity and density of notes. This replicated my jazz practice, where it was common to interpret composed material, which involves subtle and constrained variation that references to the original melody and harmony.

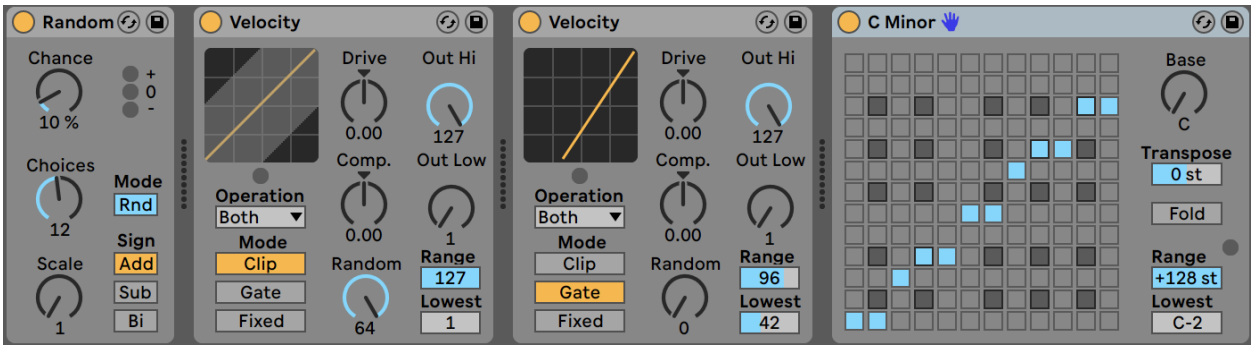


Figure 7.43: Random, velocity and scale effects.

The Device Randomiser device was useful for varying entire audio effects, which proved advantageous for continuously altering the spectral content of synthesizers. For example, I use the device randomiser to continuously vary a filter's settings (see Figure 7.44), which results in ever-changing sounds being produced by the synthesizer (see /media/StudioRecording1.mp4 1’10”-1’35”).

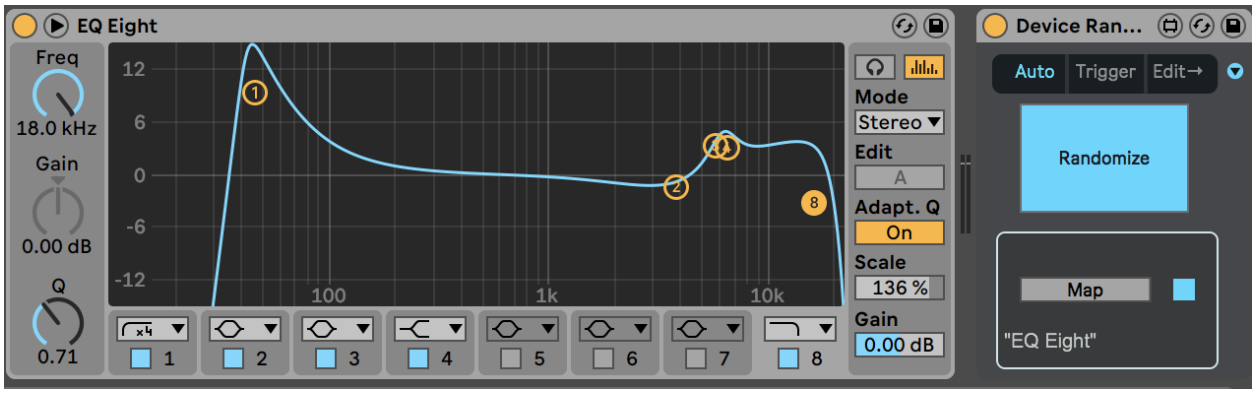


Figure 7.44: EQ eight and Device Randomiser.

The LFO effect was useful for automatically varying parameters, for example, varying the timbre of synthesizers, by making slight adjustments to an oscillator's pitch, which replicates the microinteractions found in acoustic musicians' playing.

Figure 7.45: LFO mapped to a synthesizer's oscillator detune.

Section Discussion

These customisations were designed to vary melodic, harmonic and percussive material, as well as manipulating spectral and spatial content. Live allows for human and computer improvisation, therefore, I had to consider where to take an approach based on control or delegation. I generally chose to control the processes that

produced a noticeable impact and causal gesture-sound relationships, such as changing instrumentation. The computer carried out less noticeable improvisation that would not have benefited from my control, such as microinteraction. Some of these customisations involved joint human-computer control which were designed so that my agency could outweigh that of the computers. This approach meant that if something went wrong in the noticeable aspects of a performance, I could correct this. With regards to liveness, this was useful as audiences can witness apparent gesture-sound relationships and imperfect blemishes.

7.7 Designing the Guitar and Hardware Components

This section discusses the design of the physical instrument and how it controlled the software environment while humanising the performance experience.

7.7.1 Background

Diversity in the interfaces I employed allowed for various control methods. Although the physical and virtual environments were of equal importance, I created much of the software before considering how the hardware could be applied. Throughout this process, I was experimenting and thinking about how this material could be controlled while developing bespoke software (see 7.3) that would enhance the control methods of various kinds of interfaces. Before determining which control strategies would be appropriate, I considered the layout of the physical performance environment, as this can alter the effectiveness of control strategies. This was also useful for improving the audience's experience, as it affects the visibility and comprehensibility of the interactions.

My approach to control moves between composer, conductor and instrumentalist paradigms, which provides a rich source of possibilities; however, engaging with these various aspects proved challenging. I had to determine how to make

transitioning between guitar and controllers effective while providing the experience of one coherent instrument. Augmenting the guitar was the logical solution, as this exploits the connection and physical location of the acoustic and digital layers. I also witnessed the benefits other practitioners (see 3.4.3), gained from adopting this approach.

Deciding upon controllers was challenging considering the vast array of options available, including commercial devices and custom-built. Reflecting upon my digital practice brought me to the realisation that some features of the Push were useful, including the touch-sensitive pads and visualisation of the software. It was also pertinent to factor in the spare bandwidth available. I had plenty of spare bandwidth with my right hand and feet, therefore, I desired controllers that exploit this.

To overcome the necessity to switch between performative and operational tasks, each aspect of the instrument was designed to achieve a fixed purpose. Over time this had the benefit of creating a greater awareness of how each device behaved, and how they could be used in combination. To accomplish this approach, I had to set constraints on control, as when using controllers with fixed functionality extensive control is difficult. I made compromises by relinquishing control over aspects of the software, and mainly focusing on dedicated processing tracks.

7.7.2 Choosing Controllers

Flexible control required a diverse range of options, including continuous controllers in the form of sliders, accelerometer and touch-sensitive pads, as well as binary (on/off) pads and switches. Furthermore, I wanted a device that translated the guitar's sonic output into the digital domain. I decided upon the following interfaces as they offered this diversity amongst other factors that I will address.

- Livid Guitar Wing
- Keith McMillen SoftStep 2

- Triple Play MIDI pickups

These controllers were customised for the guitar, with the variety of interaction methods I required. The different affordances they provided rendered them useful to perform in combination with each other and the guitar. I also chose these controllers because of their compactness and wireless functionality, which allowed for a moveable instrument. Furthermore, they are non-invasive, meaning the interfaces and techniques can be transferred between guitars to suit various musical contexts. Although these controllers seemed like the appropriate choice, I still needed to determine how they could be used to control the software effectively.

7.8 Integrating the Guitar, Digital Interfaces and Software

This section discusses the value in these controllers for guitarists and how they were used in combination with the software to humanise the performance experience and facilitate engaging improvisation.

7.8.1 Guitar Wing

Overview

The Guitar Wing is a non-invasive guitar body-mounted controller with three sliders, five touch-sensitive pads, six binary (on/off) buttons, four binary side switches and an accelerometer that can be turned on/off using one of the pads. The interface is designed to be placed near the guitar's strings, making it ideal for controlling with the picking hand.

Functionality

The device was used for fine control and setting digital processes in motion. This included control over the following aspects of the software:

- GlitchGenerator
- SliderMultiMap
- EnvelopeGenerator
- Gestural control of master track grain delay parameters
- Master track effects (on/off): FreezeInterpolate and FreezeyStutter
- Key chain selector: instrumentation and audio processing chains
- Beat repeat filter (on/off)
- Optional control of PolyrhythmicHumanisedStepSequencer

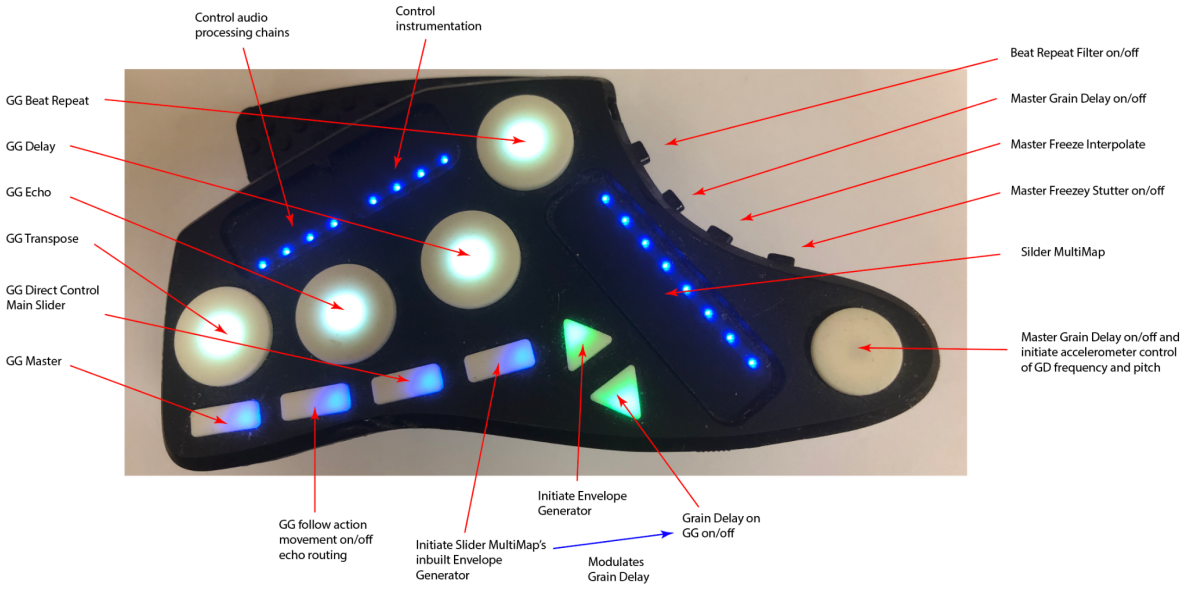


Figure 7.46: The Guitar Wing's main functionality.

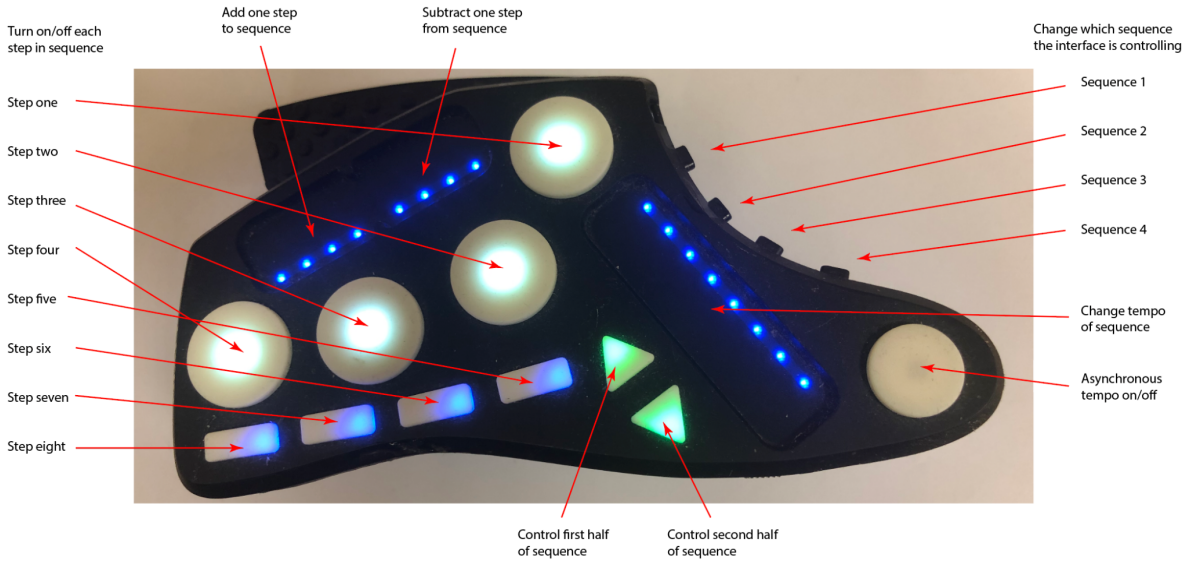


Figure 7.47: The Guitar Wing's alternative functionality, control of Polyrhythmic-HumanisedStepSequencer.

Rationale

This interface addresses humanisation through recycling virtuosity and transitioning between guitar and DMI technique (see /media/StudioRecording1.mp4 20"). Its tangibility and ergonomic layout are advantageous for navigating the entire device while keeping my right hand in one static position. This facilitates the transition between guitar and DMI technique while utilising touch and spatial awareness to guide actions. This interface can also be applied in combination with guitar pedals, which was something I found troublesome in the past when using table controllers, since guitar pedals occasionally require hand control. In these situations, it is difficult to transition efficiently between controller and pedals. I could play guitar in these situations; therefore, the Guitar Wing could also be applied, which provided the opportunity to simultaneously interact with the guitar, pedals and digital environment.

It was possible to recycle virtuosity when interacting with the sliders, as this is like the technique required when controlling the guitar's knob to achieve volume swells[28]. This proved beneficial, as I was accustomed to playing guitar while carrying out these actions. Another common guitar technique I exploited was finger tapping, which was transferable to the pads. I had developed a lot of competence with this technique which enabled me to interact with the pads effectively (see /media/GlitchGenerator.mp4 4'13").

To display a meaningful link between gesture-sound, most actions that resulted in embodied interactions were applied to the hands. This included the use of this interface's main slider in combination with my SliderMultiMap software to control effect parameters; the use of the small slider to interpolate between synthesizer sounds; and the gestural control of master track effect parameters using the accelerometer.

Gestural control required the movement of the guitar's body, which provided a means of applying an audience's mental model of guitar interaction to the digital domain, as guitarists regularly move the instrument to alter the sonic properties or interact with the instrument differently, such as with a neck bend to achieve a vibrato effect[29]. Although the other control processes were not embodied, these actions produced a causal link between gesture-sound. The immediate switch between instrumentation and audio processing resulted in an immediate shift in the sonic content of certain instruments. Similarly, the time-based EnvelopeGenerator, produced drastic movements in audio effect parameters that were immediate and apparent when triggered.

These actions are visually apparent since the guitar is directed towards the audience at most times, while inbuilt lighting makes it easier to understand which part of the interface is being controlled. Finally, the fact that I developed a moveable instrument

[28] Creating a crescendo by gradually adjusting the volume knob from zero to ten.
[29] See https://www.youtube.com/watch?v=-Z7dF0FfZTQ for video demonstration.

allows me to move away from the laptop and engage in a full-body experience, letting audiences see more of the instrument, gestures and skill.

Evaluation

I wished to find a way to use all the interface's features in combination. Carrying out direct control using every pad, switch and slider was impractical. Therefore, when configuring mappings, certain features carried out direct control, whereas others set indirect computer processes in motion. This proved beneficial for improvisation, as I could use human and computer processes in combination, thereby allowing for complexity and diversity in the sonic outcome. The main four pads were a focal point of motivic development and interaction (see /media/StudioRecording2.mp4 4'12"). This involved changing between audio processing using the main pads and GlitchGenerator in a rhythmic, motivic fashion, allowing for a digital form of jazz sequencing which incorporated computer contributions. The main slider allowed for motivic development, as I could carry out alterations to composed motives using audio effects. Finally, the control over instrumentation and audio processing chains allowed me to play the role of conductor, by varying the instrumentation and intensity level (see /media/StudioRecording2.mp4 7'40").

It is also possible to control my PolyrhythmicHumanisedStepSequencer (see 7.5.1). However, this software required the use of the majority of the Guitar Wing's features, making it necessary to carry out operational tasks to control this device, which was something I wished to avoid. Thus, I mainly use this software to generate material during the compositional process or in free improvisational contexts.

7.8.2 Keith McMillen SoftStep 2

Overview

This interface is an expressive MIDI foot controller with ten gesture-sensitive pads that register pressure and position. Each pad can be set up in numerous ways,

including toggle, pressure, XY and Y increment, meaning each pad to be customised to a parameter, with the option of switching between twelve presets. The pads also have LEDs and alphanumeric displays that show the current state of the software.

Functionality

The interface was mainly used to turn on/off audio effects and digital processes, although in some situations it was used for continuous control. This included control over the following aspects of the software:

- Processing track audio effects (on/off): stutter, echo, buffer shuffler, transpose, ring modulation and asynchronous looper
- Master track beat repeats (on/off)
- Beat repeats on individual tracks (on/off)
- Trigger SliderMultiMap gesture recording
- TouchpadGestureRecorder: return sends and synthesizer parameters
- MIDI guitar instrumentation

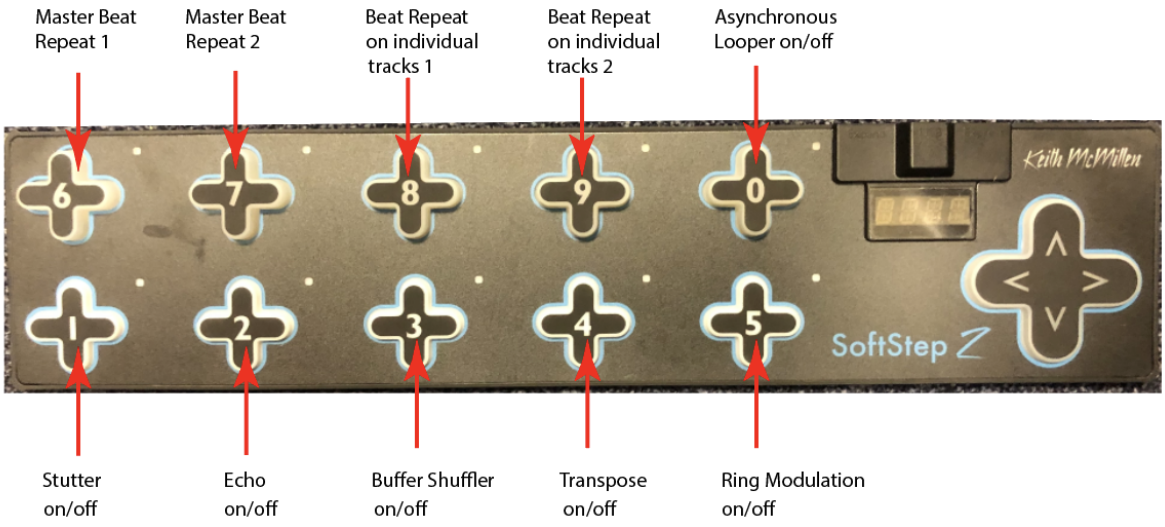


Figure 7.48: SoftStep 1 functionality.

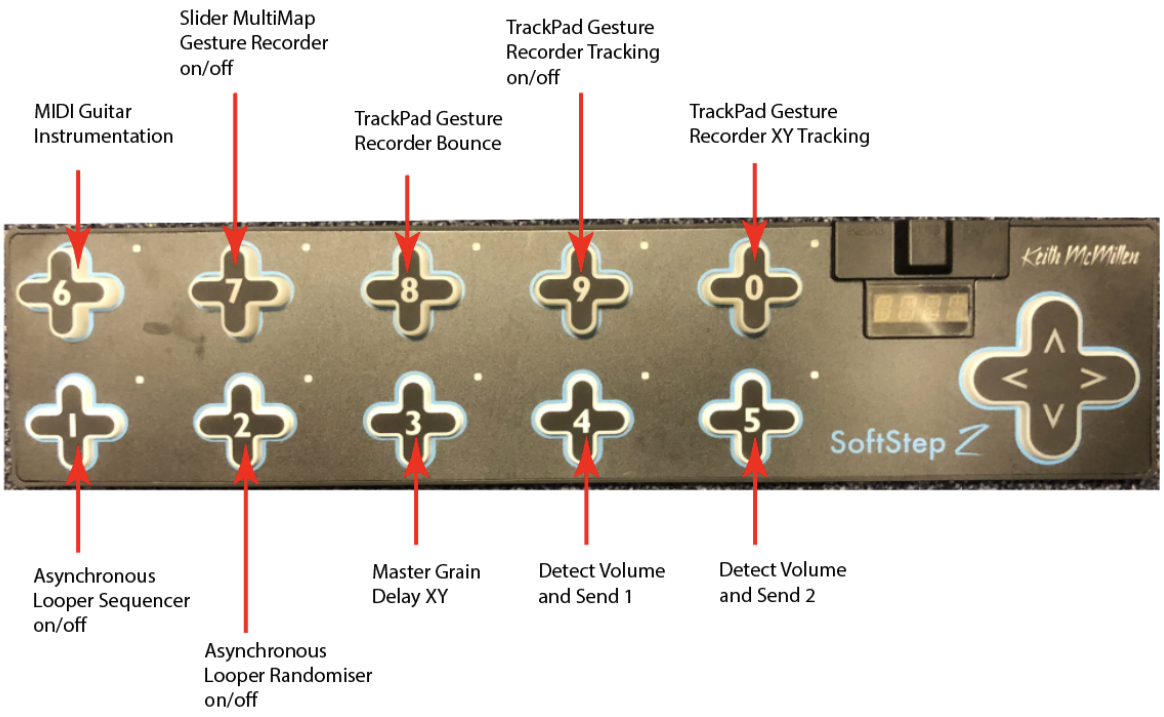


Figure 7.49: SoftStep 2 functionality.

Rationale

The SoftStep addresses humanisation through recycling virtuosity and transitioning between guitar and DMI technique. It is controlled using the feet, which allows it to be readily applied in combination with the hands (see /media/StudioRecording1.mp4 1'50") and guitar pedals. This affordance allows for the recycling of virtuosity, as it can be used to control digital audio effects much like guitar pedals. I used it in this manner to apply processing to digital compositions and live guitar, and occasionally varying MIDI guitar sounds.

This was beneficial for humanising the audience's experience, as it provided another means of applying a mental model of guitar interaction to the digital domain. This was a useful mental model, as the use of effects pedals is ubiquitous, even among non-guitarists. Furthermore, toggling on/off audio effects provides a causal link between

gesture-sound, as actions have an immediate and noticeable impact on the sonic outcome (see /media/WeeRedBarPerformance.mp4 23’38”). The way I generally use the interface does not result in embodied interactions; however, it influences the embodied interactions occurring on the Guitar Wing. This involves turning on/off effects being controlled using the main slider, which resulted in more complex, ever-changing embodied experiences. This necessitated the synchronous use of multiple limbs, which displayed skilful actions and contributes to liveness.

There was one aspect of interaction that was embodied, which involves the control of the TouchpadGestureRecorder to continuously vary MIDI guitar sounds. This afforded a transparent form of control, as upon disengagement with the SoftStep’s XY pad, it reverts to a predefined state and, therefore, engagement is a requirement to achieve an outcome (see /media/TouchpadGestureRecorder.mp4 2’39”).

Evaluation

The interface was designed as a primary method for turning on/off audio processes, therefore, in most instances it does not require a high degree of skill. Furthermore, the inbuilt lighting eased cognitive load by displaying the current state of the software. These factors had the benefit of allowing me to mainly concentrate on continuous hand control. However, using the interface to turn on/off effects in quick succession while manipulating parameters with my hands, required skill with the entire instrument to carry out these complex, synchronous actions.

Although the SoftStep afforded the ability to change between presets, I wished to avoid this so as not to distort the gesture-sound relationships and disturb the flow of performances. At first, I used one other preset in combination with MIDI guitar to restore some of the nuances lost when translating the guitar’s sonic output into MIDI. Upon reflection-on-action, I realised that it would be sensible to incorporate a second SoftStep into my setup, dedicated to MIDI guitar.

With regards to improvisation, I was able to carry out macro improvisation with the SoftStep, using audio effects to change the density and intensity level (see /media/WeeRedBarPerformance.mp4 3’18”). Furthermore, using my Asynchronous-Looper, I was able to take ideas from one section and move them to another. This SoftStep also allowed for motivic development as I was able to carry out slight alterations using audio effects. Since I could combine these effects in numerous ways, there was much scope for improvisation.

7.8.3 TriplePlay MIDI pickups

Overview

This is a MIDI guitar integration device that allows for low latency control of virtual instruments, thereby allowing guitarists to control a digital environment utilising the guitar’s tactile feel and technique.

Functionality

This device was used to directly control digital sounds, including the following:

- Operator synthesizer
- Simpler containing glitch sound design
- Simpler containing entire compositions
- Piano virtual software instrument
- Sampler containing percussive samples
- Clips in session view

It is possible to change what MIDI guitar is controlling using the SoftStep’s pads. The SoftStep and TouchpadGestureRecorder also allow for the control of the track's send returns, which can be used to send audio to the GlitchGenerator.

Rationale

This interface addresses humanisation through recycling virtuosity and the intelligence of physicality. The TriplePlay pickups were particularly effective for these purposes, as they enabled the control of music technology using embodied guitar knowledge and technique. This is useful for competent guitarists who have developed a higher level of skill with the guitar than digital interfaces. Personally, it would have taken years to develop the same level of competency on digital interfaces that I had acquired with the guitar.

When determining the functionality of MIDI guitar, I wanted the sonic outcome to differ from that of the guitar, yet maintain the same interaction methods. To accomplish this, I use it to perform glitch sound design, as well as sampling and remixing entire compositions. Since this material does not relate to the harmonic structure of the guitar, it results in sound and discovery (see 4.4), which allows for an alternative relationship with the guitar.

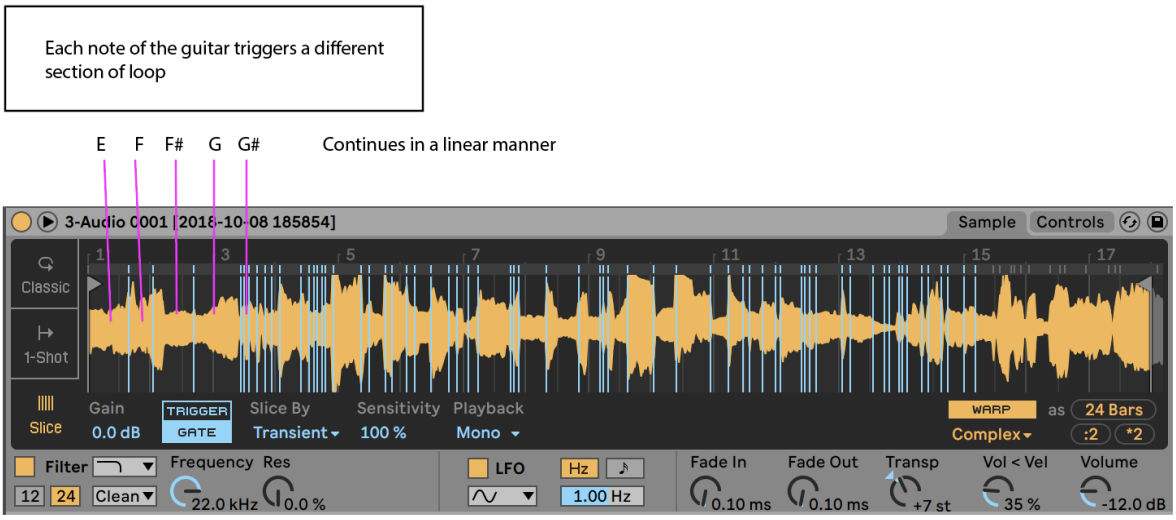


Figure 7.50: Simpler containing extended glitch sound design, subdivided into smaller samples that can be triggered separately using MIDI guitar.

This device was effective for humanising the audience's experience, as it is possible to apply a mental model of standard guitar technique to digital sounds. Furthermore, guitar technique is visible as the instrument is faced towards the audience. The direct control of digital sounds also produces a causal link between gesture-sound, as every note on the guitar has a fixed outcome while interaction is a requirement for sound to occur. Although it is possible to switch between sounds, when performing I kept the instrument fixed throughout a set. However, I often changed the sounds I was controlling for each performance to create alternative versions of my compositions.

Evaluation

Most functions that required a high level of physical competency were carried out using MIDI guitar. As controlling digital sounds on the note-based level required the greatest degree of physical competency, this became the main purpose of MIDI guitar. This approach significantly improved my sense of control, as I was able to navigate digital sounds using touch and spatial awareness, as well as guitar knowledge and technique.

This form of control was useful for humanisation, as interaction with the guitar naturally results in microinteractions and the physical limitations of the muscles. To make this audible, I designed digital sounds without significant sustain to create space between sounds. Interaction with MIDI guitar also allowed for the application of jazz techniques, such as motivic development and sequencing (see /media/MIDI-Guitar.mp4 5'26"). This benefited the music, as there was development and repetition in the motives.

Although I mostly use MIDI pickups to perform music on the note-based level, in modal compositions I sometimes trigger session view clips. In these instances, each clip incorporates a different arrangement of the composition which allows me to vary the form. Similarly, it is possible to sample an entire composition and trigger different sections using each note on the guitar. When engaging with these approaches, it is

possible to create interesting breakbeat patterns by triggering clips or sections in quick succession (see /media/MIDIGuitar.mp4 5’19”). This was compelling, as every note on the guitar produces a complex outcome, often containing multiple instruments.

A concern when using MIDI pickups was the loss of nuance, expression and extended techniques that result from converting the guitar’s sound into MIDI. However, using MIDI guitar in combination with the other digital interfaces and processes provided a way to restore some of these behaviours. The SoftStep’s pressure-sensitive pads could continuously modulate the timbre of synthesizers (see /media/TouchpadGestureRecorder.mp4 3’12”). Moreover, the gesture recording, and indeterminate techniques afforded by my TouchpadGestureRecorder meant that I could add inconsistency to MIDI guitar. This humanised MIDI guitar by providing a personal approach to playing digital instruments, with human nuance and imperfection.

The interaction methods for the guitar and MIDI guitar are the same, which makes it possible to have both sonic outcomes simultaneously. However, this was something I avoided, as this makes the gesture-sound relationships unclear. Furthermore, this often did not work well, as the MIDI sounds I was controlling did not always correlate to the harmonic structure of the guitar, which required different actions. To switch between these, I used a SoftStep pad to turn on/off MIDI guitar.

7.9 The Use of Mapping Strategies for Different Levels and Purposes

This section describes the flexibility of the mapping strategies I have created. The hybrid guitar was designed to allow for simple or complex mappings to be applied at any given moment, making the instrument accessible while providing challenge upon deeper exploration. During the initial stages of learning the instrument, simple

mappings were useful as I could easily predict the outcome of my actions, allowing me to competently play the music with precision. These mappings provided a degree of challenge at first; however, soon became too predictable and easy to use. After getting accustomed to these capabilities, I began using complex mappings which were effectively combinations of the simple mapping strategies. Initially, this made the instrument feel less intuitive; however, it immediately allowed for more complex and interconnected eventualities. Having an instrument capable of different mapping strategies proved advantageous as this meant I could vary the level of complexity. Furthermore, applying simple mappings at times gives a better insight into how the processes work in combination.

The way I used the instrument was dependent on the situation. Simple strategies worked better in structured sections that required precise manipulation, whereas complex strategies suited situations with room for experimental and drastic outcomes. Complex mappings were also useful for improvisation, as they sometimes resulted in mistakes which provided ideas and pushed performances into unanticipated directions. To gain proficiency, I had to deal with these unanticipated ideas and use them to my advantage (see 8.6). This process was aided by freezing the development of the instrument.

7.10 Freezing the Development of the Hybrid Guitar

Much like Michel Waisvisz, I froze my instrument's development for a period to struggle with it, learn what it was capable of, and develop embodied tacit knowledge. This highlighted problems with its design while giving rise to new features and modifications that improved its capabilities and playability. I avoided a complete overhaul, instead choosing to gradually add new features, keeping those that worked well with previously existing features. These alterations were designed to allow for a balance in challenge and frustration, thereby making the performance experience more enjoyable and increasing the likelihood of flow states.

As I became familiar with the instrument, I realised I could expand my control over aspects of the environment without negatively impacting my sense of control. I incorporated more direct control over the environment, which I accomplished by adding features to the GlitchGenerator (see 7.6.1). Another way I achieved this was by adding more audio effects and instruments as I became more accustomed to the system. As a result of these modifications, interaction with the hybrid guitar afforded more flexibility and complex outcomes.

I found that indeterminate computer-enhanced actions could be used to spontaneously add challenge, as when triggered, it is necessary to deal with the unpredictable consequences. This approach was useful as I was not obliged to apply these processes, meaning I could just use them in moments where challenge was desirable, providing real-time control over the balance between challenge and frustration.

Freezing development extended to compositions and improvisation strategies. This material was complex and could be manipulated in a multitude of ways, which I found overwhelming at times. After engaging with these compositions for an extended period, I discovered certain actions that were well suited to the different compositions. This allowed me to develop a rough performance plan (see Chapter 8), which helped create consistency in how the portfolio was performed.

7.11 Summary

This chapter discussed the development of software that was designed to allow for visible extended human control, as well as compelling interactions that enhance the experience for the performer and audience. Accomplishing this involved the encapsulation of knowledge, with a focus on human feel, variation and aesthetic preferences. Most methods concentrate on improvisation, human and computer, while some involved joint human-computer improvisation. This included audio effects

that provided new techniques for sound sculpting and bringing studio techniques to the stage, which expanded my sonic palette and contributed new ways of creating and manipulating material in real-time. I also described the development of software that extended and augmented human control, which was achieved through multi-mapping strategies, computer enhanced human actions, and gesture recording, thereby providing various forms of direct and indirect control.

Following this, I discussed the design of the hardware components, explaining my rationale for choosing these devices and why each device was suited to a particular functionality. My main motivation for choosing these devices stemmed from the fact that they allow me to utilise pre-existing guitar and DMI skills. Furthermore, these devices complement each other by providing different affordances and interaction methods. This had the benefit of resulting in a full-body experience, which is enhanced by the fact that it is a moveable instrument. The instrument was also designed for skilful actions that are perceivable to audiences, which was accomplished by transferring the gesture-sound relationships from guitar practice to the controllers and digital environment.

Chapter 8 Portfolio of Compositions

8.1 Introduction

This portfolio demonstrates the uses of the software, hardware and practice-led approaches discussed so far. I created compositions in a broad range of hybrid electronica musical styles that employ a variety of compositional methods. The software and improvisation methods help to instil a distinct character into every piece that gives coherence to the portfolio. Each composition is different in nature, therefore, the way I control and interact with them varies. However, since I broadly use the same methods there is sonic coherence and consistency in the gesture-sound relationships. Each piece in the portfolio contains some indeterminate computer methods that provide surprises, thereby requiring my awareness, including:

- Whether notes are triggered
- Characteristics of notes: timbre, pitch, velocity and duration
- Computer methods that capture and interpret material
- Human-computer control processes that produce unpredictable variation of audio effects

Most of the portfolio was designed to be performed entirely by a solo performer, myself, using the hybrid guitar. It is possible to perform these compositions and use aspects of the instrument within the context of an ensemble, which the composition Phases demonstrates.

8.2 Phases

Composition Summary

This composition incorporates the Guitar Wing into ensemble performance to create interplay between instrumental musicians and live electronics. The ensemble includes, clarinet, two violins, viola, cello and double bass. I composed notated parts for these musicians, and I do not apply audio processing to their parts. Interplay involves my improvisational control of the live electronics, containing drums and synthesizer. The composition has a fixed structure with identifiable sections. However, there were sections, such as the introduction, that were unpredictable as the low-level elements were generative, which required my awareness and kept me attentive for the predictable sections.

Composition Commentary

The arrangement of this composition follows the common jazz standard form of ABAB, as it has the following structure: Intro A B C A B A.

The introduction consists of an atmospheric generative synthesizer, with multiple MIDI clips of different lengths being fed into it. These clips contain melodic material in various ranges to produce multiple independent layers. This section was designed to surprise me, as it incorporates computer variation which alters the synthesizer and drums on the note-based level. For example, the synthesizer's incoming notes are being changed using random and scale effects while its timbre is altered using an LFO to detune its oscillator. Similarly, the drums contain random and beat repeat effects which alter the material on a note-based level. Unlike the intro, the A and B sections contain fixed melodic and harmonic material. Both sections have a distinct identity which I accomplished by applying different rhythmic feels. The drums in the A section have a straight eights rock feel, whereas the B section has a loose, swing hip hop feel.

With regards to improvisation, I followed the jazz standard paradigm of starting and ending with the melody with solo improvisation in between. Unlike jazz where solos occur over the harmonic movement of the A and B sections, I composed a C section that was modal and pattern based. This section contains a repeated bass and drum groove that remains in one key centre. It also incorporates a sparse ambient instrumental arrangement with an ever-changing harmony, as the clarinet and violin parts moving in and out of synchrony with the other instruments. This allows me to be experimental with my improvisation, as there is more space since fewer ideas are produced by the other musicians. The modal and ever-changing nature of this section lends itself to a digital form of 'playing outside'. I can freely superimpose alternative sounds and harmonic movement over the instrumental arrangement and resolve these ideas back to the section's key centre by ceasing the improvised audio processing.

I composed the computer and instrumental parts in tandem. The instrumentalists perform the melody, whereas the harmonies were performed by both the instrumentalists and computer. This resulted in a recognisable melody, as specific instruments played it in a scripted manner. To avoid the computer part overpowering or confusing the instrumentalists, I kept it simple and used techniques that would not significantly distort the composition's identity (see Figure 8.1).

Figure 8.1: Random and LFO effects for varying synthesizer sounds.

Performance Summary (see /portfolio/Phases.wav)

This composition was recorded at the 2019 Dialogues Festival, performed by the Rush Hour Ensemble (see Appendix A). This performance afforded liveness in the electronic part, as I fulfilled a specific role of jazz accompanist and soloist, varying the harmony while playing off the other musicians. It was important to visually conduct and be aware of the other musicians to synchronise the different elements of the composition. To accomplish this, my improvisation allowed me to quickly revert to the original harmonic structure if the other musicians got lost. This involved controlling arpeggiator and stutter effects on the synthesizer track, and routing this through the GlitchGenerator. To enhance the flow of performances, I drew up a plan (see Figure 8.2), which is concerned with when and how I should improvise and vary the intensity level.

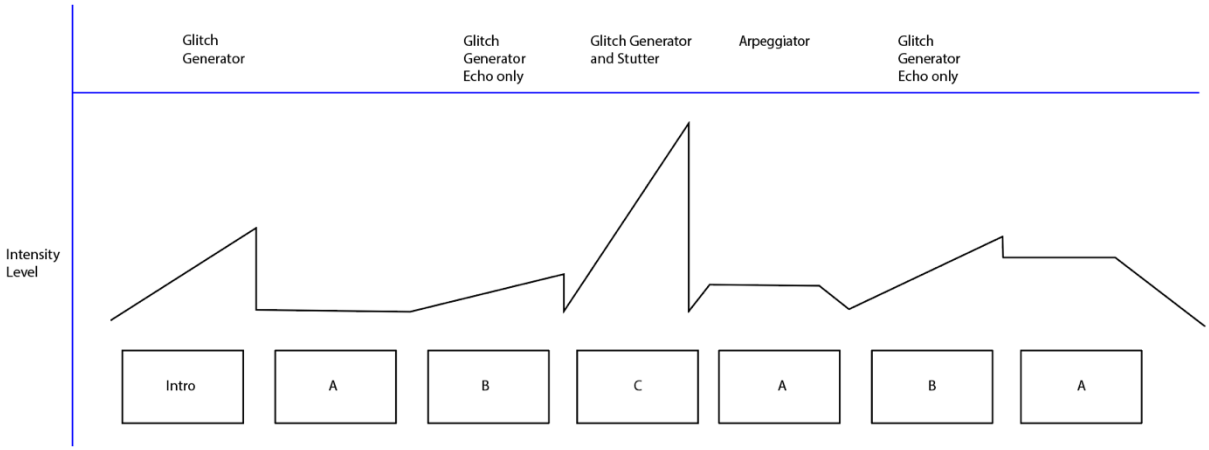


Figure 8.2: Phases performance plan.

The stage layout was important for the musicians to see my gestures and hear the computer part, to prevent them getting lost and look to me for guidance. To achieve this, I positioned myself on the stage to the side of the musicians and stood

throughout the performance. Furthermore, the sound engineers set up onstage monitors playing back the computer part.

Figure 8.3: Picture of stage layout.

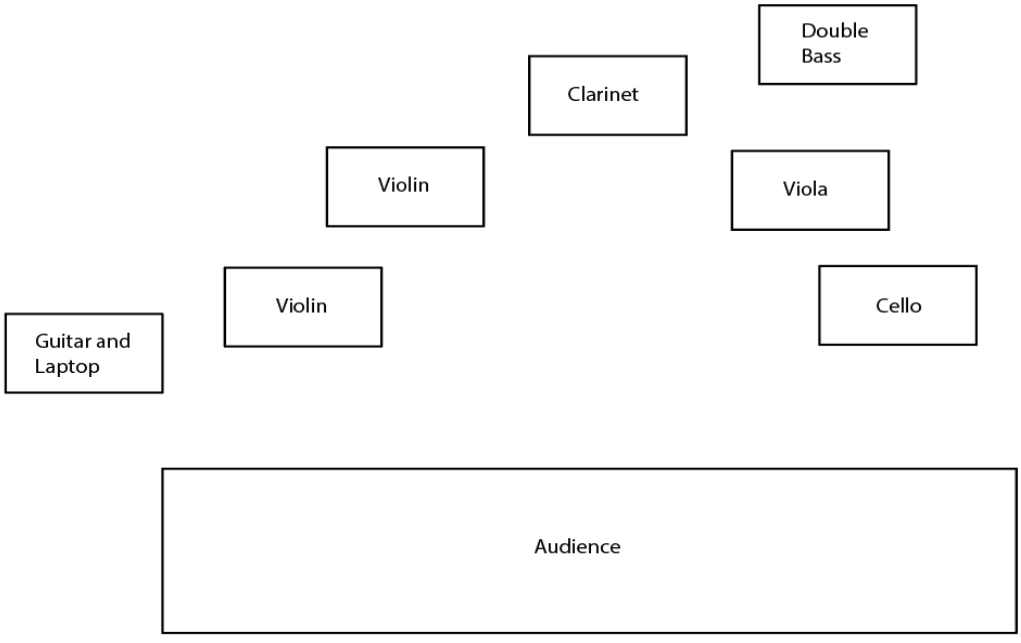


Figure 8.4: Diagram of stage layout.

Performance Commentary

I did not engage with the computer part for the first few seconds as I wished to gradually increase the intensity level throughout the introduction and demonstrate how the electronic part sounds without my input. The improvisation that follows drastically alters the composed material, which was necessary as the synthesizer was simple and repetitive.

I quickly change track routings using the GlitchGenerator, thereby adding motivic development. For example, at 11” I momentarily use the delay routing to increase the density and create movement around the stereo field. This produces call and response as it captures and repeats the composed material in a motivic fashion. At 17”, I momentarily apply the transpose routing to create new melodic material. This is followed by the echo routing with modulating follow actions at 21”, which adds dissonant microtonal movement. Then at 38”, I use the beat repeat routing to add density in a choppy manner.

I continue to apply these processes throughout the introduction; however, to increase the intensity level I leave them on for longer durations during the latter part. For example, at 51” I turn on the echo routing for a few seconds, before switching to the delay routing at 55” and then back to the echo at 1’14”, resulting in prolonged processing. Thus, the synthesizer incorporates more variation and motivic development as the introduction progresses. From the audience's perspective, it should be obvious that I am playing the role of conductor by actively controlling the intensity level, as well as contributing tension and release.

To guide the musicians, at 1’40”, I stop improvising to provide visual cues for the A section. I ceased improvising in the A section as I wanted the musicians and audience to hear the harmonic movement of the synthesizer in combination with the melody being played by the ensemble. This also reduces the intensity level, so that I have room to increase it in the following sections.

I begin improvising during the B section, yet this was constrained. I limit myself to using the GlitchGenerator's echo routing, which I keep on for the duration of the B section from 2'33" while switching between fixed and modulating follow actions. With a fixed follow action, the effect cannot be heard to the same degree, as it simply delays incoming audio by a beat, whereas the continuously changing follow actions significantly transform incoming audio, resulting in chaotic glissando modulations. Adhering to this performance plan was useful, as it produces development in my improvisation, with more experimental and drastic outcomes commencing as the piece progresses.

The C section at 3'27", was the main point of improvisation. This section is repetitive; therefore, improvisation is needed to vary the material and increase the intensity level. This involved processing the synthesizer using a stutter being fed into the GlitchGenerator. Improvisation involves changing between routings while turning on/off the stutter while varying its playback rate using the Guitar Wing's slider and indirectly with its inbuilt sequencer. This combination of effects makes the instrument feel complex and offers a wide variety of sonic possibilities.

I wished to create motivic interaction between the recorded synthesizer and my improvisation, therefore, I continually switch between a clean and processed signal. For the first few seconds I maintain a clean signal, so that the original synthesizer idea can be heard. Then at 3'49", I engage with the stutter and to create a momentary glitchy outcome.

At 3'57" and 4'02", I momentarily turn on the echo routing to create ever-changing microtonal and spatial movement. Then at 4'07", I use the transpose routing to create alternative melodic material. Similarly, at 4'20", I turn on the stutter and its sequencer to vary the pitch and rhythm of the synthesizer. To increase the intensity level, I begin getting more complex with my improvisation at 4'25", by using the stutter in parallel with the GlitchGenerator, which significantly transforms the synthesizer. However,

there are brief moments where I revert to a clean signal, for example 4’45”, to allow for playing outside. As I use these processes to drastically deviate from the composition’s harmony and structure, yet resolve these ideas by reverting to a clean signal. This affords liveness as engagement results in tension while disengagement produces release.

Some of the musicians got lost during this section, therefore, before the second A section came in at 5’25”, I stopped improvising to cue in this section. When the second A section comes in, I strive to differentiate it from the first by changing the rate of the synthesizer’s arpeggiator. Similarly, with the second B section at 6’12”, I differentiated it by applying more of the continuously modulating echo and at different points.

At 6’36”, I cease improvising to synchronise the computer part with the instrumentalists. This is followed by a final A section that acts as an outro and incorporates a different arrangement from the previous A sections. I reverse the roles of the computer and instrumentalists, using the acoustic instrumentalists to play sustained harmonies while the computer performs the melody. This reduces the dynamics and intensity level, ending with a peaceful ambience.

Addressing Humanisation

This composition explores the humanisation of a composed computer part by encapsulating human variation and microinteractions. The performance produced liveness by incorporating instrumental musicians and a computer part that was controlled in an improvisational manner. This allowed me to visibly play the role of conductor by directing the acoustic musicians; guiding the electronic part; and controlling the level of intensity and tension. The focused control of the synthesizer’s processing provided a causal link between gesture-sound, as actions significantly transformed this aspect of the composition. Finally, as joint human-computer control

allowed for sound sculpting, I could choose when to improvise which allowed me to find a balance in challenge and frustration that facilitated flow states.

8.3 What's the Fuss?

Composition Summary

This composition is designed to be performed entirely by myself, utilising the hybrid guitar. It focuses on the exploration of digitally composed glitch-based material, rather than strict harmonic and melodic structures. To give these sounds synthetic, robotic characteristics, I applied a quantised inhuman feel. Hence, there are few micro-interactions, yet there is an abundance of variation in the types of sounds and timbral movement generated, as I strived to add an element of surprise and encourage spontaneous human-computer improvisation.

To humanise this inhuman composition to a degree, much like in a jazz ensemble, I have created interplay between the constituent parts. To accomplish this, each instrument leaves space at different points throughout the piece, allowing for call and response. This is enhanced through my performance role, as in sections where one instrument has ample space, I can be more liberal with my improvisational control. Alternatively, I can play MIDI guitar to fill in space and incorporate motivic development and microvariation.

Composition Commentary

The piece incorporates three sections that are similar in design. Each section utilises a repeated bass and drum pedal/groove, which is decorated using higher pitched sounds with lots of spatial and timbral movement. It was my goal to provide contrast and increase the intensity level as the piece progresses, which I accomplish by gradually increasing the density, adding to the number of concurrent sounds and ideas.

Performance Summary (see /media/WeeRedBarPerformance.mp4 03")

The computer plays a significant role in this piece, as many sounds are left to chance using MIDI effects. I know when sounds occur, yet cannot predict what these sounds will be or their duration. For example, in section B there is a chordal synthesizer part that utilises constant structures, with the root note of each chord being randomised. Similarly, many of the glitch sounds are left to chance, as I have created an abundance of samples which the computer randomly selects from. Furthermore, one of the synthesizers is followed by an equaliser whose parameters are randomly varied, meaning certain frequencies will only be heard at times. Thus, navigating the environment requires me to surrender and go with the flow while relinquishing control to the computer heightens my awareness and makes it unclear whether I am controlling the technology, or it is controlling me.

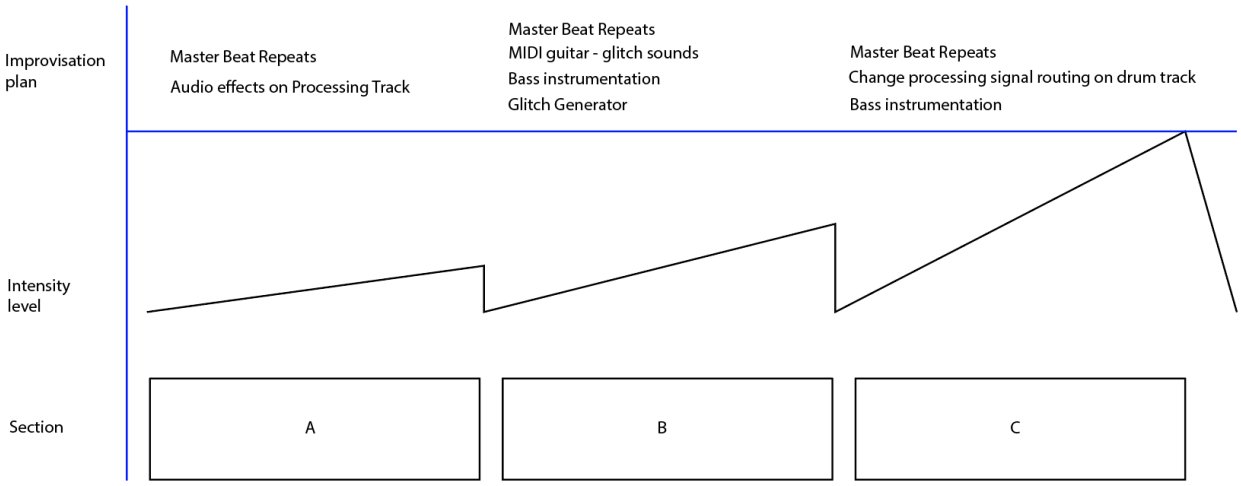


Figure 8.5: What's the Fuss? performance plan.

Performance Commentary

I kept the first section minimal so that I could increase the intensity as the piece progressed, therefore, my improvisation is sparse and constrained. However, notice-

able improvisation does occur at 25”, 45” and 50”, as I use a master track beat repeat to alter the rhythmic contents of the entire composition. This involves two beat repeats with different settings, the device at 25” and 50”, is set to gate mode, which when triggered mutes the incoming signal and captures and repeats segments of the incoming audio. The second beat repeat at 45”, does not mute incoming audio and, therefore, adds to the density of the piece, until I turn it off four seconds later to avoid too much repetition. This second beat repeat transposes incoming audio down a major third, creating a harmony that did not exist in the composed material. This approach makes the performance experience interesting for me, as I cannot predict the outcome, thereby requiring me to be attentive in case the outcome is undesirable, in which case I would quickly turn off the effect.

Section B comes in at 1’02”, and I begin getting more active to add tension. I immediately turn on stutter and echo effects on the processing track using the SoftStep while varying their parameters using the Guitar Wing’s slider. This transposes and moves the drums around the stereo field. At 1’05”, I momentarily trigger the muted master beat repeat, to create a repeating rhythmical idea in the entire composition.

Following this, I focus my improvisation on the ambient background noises. For example, at 1’14”, I turn on the GlitchGenerator’s echo routing, and switch between continuously modulating and fixed follow actions. At times, this produces prominent spectral and spatial movement, for example, at 1’27”. This improvisation was useful for complementing the main synth and bass, as it provides interesting movement in the background.

I continue improvising in this manner, and then at 1’32”, I play the role of conductor by taking control of the bass instrumentation, switching to a more distorted and sustained instrument. This produces contrast and adds intensity as the bass becomes more prominent. At 1’36”, I trigger a master beat repeat; however, as I find

the randomly generated note subdivision rhythm undesirable, therefore, I turn this off a second later.

At 1’44”, I momentarily turn on a stutter effect processing the background synthesizer noises to add microvariation. Following this, at 2’02”, I use the muted beat repeat to decrease the density, which I release just as the next section comes in at 2’05”, so this transition can be heard.

At 2’07”, I add processing to a synthesizer by turning on a buffer shuffler, which produces a shimmering evermoving atmosphere that becomes the focal point of this section. At 2’45”, my Timestretcher begins playing an ambient part which I manipulate using the GlitchGenerator, switching back and forth between a clean and processed signal. I begin with the echo routing, which transforms the peaceful ambient part into evermoving dissonant sounds. I then switch back to a clean signal at 2’51”, for a few seconds before turning the beat repeat routing on. The beat repeat routing does not significantly transform the audio, instead it adds subtle microvariation. Similarly, at 3’00”, I turn back on the echo routing, except this time with fixed follow actions, which adds subtle variation in the spatial contents of the ambient part.

At 3’02”, acoustic drums come in, which I drastically process throughout this section. This drum part was designed with room for improvisation, as without engagement it is simple and repetitive. With the addition of improvised processing, it becomes complex as I significantly transform its sonic contents in numerous ways. I achieve this by switching between complex audio processing chains. Each chain produces a drastically different outcome, for example, at 3’10” and 3’27”, I switch to a chain with a stutter effect, which captures and repeats incoming drum samples in a glitchy manner. This sustains the audio until it receives another incoming sound, therefore, I can switch to a different processing chain and the stutter will continue repeating captured segments, thereby adding to the density of the composition. I add more repeating glitchy patterns at 3’18” and 3’22”, using master beat repeats. Then at

3’25”, I switch to a chain with a resonant filter, which transforms the acoustic drums into synthesizer sounds. I continue switching between these chains, to add constant movement in the timbre and density of the drums.

During this section, from 3’05”, I also vary the bass instrumentation, switching between sub and distorted instruments. The improvisation during this section significantly transforms the composed material. Around 3’55”, I again switch to the chain with the resonant filter, yet this time leave it on for a sustained duration, which again transforms the drums into a synthesizer with compelling rhythms. The climax of the composition is reached at 4’07”, which I make more pronounced using distortion. I also add processing to the drums by turning on/off a stutter with the SoftStep while simultaneously controlling its playback rate using the Guitar Wing’s slider. Furthermore, I intermittently use the beat repeat to add alternative contrasting rhythms to the composed material. These interventions make this section more hectic and aggressive than the rest of the piece. I arrive at the endpoint at 4’40”, and blend this composition into the next by triggering the GlitchGenerator’s echo routing to sustain a synthesizer.

Addressing Humanisation

This approach to filling in space taken with this composition helps display liveness, as it incorporates a full-body experience with gesture-sound relationships that are visually and sonically apparent. The unpredictable nature of this composition requires awareness and spontaneity, much like performing with a jazz ensemble, I need to consider when there is space to improvise. Furthermore, I must be acutely aware of my actions, as the indeterminate computer processes I control do not always produce a desirable outcome. Finally, this composition explores the intersections between human and inhuman, resulting from the use of inhuman sounds in combination with humanising techniques for control and variation. Moreover, sampling digital sounds using MIDI guitar allows for the blending of acoustic and digital practices.

8.4 One Step at a Time

Composition Summary

This is a pop composition; therefore, the focus is on simple and memorable melodic and harmonic material that is embellished through digital comprovisation techniques. The composed instrumentation reflects an ensemble of pop musicians, containing bass, percussion, piano, guitar and synthesizer. The performance is guitar centric, exploring the interplay between guitar and digital processing, including a freely improvised introduction and solo that extend the sonic capabilities of the guitar using audio processing.

Composition Commentary

The piece has the following form: Intro A A B C A B. The A and B sections contain the main harmonic and melodic material. To make a simple pop harmony compelling, I added an arpeggiator to the synthesizer which makes a harmony in one key centre dense and ever-changing. I also apply improvised audio processing using the GlitchGenerator to add harmonic and spatial movement.

I wished to avoid too much repetition; therefore, I differentiated each section by using alternative instruments and processing. For example, the synthesizer in the B section has been altered using automation to send it through multiple GlitchGenerator tracks. This results in drastic processing that would not have been possible when controlling the GlitchGenerator, which only allows for one routing at a time. Another way I achieved this was by gradually building the composition in intensity, increasing the instrumentation, dynamics and density. Apart from the C section which functions as an interlude that brings down the intensity level to provide room to build my guitar solo in the following A section. This reflects jazz practice, as generally solos start with less intensity, and build as they progress.

As I desired a freely improvised introduction, I kept the composed material minimal with no set harmony or groove, therefore, improvisation is required to make this section compelling. To create an interactive jazz ensemble feel, I utilised software that produces indeterminate outcomes, thereby contributing ideas and producing interplay between guitar and computer. For example, the Asynchronous Looper is used for motivic interaction by automatically capturing guitar and playing it back at different times and pitches, with variable shuffling. While in the background, the EnvelopeGenerator is set up to modulate the course and level settings of an Operator synthesizer resulting in an ever-changing FM synthesis.

Performance Summary (see /media/WeeRedBarPerformance.mp4 5’15”)

Apart from the intro, this composition is heavily arranged and structured, meaning there is less need for improvisation than my other pieces. The improvisation that does occur is noticeable, including a guitar solo, audio processing on a prominent synthesizer, and control over bass instrumentation.

I intended for the performance to include scripted and improvised guitar, as well as scripted and improvised processing applied to the guitar. This allowed for constant variation by extending the guitar's capabilities and sonic palette. However, the extensive use of guitar makes it challenging to control other aspects of the environment, therefore, I created a performance plan to help set constraints.

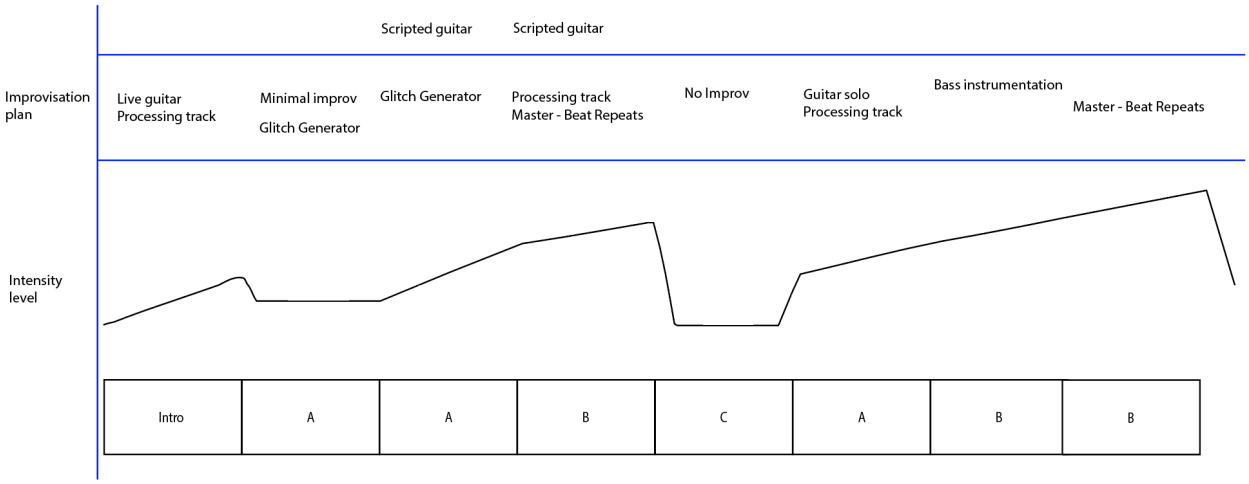


Figure 8.6: One Step at a Time performance plan.

Performance Commentary

During this concert, this composition's introduction begins at 4'50", and I leave space to help the audience assimilate what has come before. Shortly into the introduction, I begin improvising on guitar while in the background a synthesizer is continuously modulated using my EnvelopeGenerator producing short staccato bursts that add a shimmering texture and provide a foundation for improvisation. The guitar is being sent into the Asynchronous Looper with the incoming signal muted so that only the effect can be heard. It is not until 5'27" that the Asynchronous Looper captures and begins playing back the guitar, which produces delayed anticipation (see 5.3.3). The looper is in randomisation mode as I desired an unpredictable outcome that influenced my guitar playing. This heavily restructures the guitar, producing choppy, glitch sounds that are dispersed around the stereo field. The dense outcome that makes me play guitar more reservedly, as I did not wish to oversaturate the looper.

A synthesizer playing the harmony of the A section begins at 6'55". I wished to gradually introduce this idea, therefore, I sporadically manipulate the synthesizer using the GlitchGenerator's echo routing, so that the original signal can only be heard at times. To further alter the synthesizer, at 7'15", I use the Guitar Wing to turn on a

grain delay and trigger my EnvelopeGenerator. This automatically varies the delay's parameters, creating a dramatic rise and drop in the synthesizer's frequency. I continue improvising in this manner until the second A section comes in at 8'00".

At this point, I have differentiated the second A section by arpeggiating the synthesizer harmony. The first A section is sparse and relaxed, while the second is dense and intense. The arpeggiated synthesizer becomes the focal point of the composition, which I take advantage of by improvising with the synthesizer using the GlitchGenerator to display the impact of my control. To add motivic development throughout this section, I utilise every GlitchGenerator routing, providing contrasting rhythms, glissando modulations, transpositions and movement around the stereo field.

For example, at 8'05", I initiate the echo routing, which momentarily creates space before glissando modulations commence. From 8'09" to 8'25", I continuously switch between the beat repeat and delay routings, to add microvariation in the rhythm of the synthesizer, as well as contributing density and movement around the stereo field. At 8'30", to create contrast, I initiate the transpose routing to vary the melodic content. Following this, I again focus on the beat repeat and delay routings, before turning on a grain delay on the GlitchGenerator routing track while using the EnvelopeGenerator to continuously vary its settings at 8'39", thereby producing interesting spectral movement. These interventions make an otherwise repetitive synthesizer engaging, which was intended to keep the audiences' attention, as they cannot predict what is coming next.

At 8'45", I cease interacting with the GlitchGenerator to play a scripted guitar part and allow the synthesizer's harmony to be heard in combination with the guitar melody. I continue playing scripted guitar into the B section which begins at 8'55", yet to interpret this melody I add improvised audio processing. This involves the use of stutter and buffer shuffler effects, which rearranges the melody and disperses it

around the stereo field. The buffer shuffler was useful for filling in space here, as there was little activity in the far ends of the stereo field.

At 9’11”, I use a master beat repeat to create a rhythmic pattern that unifies live guitar and composed material. However, I only apply this for a second as I wished for the melody to be audible.

The interlude comes in at 9’50”, and I leave the buffer shuffler from the previous section on to blend the previous melody into the interlude. I sustain this for a few seconds, and then cease engaging with the instrument as the interlude did not require my input. This allows me to prepare for the guitar solo by configuring my pedals.

At 10’19”, the third A section begins, which was designated for a guitar solo, yet I do not immediately start soloing as I wish to create space and build anticipation. I come in shortly afterwards with a solo that utilises the section’s harmonic structure, with added chromaticism and sequences that weave in and out of the harmony. I enhance my solo using digital processes that I simultaneously control using my feet. For example, I trigger a stutter at 10’34”, and a buffer shuffler at 10’55”. The buffer shuffler keeps me engaged as it produces an unpredictable outcome and human-computer motivic interaction, as I can feed guitar lines into the effect and it will interpret and play them back to me This is interesting from the audiences’ perspective as they get to witness call and response, a common jazz technique.

At 11’15”, the second B section begins, and I play the role of conductor by varying the bass instrumentation, switching between clean, growling and distorted instruments. This was useful to differentiate it from the other B sections and increase the intensity level.

The third B section comes in at 11’55”. This section is compositionally dense, therefore, there was little need for improvisation. I take a subtractive approach at times by using a master beat repeat to reduce the density, turning multiple ideas into

one rhythmic idea, for example, at 11’58”, 12’01” and 12’41”. Towards the end of the section, at 12’30”, I play the role of conductor to create a climax, by switching to aggressive, distorted bass sounds.

At 13’04”, the outro begins, which involves an ambient synthesizer playing my harmonic arrangement of My Favourite Things (Rodgers and Hammerstein, 1959). However, I do not play this jazz standard’s melody, instead I improvise with the guitar, effects pedals and buffer shuffler in combination. In this instance, I turn up the feedback on my delay pedal and feed this into a Whammy pedal, sustaining the guitar while I continuously change the pitch by adjusting the Whammy. When used in combination with the buffer shuffler, this produces ever-changing harmonies with diversity in frequency and spatial content. This worked well with the repeating synthesizer which contains little movement.

Addressing Humanisation

This composition addresses humanisation through the incorporation of live guitar and improvised audio processing on prominent elements of the composition, thereby displaying liveness and a causal link between gesture-sound. Similarity in the processing applied to the guitar and digital material, means audiences can witness how this affects guitar and translate this to the digital material, which provides a better understanding of these processes.

The approach taken in this composition allows a performer to decide whether to implement scripted or improvised computer actions. This contributes to liveness, as audiences can observe a performer altering how the computer behaves. Furthermore, this enables sound sculpting, as the performer can set computer processes in action and step back to consider the next course of action.

This composition explored a balance in composition and improvisation that was heavily weighted towards composition. Thus, significant improvisation with the

composition was unnecessary to create compelling music. Certain instruments were repetitive, which required focused improvisation to add interesting variation. The fact that this composition did not require an abundance of improvisation allows me to collect myself for the more challenging pieces.

8.5 Function Operator

Composition Summary

This is a solo electronic composition that focuses on the interplay between human-computer, and the creation of an improvisational partner through the encapsulation of indeterminate computer methods. This results in a nondeterministic, ever-changing composition that can be readily manipulated during performance. To achieve this, I composed a minimalist structure that when combined with generative techniques and improvisational control methods results in an elaborate piece.

Composition Commentary

The focus of this composition centres on two tracks containing multiple synthesizers and a drum rack. This limited number of tracks makes the composition easier to perform, yet the control methods can produce complex outcomes, which allows me to find a balance between challenge and frustration. Initially I composed this piece in the session view, with a drum track that consisted of a loop being varied using Random and Beat Repeat effects. The synthesizer is more complex as I sent multiple MIDI clips of different lengths to this track to create complex polyrhythms that produce an ever-changing bassline and melody. To create background noises, I composed two additional layers, containing a high-pitched synthesizer and glitch sound design, which come in and out at various stages throughout the piece. To incorporate continuous movement in these layers, I included Beat Repeat, Auto Pan and Buffer Shuffler effects.

Performance Summary (see /media/WeeRedBarPerformance.mp4 15’08”)

When set in motion this composition is ever-changing without a performer’s input. Human control creates more diversity in its sonic characteristics. As the piece is dense and chaotic without input, I take a subtractive approach to improvisation to create structure, using beat repeats on gate mode to sustain captured notes while muting incoming audio. Human improvisation also involves interpolating between synthesizer sounds, as well as manually turning on/off the beat repeat’s repeat function to contribute additional material and variation to the composed drums and synthesizer. As with my other pieces, these tracks are also being sent to dedicated processing tracks, which allows for further manipulation. This composition’s design facilitates experimental improvisation, as there is no strict harmonic or melodic structure that needs to be adhered to.

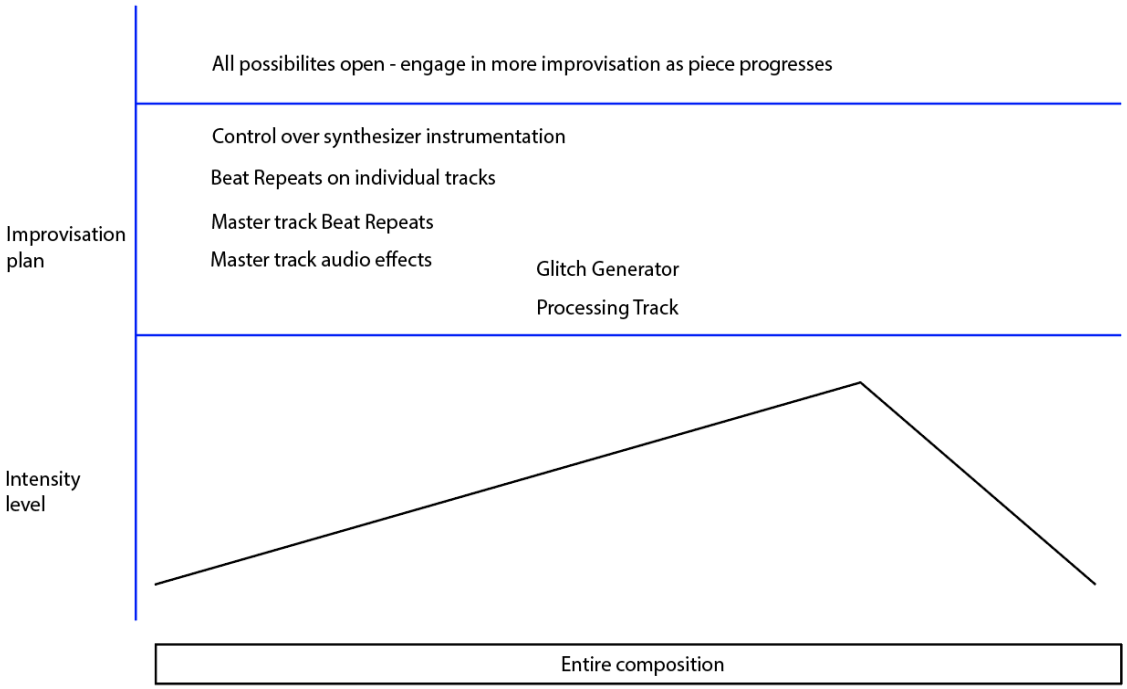


Figure 8.7: Function Operator performance plan.

Performance Commentary

The composition begins 15’08” into this concert, yet I do not immediately start improvising so the audience can hear the piece without my input. At 15’20”, I realise there is room to improvise spatially, therefore, I use the GlitchGenerator’s echo routing to move the synthesizer around the stereo field, before quickly turning back to the clean routing to avoid overly distorting the melody.

At 15’28”, I trigger a beat repeat processing the synthesizer, which adds density. However, I did not appreciate the short note division rhythm that is randomly generated, therefore, I quickly turn this off.

I play the role of conductor, at 15’30”, by switching to a different synthesizer sound to give the impression of a new section. I then engage with beat repeats on the individual tracks and master track to add density and rhythmic variation. This improvisation was useful as without it, the synthesizer is repetitive, since its timbral, rhythmic and spatial characteristics remain consistent throughout the piece. The use of the master beat repeat at 15’36”, produces an unexpected prominent, dissonant outcome, which I quickly turn off, as I did not wish to take the audience's attention away from the melody being played by the synthesizer. These imperfect blemishes can contribute momentary tension, which can prove beneficial in some instances, yet often not when left on for sustained durations.

At 15’42”, I play the role of conductor by briefly bringing in more drums by turning off a beat repeat on gate mode. As this device mutes the incoming audio, it dramatically reduces the density of the drums when it is on. A few seconds later, I turn this beat repeat back on, to reduce the density of the drums. I have automated this beat repeat to change to insert mode in the middle of the composition, which produces the opposite effect, as in this instance, when triggered, it adds to the density of the drums.

From 15’52” to 16’03”, I apply the GlitchGenerator’s beat repeat routing to create a dense, glitchy synthesizer part, with motivic development. From 16’07” to 16’13”, I again process the synthesizer, only this time using a beat repeat on its track. This randomly generates a repeating triplet pattern that did not exist in the composed material. While this is occurring, at 16’09”, I also apply a beat repeat to the drums, which creates contrasting rhythms between these instruments that was unexpected, yet proved interesting.

At 16’15” and 16’17”, I apply master beat repeats, which adds variation to the composition's rhythms. Then at 16’20”, to contribute more density and repetition to the synthesizer, I briefly turn on a beat repeat on this track.

At 16’24”, I vary the instrumentation of the synthesizer, by momentarily switching between two other instruments, before reverting to the initial instrument at 16’28”. This drastically alters the synthesizer’s timbre, which allows for a timbral version of playing outside. At 16’36”, I turn on a pitch shifted master beat repeat, which again produces a noticeable, dissonant outcome that I quickly turned off to avoid taking the audience's attention away from the melody.

At 16’43”, I trigger a beat repeat processing the drums, which adds density. Shortly after, at 16’45”, I start using a beat repeat to process the synthesizer, creating new computer-generated rhythms. To create constant variation, I turn this on/off in quick succession to create ever-changing rhythms. At 16’52”, I also trigger a master beat repeat, which when used in tandem with the other beat repeats, significantly transforms the composed material.

I continue improvising in this manner, turning on/off these beat repeats. Then at 17’00”, while I am doing this with my feet, my hands simultaneously trigger the GlitchGenerator’s echo routing to further process the synthesizer, sending it spiralling around the stereo field. At this point, the piece reaches its climax, with the help of my

improvised processing that adds constant variation and density to the spatial, rhythmic and spectral components.

One last noticeable form of improvisation occurs at 17’25”, where I trigger a beat repeat on the synthesizer track, followed by a pitch shifted master beat repeat, and the GlitchGenerator’s echo routing at 17’27”. This produces a tense, climactic moment, with extreme harmonic and spatial variation that displays joint human-computer control.

Following this, I gradually turn off the audio processing to decrease the intensity level and create an outro section. The composition itself also becomes sparser at this point, which aids in this transition.

Addressing Humanisation

This composition addresses humanisation by creating an environment that requires human agency to establish musical structure and development. The composition leaves much space for improvisation, since the underlying structure can be flexibly interpreted by the performer. It facilitates playing rather than programming (see 5.4.3), as a performer must search for the desired sounds and outcomes, sometimes in an embodied manner, for example, when interpolating between different synthesizer sounds (see 7.6.3). This approach contributes to liveness as a performer must continuously engage with the piece to create compelling music. With improvised actions that produce noticeably different outcomes than what exists in the composed material, thereby producing a causal link between gesture-sound.

The piece was designed to facilitate flow states, since the performance can be as challenging as the performer desires, allowing for a balance in challenge and frustration. The indeterminate methods require a performer to surrender and go with the flow, which enhances engagement and contributes to liveness. The abundance

of human and computer improvisation in this piece helps create drastically different realisations of this composition, which keeps the music exciting.

8.6 Technophobia

Composition Summary

This solo electronic composition focuses on human-computer interplay. The computer acts like a jazz ensemble rhythm section that heavily interacts, making it chaotic and indeterminate, which necessitates human guidance to create a structured and coherent piece. Consequently, this composition incorporates an abundance of improvisation, which means it varies drastically with each performance. However, its identity remains partially intact using the same sonic material and improvisation methods.

Failure and imperfection were important in this composition, which I achieved by applying an excessive amount of audio processing to magnify the sounds of computer algorithms that would otherwise not be heard. Human failure and imperfection emerge from the challenge of carrying out actions with precision, because of the indeterminate computer contributions that influence human actions.

Composition Commentary

I created this composition by constantly iterating, carrying out human and computer improvisation on an initially simple idea repeatedly to produce complex outcomes. Initially, this was a process I used to generate compelling sound design which could be moulded into a structured and elaborate composition in non-real-time. I later realised this way of generating material offered a compelling alternative approach to digital comprovisation that focused on experimental sonic exploration, and the tension and release created through real-time control. There are never more than three tracks playing at once, which changes my performance role from micro to macro

management. This allowed for experimentation, as there is less potential for unwanted dissonances when most of the composition is altered synchronously.

Originally this piece only had one section that relied on computer indeterminacy and structuring music in real-time. I decided it needed more development compositionally speaking, therefore, I added two other sections that focused on creating an atmosphere. As I wanted to create contrast and change throughout the composition, these sections were more predictable and repetitive. This first section is minimalist, containing an atmospheric soundscape that was decorated by a sparse, aggressive bass pedal, as well as ever-changing percussive and glitch sounds. This is followed by an intermediary section that combines elements of the first and last section which unifies the piece, as otherwise the transition from a minimal, predictable soundscape to a dense, chaotic one would sound like two distinct pieces.

Performance Summary (see /media/WeeRedBarPerformance.mp4 18’50”)

I consider performing this piece a process of decomposition and recomposition. Decomposition involves the use of beat repeats to break down complex material into simple rhythmic patterns. This outcome is partially randomised by the computer; therefore, I may choose to sustain or discard ideas depending on whether they suit a particular moment. If I sustain an idea, I can add movement using the beat repeat’s filter. Conversely, recomposition involves varying the instrumentation and applying processing to alter the existing material.

These processes were useful for creating structure, especially in the last movement, allowing me to divide material into dense and minimal moments. Without the use of decomposition, the last section would always be at a high intensity, which would get mundane and repetitive. The control over instrumentation and drastic processing also allows me to adjust the intensity level throughout the piece and add variation, by altering the spatial, spectral and rhythmic components. The macro improvisation occurring on this composition allows me to be a specialist rather than a well-rounded

multitasker. This approach offers flexibility, as I can simultaneously control every track using all the processes at my disposal, thereby making full use of the instrument's capabilities.

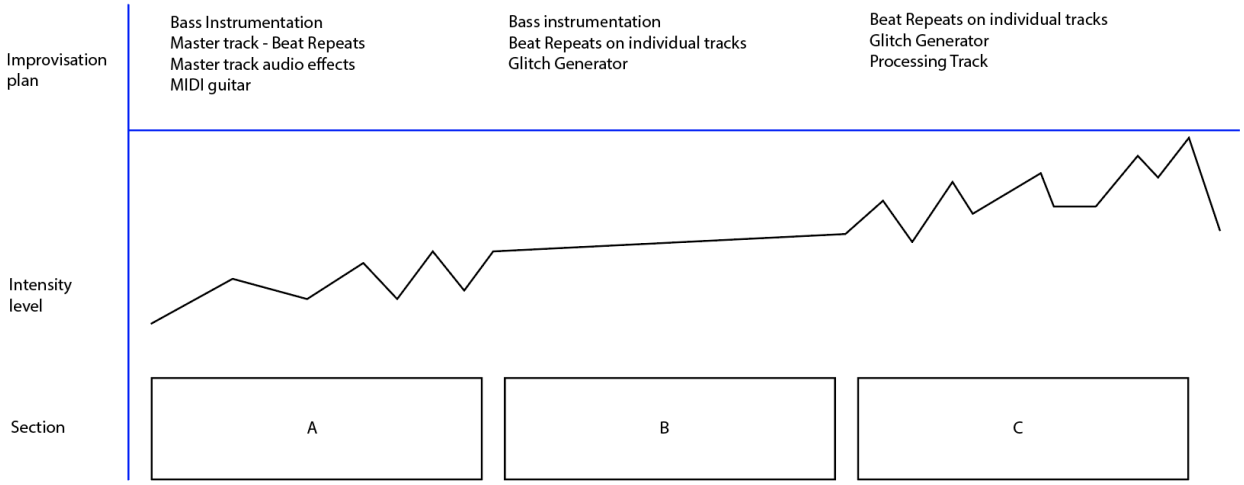


Figure 8.8: Technophobia performance plan.

Performance Commentary

This piece starts at 18'50", and is minimalist in content and action as I wish to create contrast between sections. During the first section, my role involves occasionally switching between bass sounds, triggering master beat repeats and processing the sub-bass soundscape.

I choose not to add any drastic improvisation at the beginning of this section so the experimental sound design can be heard. The improvisation I do engage in is subtle, involving the processing of the sub-bass soundscape using the GlitchGenerator, which adds some variation in its spatial characteristics. It is not until the first prominent bass sound comes in at 19'41", that I engage in transparent actions by triggering a master beat repeat which unifies every track into a glitchy triplet rhythmic pattern.

At 20’19”, I take control of the bass instrumentation, changing to a tense, distorted instrument. A few seconds later, at 20’26”, I add more tension by changing to an even more aggressive bass. Following this, at 20’33”, to create a momentary release I return to the initial bass sound, before changing back to an aggressive bass sound at 20’40”. This provides contrast throughout this section and allows me to create tension and release.

Whilst varying the instrumentation, I concurrently trigger master beat repeats. One just after the bass comes in at 20’34”, which adds choppy rhythms that are most audible in the bass. I trigger another after the next bass sound at 20’40”, which again produces a choppy rhythm only this time at a faster rate. I turn this off a second later and turn on the pitch shifted master beat repeat, which increases the dynamics and duration of the bass. I repeat this action at 20’54”, only this time it adds an interesting contrasting rhythm over the incoming signal.

I continue to improvise with the bass instrumentation into the following section, which begins at 21’06”, with the addition of a synthesizer. I also begin manipulating the synthesizer using the GlitchGenerator, adding drastic spectral and spatial movement to an otherwise repetitive idea. From 21’40”, I trigger beat repeats on individual tracks, which when applied to the synthesizer track resets a Shepard tone pattern to a new starting pitch. At 22’50”, I lose my place in the composition’s form, therefore, I need to look at the laptop to determine when I should trigger certain effects ahead of the C section. When the C section begins at 23’00”, I use the same approach to bring in and out the dense glitch and percussive part. At first, I rely heavily on the use of beat repeats to create space while manipulating the spectral contents of this material using a filter, which instils an EDM/techno nightclub feel. To add repetition and development, I turn on/off the filter at regular intervals.

During this section, I begin engaging in more complex actions, simultaneously controlling and changing between multiple effects to create climactic moments. For

example, when the dense glitch part comes in at 23’00”, two seconds later I turn on a gated beat repeat which turns a complex part into a repeated rhythmic pattern. At 23’06”, I turn this off and then turn on a gated beat repeat processing the synthesizer, which similarly turns an arpeggiated synthesizer into a simple one note rhythmic pattern. I then quickly turn the beat repeat on the glitch part back on, which produces an alternative rhythmic pattern. Following this, from 23’09” to 23’20”, I use the Guitar Wing to turn on/off the filter on the beat repeat at regular intervals, which varies the spectral contents, transitioning between subtle and prominent sonic outcomes. At 23’20” and 23’22”, using my feet I momentarily turn on a stutter effect processing the glitch part while varying its parameters with my hands, thereby adding microvariations.

From 23’23” to 23’28”, I turn off the beat repeat on the glitch part, which unmutes the incoming audio so the dense glitch part can be heard. I simultaneously engage with the stutter effect to manipulate this material. At 23’30”, I turn off the synthesizer beat repeat so that its arpeggiation can be heard. I then begin turning on/off the beat repeat filter processing the glitch track. I attempt to do this at regular intervals in synchronisation with the arpeggiated synthesizer to create interplay between these parts. I also briefly turn on a master beat repeat at 23’32”, which adds microvariation to the entire composition.

From 23’38” to 23’42”, I turn off the glitch track beat repeat, so the dense part can again be heard, and begin processing this by turning on/off stutter and echo effects in quick succession while varying both of their parameters using my SliderMultiMap software. This makes the instrument feel complex and produces experimental outcomes, as every point on the slider produces drastically different outcomes, which is furthered by turning on/off the effects.

At 24’00”, I use stutter, echo and beat repeat effects in combination to create an intense sustained build that is reminiscent of an explosion. I again quickly turn on/off

these effects with my feet while controlling their parameters with my hands, thereby producing complex, expressive and full-body actions. In these situations, my actions rely more on the intelligence of the muscles than the mind. As the outcome of my actions become harder to predict, I rely on the feel of the instrument to experiment and see what works best.

The climax of the piece occurs at 24’00”, at which point I bring down the intensity level by using fewer effects. However, at 24’48”, I begin using more effects to create a transition into the next composition, which I accomplish using echo and beat repeat effects to sustain the sonic material.

Addressing Humanisation

With regards to the struggle between liveness and perfection, the approach taken with this composition leans towards liveness. It does not have a strict compositional structure that needs to be adhered to, which allows me to create structure in real-time. This results in spontaneous actions and imperfect blemishes that display the liveness of the moment.

The extensive use of the SoftStep in combination with the Guitar Wing’s main slider controlling my SliderMultiMap software, facilitates extended, expressive and embodied control. This contributes to liveness, as the simultaneous control of multiple effects and instruments produces drastic and apparent gesture-sound relationships. The process of decomposition using beat repeats is also apparent, as actions transform dense, multi-layered music into simple rhythmic patterns, while simultaneously turning on/off a filter significantly alters spectral content.

The full-body engagement and multi-mapping strategies employed on this composition contributed to liveness and replicate the experience of acoustic instruments which improves my sense of control. Using controllers in combination offers flexibility which makes the instrument more complex, thereby requiring me to

struggle with the instrument. However, the nature of the piece allows for a balance between challenge and frustration, as precision is not a requirement since there is no strict compositional structure and improvisation involves macro management. Thus, it is less challenging to produce ideas that work, which allows for experimentation and facilitates flow states.

8.7 Portfolio Evaluation

I was satisfied with the outcome of this performance; however, I did overly rely on certain processes, particularly the GlitchGenerator. This stemmed from the fact that this was the last performance I could do before Covid-19 occurred, in the middle stages of my research. Ideally, I would have done another live performance at a later stage, yet this proved difficult. During this performance, I wished to set limitations to encourage flow states, as I was not overly competent with the entire instrument at the time. The supplementary recordings I submitted with the portfolio demonstrate a fuller use of the instrument. Particularly with the incorporation of MIDI guitar in combination with my TouchpadGestureRecorder's bounce functionality which adds inconsistency to these sounds (see /media/StudioRecording1.mp4 28") and use of the Guitar Wing's accelerometer to control a master track grain delay's parameters (see /media/StudioRecording2.mp4 34").

Even in these videos I did not use some features, such as my Polyrhythmic-HumanisedStepSequencer and DetectVolumeandSend software. With regards to the former, I found switching between modes on the Guitar Wing to operate the device made actions less immediate, which hindered the flow of performances. Thus, I mainly used the device to help generate material when composing. I also plan to use it in free jazz contexts in combination with live guitar, which would allow for the spontaneous creation of percussive parts in response to guitar, resulting in interplay and giving the impression of an ensemble. With regards to the latter, I found it

unnecessary within the context of these compositions, as the environment already afforded a vast array of improvisational possibilities while the GlitchGenerator enabled variation of track routings.

In these supplementary recordings, I was more satisfied with the instrument as it offered more choice and flexibility. This let me vary compositions to a greater degree, allowing for the creation of different versions of the pieces. The complexity of the instrument pushed performances into unanticipated directions, as the challenge of controlling multiple processes at once occasionally resulted in imperfect blemishes and unintentional outcomes. This proved advantageous, as it provided surprises and ideas which required me to stay present. The supplementary recordings also demonstrate one of my compositions called Glitchy (see /portfolio/Glitchy.mp4) which was not discussed in this chapter. I felt this unnecessary as the methods used on this composition are like what has been discussed.

When performing this portfolio, I became aware that guitar and MIDI guitar did not work well in combination as they produce alternative sonic outcomes, which require different actions. I also found switching between the two took a degree of immediacy away from performances. I devised a solution where certain compositions incorporated MIDI guitar and others live guitar. This worked well, as compositions were better suited for each. Inhuman glitch compositions, such as What's the Fuss?, benefitted from MIDI guitar and experimental sounds rather than a traditional guitar solo which was better suited the human ensemble feel of One Step at a Time. These performances demonstrate the benefit of having a performance plan, as without it the instrument becomes overwhelming with too many actions to choose from in this work.

8.8 Summary

I took a variety of compositional approaches, yet the underlying goal and system remained consistent, as the entire portfolio demonstrates ways to elicit humanisation

using the hybrid guitar, software and performance methods. The main difference throughout the portfolio results from the fact that I have written compositions in a range of styles and balances between composition and improvisation. Whereas some pieces are structured compositionally with forms that must be closely adhered, others are chaotic and indeterminate which requires a performer to create structure. The use of different styles means that certain compositions focus on inhuman rather than human sounds, yet both involve imperfection and variation.

Every composition was designed to contribute ideas and influence improvised control. This requires awareness, as a performer must determine the best course of action, which varies with each performance. This contributes to liveness and facilitates flow states as it is necessary to make in-the-moment decisions and engage in full-body actions that are guided by the intelligence of the muscles.

Chapter 9 Conclusion

9.1 Summary

This research contributes knowledge, involving the integration of the guitar, MIDI controllers and a customised Ableton Live environment with a suite of bespoke Max for Live devices. This provides novel approaches to improvisation with flexible routings, instrumentation and audio processing, as well as complex control strategies and indeterminate computer processes for automating control and encapsulating human characteristics in software. A portfolio of compositions, composed for and performed with this instrument and methods, demonstrates and documents the research outcomes. The outcome of this research improves a guitarist's sense of control when performing and improvising with digital compositions and may lead to enhanced audience experiences. This research provides new insights into ways commercial software and hardware can be enhanced and applied in novel ways.

I carried out this research as there is a knowledge gap with regards to using the guitar as a digital controller, which I considered to be important as this allows guitarists to recycle virtuosity and situate as a primary agent within a digital system: visually and sonically. I was also interested in creating an ensemble feel in solo electronic music performance to help keep performances interesting, heighten awareness and better facilitate improvisation. These motivations led me to the concept of humanisation, which extended to incorporating human personality, feel and characteristics into performances and software.

This thesis addressed humanisation from many vantage points, therefore, different methods and thinking have informed my practice and perspective. Chapter 2 discussed human agency, liveness and the encapsulation of knowledge, with a focus

on problems that arise when composing and performing digital music. For example, Paradiso (1999) suggested the use of hidden interfaces or advanced automation and mapping strategies can make it difficult for audiences to understand a performer's input, whereas Puckette (1991) emphasised the need to have a causal link between action-sound. Throughout this chapter I considered the arguments and opinions from the relevant literature, to develop personal approaches for the humanisation of digital systems, including:

- Liveness through noticeable actions
- Embodied interactions
- Control that is nuanced and expressive
- Extending and augmenting human control
- Recycling virtuosity
- Encapsulating knowledge and human characteristics into software

Chapter 3 considered motivations for creating new instruments and explored approaches taken by either practitioner, to determine an approach for using the hybrid guitar to control a digital environment. I discussed more recent instruments, including those used by controllerists, as these instruments allow for more physical engagement and the visualisation of software which makes human agency visible compared with directly using a computer. My research was influenced by these practitioners; however, I developed a guitar centric approach that allowed me to utilise both guitar and DMI technique effectively.

Chapter 4 discussed the advantages of hybrid instruments with respect to acoustic musicians and humanisation. Furthermore, I considered how practitioners can design hybrid instruments by taking the best aspects traditional and digital instruments provide, in a mutually beneficial way, thereby allowing for the recycling of virtuosity, and creation of a unique identity around one’s practice. I also discussed how practitioners, such as Tod Machover, are using these instruments to combine

advanced studio techniques with the spontaneity and human communication of live performance.

The design of the physical instrument and interaction methods were not the only central concern with regards to humanisation, as it was equally salient to design an environment that produced compelling music, with human feel and variation. I desired an environment that heightened my engagement during performances. Thus, Chapter 5 discussed composition and improvisation with a focus on how digital compositions and software can be designed to facilitate improvisation, while highlighting the kinds of improvisation performers and computers may engage in.

Chapter 6 addressed control, as it was practical to consider how to couple the software and hardware components through mapping strategies, as well as determine the appropriate affordances and constraints the instrument provided. These were important considerations, as their design affects the extent to which one can control an environment, and how complex and flexible an instrument is. This influences the level of difficulty which impacts learnability and the performance experience, as well as the likelihood of flow states.

Chapter 7 describes how I designed the instrument while explaining how this was influenced by the topics from the prior chapters. For example, I discuss the bespoke software which provided new opportunities and affordances; why certain controllers were suited for my needs; how I determined the ideal functionality for each controller; how I recycled virtuosity and made this visually apparent to audiences; and how I gained proficiency with the system.

Finally, Chapter 8 demonstrates the instrument in action, explaining how this worked out in practice, and evidenced the topics and themes discussed throughout this thesis.

9.2 Limitations and Further Research

The broad nature of this research was a limitation, as it meant I was unable to cover some topics in depth. For example, I could have looked more extensively at musicians who use the hybrid/augmented guitar, such as Johnny Greenwood, Christian Fennesz and Matt Bellamy. These musicians are producing compelling music; however, they focus on extending the capabilities of the guitar in a solo context or to contribute to the compositions being produced by the wider ensemble. My research explores how the guitar can be used to control digital compositions, therefore, it was more worthwhile focusing on controllerists, such as Darlington (see 3.9.2) who work with composed material. However, my research was influenced by these aforementioned practitioners, as I control audio effects in a comparable manner. Much like Greenwood, I regularly rely on a Stutter effect created in Max/MSP (see 7.4.3). I also considered attaching a Roli Lightpad Block to my guitar to replicate Bellamy's augmented guitar; however, instead decided to accomplish this using the SoftStep's XY pad.

In the future, it would be advantageous to question other performers and audiences about their experiences. I was able to address the experiences of performers through resources I found online, as I discovered many discussions on the use of software and hardware. However, ideally, I would like to test the hybrid guitar with willing guitarists and improvisers. Unfortunately, when I completed the practical aspect of my work, Covid-19 occurred, which made it difficult to engage with people. With regards to the audience's experience, although I was able to deduct conclusions from relevant literature, it would be beneficial to hand out questionnaires following concerts, asking for feedback on the performance experience. This would help me comprehend whether the instrument provides a satisfactory performance experience while highlighting modifications that could be made.

Another strategy I would like to explore in the future is the use of gesture tracking to humanise software in an indirect manner. This would involve subtle microvariation in a composition's tempo or timbre of software instruments using unintentional gestures, which would naturally exploit body movements to contribute human feel and imperfection. This would not require conscious thought as even dramatic gestures would not noticeably impact the tempo.

During this research, I experimented with real-time control of an entire composition's harmony, using MIDI guitar. This allowed me to determine the scales that MIDI instruments are constrained to, by spontaneously selecting notes on the guitar, applying jazz guitar skills in the digital domain. This affords more possibilities than Live's Scale effect which is fixed to one scale. Unfortunately, I came across a latency issue with this device which made it unusable in performance situations in the timescale of this research.

9.3 Outcomes

This research produced novel approaches for controlling and interacting with digital music, with a focus on interface design; recycling virtuosity; mapping strategies; human and computer improvisation; and encapsulating personal knowledge in software. The resultant methods improved my performance experience by utilising the skills of a guitarist while incorporating some of the concerns of jazz ensemble performance into software. This research moved towards an instrument with visible action-sound relationships, by having controllers with fixed functionality, and gestures that could be clearly seen (see 7.8). This contributes to liveness and provides audiences with a greater understanding of human agency in electronic music performance.

Although the need for improvisation was a personal requirement, this research describes how improvisation can be useful for improving performer and audience

experience. Since performer engagement and effort is not always necessary to create an exact realisation of a digital composition, incorporating improvisation is useful for creating this engagement and inadvertently producing imperfect blemishes that display liveness. This is beneficial as Collins, Schedel and Wilson (2013) suggest that people enjoy going to concerts to witness these blemishes. Furthermore, when an audience is familiar with the work of a performer, they will be able to distinguish more differences between the original and performed material when improvisation is incorporated, especially when imperfect blemishes change the course of a performance.

Throughout this research, I discovered what I desired in an instrument closely correlates to the perspectives on how musicians can display liveness discussed throughout this thesis. I wanted an instrument that was intuitive, understandable and direct, and moreover, replicated aspects of acoustic instruments, such as a full-body experience, embodied interactions and the intelligence of physicality. However, I worked with a complex software environment that did not require continuous human control, therefore, I did not control most of the compositional material.

My research devised viable solutions that allow for the delegation of tasks to the computer without negatively impacting the performance experience. For example, I set limitations on human control while having a degree of consistency in the gesture-sound relationships as demonstrated by the GlitchGenerator which is used throughout the portfolio in a comparable manner. Although this meant that computer contributions sometimes outweighed human agency, I could focus on specific roles while the gesture-sound relationships remained intact.

This research is closely aligned with recent developments in electronic music and, therefore, does not entirely contradict existing methods. I argue that some of the mainstream approaches are lacking in certain areas, such as expression and embodiment which practitioners such as some of those working with NIME are

currently addressing. Unlike those in the NIME community, my research was not about creating an entirely novel instrument to solve these problems, rather it does so by using and modifying the guitar, in combination with commercial hardware and software. To find solutions it was necessary to create bespoke software and develop new ways of interacting with commercial controllers. To discover an appropriate approach, I addressed the value in the methods and perspectives taken by other digital practitioners, which provided a review of DMIs and how they can be useful for humanisation. This allows readers to deduct their own conclusions as to what type of controllers and software might work best for them.

The practices and tools developed throughout this research have been successful in improving my sense of control and engagement with technology. For example, the hybrid guitar has allowed me to stay present while easily switching between guitar and DMI technique (see 7.8). In certain instances, I use one to augment the other, for example, using MIDI pickups to perform glitch material, thereby creating a new relationship with the guitar based on sound and discovery (see 4.4). The varied set of tools and skills I developed has allowed for greater flexibility and improvisational possibilities, which when combined with variable computer processes allowed for different realisations of the compositions. This included a variety of audio effects, each producing a unique sonic outcome that can be controlled in numerous ways using various mapping strategies and computer processes. With an environment that acts like a jazz rhythm section, by outlining each composition's harmony and arrangement, therefore, never distorting the composition's identities to the point they become unrecognisable.

This research has expanded knowledge of digital composition and performance while developing a new perspective on humanisation. In practice, this led to the design of an instrument that was a personal interpretation of the guitar, Live, Max/MSP, as well as musical preferences and background. Although still somewhat limited to Live's workflow, the application of bespoke software and that of the Max/MSP community

has allowed for the creation of a unique composition and performance style, contributing to discussion of personality, knowledge and aesthetic preferences into digital software, instruments and performance.

This research demonstrates how to apply guitar skills to digital interfaces in the control of a digital environment and extension of the guitar's capabilities. I addressed how to apply extended guitar technique by using controllers that exploit the same interaction methods when engaging with the guitar's tone and volume knobs, as well as effects pedals (see 7.8). In addition, this research explored the simultaneous use of orthodox guitar technique, utilising the guitar's sonic output or using MIDI pickups to perform digital sounds directly, both of which could be augmented using digital controllers and computer processes (see 7.8.3). This personal approach to playing guitar and software instruments naturally results in human nuance, expressivity and imperfection.

The hybrid guitar's design makes full use of the spare bandwidth that interaction with the guitar provides while spreading skills throughout the entire body, allowing for the full creative use of the acoustic and digital layers of the instrument. The positioning of the digital controllers made it easier to navigate the entire instrument using touch and spatial awareness, while the fact that the hybrid guitar was a moveable instrument enabled the theatrics guitarists are capable of.

The design of the hybrid guitar was useful from the audience's perspective as the control methods I applied correlate with guitar practice. The moveable nature of the instrument contributes to liveness by allowing me to get away from the computer while engaging in a full-body experience with dramatic gestures. Furthermore, the controllers' lights allow for the visualisation of software, thereby providing a better insight into the computer processes than is possible with a laptop or interfaces that are out of sight on a table. I learned from Kjus and Danielsen (2016) that when augmented instrumentalists depart from conventional action-sound relationships they

can provide mystery which can be intriguing for audiences. Thus, some of the guitar processing distorts the instruments' action-sound relationships, for example, the delayed anticipation capability of the Asynchronous Looper (see 7.4.1).

Throughout this research, mastering the hybrid guitar often required setting constraints and freezing development. This allowed for a deeper relationship, which was important as the hybrid guitar was a new instrument, and even though it adopted the interaction methods of the guitar, I needed to adapt to the alternative functionality it provided. Furthermore, engaging with the system and portfolio improved my improvisational capabilities, as I was better able to judge what the best course of action was at any given moment. This was important as different compositional methods tend to require different forms of improvisation, for example, I was able to be more experimental with my improvisation on modal compositions (see 8.3 and 8.6) compared to highly composed and structured pieces (see 8.2 and 8.4). Another example is the use of live guitar, as certain compositions benefitted from this, whereas others benefitted from control of audio processing.

I discovered that the style of composition influenced the use and development of the software. For example, when working with glitch compositions, it was unnecessary to apply microinteractions, as this material benefited from computer precision. However, meso and macro improvisation was useful, as this varied the material which kept the music interesting and displayed real-time control.

The developed mapping strategies augment and extended human control over a digital environment in compelling ways. The instrument was designed to allow for varying levels of complexity to make it useful in various situations (see 7.9). One-to-one mapping strategies provided subtlety and precision, whereas multi-mapping strategies could be used when complex and unpredictable outcomes were desired. This made some of the instrument's features easy to learn, while the more complex capabilities required consistent practice. However, as Hunt and Wanderley (2002)

suggested, the complex capabilities made the instrument more enjoyable in the long-term by replicating the feel of acoustic instruments.

Once learned, the complex strategies produced more compelling outcomes that allowed for the use of multiple limbs in combination. This is the case with my SliderMultiMap software (see 7.3.2) which enables the simultaneous control of the parameters of numerous effects with the Guitar Wing, with the option to concurrently turn these effects on/off using the SoftStep (see 7.8.2). This afforded diverse sonic outcomes, achieved readily utilising complex mapping strategies that relied on the intelligence of the muscles, thereby allowing me to focus on the music rather than the tool.

This research also highlighted the benefits of replicating the nonlinear and unstable aspects of acoustic instruments which was accomplished using computer processes that alter human actions (see 7.3.1 and 7.3.3). Joint human-computer control required me to take account of my actions, as indirect computer contributions did not always produce the desired outcome. This adds inconsistency in how the instrument behaved, which as Eno (2010) suggests requires a musician to learn to deal with these inconsistencies, producing a deeper relationship.

Considering Magnusson's (2010) suggestion that there is value in setting constraints, I delegated many tasks to the computer, thereby setting constraints on human control. I found that taking an approach based on immediacy and noticeable outcomes proved beneficial, as this allowed me to be in-the-moment while carrying out embodied interactions in certain instances. This was important, as I learned from Butler (2014) and Green (2011) that embodied interactions allow a musician to communicate more effectively.

Throughout this research, I discovered it was possible to change the type of human improvisational control required by designing the compositions and software in particular ways. One of the more noticeable differences was whether structure needs to

be created by the human or computer. For example, modal compositions implemented a chaotic computer part that required real-time human control to create a coherent piece (see 8.6), whereas others had a compositional structure that was outlined by the computer (see 8.4) and human control involved the addition of embellishments and variation. This contributed another means of keeping performances interesting by producing different styles of composition and improvisation, as well as human-computer interplay.

In conclusion, the methods devised throughout this research have incorporated more of my aesthetic preferences, skills and knowledge into a DMI. This has allowed me to compose and improvise with music technology in a unique way that exploited my musical background and produced an expansion in the performance techniques and roles available. Thus, enabling me to manifest human agency more effectively during composition and performance, through physical, mental and encapsulated computer presence, with compelling interaction between these. This has significantly improved my sense of control, by allowing me to situate myself as a primary agent within a digital composition and performance environment. This benefit is transferable to the audience's experience, who can witness my resultant influence over digital music, as well as an intriguing performance approach that blends acoustic and digital practices. As this research documents the entire process, it provides a useful framework of reference and resource for other guitarists, composers and electronic musicians who may wish to develop similar practices in the future.

Appendix A

Phases instrumental score. Performed at the 2019 Dialogues Festival by the Rush Hour Ensemble, conducted by Peter Nelson.

Musicians:

John Konsolakis - Clarinet

Muang Luanghvisut - Violin

Georgina Finlayson - Violin

Daniel Safford - Viola

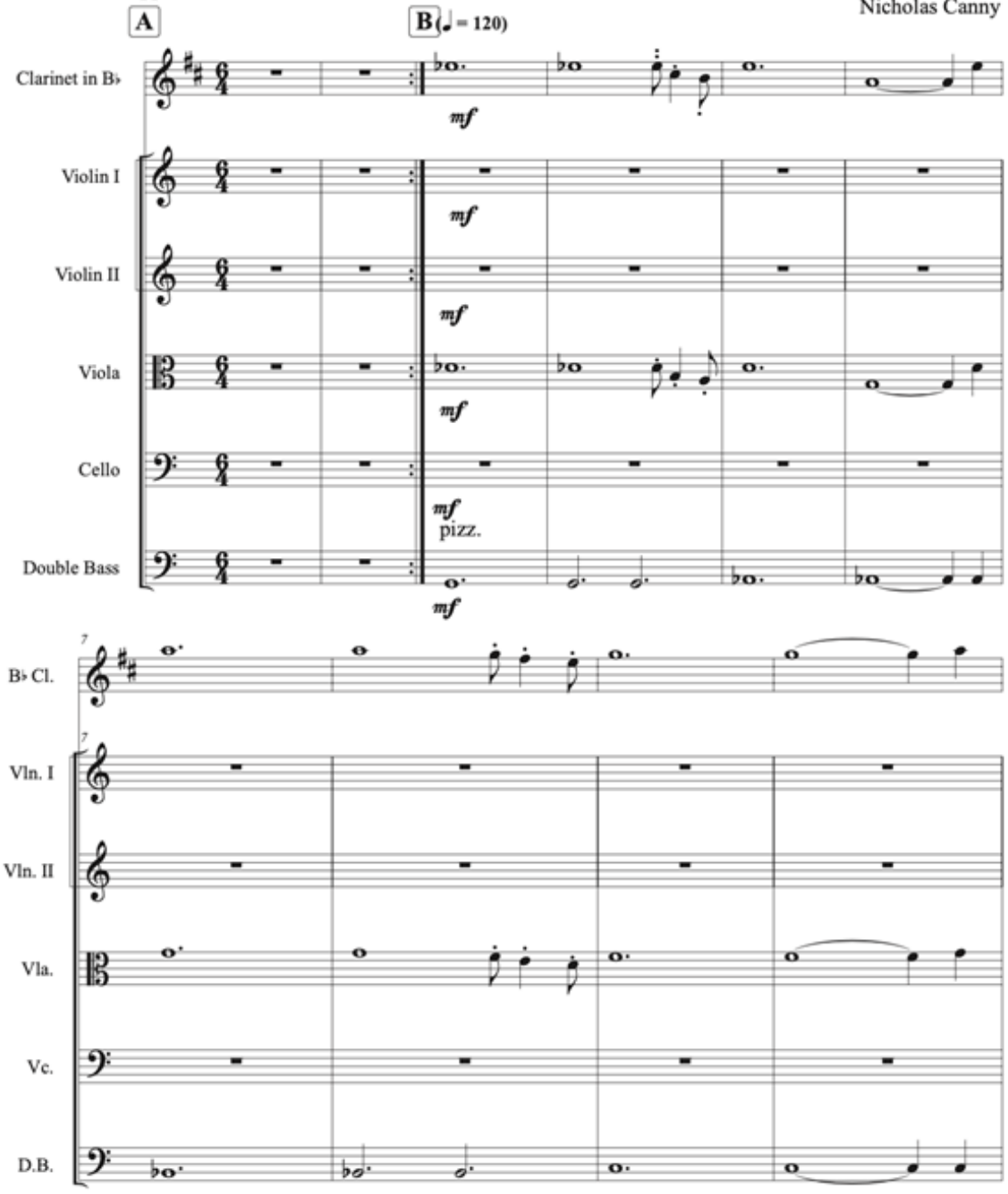
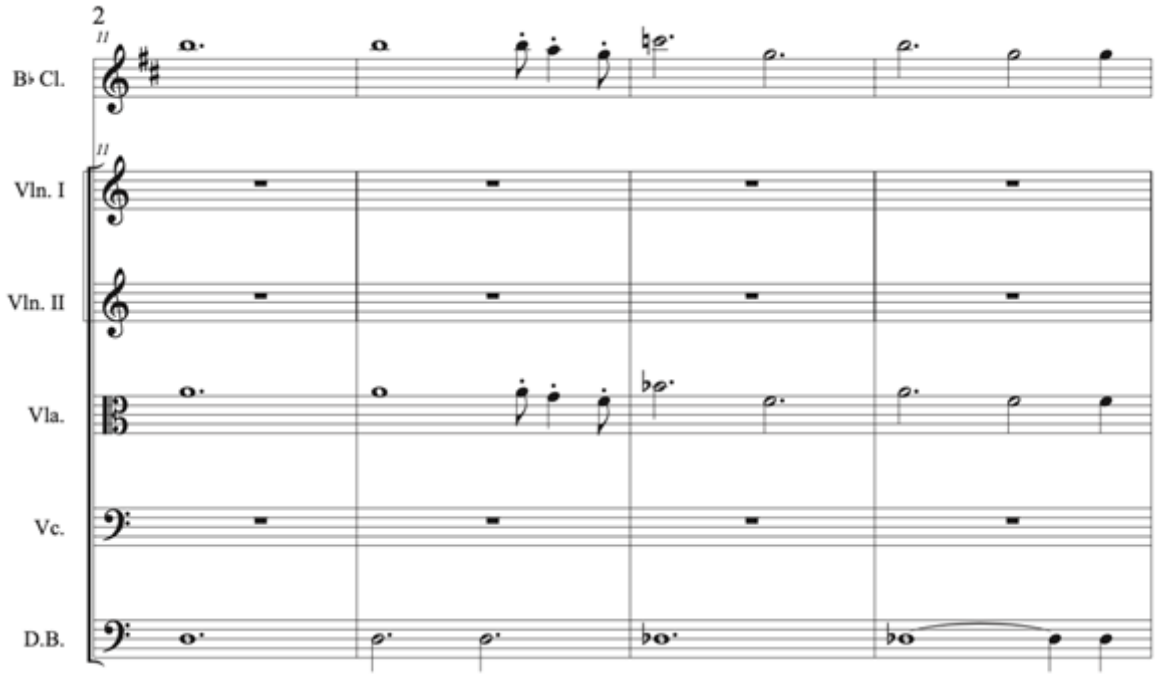
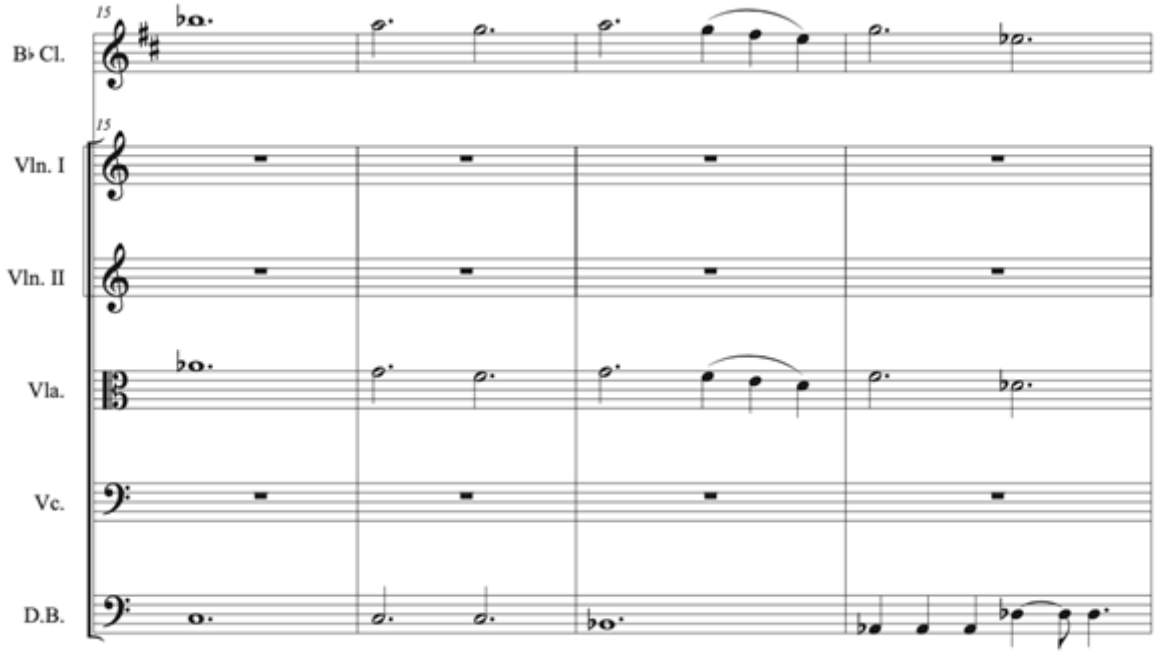
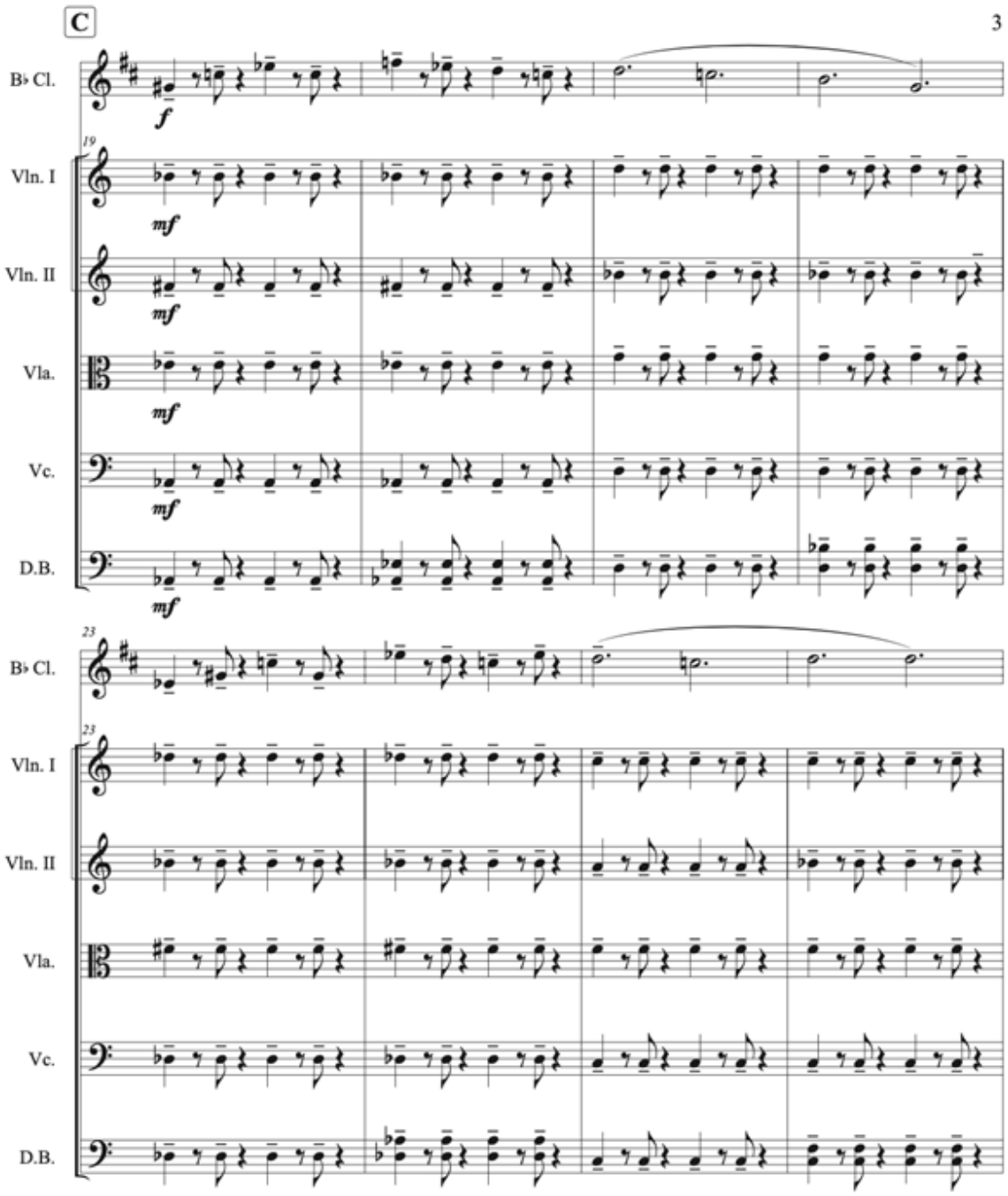
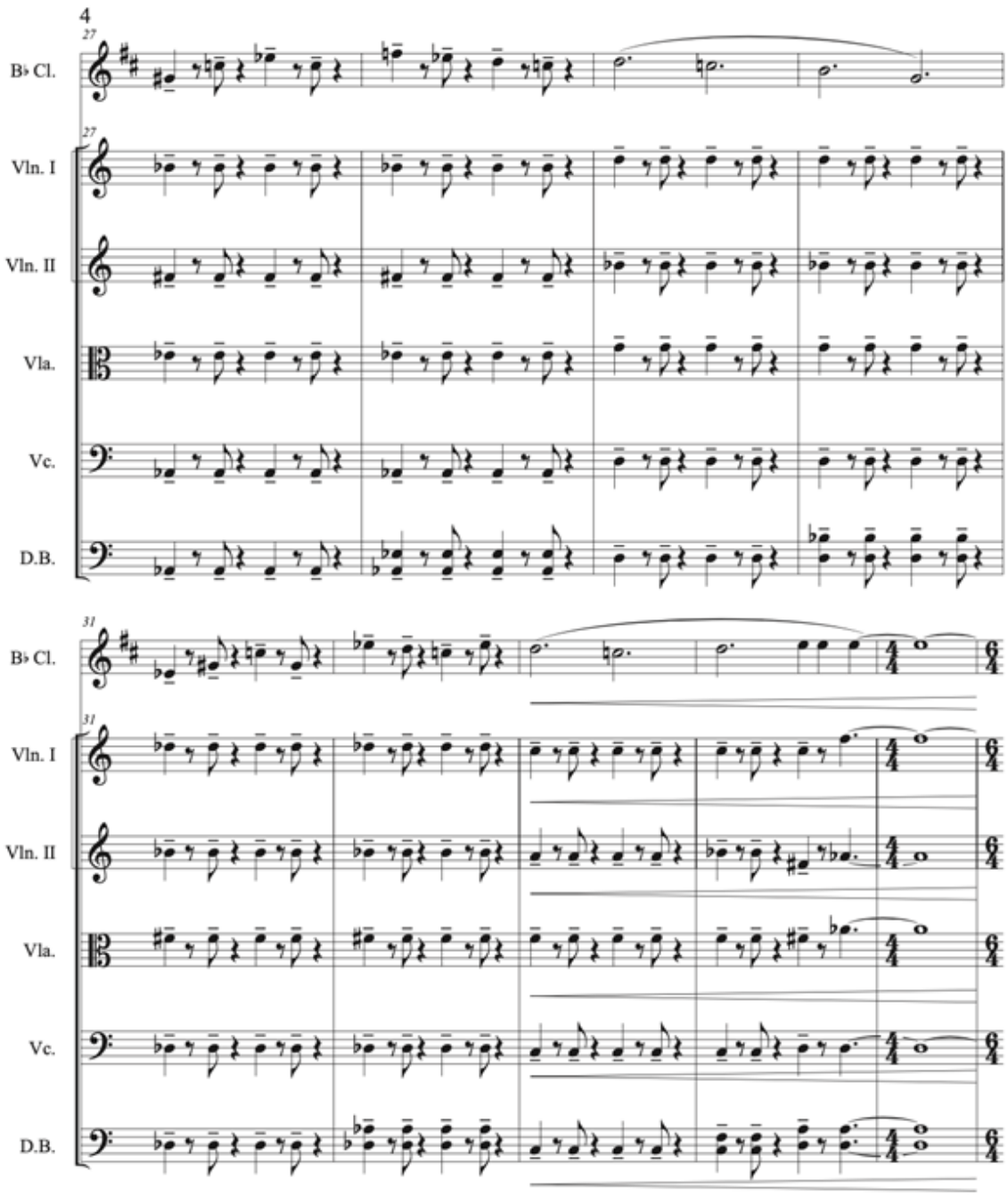
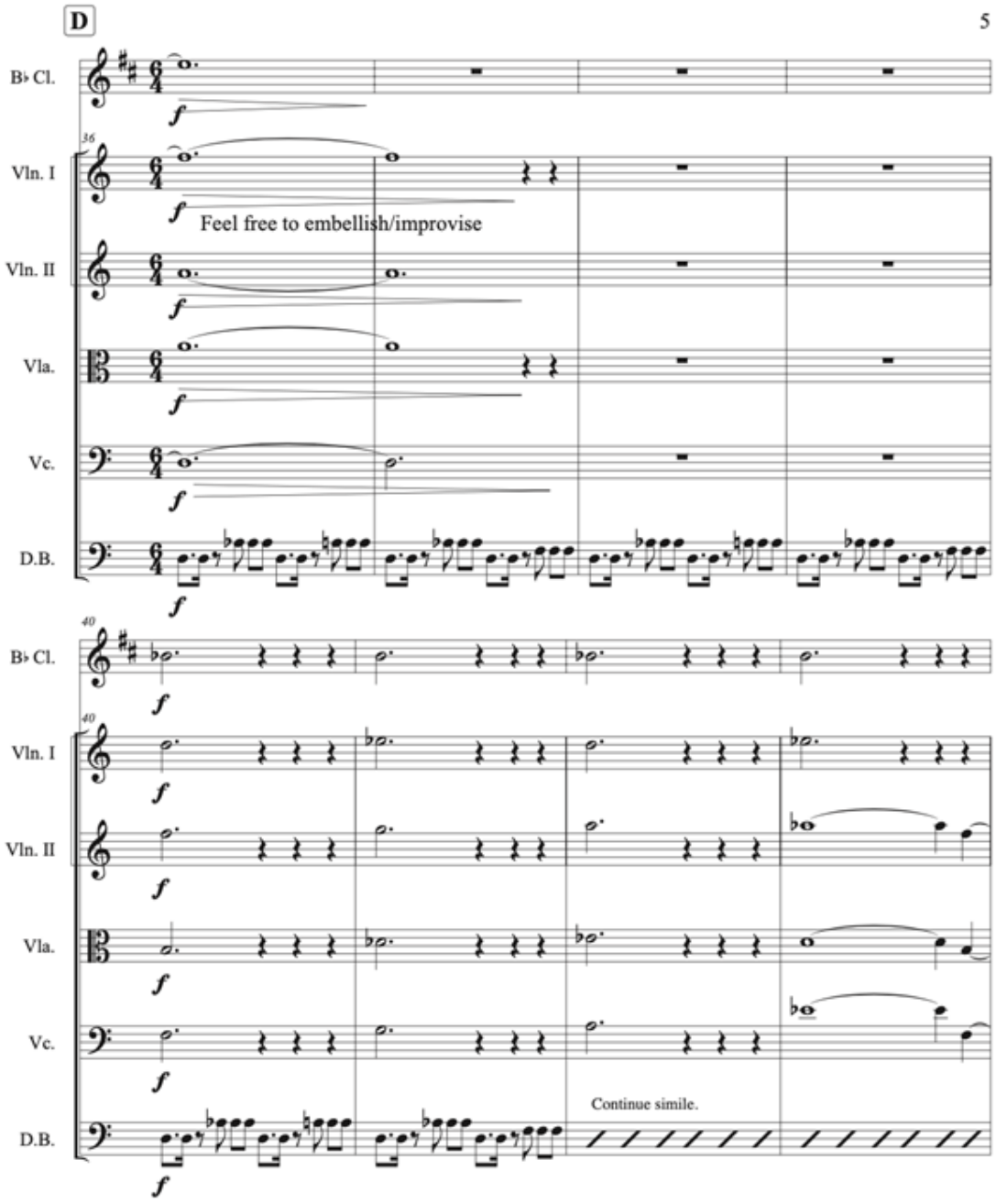
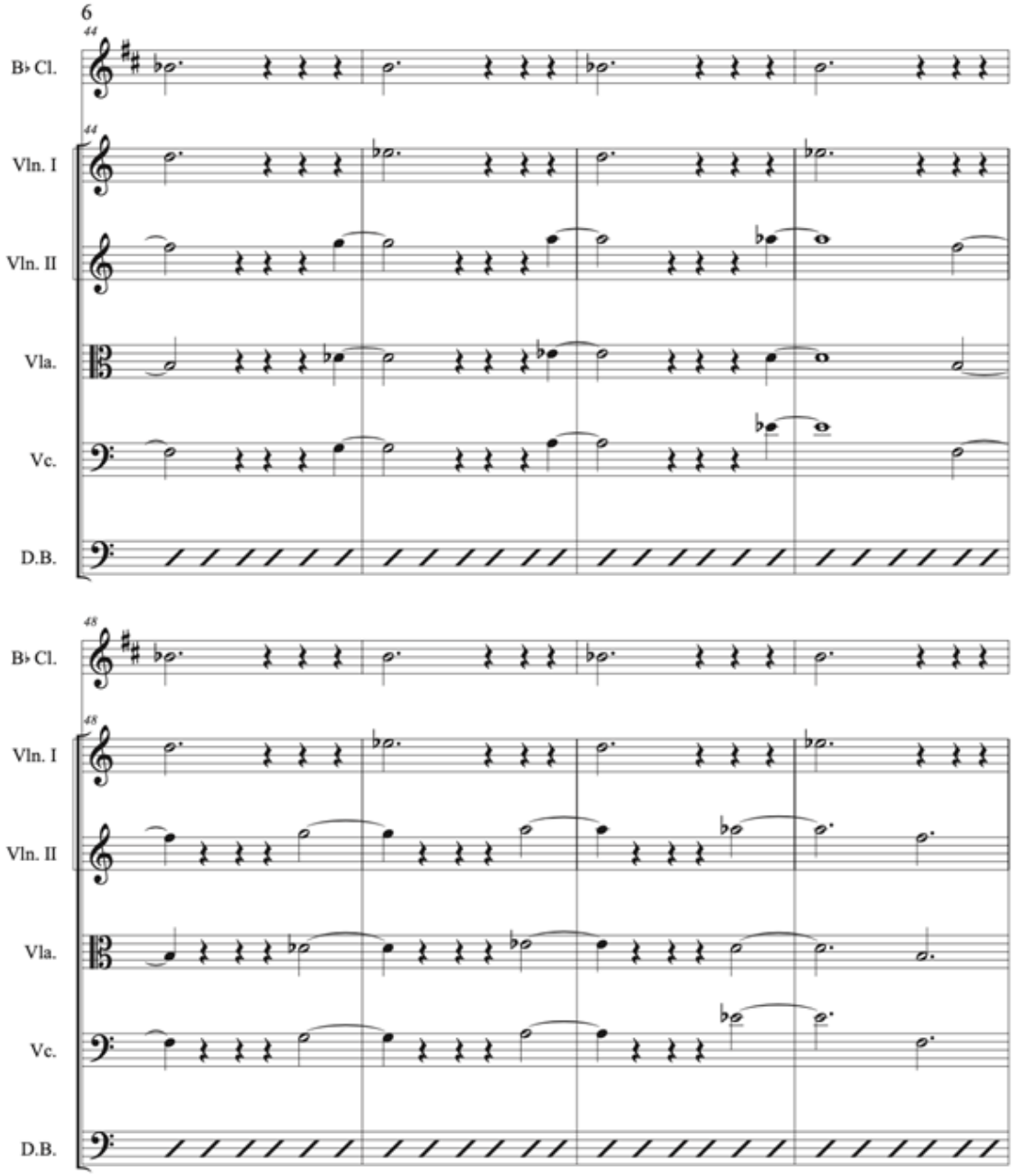
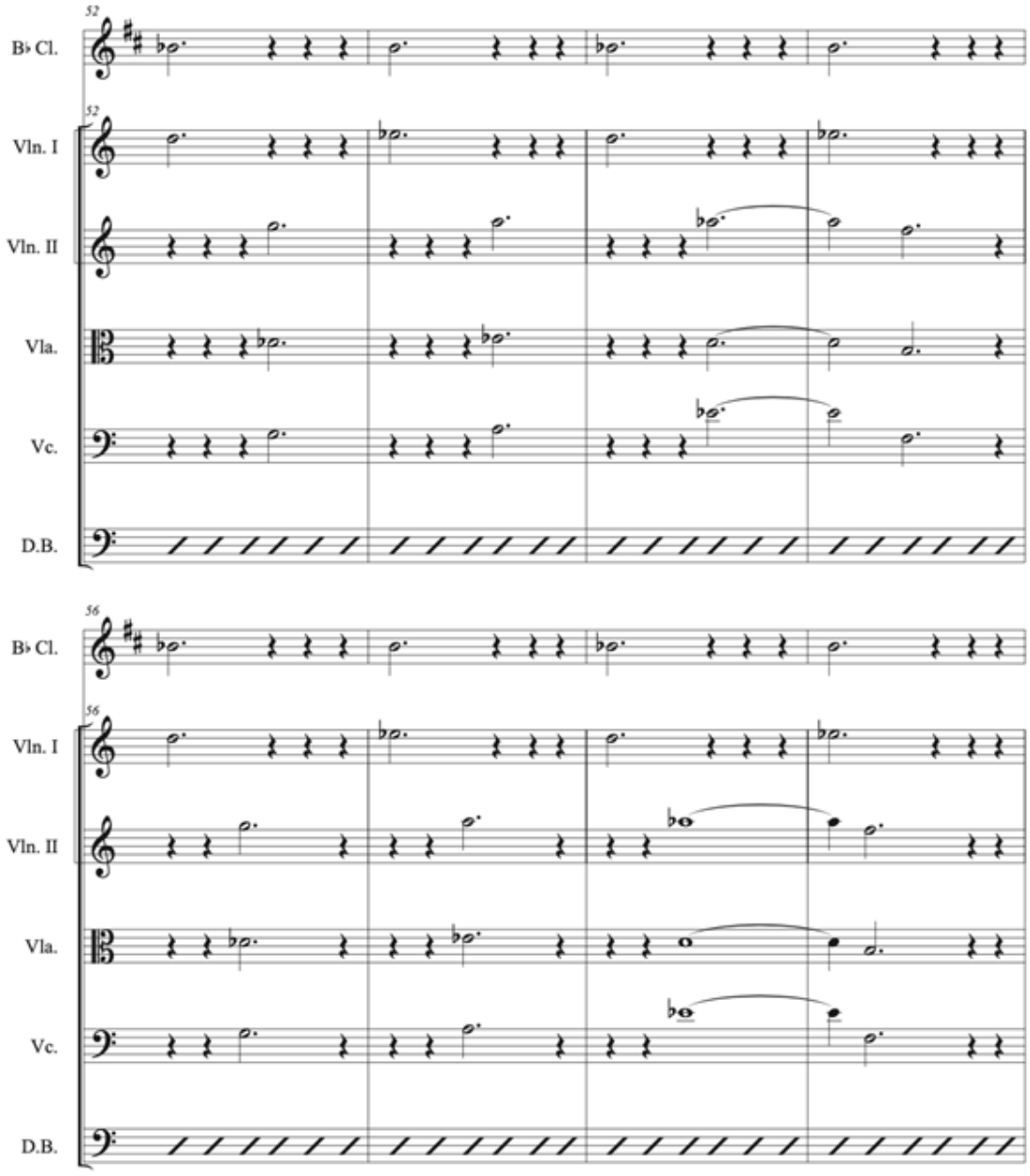
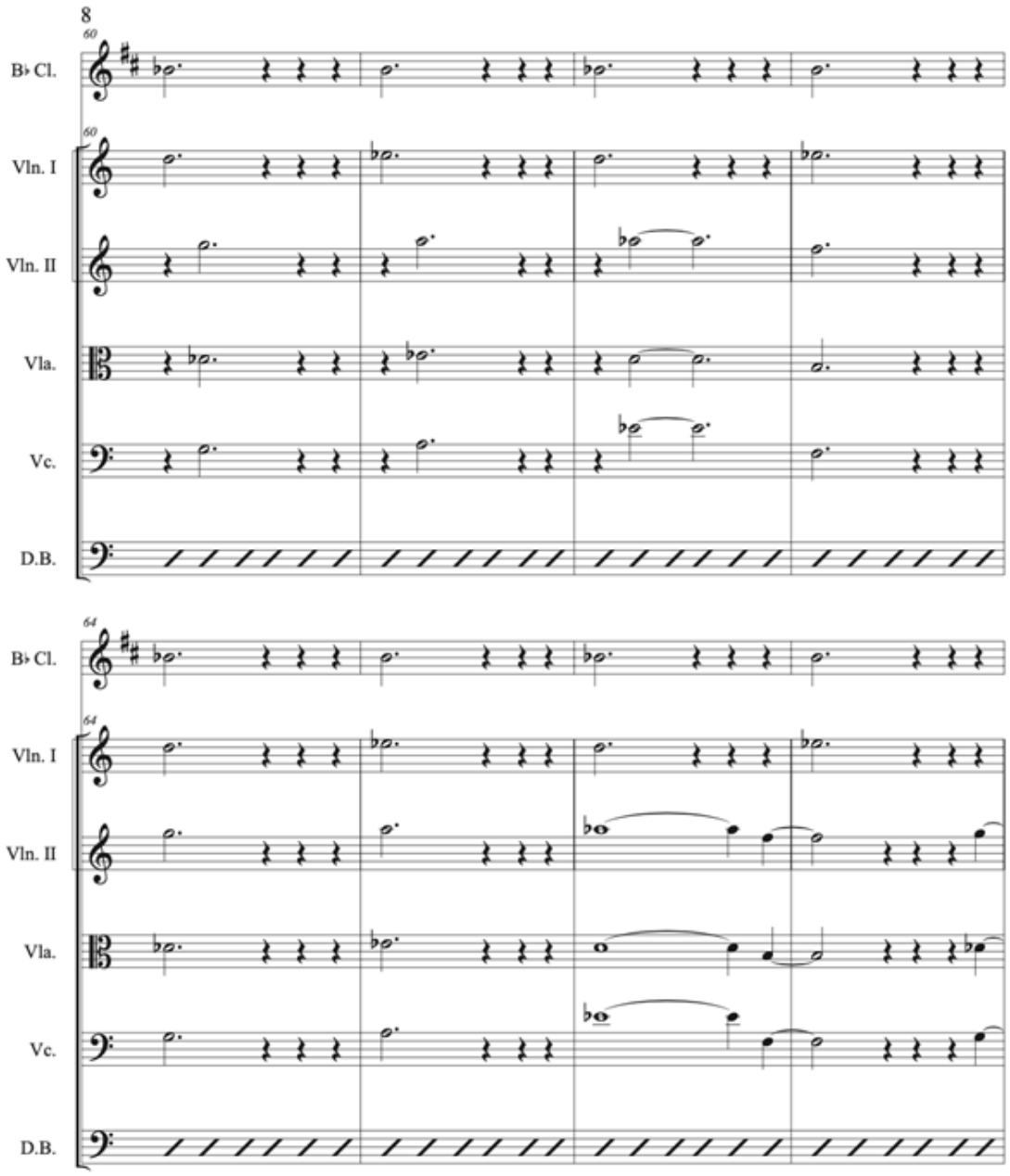
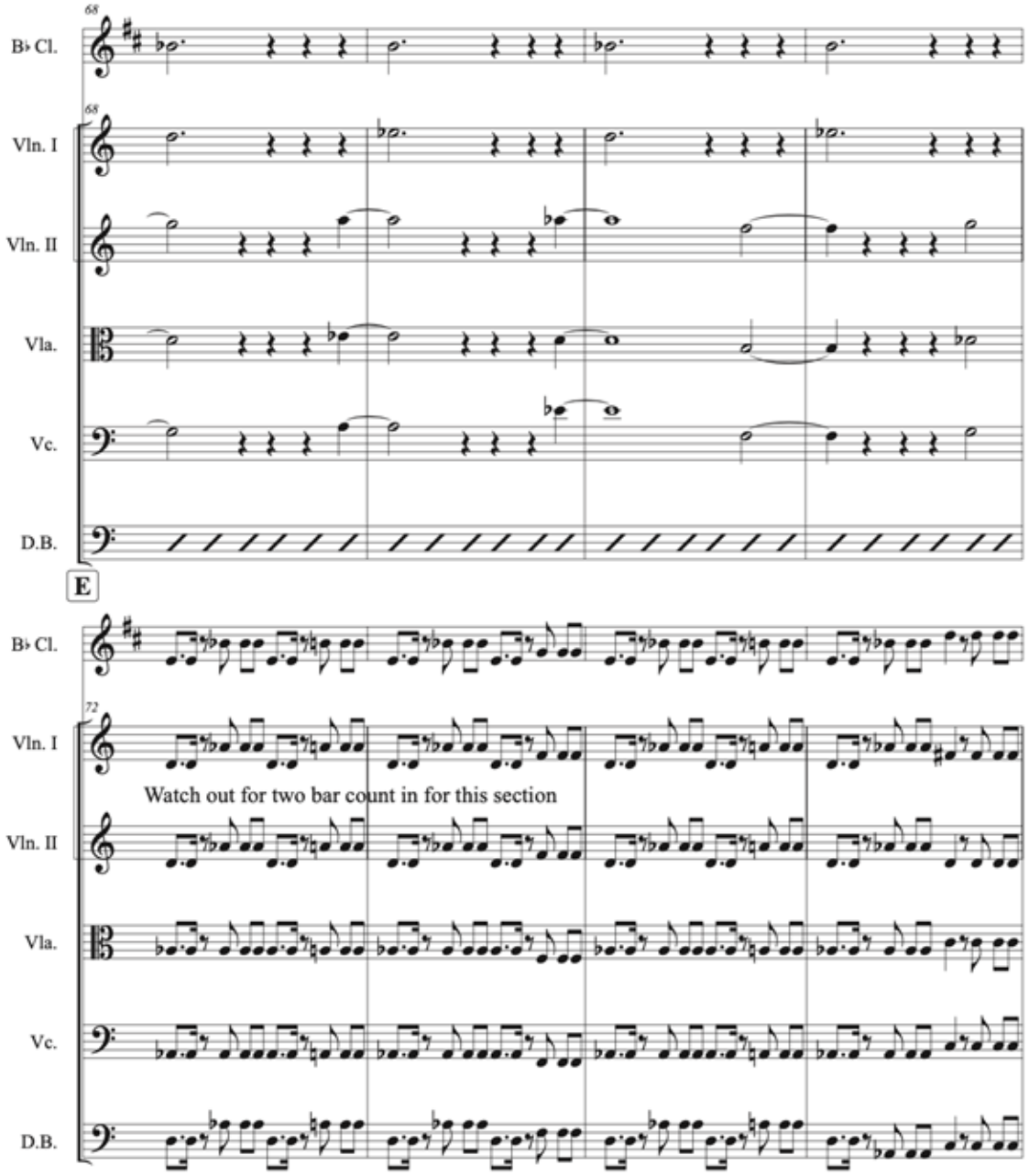
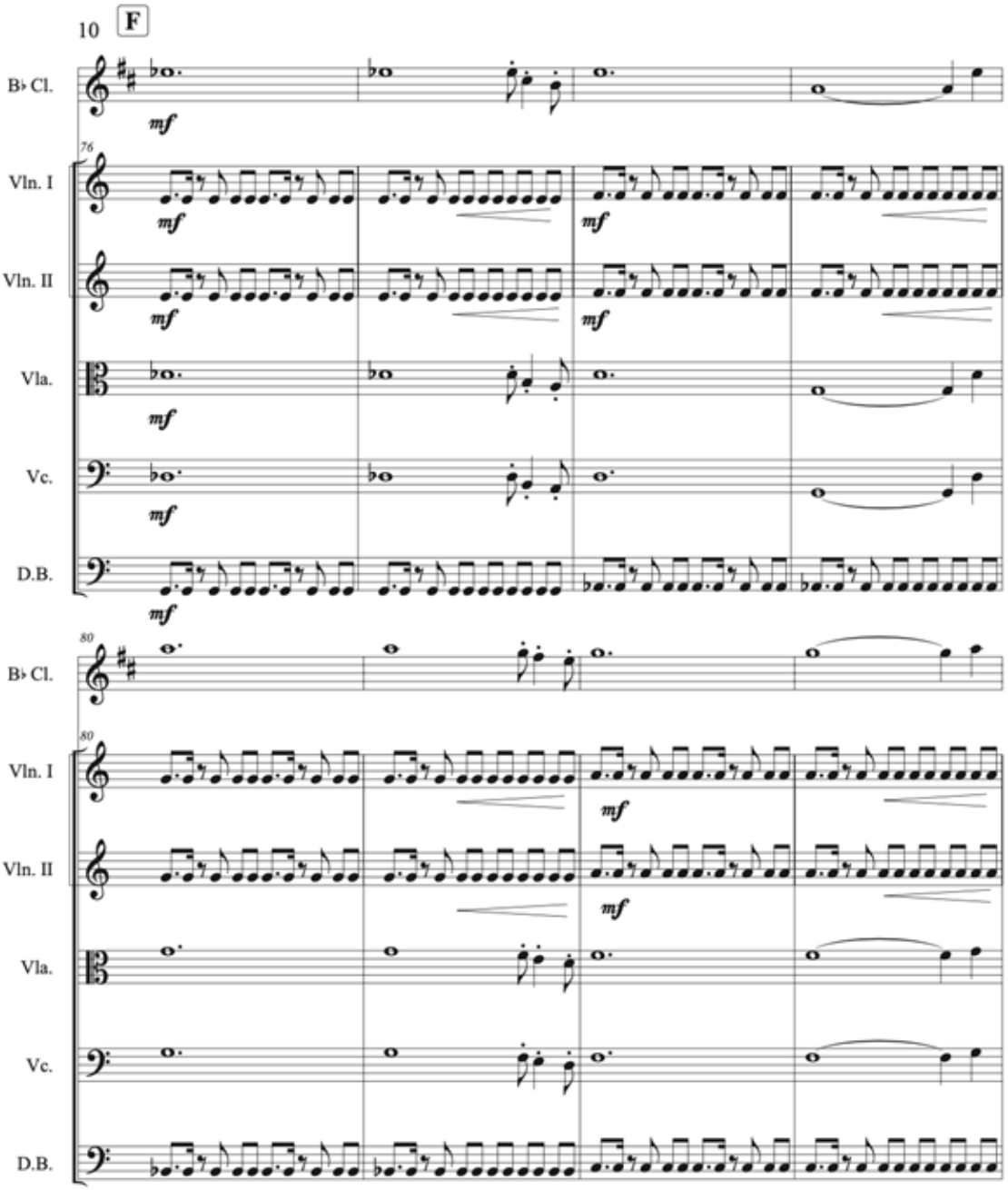
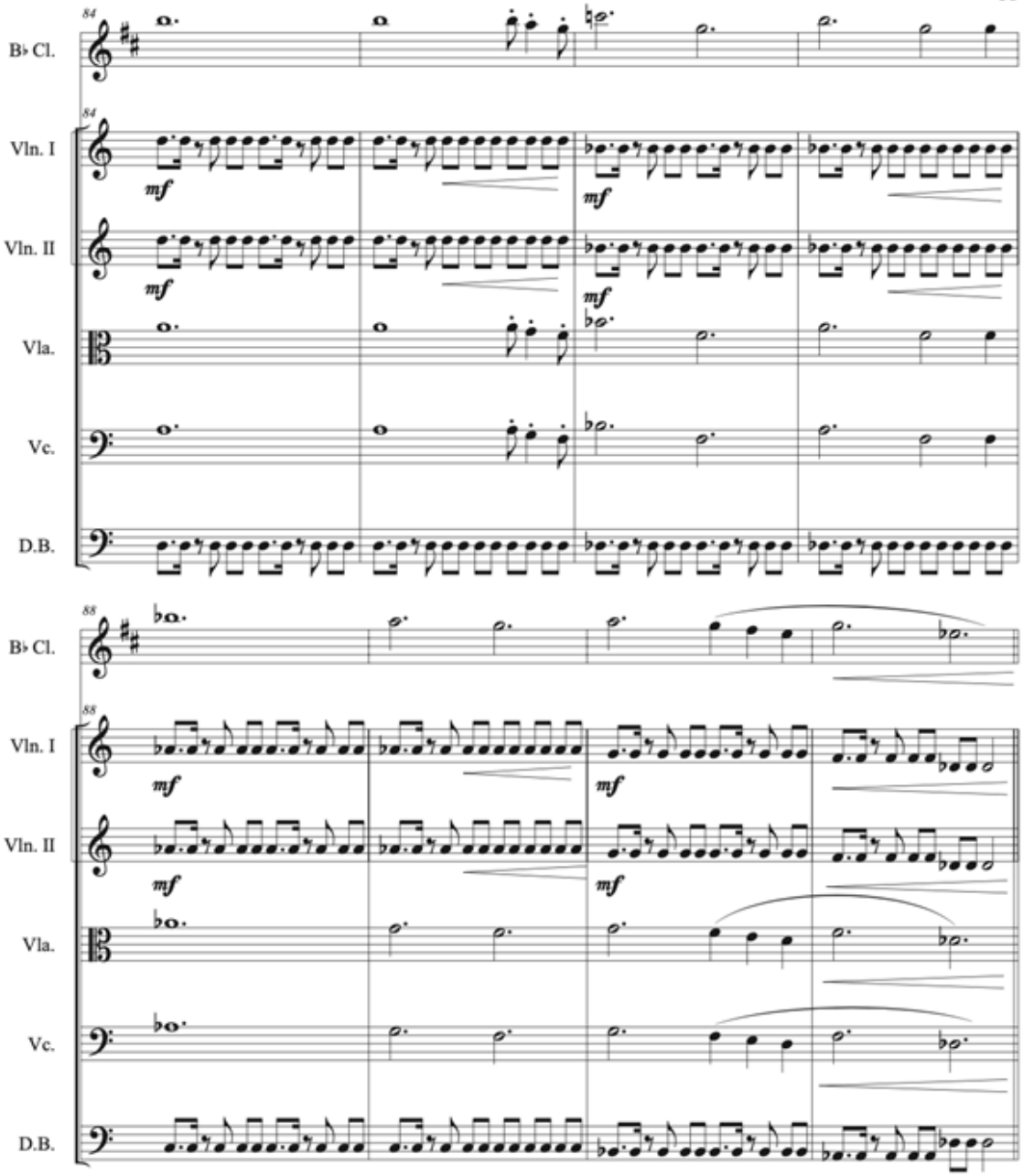
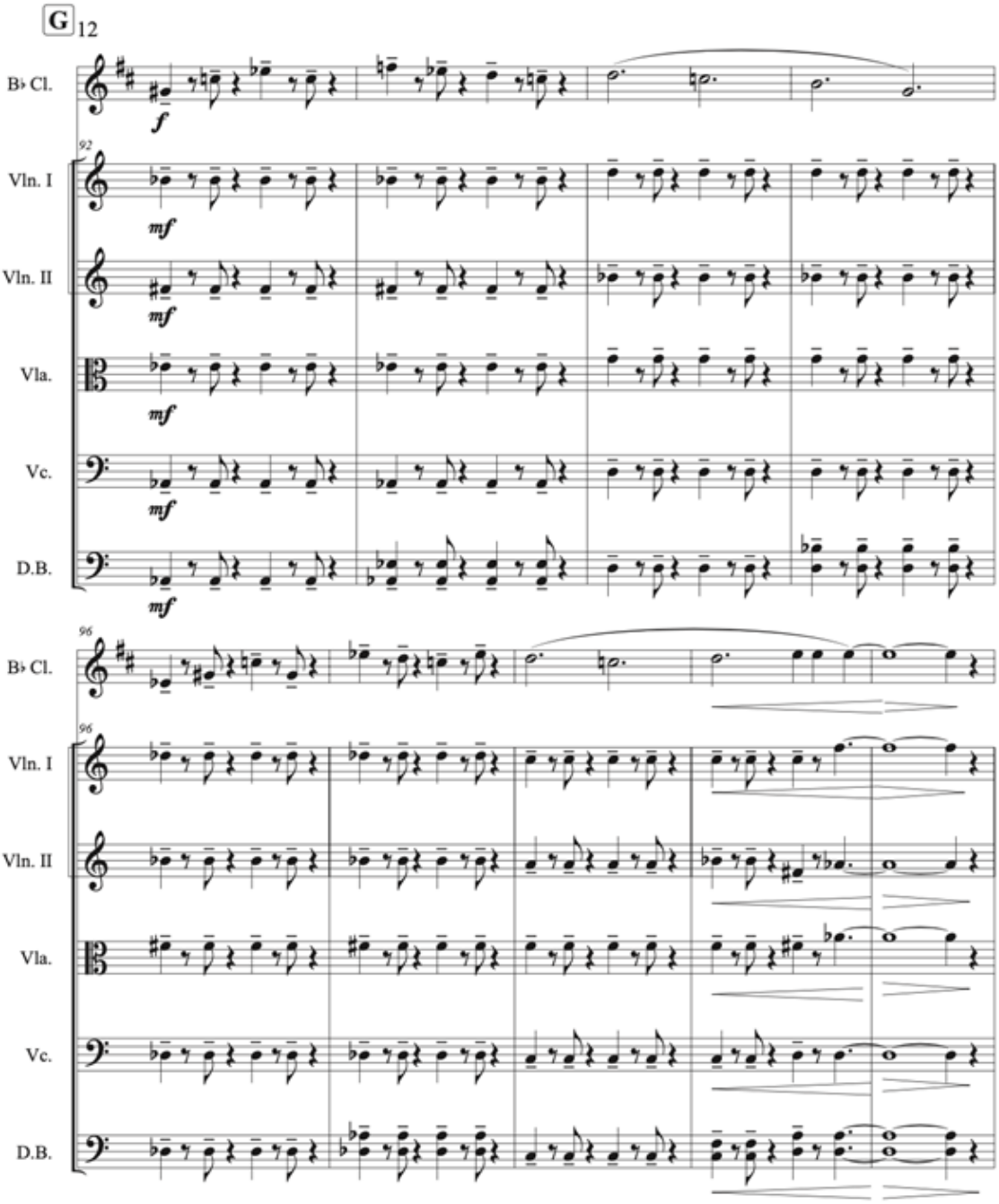
Justyna Jablonska Edmonds - Cello

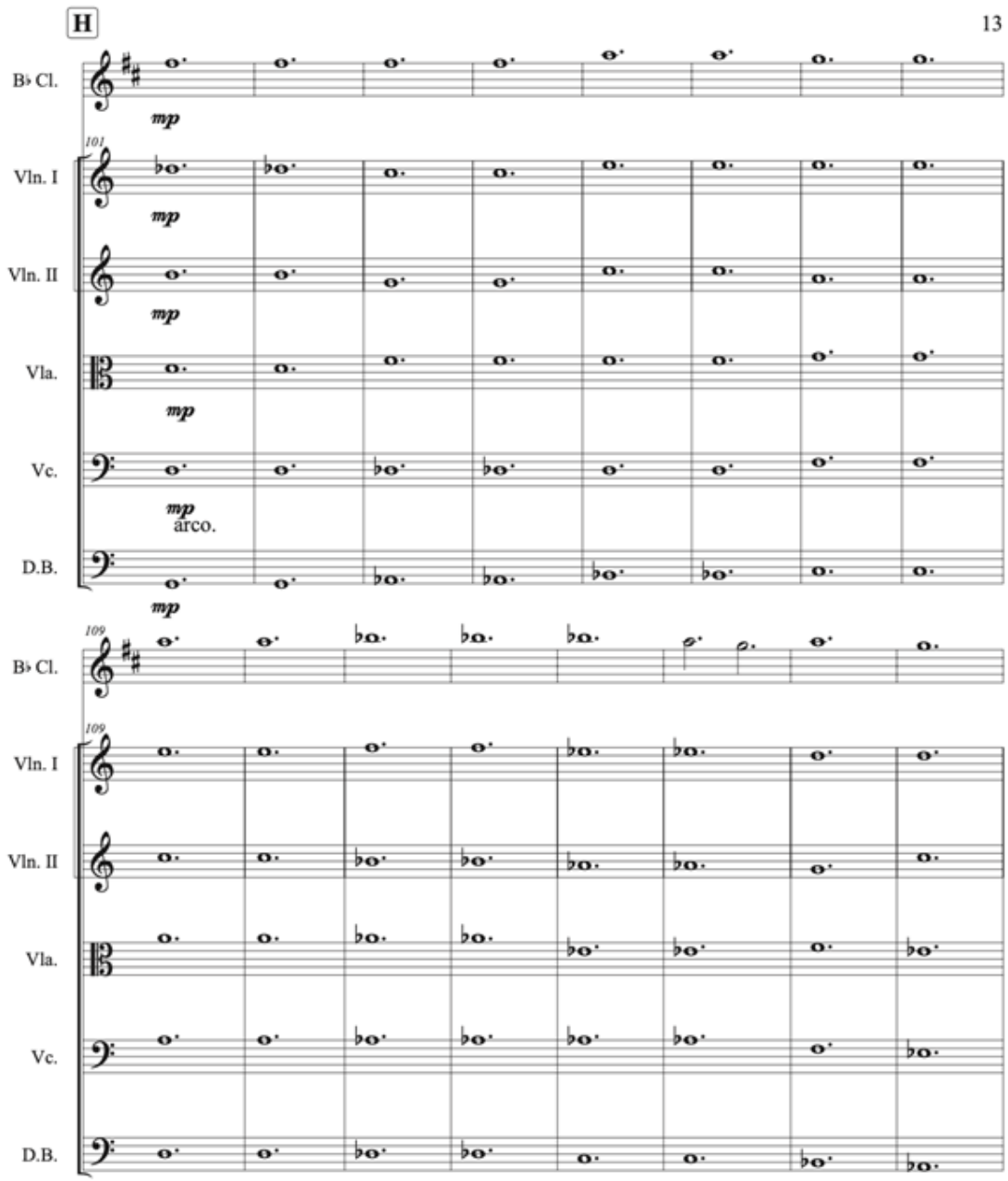
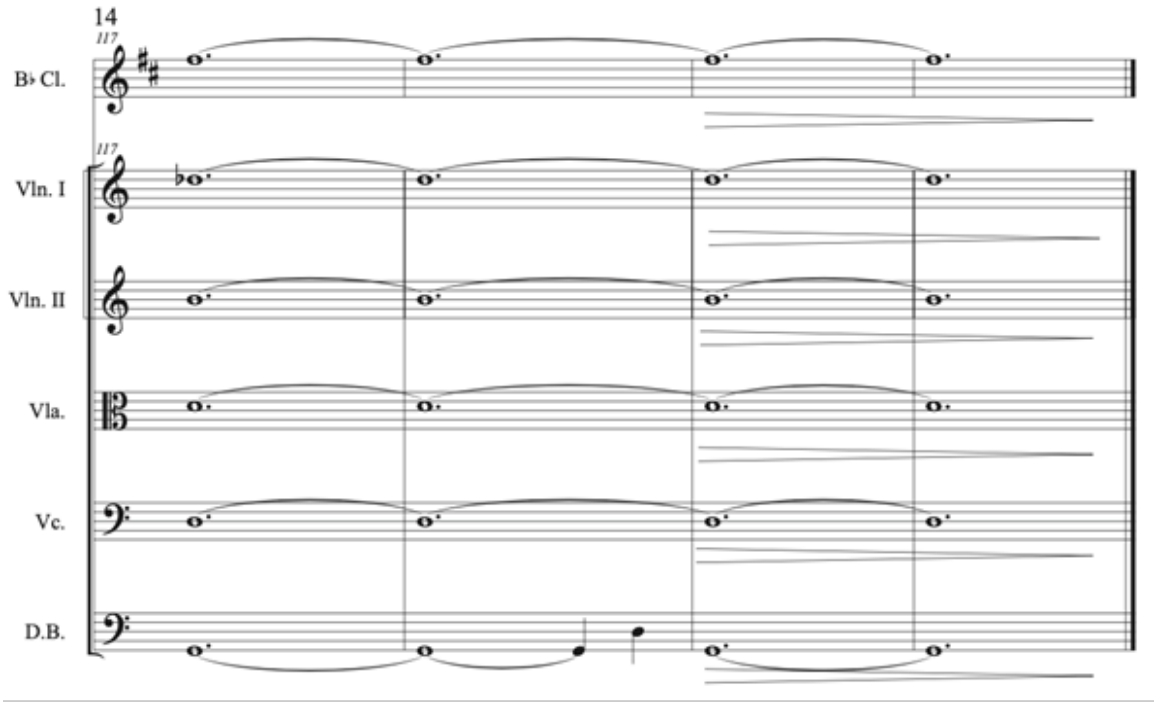
Russel Wimbish - Double Bass

Score

Phases

A - Intro - Generative electronic section -
approx. 2 mins - Watch for 2 bar count in for B section

Nicholas Canny

2
11
B♭ Cl.
11
Vln. I
Vln. II
Vla.
Vc.
D.B.

15
B♭ Cl.
15
Vln. I
Vln. II
Vla.
Vc.
D.B.

C
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.
19
23
f
mf

4
27
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.
31
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.

D
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.
36
40
Feel free to embellish/improvise
Continue simile.
f

6
44
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.
48
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.

52
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.
56
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.

8
60
B♭ Cl.
60
Vln. I
Vln. II
Vla.
Vc.
D.B.
64
B♭ Cl.
64
Vln. I
Vln. II
Vla.
Vc.
D.B.

68
B♭ Cl.
68
Vln. I
Vln. II
Vla.
Vc.
D.B.
E
B♭ Cl.
72
Vln. I
Watch out for two bar count in for this section
Vln. II
Vla.
Vc.
D.B.

10
F
B♭ Cl.
Vln. I
Vln. II
Vla.
Vc.
D.B.
mf
76
80

84
B♭ Cl.
84
Vln. I
mf
mf
Vln. II
mf
mf
Vla.
Vc.
D.B.
88
B♭ Cl.
88
Vln. I
mf
mf
Vln. II
mf
mf
Vla.
Vc.
D.B.

G
12
B♭ Cl.
f
92
Vln. I
mf
Vln. II
mf
Vla.
mf
Vc.
mf
D.B.
mf
96
B♭ Cl.
96
Vln. I
Vln. II
Vla.
Vc.
D.B.


H
13
B♭ Cl.
mp
101
Vln. I
mp
Vln. II
mp
Vla.
mp
Vc.
mp
arco.
D.B.
mp
109
B♭ Cl.
109
Vln. I
Vln. II
Vla.
Vc.
D.B.

14
III7
B♭ Cl.
III7
Vln. I
Vln. II
Vla.
Vc.
D.B.

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