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Establishing a laptop orchestra in South Africa:

An emic-centred inquiry into computer music performance

by

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Declaration

I declare that the work that has been presented in this dissertation is my own original work and has not previously been submitted for degree purposes at any other University.

Signature:

Date: 10/05/2022

Ethics Statement

The author, whose name appears on the title page of this dissertation, has obtained, for the research described in this work, the applicable research ethics approval.

The author declares that they have observed the ethical standards required in terms of the University of Pretoria's Code of ethics for researchers and the Policy guidelines for responsible research.

"That inner voice has both gentleness and clarity. So, to get to authenticity, you really keep going down to the bone, to the honesty, and the inevitability of something."

Meredith Monk

Abstract

A few months into the final year of my undergraduate degree an opportunity emerged to oversee and coordinate the technical and organisational aspects of UPLOrc (University of Pretoria Laptop Orchestra), an ensemble of laptops consisting of undergraduate and post-graduate students whose focus is to explore collective live coding practices. In addition to coordinating the activities of UPLOrc, in April 2020 I was invited to collaborate with SuperContinent, a networked live coding ensemble whose members are located across various continents at a minimum distance of more than 500 kilometres apart.

A qualitatively-driven mixed-methods research paradigm was implemented guiding the collection of data from multiple sources in order to obtain a broader understanding of the complexities involved with live coding in collaborative contexts. A netnographic methodology was chosen for the qualitative component of this research, and incorporated an intersecting secondary quantitative component in the form of a survey administered to members of the networked performance community. The research is presented from an emic (insider's) perspective in the form of an autoethnographic account of my experiences as a performer and instructor of live-coded music. Adopting the perspective of an insider initiated a process of critical self-reflection in which I attempted to understand my role as a student, teacher and collaborator in both performance and educational contexts.

The procedures implemented in this research prompted by my collaboration, communication, active participation, and performance with the members of both ensembles over a two-year period, have allowed me to realise the purpose and power of collaborative networked live coding in terms of its potential for cultivating transformative spaces for musical creativity. In addition, conducting this research has provided me with the opportunity to begin the process of building an identity as a live coder, an identity that is multifaceted, complex and constantly negotiated no matter the context in which it operates.

Keywords: Collaborative performance, musical identity, laptop orchestra, networked performance, live coding

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A special thank you to each of my fellow co-members of SuperContinent, for welcoming me into the ensemble, and for your openness and willingness to share your experiences and knowledge with me. Being a part of the group has provided me with invaluable experiences that I will never forget, and allowed me to build connections and relationships in ways I never could have imagined. Rehearsing and performing with you all has brought me great joy and fulfilment, and of course, thank you to the members who were willing to participate in this project.

To all current and past members of UPLOrc, thank you for your willingness to participate in UPLOrc activities, and particularly, for your patience as I was navigating and discovering live coding practice. Your input as members of UPLOrc and participants of this project was critical during this process. I am truly grateful.

To my parents, Ben and Lisa, thank you for encouraging me to take my time in finding and forging my own career path, and supporting me in everything I do. Your unconditional love, support and guidance, as well as your financial support, have provided me with opportunities that many people only dream of. For that I will always be grateful. I love you both endlessly.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

A few months into the final year of my undergraduate degree an opportunity emerged to oversee and coordinate the technical and organisational aspects of UPLOrc (University of Pretoria Laptop Orchestra), an ensemble of laptops consisting of undergraduate and post-graduate students whose focus is to explore collective live coding practices (Collins et al., 2003). An inaugural performance held by the members of UPLOrc in August 2019 at the University of Pretoria Music Festival (UPMF), marked our debut performance as a newly-formed laptop orchestra established in May of the same year. To my knowledge at the time, no such ensemble had existed on the African continent. The ensemble remains small, although continues to grow with each year that passes. Our initial objective was to explore live coding with the intention to perform in concert halls and other similar settings. Although this is certainly not the first occasion where network technology was used for musical performance (Chatzichristodoulou, 2012; Oliveros et al., 2009), many laptop orchestras and music ensembles including UPLOrc (Laubscher, 2021), were forced to incorporate network technology as part of their practice due to the Covid-19 pandemic[1] (Caruso, 2021; Fasciani, 2020).

Although laptop orchestras emerged from academic and educational contexts (Ogborn, 2012; Trueman et al., 2006; Trueman, 2007; Tsabary, 2014; Wang et al., 2008), some form a portion of the greater and developing live coding community (Knotts et al., 2020; Renaud et al., 2007) including network ensembles such as SuperContinent (Betancur et al., 2021; Ogborn, 2018). Through the development and use of Estuary, a browser-hosted application and multi-lingual live coding platform (Ogborn et al., 2017), members of laptop orchestras and network ensembles are able to perform collaboratively regardless of their location. Both SuperContinent and UPLOrc perform live-coded network music using the platform, with the exception that UPLOrc does not incorporate a visual art element into their live coding practice (Betancur et al., 2021; Laubscher, 2021). In addition to coordinating the activities of UPLOrc, in April 2020

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[1] See https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4 [Accessed 01 Mar. 22]

I was invited to collaborate with SuperContinent, whose members are located across various continents at a minimum distance of more than 500 kilometres apart (Betancur et al., 2021).

Throughout the process of exploring live coding practice in both ensembles, some questions emerged that have informed how this research was conducted. How could I apply what I learned through exploring live coding practice in order to teach others how to live code? Since UPLOrc is a performing ensemble, how would we go about organising a performance both logistically and sonically? What are the absolute minimum technological requirements we would need to meet in order to explore collective live coding practices? How do we go about collectively positioning ourselves in a sonic space in order to achieve a cohesive sound as a group, thereby attempting to merge multiple individual aesthetic preferences?

Through continuous and long-term online interactions with the members of SuperContinent and the greater networked performance community, I have obtained invaluable knowledge which has informed a considerable portion of my approach to coordinating the activities of UPLOrc. In conducting this research various considerations have emerged concerning my position and role as the coordinator of UPLOrc through my participation as a member of both SuperContinent and UPLOrc. In exploring this position, I argue that the understanding of my own musical identity (Hebert, 2009) is inextricably linked to my development as a solo performing musician and artist (Hargreaves et al., 2012). To understand my perspective as an insider in the networked performance community, my identity development cannot be excluded from the argument presented in this research (Hargreaves et al., 2002). In this context, this refers to the self-knowledge and experience obtained through continuous and inherently social interaction in a collaborative setting (Born, 2012; Hebert, 2009).

An overview of the current literature provides a framework for discussion concerning networked live coding performance in educational and collaborative contexts. What follows is an insider's account (Hoare et al., 2013; Morey & Luthans, 1984) of my experiences and knowledge obtained through my position as an ensemble member, instructor and live coder within the social context of collaborative network performance (Butz & Besio, 2009; Hains-Wesson & Young, 2017; Rowsell et al., 2012).

1.2 PURPOSE OF THE STUDY

The aim of this research is to determine the ways in which the members of network ensembles organise themselves, and how this translates into live coding practice (Lee & Essl, 2014; Ogborn, 2014, 2016; Tsabary & Woollard, 2014). Particular emphasis was placed on the ways in which collective creativity is achieved (Bishop, 2018) using the MiniTidal live coding language (McLean, 2014) in Estuary. The purpose of this study, therefore, was to understand how the members of SuperContinent perform live-coded music and whether the knowledge I obtained as a member of the ensemble could be applied or adapted to the live coding practice of UPLOrc. In adopting an experimental mixed-methods approach (Creswell & Creswell, 2018), the research presented here is an attempt to establish a deeper understanding of the musicological, organisational and technological aspects of live coding in a collaborative context.

1.3 RESEARCH QUESTIONS
1.3.1 PRIMARY RESEARCH QUESTION

What are the logistical, technological and musicological criteria or parameters required for the establishment of a laptop orchestra at a South African university?

1.3.2 SECONDARY RESEARCH QUESTIONS

The following sub-questions elaborate on the primary research question:
- In the context of a networked live-coded music performance, how do laptop orchestras organise themselves and express collective creativity through the use of browser-based technology?
- What are the benefits and disadvantages of performing collaboratively in a live-coded network ensemble using browser-based technology, and how is this significant for contemporary collaborative ensemble performance?
- How and to what extent do the social activities of collaborative live coding, including political, ethical and aesthetic decisions made by performers, facilitate individual and collective musical identities?

1.4 METHODOLOGY

The following presents an overview of the methodology implemented throughout the research process. An in-depth description of these is provided in chapter three.

A mixed-methods research paradigm (Johnson, 2015) was implemented through the collection of multiple sources of data, the analysis of this data and the subsequent synthesis of the results. This approach was used in order to utilise the affordances of mixed-method research, allowing for the triangulation of data originating from both qualitative and quantitative sources (Jick, 1979; Johnson, 2015; Nieuwenhuis, 2019; Pietersen & Maree, 2019). In addition, this approach offers the opportunity to design a distinct methodological process of inquiry (Creswell & Creswell, 2018; Creswell & Plano Clark, 2018; Tashakkori & Teddlie, 1998), which aimed to obtain a broader understanding of the complexities involved with live coding in collaborative contexts (Ogborn et al., 2017; Xambó et al., 2016). Adopting a mixed-methods approach provided me with flexibility in how the research design was implemented, with particular focus directed toward answering the research questions (Tashakkori & Teddlie, 2009) and effectively implementing what Creswell & Tashakkori (2007) refer to as a practice perspective or approach to mixed-method research.

Netnographic fieldnote data generated as a result of online discussions between ensemble members in these collaborative contexts, provided valuable documentation from an insider's perspective into the interactions of group members (although these were not included in the data analysis phase of this research). Semi-structured interviews were conducted with the members of SuperContinent and UPLOrc once I had completed roughly a year and a half of fieldwork. Furthermore, consideration of my position as both member and coordinator of a live coding ensemble in an educational context was an important aspect of this research. This was accomplished through an emic perspective (Fetterman, 2009) that pertains to the critical review and correlation of the results obtained during the analysis phase (Minowa et al., 2012). An online survey administered to members of the networked live coding community attempted to support the qualitative results of the study. Interview participants for this study included nine in total, five of which are or were members of the SuperContinent live coding ensemble, and four members of the UPLOrc live coding ensemble. Since all participants were active members of each ensemble, all met the criteria to participate in the research, which required that participants be:

- An active and current member of an existing and performing laptop ensemble/orchestra with university affiliation;
- an active member with, at least, a number of months' worth of experience as a laptop ensemble/orchestra member;
- a performer or user of any live coding language (both audio and visual live coding);
- a performer of computer network music;
- and a user of the *Estuary* collaborative live coding environment.

None of the participants was exposed to any harmful or humiliating lines of questioning, and all participants agreed to participate voluntarily. Various analyses of the data were performed including a thematic analysis (Ryan & Bernard, 2003) of the interview data, and a descriptive statistical analysis of the survey data (Pietersen & Maree, 2019).

1.5 DEFINITION OF KEY CONCEPTS

CONCEPT	DEFINITION
Aesthetics	Aesthetics is defined as the appreciation one holds for a particular object or event in which one questions the nature thereof (Adorno, 2003; Emmerson, 1986).
Politics	While politics can be viewed as relating to group decision-making processes (Axford et al., 2005), it is also related to the organisational structure of the particular group in question (Knotts & Collins, 2014). Politics exists on a spectrum that is indicative of the views held by individuals and how these views are negotiated as part of democratic interaction (May, 1978).
Negotiation	The act of negotiation, as defined by Zohar (2015), involves the autonomous resolution of conflict or division of resources between members of a group.
Mediation	In negotiating conflicts between two or more autonomous agents, mediation refers to a third-party whose role is to determine how negotiation is achieved (Born, 2005; Silverstone, 2002; Valiquet, 2017).
Sociality	Sociality refers to the inherent relationality that individuals share with one another (Long & Moore, 2012).
Culture	Culture, as defined by Arowolo (2010), encompasses generally acceptable practices performed by a group that also passes that knowledge on to others.

1.6 LIMITATIONS

This research attempted to understand my experiences as an active member within the network performance community and as a member of two network ensembles. Additionally, my role as the coordinator of one of these ensembles also came into question. Several challenges were encountered throughout the research process, some of which involved technical difficulties in capturing data, the handling and processing of collected data, and most notably, formulating an understanding of the data in its disorganised state. While the nine interviews yielded a considerable amount of data, survey responses gathered from the live coding community were far less than expected. This may be attributed to the amount of time spent making sense of how to process the qualitative data, rather than engaging with the data and allowing themes to emerge. Once I had adopted this way of thinking, there was little time to administer the quantitative component as would be preferable in mixed-method research incorporating qualitative and quantitative components as equal parts of the research design. Therefore, due to the small sample sizes of both the interview and survey participants included in this study, the results obtained may not be applicable to all those who engage in some form of collaborative live-coded performance. From an emic perspective, the small interview sample produced data that provides valuable insights into the organisation and the creation of collaborative live-coded performance.

1.7 CHAPTER OUTLINE

Chapter one provides the background and motivation for conducting this study and includes the research questions that have guided the research, the definition of key concepts and the limitations of the study. The purpose of the research and overview of the methodologies used are also presented.

Chapter two discusses the relevant literature identified for this study, focusing on research conducted in computational musicology, cognitive and empirical musicology, and social psychology.

Chapter three presents the processes or mixed-methodologies implemented during the research process. This includes the adopted research approach, the research design, the role of the

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researcher, data collection techniques and sampling strategies. This section also outlines the analysis and interpretation of the collected data, the ethical considerations for the research and the reliability and validity of the research findings.

The fourth chapter is concerned with presenting the research findings obtained through the analysis of various artifacts gathered during data collection. These include interviews, a networked performance community survey, and audio-visual artifacts. Findings based on these sources of data are synthesised and constructed and presented as commonly identified themes. This is followed by all relevant artifacts that were used to identify common themes.

Chapter five is a discussion of the findings presented in chapter four. A comparison is drawn between the existing literature and the research findings for the purpose of the discussion.

Chapter six concludes with the primary outcome of the study and is presented by answering the research questions. The chapter concludes with recommendations for future research and closing remarks.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Significant *LOrk* models, or simply pedagogical models[2], implemented by ensembles such as *The Hub* (formerly *The League of Automatic Composers*), *PLOrk*, *CLOrk* and *Cybernetic Orchestra*, all share at least one of five commonalities representative of their current and emerging presence in worldwide academia. Analogue electronics, the personal computer, alternate controllers[3], a network connection and electroacoustic performance practice[4] evolved into the emergent field of networked performance. From these historical influences, Weinberg (2005, p. 23) constructed a framework illustrating the theoretical aspects of "musical interconnectivity." A review of the literature is presented here and includes a discussion of the origins of networked live coding performance, extant pedagogical laptop orchestra models and musical identity and collaborative performance.

2.2 THE ORIGINS OF NETWORKED PERFORMANCE

The existence of networked performance is attributed to advancements in technology and network infrastructure first used in live performance by *The League of Automatic Composers* in 1978 (Knotts & Collins, 2014). New network technology aided performers in sending and receiving data in a circular structure between themselves (Bischoff et al., 1978). The first person to term computer network orchestra/ensemble was Jim Horton (Gresham-Lancaster, 1998), co-founder of *The League*, as they were known until they merged into a larger group known as *The Hub* in 1987 (Barbosa, 2003). Important aspects of the practices with which *The Hub* were concerned were experimentation, musical freedom and improvisation. Another co-founder of *The Hub*, Chris Brown recalls (Gresham-Lancaster, 2017, p. 73)[5]:

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[2] Pedagogical models – as introduced in Knotts & Collins (2014, p. 193).

[3] MIDI controllers and other independently operated electronic instruments or devices.

[4] See Chagas (2014, p. 156).

[5] Chris Brown in Radio Web MACBA, "Interruptions #2: Once Upon a Time in California," in Interruptions [audio series], <www.rwm.macba.cat/en/interruptions-tag> (accessed December 2016). PDF transcription <http://rwm.macba.cat/uploads/20110118/02Interruptions_eng_PDF.pdf> (accessed July 2017).

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[m]usic experimenters were dreaming of a future where technology might enable new kinds of musical freedom—freedom from orchestras and scores, freedom from scales and temperament, freedom from the academy, freedom from the music business, and, most of all, freedom for noise.

Bischoff et al. (1978) support Weinberg's claim that individual agents should be able to control specific musical parameters and only then introduce their individual ideas alongside that of other group members. Performing multiple activities within one larger activity is understood to be an ideal circumstance to collaborate without any constraints being imposed on performers. In addition, the origins of computer network music can be traced back to the works of John Cage, who pioneered the simultaneous performance of multiple works, and experimented extensively with process music (Weinberg, 2005). Bischoff et al. (1978, p. 28) reiterate:

John Cage set up a new minimum, on the potential plane of music, away from the classical music valley, but close enough to draw composers away from it, which allowed for the direct modelling of contemporary ideas…and the use of the available technology for sound production.

The importance of these early network capabilities has become more apparent in a global society that has progressed in terms of technological advancements, in particular, the democratisation of communication that network infrastructure affords (Knotts, 2015; Knotts & Collins, 2014).

2.2.1 ELECTROACOUSTIC COMPOSITION AND PERFORMANCE PRACTICE

Electroacoustic composition and performance practices have informed the works of various computer music performers and practitioners (Algie, 2012). This is reflected in a 1991 lecture presented by composer Karlheinz Stockhausen in which he underlines six areas of Electroacoustic (EA) performance practices. They include recording technique, amplification technique, transformation technique, the technique of pre-formed music, electronic musical instruments and combined electroacoustic practices (Stockhausen & Kohl, 1996). All of these techniques are implemented in various ways in laptop performance. For example, Tsabary (2016), the director of *CLOrk*, continuously refers to sound generation in computer music performance as the "transformation" of sound. This is supported by the techniques presented in

Stockhausen's lecture and is also explicitly referred to as "transformation techniques" in Tsabary (2017). Here, transformation techniques refer to the discovery, development and exploration of new and innovative music-making methods, as is the case in the development and discovery of any other musical genre. Stockhausen's definition of the term exhibits an approach to composition that embraces experimentation with sound so that no one composition or performance is identical or similar to another (Stockhausen & Kohl, 1996). Additionally, the transformation of sound is a fundamental compositional technique required to generate sufficient electroacoustic material in EA composition (Sefchovich, 2003).

The interactive music system known as *Max*, introduced by Miller Puckette in 1988, is the first Human-Computer Interactive (HCI) environment developed for live electronic music performance (Puckette, 2002). Systems such as these require input from a performer into a Graphical User Interface (GUI), enabling mediation between computer and performer, hence the presence of the term *Interactive* (Drummond, 2007; Valiquet, 2017). They require reciprocal influence between two or more regiments that result in communication and musical output (Jordá, 2017; Rowe, 1993). *Max* and its extended versions, *Max/MSP*, *Jmax* and *Pure data* (*Pd*), are pre-designed software packages that use Object-Orientated Programming techniques, enabling real-time computer synthesis and sound design for live computer music performance (Puckette, 2007). A version of Pure Data known as "*Purr-Data/Pd-L20rk*" is used extensively by *L²Ork (Linux Laptop Orchestra)* at the Virginia Polytechnic Institute (Bukvic et al., 2016).[6]

Organised sound, a concept introduced in the works of composer Edgard Varèse, proposed a new approach to composition that placed emphasis on the materials used in the arrangement of sound. Similar to the recording methods adopted by French composer and musicologist Pierre Schaeffer (2017), Varèse was very particular in collecting and recording suitable sounds to work with. Attempting to explore new methods of expression, selecting sounds for his works encompassed a search for previously unheard sounds. In organising these materials, Roads (2015) argued that the sounds selected by Varèse invariably influenced how these were organised and signalled a new approach to viewing sounds in terms of their shape and spectromorphological qualities (Smalley, 1997). In contrast to the transformation techniques adopted by Stockhausen (Stockhausen & Kohl, 1996), Smalley (1993, p. 279) further expanded

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[6] See http://l2ork.music.vt.edu/main/ for more information.

on the concept of transformation to include a more poetic description of these techniques, referring to them as the "metamorphosis" or "mutation" of sound materials from a base identity, or a sound heard for the first time. From this base identity, a sound is transformed into a one which bears no resemblance to its original form, hence Smalley's use of the term *morphology* in the spectromorphological analysis of sound (Smalley, 1997). *Spectro*, on the other hand, refers to the spectral aspect of sound expressed in cycles per second and measured in Hertz (Hz), which is more commonly attributed to operating in the frequency-domain (Roads, 2015). Thus, the term spectromorphology denotes the way in which the spectral qualities of a sound are developed over time (Smalley, 1993).

Roads (2015) points out that in these descriptions of a technique for the transformation of sound, Smalley distinguished between two types. The first was that of source-cause transformations, which refers to the detection of the source of a sound and its cause. A sound's source and its cause, or the gesture responsible for producing a sound, is what constitutes its base identity (Smalley, 1993). The second type is that of spectromorphological transformation, referring to the "alteration of a sound's perceived acoustic properties, such as pitch, duration, loudness, spectrum, spatial position, etc" (Roads, 2015, p. 116). These apply to those sounds whose sources are both known and unknown. Roads further proposed a basic taxonomy of effects or transformational possibilities which are achieved through the implementation of various techniques. This is an extensive list that includes techniques such as the mixing of two or more sound signals, the re-recording of sounds, the reversed playback of a sound, processing of pitch, frequency- and time-domain processing, granulation, spatialisation and reverberation, to name only a few.

2.2.2 COMPUTER MUSIC

Max Mathews first proposed performing music using computers in 1963 (Mathews, 1963; Clarke et al., 2020). Advancements in technology since then have resulted in further capabilities and approaches to computer music performance. Computers have been classified as instruments with infinite sound-production capabilities and the ability to control and create sonic parameters with methods such as computer synthesis (Jordá, 2017; Rowe, 1993). The creation of a larger sonic environment is now possible using these computer synthesis methods, which go beyond that of a traditional orchestra (Roads, 1996) and more specifically expand on the compositional

possibilities of music (Roads, 2015). The computer music tradition has its origins in electroacoustics as Emmerson (2007) attests in his writings concerning live electronic music. Computer music particularly emerged as a practice that attempted to reduce the amount of hardware technology required in order to engage in electroacoustic composition. This resulted in a shift from analogue to digital signal processing primarily controlled by the commonly used Musical Instrument Digital Interface (MIDI) protocol (Manning, 2013). Other forms of interaction with computers for composition were introduced through computer synthesis methods such as granular, wavetable lookup and additive synthesis (Roads, 2015). Digital signal processing thus involves the manipulation of audio signals as numerical representations through the use of computers (Roads, 1996).

High-level computer programming languages were also introduced as a form of musical expression using technology (Loy & Abbott, 1985), allowing composers to communicate their ideas in terms that both the composer and computer are able to understand. Since computers are only able to deal with numbers, this process requires that a computer perform an interpretation based on a set of rules or a program written by a composer. An interpreter is responsible for translating these sets of rules, often defined in the form of an algorithm, into a language that is understood by the computer referred to as assembly language (Waite & Goos, 2012). Some computer programming languages, such as Lisp (Abelson & Sussman, 1996) and Java (Arnold et al., 1996), make use of a compiler in addition to an interpreter. In its simplest form the function of a compiler, according to Waite and Goos (2012), is to execute the procedures declared by the programmer in order to determine their structure, after which the compiler will create a program in assembly language for execution by the computer.

2.2.3 MEDIATION TECHNOLOGY AND LIVE CODING PRACTICE

First introduced in the 1980s by Barry Vercoe, in the form of the multi-functional music programming environment known as *Csound* (Lazzarini et al., 2016), live coding emerged as an accepted approach to perform computer music in a similar manner to a live orchestral performance (Vercoe, 1992). Live coding is closely associated with algorithmic composition, a form of abstract and procedural thinking, which allows a composer to formulate a solution to a compositional problem (Jacob, 1996; Nierhaus, 2009). In cognitive musicological terms, live coding environments such as *Csound* act as a platform for mediation between the performer

and computer. Mediations of these types, also termed task environments (Laske, 1988), are often studied to determine the cognitive thinking of the performer and the extent to which their thinking is informed by the task environment (Laske & Tabor, 1999; Valiquet, 2017).

The concept of mediation, if applied to music technology, refers to the role of technology in mediating the intentions of a performer and the resultant sonic feedback received from communicating these intentions to the technological platform in use (Leman, 2007; Schiavio & Menin, 2013). Due to the communicative affordances of mediating technology, researchers have expressed particular concern with the behaviours exhibited not only by those who create and perform music, but also in terms of audience interaction (North & Hargreaves, 2010). In addition, research in cognitive musicology has attempted to determine what the implications are for task environments as a consequence of musical thought (Laske, 1988), signifying the existence of a communicative process not only between human and machine but also between humans. Moreover, the research attempted to establish a relationship between musical perception and action (Bel & Vecchione, 1993). The combination of perception and action gave rise to the research field of computational musicology, whose practitioners make use of computers to explore music (Cook, 2004). In the context of live coding, computational musicology then refers to the exploration of the procedures implemented by performers of live-coded music. Scant research exists concerning these procedures, particularly in collaborative performance contexts.

Live coding exploits various audio programming languages (Boulanger & Lazzarini, 2011) and software packages as performance tools for computer music performance in laptop ensembles (Collins et al., 2003; Lazzarini et al., 2016). Whether performing collaboratively or individually, live coding involves mental processes that are complex in the way they are executed through compiling computer code in real-time (Nilson, 2007; Sayer, 2015; Collins, 2011). Comparably, research concerning live coding practice has either focused on specific live coding environments such as Extempore (Attanayake et al., 2020; Sorensen, 2018), or adopted an approach that compares the cognitive processing in a live-coded performance to that of an instrumental ensemble (Sayer, 2015). Scant research exists concerning strategies and approaches for collaborative live coding in networked contexts. The following section examines the network systems that make networked live coding possible.

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2.2.4 NETWORK MUSIC SYSTEMS

Telematic music, from which networked live coding originates, involves the collective performance of music with the assistance of an internet connection (Oliveros et al., 2009; Lemmon, 2019), and whose performers are placed across various locations (Barbosa, 2003). Similar to telematic music, networked live coding also makes use of the internet, with the added benefit that performers require less equipment in order to collaborate. Termed *interaction typologies* by Matuszewski et al. (2019), the concept of network music systems was first proposed by Weinberg (2002) who later refined it into what is commonly referred to as Interconnected Musical Networks (IMNs) (Weinberg, 2005). In this, Weinberg proposed a theoretical framework for IMNs, which aimed to define and classify the meaning of musical interconnectivity, beginning with interdependency between the members of an ensemble. Interdependency is a determining factor in the social organisation of group performance and is essential in any form of human interaction that involves music performance and shared experiences. Not only are social hierarchies in group performance influenced by member interdependency, but they also depend on the level of control a member is given in a performance (Weinberg, 2005). This control, also termed "performer agency", is at the forefront of research investigating and developing "strategies for ensemble organisation" (Knotts, 2018, p. 10).

Barbosa (2003), however, identified four different types of network music systems which may be classified as being either asynchronous versus synchronous, referring to the type of temporal interaction between performers, as well as remote versus co-located denoting the spatial location of the performers. These four types of network systems are Local IMNs (Weinberg, 2005), Music Composition Support systems (Latta, 1991), Remote Music Performance systems (Jordà, 1999; Xu et al., 2000) and Shared Sonic Environments (Burk, 2000). Weinberg (2005) extended upon this classification of network systems into what he referred to as *Architectures and Typologies*, which are essentially network structures that represent the varying options available for social interaction between performers. It can thus be realistically determined that the network being used as a medium for performance has significant consequences in relation to performer agency in that predetermined network structures are known to regulate the amount of control assigned to a performer. Centralised networks, for instance, allow interaction between performers and controllers which do not bear any connection or direct influence on the output of another performer. Decentralised networks allow performers to be in direct contact

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with each other's musical material. A decentralised approach to network performance is documented in the works of Hamilton et al. (2011), Knotts (2018) and Trueman (2007). Works by these authors, and Weinberg, make particular reference to political theory to describe the typology of a particular network music system.

Political theory is used as a metaphor to illustrate the relationships and decision-making that exist between performers who use musical networks to interact with their co-performers (Knotts, 2018). This, alongside ethics, cannot be disregarded when discussing IMNs, as interactions with others are by their very nature social interactions – what one performer decides to do directly influences another performer by simply reacting to what is being presented to them (Weinberg, 2005). Ethically, network performers have a responsibility to be explicit and reflective in regard to their actions and thought processes, especially when designing technologies and networks that will be used by other performers (Magnusson, 2010).

Determining musical content and control in computer music performance is a challenging feat due to the complexities of musical expression and subjective experiences thereof (Weinberg, 2005). Often referred to as aesthetics, Emmerson (1986, p. 105) explains this issue to some degree, stating that "a musical idea is only what it seems to be." Aesthetic value, in the context of computer network music performance, is entirely dependent on decisions made by individual agents over the musical parameters they utilise, manipulate and transform during a performance. It is important to distinguish here that Weinberg proposes either a structure- or process-centred approach to networked performance, which should be "interdependent, dynamic" and benefit the social interactions between group performers (Weinberg, 2005, p. 31).

2.3 LAPTOP ORCHESTRA (LORK) MODELS

The laptop orchestra model referred to here is an abstract representation of the real-world phenomenon that is the laptop orchestra. It is explicitly referred to as a model denoting the pedagogical approaches undertaken in laptop performance (Knotts & Collins, 2014; Valiquet, 2017). The first laptop orchestra model, established by *PLOrk* in 2006, adopts "*LOrk*" as an abbreviated naming scheme representing the organisation. Other examples include *CLOrk* (Concordia Laptop Orchestra) and *OxLOrk* (Oxford Laptop Orchestra) (Knotts & Collins, 2014). A *LOrk* model is also representative of organisational structures (Albert, 2012) and

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practices associated with the performance of computer music, teaching pedagogies in the context of tertiary education (Tsabary, 2014), and other overarching variables involved with the laptop orchestra phenomenon (Wang et al., 2008). *PLOrk* is representative of one type of laptop orchestra model, of which many variants exist depending on the ensembles' aesthetic, preparations for performances and their overall hierarchical structure, whether present or not (Knotts & Collins, 2014).

2.3.1 SIGNIFICANT PEDAGOGICAL LAPTOP ORCHESTRA MODELS

As the Table 1 illustrates, various laptop orchestras and network ensembles make use of a wide variety of technology for collaborative performance. These were included here to illustrate which of these technologies ensembles make use of as tools for communication, effectively operating them for the purpose of mediating communications between various ensemble members. Each ensemble's platform type is described either as being browser-, hardware- or software-based. Regardless of the fact that each ensemble requires some type of hardware (laptops), some ensembles expand their performance capabilities by developing and sometimes inventing new electronic instruments[7]. Software, in most cases, is prioritised since it affords greater flexibility and offers computer musicians the capabilities required to design and customise a performance. The most common software or environments in use today are *ChucK*, *SuperCollider*, *Max/MSP* and *Pure data*. Other accompanying software packages include *Jacktrip*, *Open Sound Control (OSC)* and *espGrid*.

Table 1: Technologies for computer music performance

Ensemble	Platform type/Technology	Platform
Princeton Laptop Orchestra (PLOrk)	Meta-instrument including laptop, software and external speaker (Trueman, 2007)	• ChucK • SuperCollider • Max/MSP
Cybernetic Orchestra	Browser-based; software (Ogborn et al., 2017)	• TidalCycles (MiniTidal) • Estuary • espGrid; Jacktrip

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[7] See Trueman, D., & Cook, P. (2000). BoSSA: The deconstructed violin reconstructed. *Journal of New Music Research*, 29(2), 121-130.

Ensemble	Platform type/Technology	Platform
		• OSC (Open Sound Control)
Concordia Laptop Orchestra (CLOrk)	Browser-based; software (Tsabary & Woollard, 2014)	• espGrid; Jacktrip • Pure data • OSC (Open Sound Control)
SuperContinent	Browser-based (Ogborn et al., 2017)	• Estuary • TidalCycles (MiniTidal) • Punctual • Hydra
Stanford Laptop Orchestra (SLOrk)	Meta-instrument including laptop, software and external speaker (Wang et al., 2009)	• ChucK
Linux Laptop Orchestra (L^{2}Ork)	Software (Bukvic et al., 2016)	• Pure data • Pd-L^{2}Ork • JACK
Huddersfield Experimental Laptop Orchestra (HELO)	Hardware and software (Hewitt et al., 2010)	• Cross-platform laptops • Wii-motes
Birmingham Laptop Ensemble (BiLE)	Software (Booth & Gurevich, 2012)	• Max/MSP • SuperCollider
Laptop Orchestra of Louisiana (LOLS)	Hardware (Berdahl et al., 2018) and software (Beck et al., 2011)	• Arduino (FireFader) • GRENDL

2.3.2 PRINCETON LAPTOP ORCHESTRA

PLOrk was the first modern laptop orchestra to be introduced into tertiary curricula, with various researchers (Knotts, 2018; Knotts & Collins, 2014; Valiquet, 2017) referring to *PLOrk's* pedagogical model as the *PLOrkian* model. It borrows its organisational structure from traditional symphonic orchestras and embraces its power imbalances, i.e., a "composer-conductor-performer model" is preferred (Knotts, 2018). Although the ensemble layout is used in this way, Trueman et al. (2006) attribute the decision to the most efficient use of space and the ease with which ensemble roles can be assigned to members. It is also their position that

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this layout functions the best in terms of hearing "oneself in relation to others" (p. 3) in the ensemble. The introduction of the *PLOrkian* model at Princeton saw many other institutions follow suit. Not long after, Stanford University established its own ensemble, known as *SLOrk* (Stanford Laptop Orchestra) (Wang et al., 2009).

2.3.3 CONCORDIA LAPTOP ORCHESTRA

CLOrk's fundamental performance practice is informed by an action-centred approach to identifying problems and possible solutions to these problems (Tsabary & Woollard, 2014). This allows for direct control over problems that may arise during a performance. Tsabary's approach simply refers to what he defines as "performance-based inquiry-cycles" (Tsabary, 2014, p. 663). This form of inquiry not only presents promising and interesting results from a performance perspective, but also from an educational perspective. The study explored the process in which a performance is organised by the participants of *CLOrk* and the skills obtained in doing so. Viewing this process from an educational approach addresses the skills obtained during the planning and execution of a performance. Ensemble skills are essential within tertiary music education programmes, as many of them require music students to participate in some form of ensemble playing (Cheng, 2018).

From an educational perspective, participation in laptop orchestra performance provides a platform for students to engage in experimentation and discovery of new music-making techniques, whilst also developing their social skills (Tsabary, 2016). Tsabary and Woollard (2014) present *CLOrk's* principal research purpose as *action* leading to the transformation of practices, and *research* as the understanding of the action and practices themselves. This may involve a multitude of aspects including the development and expansion of the ensemble's "creative output" (p. 56). Other performance objectives include the development of members' skills - either listening, improvising, collaborating or improving technical skills. Tsabary and Woollard (2014) also infer that it is in *CLOrk's* interest to develop these objectives as efficiently as possible so as to remain relevant due to the rapid advancement of computer music performance practices. Furthermore, and most importantly, *CLOrk's* action-centred approach relies on the critical reflection of its members so that further actions may be determined for future performances.

2.3.4 CYBERNETIC ORCHESTRA

Ogborn (2012) expands on the notion of musical freedom with his Cybernetic Orchestra (CO), adding that laptop orchestra members should include a variety of individuals from different backgrounds, meaning that entry into an ensemble of this nature requires little or no knowledge of live coding. CO prioritises live coding as their most important performance practice (Ogborn, 2014), with preference given to "performance and improvisation over composition" (Ogborn, 2012, p. 56). CO's model gets around the problems of limitation where pre-composed work is required. In this case, less compositionally experienced members have difficulty in actively contributing to a performance, whereas with the inclusion of an improvisatory approach, as with CO, this is mitigated. CO further embraces pulse-based music, aimed at appealing to a greater audience than electroacoustic music would. With this in mind, Ogborn (with others) developed a zero-installation, browser-based platform capable of hosting various live coding languages as well as globally distributed participants. *Estuary* (Ogborn et al., 2017)[8] and *Extramuros* (Ogborn et al., 2015) utilise network architecture (refer to *2.2.4 Network music systems*) to host the platform.

2.4 MUSICAL IDENTITY AND COLLABORATIVE PERFORMANCE

In considering the social interactions that occur between members of an ensemble and how creativity is achieved through collective performance (Bishop, 2018), it is essential to understand what the significance is of an individual's musical identity, in terms of understanding how they develop as a musician (Born, 2011; Hargreaves et al., 2012). The concept of *musical identity* has primarily been defined in terms of cognitive, developmental, and social psychology (Hargreaves et al., 2002), while much of the existing literature regarding musical identity has often excluded socially-constructed musical identities. In particular, how these are constructed in performance contexts in which multiple agents are constantly engaging with one another (Trevarthen & Malloch, 2017). The term *identity* is associated with many interrelated concepts, most notably with the notion of *value* and *alterity* (Beard & Gloag, 2016). The following section discusses musical identity and related research in terms of social-psychological theory and musicology (Hargreaves et al., 2002; North & Hargreaves, 2010).

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[8] Browser-based technologies for live coding. Accessible from Google Chrome or Microsoft Edge at https://estuary.mcmaster.ca/

Developing a musical identity is a continuous process by which an individual realises an understanding of themselves and the various qualities that represent their identity (O'Neill, 2002). Developmental psychological descriptions of musical identity are primarily concerned with the influence that an individual's environment has on the formation of their musical identity (Hargreaves et al., 2002). Independent of music, Chryssochoou (2003) defines *identity* as the way in which individuals construct their own perception and knowledge of themselves and how they motivate their actions in relation to everyday social interactions. Côté and Levine (2002) suggest that forming an identity is dependent on social and cultural norms particular to an environment or community. Similarly, *identities in music*, an idea put forward by Hargreaves et al. (2002), corresponds to the notion that the development of an individual's music identity is predetermined by the cultural and social norms commonly accepted by a community and may involve features including, but are not limited to, composer, improviser or performer roles.

Hargreaves et al. (2012) propose two opposing schools of thought concerning the role of social and cultural influences in the development of musical identity. From a Vygotskian point of view, Hargreaves et al. (2012) suggest that our social environments shape our individual development, whereas Piaget's view (Piaget, 1973) was that our thinking takes preference over environmental or social influences. Since music is an inherently social activity (Bishop, 2018; North & Hargreaves, 2013), Piaget's view does not hold as strongly as that of Vygotsky, whose sociocultural theory is essential for understanding the interactions between members who engage in collective musical activity (Marginson & Dang, 2017). Vygotsky (1978) expressed that social interaction is crucial for human development in general, all the more so when individuals attempt to construct and retain new knowledge. His theory, commonly referred to as the Zone of Proximal Development, places emphasis on not only what an individual may achieve on their own, but that they may achieve far more with the guidance of those who exhibit a higher level of capability.

According to Marginson and Dang (2017, p. 6), Vygotsky also underlines the "role of mediation in the development of reflexive and self-determining human agency." He argues that mediating tools, or any tool that may be used to establish and maintain communication between two or more agents, exhibits the potential to empower those who use them to express their identities. As Põder & Kiilu (2015) suggest that individuals' identities comprise personal identity, and social identity, and that each is dependent on the other. Therefore, engaging with others through mediating tools, provides the individual with an opportunity to reflect on and develop a deeper

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understanding of their own identity in relation to their social environment. Hargreaves et al. (2012) similarly argue that developing a sense of self as a musician, or rather a perception of the aspects that constitute one's identity as a musician, may assist or often determine whether an individual is able to express themselves musically or not. If a musician holds a negative perception of their abilities as a performer, this greatly affects their ability to perform in the first place. This, once more, is closely linked to the culture of a society or a community within a society whose cultural practices shape the identity of those who are members of it (Marginson & Dang, 2017).

Associated with this is the idea of *alterity* or otherness, as defined by Beard and Gloag (2016). A society that promotes one particular way of existing in the world immediately excludes those who do not perceive themselves to be that which is prescribed by the social and cultural norms of a society. In literature, this is often referred to as *"the Other"* (Beard & Gloag, 2016, p. 9), which may be interpreted in one of two ways: an individual is different to what most in a community consider to be the norm, and in terms of the interpersonal relationships humans develop with others (Trevarthen & Malloch, 2017; Marginson & Dang, 2017; Shekhovtsov, 2013). The concept of alterity brings to fore the point at which a person relinquishes their current perception held of themselves, as prescribed by the cultural and social norms of a society, allowing them to transform their perception into one that was entirely constructed on their own terms. This concept is in coherence with Vygotsky's sociocultural theory (Marginson & Dang, 2017), which delineates that developing a musical identity is first and foremost dependent on the social interactions an individual has with others. It is only after the fact that an individual develops a consciousness of their own perception of their musical identity.

In contrast to *identities in music*, *music in Identities* as proposed by Hargreaves et al. (2002), involves the study of the ways in which music assists with the development of individual identity independent of the aforementioned culturally-defined musical roles. *Music in identities* asks how music may be used as a tool to construct self-knowledge of the various traits that represent a person's identity. These may include aspects such as gender (Dibben, 2002), nationality (Folkestad, 2002), youth identity (Tarrant et al., 2002) and disability (Magee, 2002). During the process of developing a musical identity, it is essential that individuals be provided with opportunities to explore their identity as musicians in and through music. This speaks to a number of interdependent concepts related to musical identity; that of *autonomy*, *value* and *play* (Beard & Gloag, 2016). Trevarthen & Malloch (2017, p. 160) define play as "the creativity of

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actions with emotional values of the body, generated from within," and "engaging with objects of the world experimentally." The autonomous nature of art and music (Beard & Gloag, 2016), as a separate entity free from any context in which it is created, exhibits the qualities necessary for engaging in experimentation or play in the process of exploring a musical identity. Musicians are therefore able to explore their personal aesthetic preferences associated with their own identity through music (Hargreaves et al., 2002). Aesthetic refers to the value that any individual attributes to a particular artwork (Beard & Gloag, 2016). Therefore, music and art are a means for expressing one's personal preferences and in turn act as representations of one's identity as a musician (Born, 2011).

2.5 CONCLUSION

It is reasonable to conclude that the current practitioners of computer music performance are leaning toward experimentation, free improvisation and process-driven objectives. These processes are essential to the understanding of the individual experiences and multiple perspectives of computer music performers in a social environment. The need for an in-depth account of the thought processes behind the actions of laptop/network ensembles members will assist in achieving a greater understanding of the goals and motivations, social structures (Marginson & Dang, 2017), technologies and architectures (Weinberg, 2005), as well as the communication that occurs through musical content associated with networked performance (Bishop, 2018).

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research methodology implemented and includes the selected research approach, research design, sampling strategies and data collection techniques used by the researcher. I also present how the data was subsequently organised, analysed and interpreted. Furthermore, this section serves as an outline of the netnographic methodology adopted as the overarching analytical framework in the research. Finally, the ethical considerations and legitimation of the results obtained in this research are discussed.

3.2 RESEARCH APPROACH

Due to the complex nature of live-coded performance, this research project was conducted using a multi-paradigmatic qualitatively-driven research approach (Hesse-Biber, 2010; Johnson, 2015) to aid in constructing a deeper understanding of the communication between the various agents of a networked live coding ensemble. My initial assumptions in compiling this work were that an interpretivist approach would be best suited, though during the research process this premise changed. Literature discussing paradigms in research provides clearly-defined criteria for each (Christ, 2013), all of which could be applied to this research in one form or another, prompting me to implement a multi-paradigmatic research approach. This was chosen in consideration of the possibility that conducting an analysis of the data would require sensitivity toward multiple perspectives or opposing opinions. Combining multiple paradigms has reinforced the research process and supported the methodologies executed. Ghiara (2020) proposes that mixed-method research (MMR) be considered a paradigm of its own, an idea that supports the notion of ontological pluralism and dialectical epistemology proposed by Johnson (2015). Combining multiple research methods and paradigms gives rise to various approaches in the scientific community in the way that ontologies and epistemologies are interpreted and applied to research (Gioia & Pitre, 1990; Johnson, 2015). Complimenting one research paradigm with another in this way, aids the researcher in achieving a deeper understanding of the studied phenomenon (Bogna et al., 2020). The sections that follow describe the researcher's ontological and epistemological position in conducting this research.

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3.2.1 ONTOLOGICAL FOUNDATIONS

Ontology, sometimes also referred to as metaphysics (Smith, 2004), is rather a subset of research in metaphysics concerning entities that exist in the world (Ney, 2014). The term "entity" is rather vague in the context of this research, since there are so many entities involved with live coding practice. Following Dialectical Pluralism, the paradigm's ontological foundation accounts for the multiple constructed realities that should be taken into consideration in collaborative contexts, hence their use of the term *pluralism*. Johnson (2015) further points out that the primary ontological position taken in Dialectical Pluralism is concerned with viewing multiple constructed realities as beneficial for understanding the complexities of group-related research. For this research this may include referring to what Johnson (2015) terms *disciplinary realities*. This seems appropriate given that live-coded performance is a product of multiple disciplines. Adopting an ontological position such as this accounts for the perspective of each individual research participant who may have constructed their reality by means of a particular discipline. Thus, in the process of obtaining a deeper understanding of the social and political aspects of ensemble performance (Knotts, 2018; Knotts & Collins, 2014), among other aspects of this research, I adopt an emergent ontological position in order to understand the complexities and unpredictability involved in networked live coding practice (Hartley III, 2018; Johnson, 2015).

3.2.2 EPISTEMOLOGICAL FOUNDATIONS

In the process of constructing knowledge, the dialectical aspect of Dialectical Pluralism underscores the importance of considering multiple epistemologies in determining what is relevant to a particular study. Johnson (2015, p. 10) describes this as "epistemological listening" which requires that the researcher develop a dialogical relationship with multiple epistemologies. Johnson (2015) further argues that this relationship will result in research that demonstrates consideration and thoughtfulness in the way that knowledge is constructed. Onwuegbuzie and Johnson (2006) contend that epistemological reality in mixed-methods research questions the notion of validity (see *Research quality* below), and rejects the idea that a single objective truth exists. Rather it is the context in which a truth or reality is situated that determines how any individual comes to know and interact with their environment. In accordance with this approach, it is my epistemological position that the way in which

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knowledge is constructed is not orderly or linear, but rather unpredictable and fallible (Cohen et al., 2018; Johnson, 2015), and is often cultivated through differing means (Onwuegbuzie & Johnson, 2006).

3.3 RESEARCH DESIGN

Using a mixed-method approach, an exploratory sequential research design was initially deemed appropriate for this study, and intended to combine qualitative and quantitative methods as equal components in two separate phases (Ivankova et al., 2019). The procedures that were implemented were rather in support of a qualitatively-driven mixed-method research design referred to as an "intersecting secondary method" (Creswell & Creswell, 2018, p. 309). Hesse-Biber (2010) similarly denotes this as a nested method within a qualitatively-driven research design. As this study evolved over a period of two years, it was apparent that an exploratory sequential design (Creswell & Creswell, 2018) no longer supported the netnographic research methodology as the analytical framework and data collection method used in this research (Kozinets, 2010). An exploratory sequential mixed methods design, unlike an intersecting secondary method, is defined by an introductory qualitative phase of data collection and analysis, followed by a phase of quantitative data collection and analysis, that finally results in a phase of linking the data from the two separate sections of data (Berman, 2017). The use of quantitative methods in this study was rather to enrich the qualitative methods and intended to support the interpretation of the qualitative results.

Procedurally, the qualitative component involves conducting the research based on the principles of netnographic research methodology (Kozinets, 2010), while the quantitative component involves developing and administering an online survey (Maree & Pietersen, 2019b) as a process that occurs in-between various stages of engaging with the qualitative component (see Appendix C: Research design). Netnographic methodology is commonly used for marketing research purposes (Kozinets, 2002) and is derived from ethnographic research in that it concerns the study of the social interactions and experiences of individuals in online communities (Angelone, 2018; Cohen et al., 2018; Hine, 2020). In this context, the researcher has no physical contact with the research participants, but is actively involved in ensemble activities. Communications between the researcher and participants are only obtainable through technologically mediated activities that community members engage in (Cohen et al., 2018),

including live-coded performance (Freeman & Troyer, 2011) and online discourse (Witschge, 2008). The method of netnography adopted in this research involves long-term ethnographic fieldwork and immersion in the activities of the SuperContinent network ensemble, in which I observed the interactions between ensemble members while participating (Johnson et al., 2006; Kozinets, 2010). Adopting a mixed-methods approach provided me with flexibility in how the research design was implemented (Creswell & Creswell, 2018; Creswell & Plano Clark, 2018; Tashakkori & Teddlie, 1998) with a particular focus on answering the research questions (Tashakkori & Teddlie, 2009), and effectively adopting what Creswell & Tashakkori (2007) refer to as a practice perspective in conducting mixed-method research. This study was conducted in two phases. What follows is a description of the procedures that were implemented during the research process.

3.3.1 PHASE ONE

Phase one of the research design occurred in a series of four steps (see Appendix C: Research design). The first step was to simultaneously collect qualitative data in the form of recorded interviews and observational field notes from members of SuperContinent (hereafter Group 1) and UPLOrc (hereafter Group 2). This was done so that the data captured from Group 2 would allow for closer examination at a later stage in order to determine whether there were any areas of practice which could be improved on. Step 2 involved the analysis of Group 1 interviews[9], whereafter a quantitative survey was administered as part of step 3. As recommended by (Kozinets, 2010), the survey was distributed with the intention of gaining initial insights into the live coding community. The fourth and final step which concluded phase one, was to analyse the quantitative survey to determine whether classifications that were extracted from the qualitative data of Group 1 were verifiable, to some extent, from other members in the live coding community.

3.3.2 PHASE TWO

As with phase one, phase two was completed in four steps (see Appendix C: Research design). The first step involved analysing the data from Group 2 interviews, while step two was to

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[9] Observational field notes were excluded from the analysis phase due to the large amount of qualitative data generated during interviews.

determine whether Group 2 interviews gathered in phase one revealed any correlation with data collected from Group 1 interviews. Step 3 involved the interpretation of the results obtained during data analysis, and finally, step 4 entailed presenting the research findings in the discussion chapter of this dissertation.

3.4 ROLE OF THE RESEARCHER

The multi-paradigmatic qualitatively-driven research approach used in this study, has influenced my role as the researcher. To conduct the study from an intrinsic cultural perspective (Rowsell et al., 2012) an emic approach was used to understand the research context. The emic perspective is essentially the "participant's perspective as their point of analytic departure" (Markee, 2012), requiring that the researcher maintain a process of critical self-reflection throughout the research (Minowa et al., 2012). While this perspective is not necessarily objective, it informs the researcher of the actions of an individual and often the thought processes beyond those actions (Kubik, 1996). To avoid bias the researcher kept in mind how the participants perceived their practices and included all valuable information. Determining my role as a researcher was essential for the accurate description of human behaviour within this research context. Therefore, my involvement as a participant in both ensembles included in this research aided in understanding the behaviours of my fellow ensemble members. Important to the research design is the researcher's awareness and implementation of an emic-centred inquiry defined by Fetterman (2009, p. 6) as "the insider's or native's [sic] perspective of reality." Cohen et al. (2018, p. 289) corroborate this, stating that:

> Social reality, experiences and social phenomena are capable of multiple, sometimes contradictory interpretations and are available to us through social interaction. Researchers focus on subjective accounts, views and interpretations of a phenomenon by the participants (including the researcher): their 'definition of the situation', which is typically reported verbally rather than numerically. Social research examines situations through the eyes of the participants; the task of ethnographies, as Malinowski (1922, p. 25) observed, is to grasp the point of view of the native [sic], his [sic] view of the world and in relation to his [sic] life.

3.5 DATA COLLECTION TECHNIQUES

This section describes the process by which four types of data were collected. These included semi-structured interviews, field notes, a live coding community survey and audio-visual artifacts.

3.5.1 SEMI-STRUCTURED INTERVIEWS

Semi-structured interviews (Nieuwenhuis, 2019b) were conducted with the ensemble members of both Groups 1 and 2. Informants[10] were contacted via email informing them of the research and their potential involvement. Attached to the email was a participant information letter (Appendix A) detailing the objectives of the research, with an informed consent letter attached (Appendix B). Each group received their own version of the same letter and was asked to sign and return the letter of informed consent. Before questioning began, each participant was provided with the necessary context to be able to answer the questions presented to them. Informants were asked to respond to a set of prepared open-ended questions and were encouraged to reflect on the question as was comfortable or natural to them.

Using a general interview guide approach (Turner III, 2010), two elementary interview guides were constructed to assist with monitoring the lines of questioning that continued to emerge as data was collected (see Appendices D and E). Each guide was pre-compiled before interviews were held with each group. This allowed me to respond or follow-up with a line of questioning that may have resulted in an unexpected response from the participant, in addition to exploring as many lines of questioning as possible with a small sample. Turner III (2010) considers this approach to have a "lack of consistency" in questioning, whereas it may serve as an advantage in the effort to include a wider variety of responses accounting for potentially opposing viewpoints. The participants that were interviewed for this study included nine in total, five of which are or were members of the SuperContinent live coding ensemble, and four members of the UPLOrc live coding ensemble. Group 1 interviews were conducted with five members of SuperContinent, all of whom are current or previous members. Each participant interviewed for this study, was a member of the SuperContinent for well over a year at the time interviews were

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[10] In this context, the term *informant* refers to those who participated in semi-structured interviews and should not be confused with other social science roles such as *respondent*, a term associated with individuals who respond to survey questionnaires.

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conducted. Not only did these participants have extensive experience with live coding practice, but they also perform as individuals in settings that are not commonly associated with educational contexts. Due to the combined amount of experience members of SuperContinent have nurtured, both as individuals and as a group, the majority of questions aimed to gather information regarding their individual practices alongside their approach to live coding performance in solo and collaborative contexts.

Group 2 interviews were conducted with four undergraduate students, most of which had only been members of the ensemble for nine months. One of the three participants had been a member for one year and nine months at the time of data collection. All participants that were interviewed were students either studying classical or jazz music. Since Group 2 involved less experienced live coders, for the most part, these questions aimed to elicit whether informants were able to obtain any educational benefit from engaging in collaborative live coding activities. Interviews were conducted online (Kozinets, 2010) in face-to-face settings using various conferencing platforms (e.g. Google Meet, Zoom and Discord), depending on the preferences of the participant and the stability of both the interviewer and participants' network connections. One informant from Group 2 opted not to enable their webcam during the interview. Interviews were recorded with permission obtained from participants when they signed and returned the informed consent letter (Nieuwenhuis, 2019b).

3.5.2 FIELD NOTES

Field notes for netnographic research can be generated in various ways. Rooted in an ethnographic methodological framework (Cohen et al., 2018; Naidoo, 2012), netnographic research involves long-term online fieldwork (Kozinets, 2010) and the documentation of everyday social interactions which occur between those that operate in a community. These interactions were documented in the form of field notes (Emerson et al., 2011). For this study, these were generated through pre- and post-rehearsal communications posted by ensemble members on the Discord[11] and Slack[12] communication platforms (Kozinets, 2010). While these communications included interactions between ensemble members, they also included that of the researcher, therefore serving as observational field notes for the data analysis phase

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[11] https://discord.com/company

[12] https://slack.com/

(Emerson et al., 2011; Nieuwenhuis, 2019b). These were collected from the Slack servers used by both Group 1 and 2 in the form of archival documentation, and later when both groups moved to Discord, screenshots were made of the discussions between ensemble members. Due to the large amount of qualitative data generated from conducting interviews field notes were excluded from the analysis stages of this research.

3.5.3 COMMUNITY SURVEY

A community survey was administered to various discussion platforms in which sub-communities of the greater live coding community operate. The survey was administered using Google forms as the data collection method. Sources included Estuary, TidalCycles, Hydra, Pure Data, Toplap and SuperCollider Discord servers, as well as the Toplap[13] and TidalClub[14] discussion forums, together with the live coding Reddit page[15] hosted through the web browser. Those active on these forums share and discuss anything related to live coding practice, but more specifically, discussing the technology that facilitates shared practices rather than the practice of live coding itself. Therefore, the survey served as means to obtain a deeper understanding of the interactions between individuals who live code, and aimed to elicit an initial overview of the community (Kozinets, 2010). The questionnaire included a mixture of open-ended questions intended to elicit qualitative data, while some Likert-scale questions were included as well (Pietersen & Maree, 2019a). The accompanying questionnaire that was administered is available in the appendices attached (see Appendix F: Community survey questionnaire).

3.6 SAMPLING STRATEGIES

The following sections describe the sampling strategies that were implemented in the data collection process. Qualitative data and quantitative sampling strategies are discussed separately.

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[13] https://forum.toplap.org/
[14] https://club.tidalcycles.org/
[15] https://www.reddit.com/r/livecoding/

3.6.1 QUALITATIVE DATA

In total nine individuals were interviewed over the course of eight weeks. Five participants were from Group 1 and four from Group 2. The sample obtained was a matter of convenience in this study, since I had been immersed in both contexts for an extended period of time (Cohen et al., 2018). I had already cultivated a long-term relationship with all the participants and therefore it was logical to begin the interviewing process with these two groups. In addition to this sample being a matter of convenience, participants were required to adhere to a set of pre-determined criteria, known as purpose criterion-based sampling (Cohen et al., 2018) in the event that further interviews needed to be conducted. These criteria required that informants meet the following requirements:

Interview participants must be:
- an active and current member of an existing and performing laptop ensemble/orchestra with university affiliation;
- an active member with, at least, a number of months' worth of experience as a laptop ensemble/orchestra member;
- a performer or user of any live coding language (both audio and visual live coding);
- a performer of computer network music;
- a user of the *Estuary* collaborative live coding environment.

This approach aimed to identify participants who meet specific requirements in relation to the community that was being studied (i.e., the live coding community) (Cohen et al., 2018). This strategy was particularly suitable for this research since the shared experiences of multiple performers are being brought into question. According to Crouch and McKenzie (2006), it is not necessary to provide an exact sample size for interview-based research. This type of research is focused on gathering empirical data, where the variables in question are the performers themselves, and is rather more concerned with gathering information about the types of things that exist as opposed to how many there are. Coyne (1997, p. 628) refers to criterion-based sampling as "selective and theoretical sampling" where respondents are carefully selected based on predetermined criteria. As Crouch and McKenzie (2006) point out, a small sample such as this requires that the researcher be an active member in the research being conducted. Due to time constraints, a larger sample could not be obtained, therefore a convenience sample of participants who met the above-stated criteria was

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included. Regardless, a large sample size would not suit this research, since its main concern is understanding the dynamics between individuals in the community (Kozinets, 2010).

In terms of field notes that were gathered, the researcher adopted a purposive sampling strategy in which specific discussions were included based on their relevance to the research and whether there were any correlations between the data obtained during interviews (Cohen et al., 2018; Maree & Pietersen, 2019a). A similar strategy was implemented when selecting audio-visual artifacts for analysis. Two audio-visual recordings, in the form of archived YouTube content, were selected as artifacts and were gathered as performances completed by both groups. Both samples were carefully selected in order to represent each group sufficiently, since only two recordings could be included due to the large amounts of data generated from both groups.

3.6.2 QUANTITATIVE DATA

Before the online survey was administered, various sources were identified that all share the common thread of live coding practice. These were obtained from the Discord platform, as mentioned in the community survey section above (see 3.5.3). Thus, a clustered sampling strategy was implemented through the identification of various subgroups of the community after which a simple random sample was gathered from each subgroup (Maree & Pietersen, 2019a).

3.7 DATA ANALYSIS AND INTERPRETATION

The methodological implications for the implementation of a dialectical pluralistic paradigm in this research, constitute that a mixture of varying and divergent analytical procedures be implemented (Johnson, 2015). Due to the nature of the data that was gathered, two analytical frameworks were applied, each imbedded within an overarching netnographic methodological framework: a grounded theory analytical framework (Charmaz, 2014) for analysing qualitative interview data and a descriptive statistical framework (Pietersen & Maree, 2019b) for analysing survey responses. Upon completion of the data analysis, various themes were identified and presented in chapter four (Ryan & Bernard, 2003). In this section, I also discuss the procedures with which interviews were transcribed and prepared for analysis.

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3.7.1 INTERVIEW TRANSCRIPTIONS

Once all the interviews were concluded with both groups, transcripts were created using the online transcription service *Otter.ai*[16]. This significantly reduced the amount of time required to transcribe each interview by hand, since a large amount of data was generated from the nine interviews that were conducted. Recordings of the interviews were processed into audio format, whereafter transcripts were edited and completed in order to account for any missing information that was omitted by the transcription software (McLellan et al., 2003). A second review of the transcripts involved creating fluent passages in which language was edited to read more comfortably, without removing the essence of what was said by the participant. During this process non-essential words that were deemed unnecessary for data analysis were removed, for example, filler words such as *kind of* and *you know* (Hazel et al., 2011). On occasions where words were omitted by either the researcher or informant, some words were added to provide the reader with more context. Since this research does not call for analysis informed by the pronunciation of specific words or the interaction between researcher and participant, this was deemed unnecessary for the study. Once the transcriptions were completed, interview participants were provided with the opportunity to review the processed data.

3.7.2 GROUNDED THEORY ANALYSIS

A constructivist grounded theory approach was used to analyse the data collected (Charmaz, 2014). This constitutes an inductive or bottom-up approach involving the construction of data into emergent themes (Cohen et al., 2018). According to Kozinets (2010), an inductive approach is well-suited for forming a thick hermeneutic description which contains consistent, intelligible descriptions that provide insight into social and historical aspects of the data, yet will yield an interesting and gainful understanding of live coding practice in collaborative environments (Cohen et al., 2018). The procedures implemented during the analysis of interviews and field notes involved assigning initial codes to the data (Charmaz, 2014; Kozinets, 2010). This was followed by creating more focused (Charmaz, 2006) or axial codes, as referred to by Moghaddam (2006), which were finally reduced into selective codes forming the basis of the thematic analysis (Ryan & Bernard, 2003) applied across all data (Nieuwenhuis, 2019a). Procedurally this was conducted in an iterative manner as can be seen in Appendix C.

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[16] https://otter.ai/

Although presented as a linear process, new connections and conclusions were continuously made throughout the analysis process, which influenced how further data was collected (Charmaz, 2014). The use of the Computer Assisted Qualitative Data Analysis Software (CAQDAS) program *Atlas.ti*, assisted with the organisation of all the data and allowed the researcher to make connections between data and identify the themes presented in chapter four (Kozinets, 2010).

3.7.3 DESCRIPTIVE STATISTICAL ANALYSIS

Descriptive statistical analysis aids the researcher in organising both qualitative and quantitative data (Pietersen & Maree, 2019). The questionnaire administered to community members asked questions eliciting both types of data. Although the survey did not prove useful due to the small number of participants that responded (12), it did yield some initial insights into the live coding community (Kozinets, 2010). Since twelve responses were not nearly enough to represent the entire live coding community, the data was instead used to supplement the interpretation of the qualitative data.

3.7.4 ANALYSIS CHAPTER STRUCTURE

Following the completion of all analytical procedures, the findings were documented and presented in chapter four which is divided into four sections, each building on the findings of the previous section. The first section deals with the findings of the interview data that was analysed. To ensure the anonymity of the interview participants each was assigned an identification letter also locatable on the interview transcripts. While the field notes that were generated and collected provided useful observational information, interviews with Group 1 produced far more in-depth information and therefore field notes were not included in the analysis chapter. Section two includes an appraisal of the survey administered to the live coding community and builds on the findings discussed in section one. The third section shows the findings obtained during the analysis of interviews from Group 2. The fourth and final section includes the findings obtained from analysing one audio-visual recording from Group 1. All findings are discussed further in chapter five.

3.8 ETHICAL CONSIDERATIONS

Interview participants were provided with letters of participation and informed consent to ensure that they are fully aware of the purpose of, and their role in the research (Cohen et al., 2018). To ensure that the words of interview participants were represented as accurately as possible, each interviewee was given the opportunity to view the processed transcripts before they were included as part of the data analysis chapter. In an attempt to protect the privacy of the participants I opted for excluding as much identifiable information as possible, although where participants were asked to identify themselves, this could not be avoided (Saunders et al., 2015). Absolute confidentiality was assured to interviewees throughout the research process (see Appendix A) (Cohen et al., 2018). In terms of survey data collected, participants were asked, but not required to, complete all the survey questions that were asked. Additionally, no identifying information such as email addresses were collected. I also ensured that I acquired the necessary permissions for posting a survey to some of the forums, although all were publicly accessible and already contained surveys from previous research projects. Nonetheless, persons who responded were assured that their information would remain anonymous.

3.9 RESEARCH QUALITY (LEGITIMATION OF RESULTS)

In establishing the reliability and validity of the results obtained (Roberts & Priest, 2006), the research presented here attempted to adhere to two quality criteria namely trustworthiness and credibility (Nieuwenhuis, 2019a). Some practitioners of mixed-method research, as Onwuegbuzie & Johnson (2006) argue, reject the concept of validity entirely and instead recommend that the term legitimation, alongside the aforementioned criteria, be used to evaluate the quality of their research. The sections that follow describe how these criteria were implemented during the research process.

3.9.1 TRUSTWORTHINESS

To ensure the trustworthiness of the results obtained from the qualitative component of this research, and as a measure of the reliability thereof (Nieuwenhuis, 2019a), this was achieved through recording and transcribing the interviews conducted with research participants. The researcher's audio in one interview (participant F), however, was not captured during the

recording process. Utilising a pre-compiled interview guide (see Appendix E), I reconstructed the questions asked during the interview and subsequently matched them to the responses of the participant. Furthermore, research participants were provided with the opportunity to review the transcription of their interview in order to ensure that their words were represented as accurately as possible, thereby further increasing the trustworthiness of the research (Nieuwenhuis, 2019a).

The quantitative component of the research attempted to measure whether three constructs that were identified during the analysis of the qualitative component were present within the practices of others in the live coding community (Pietersen & Maree, 2019a). These constructs include *maintaining awareness*, *adjusting to the group aesthetic* and *detecting openings*. I administered the quantitative component with the intent to measure whether other live coders also engage in these processes, which are associated with negotiating their personal aesthetics in collaborative settings. While the graphs generated from survey responses provided some insights into the complexities of the identified constructs, measuring the internal reliability using Cronbach's alpha coefficient[17] (Pietersen & Maree, 2019a) produced a result that confirms low or poor reliability ($\alpha = 0.542$) of the measuring instrument administered in this study. This low reliability points to inaccuracies in the phrasing of survey questions respondents were asked to answer (Maree & Pietersen, 2019b), and not to the reliability of the overall results obtained in this study. Therefore, the instrument intended to measure a high degree of similarity between each of the aforementioned constructs, according to Cronbach's internal reliability test of the instrument, is an unreliable means for determining whether these constructs may be considered acts of negotiation in the context of live coding (Pietersen & Maree, 2019a).

3.9.2 CREDIBILITY

To avoid any potentially problematic areas within the research, Cohen et al. (2018) recommend that a hermeneutic exercise be performed in order to ensure consistency in the reporting of findings, thereby increasing the internal validity of the research (Kozinets, 2010). This process involved "uncovering and interpreting meanings" (Cohen et al., 2018, p. 20) in relation to my development and growth as a newcomer to live coding, and as someone who had worked with

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[17] This was calculated using the *Anova: Two-Factor Without Replication* data analysis tool in Excel.

others using similar methods of performance. I also attempted to, as Cohen et al. (2018, p. 20) put it, "see the social world through the eyes of the participants, rather than as an outsider." Although not entirely possible, avoiding researcher bias required that I engage in a process of "critical self-reflection" throughout the research process (Johnson, 1997, p. 283). The fifth chapter of this dissertation serves as evidence of this process. Furthermore, in providing an autoethnographic account of my experiences (Starr, 2010), I attempted to achieve crystallisation through the correlation of multiple sources of data (Maree, 2019).

Triangulation of the research findings originating from multiple data sources also assisted in increasing the credibility of this study, as the aim was to establish a deeper understanding of live coding practice in a collaborative setting (Nieuwenhuis, 2019a). Furthermore, adopting a multi-paradigmatic approach (Johnson, 2015), also referred to as paradigmatic mixing according to Onwuegbuzie and Johnson (2006), allowed me to consider possible opposing viewpoints in the process of including responses of all those who participated in the research (Nieuwenhuis, 2019a). In lieu of this, Cohen et al. (2018, p. 649) state that not only is it essential to scrutinise an event "through the eyes of the researcher," but if done so with the inclusion of the viewpoints of others, an increased amount of reflexivity in establishing credibility is maintained (Bieler et al., 2021; Roberts & Priest, 2006). This is supported by Roberts and Priest (2006), who recommend that including verbatim statements made by interview participants increases the reliability of the research. To ensure that I represented each participant's viewpoint I included and correlated as many statements with one another from which appropriate themes were derived (refer to chapter four).

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

This chapter comprises three sections, each of which presents different analyses of the variety of data collected in this study. The first presents an analysis of the interview data obtained from Group 1, after which the second discusses the results of the survey administered to the networked performance community. The final and third section presents an appraisal of the interview data obtained from Group 2. The chapter then concludes with a summary of all the findings.

4.2 INTERVIEW DATA ANALYSIS: GROUP 1

Common themes between each section of Group 1 interview data that were analysed are discussed further in the following sections. Each main theme consists of multiple sub-themes. Main themes that were identified are as follows:

Theme 1: Constructing coherence
Theme 2: Negotiating a collective live coding practice
Theme 3: Cultivating connections

Table 2: Summary of identified themes

Theme 1: Constructing coherence	
Sub-theme	**Underlying theme**
1. Multi-disciplinarity	Research in live coding
2. Collaboration	Collaboration as educational practice
	Openness in sharing knowledge
	Learning the language
	Communication
3. Paradigmatic shift	Restriction and rigidity
	Accessibility and inclusivity

4. Developing a musical identity	Individual identity
	Overcoming obstacles
	Embracing failure
	Aesthetics of technology
	Embracing uncertainty and inconsistency
	Adaptability
Theme 2: Negotiating a collective live coding practice	
Sub-theme	**Underlying theme**
1. Exploration	Developing strategies
2. Dynamics	Group dynamics
	Understanding position and power
3. Negotiation	Maintaining awareness
	Maintaining balance
4. Rehearsal to performance ratio	
5. Autonomous systems	
Theme 3: Cultivating connections	
Sub-theme	**Underlying theme**
1. Local and global narratives	Human co-existence
	Human connection

4.2.1 THEME 1: CONSTRUCTING COHERENCE

The first main theme to emerge from analysing interview transcripts was that of constructing coherence. Sub-themes that were identified include multi-disciplinarity, collaboration, paradigmatic shift, and developing a musical identity. Each sub-theme explores underlying themes relating to the sub-theme. Underlying themes discussed under each sub-theme include research in live coding, collaboration as educational practice, openness in sharing knowledge, learning the language, communication, restriction and rigidity, accessibility and inclusivity, individual identity, overcoming obstacles, embracing failure, aesthetics of technology, embracing uncertainty and inconsistency, and lastly, adaptability. These themes are critical for understanding how ensemble members may go about constructing their own sonic identity in relation to others in a collaborative setting.

Sub-Theme 1: Multi-disciplinarity

The first sub-theme to emerge from data collection involved the multi-disciplinary nature of live coding performance. Questioning relating to the current occupations of participants revealed that each one operates within multiple disciplines, including but not limited to music education, visual arts, computer programming and music composition.

> ...the department of music where I'm [teaching], [is] very open and very well situated to mix with a lot of other things in the arts. (E)

> ...when all other things are equal, which they often are not, the title that I prefer is the title of artist programmer. (C)

> ...officially [and] professionally, I do present myself as a designer, as a visual artist, [and] a researcher. (B)

> I have not had any formal computer science training... I studied music and then I did a master's and PhD in music composition. I didn't really do anything with computers until my second year of [my] undergraduate music degree where I was [enrolled in] the SuperCollider programming course. (D)

One participant had no formal training and considers themselves to be self-taught within various disciplines.

> I'm a self-taught person in a lot of the things that I've done, [including] music. (A)

Most of the participants had experienced some form of music before becoming involved with or incorporating live coding into their practice as artists.

> I was doing a lot of composition and so I did another undergraduate degree in composition and went on to do a Master's Degree and Doctoral Degree in composition. (C)

> I studied music and then I did a master's and PhD in music composition. I didn't really do anything with computers until my second year of [my] undergraduate music degree where I was [enrolled in] the SuperCollider programming course. (D)

[Perhaps] around 10 years ago, I was doing visual arts and I started to work in this music centre.. (B)

...eventually I found myself in a doctoral [programme] in music education. (E)

Although it is the case that all participants had some form of exposure to music before beginning live coding, participant A stressed that by no means is it a requirement to have any musical background to be able to live code.

I don't believe that music experience is something that you need at all. A lot of the times people come to me and [they] really want to [learn how to live code], but have no musical training. I always tell them [that] I spent many years unlearning everything I learned in school. It's almost an advantage not to have so much musical training. (A)

Research in live coding
Participant B, for that matter, had no formal musical training to speak of and instead became involved in developing research that examined how code is displayed and communicated to the audience.

[Specifically] the way we use code, [how] we [display] code [on] the screen [and how the code] can also communicate with the audience. (B)

It's [research] about the way we use technology [with art]. I have different papers I have [completed for] my PhD, and recently I've been involved in writing about coding and art, but not necessarily [exclusively] about live coding. I'm also interested in electronic literature. (B)

In general, the interview participants engage in, or have engaged in some form of research relating to live coding.

I was working as a researcher for some years in academia, working on various projects around algorithmic music making and improvisation. Some of that was to do network music specifically, and some was to do with AI [Artificial Intelligence]. (D)

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...live coding together. I see that more broadly as part of a larger field of research that has to do with computational play. How people engage with, learn about, critique and interpret things that have to do with computation, through play, art, and improvisation. (C)

In collaborating with others participant B combines electronic literature as part of their research as well as a visual component in their live coding practice. Interviewing participant B provided insights into the visual aspect of live-coded performance, which is a vital element in the performances of SuperContinent.

I started to get a little bit more involved in electronic literature [again]. That's where it kind of clicked [for] me. Again, I do collaborate with [my family] and we also perform together. [They read poetry] live while I'm doing visuals and other people are doing [the] sound [element]. (B)

Sub-theme 2: Collaboration

Within these multiple disciplines informants placed substantial emphasis on collaboration, not limited to, but particularly in the context of laptop orchestra performance and music education.

I know that in the laptop orchestra my ideal performance is this shared co-creating. (E)

Even in [improvisation], I was always collaborating with different people. (D)

What I found with music education is, that although what I was studying had nothing to do with electroacoustics, the culture of music education or music as a more collaborative people-centered thing, made way more sense to me. (E)

I also collaborate a lot with [a family member]. (B)

For one participant their primary discipline, which happens to be music, was their doorway into creating collaboratively.

I love collaborating with people and in a way music has been my natural channel into a world where I can just collaborate. (E)

Referring to collaboration between human and computer, two informants equated live coding with the ability to expand individual and collective creativity through the use of computer technology, and more specifically live coding languages.

> Live coding definitely allows me to do that. It's [similar to] having an orchestra in the laptop. (A)

> ..the thing that we do in the computer, is a way of doing that - that's really scalable. (C)

Collaboration as educational practice

Most who participated in interviews spoke to the learning environment that is present when collaborating with others in SuperContinent. In many ways this learning environment, as participant B expresses, exposes one to ideas and concepts that otherwise would not have come across out of one's own volition.

> I learned [TidalCycles] by reading code and by reading [my friend's] code. That's how it started.. (E)

> If we do it in a kind of collaborative live coding setting, there's all kinds of other pedagogical benefits.. (C)

> What I really like about SuperContinent [is that], because some of you have more experience with Tidal, for example, I was always noticing [the] new functions. I [would go and] explore them later on. That worked a lot for me when I was working on the [my] project. And so, I tried to borrow those functions that otherwise I wouldn't really have encountered [on my own]. (B)

> ..one thing that I've enjoyed is learning through so much Tidal, through seeing what other people do and trying to work out what a function does and trying it out. (D)

> In terms of making music in performance I prefer the collective setting. I just love people. I love to see how they work; I love to learn from them and I love to share with them. (E)

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Openness in sharing knowledge

Within this collaborative learning environment SuperContinent members contend that there is a general openness in sharing knowledge between one another. This is reflected through various statements relating to the ease with which members can copy and share their code with one another and points to another affordance of the technology used to create collaboratively, which is that it allows for easily sharing code between one another.

> ...network music gave me a different way to think about working with people, which was more about sharing and working out a practice together and less about giving you some instructions on what to do. (D)

> I'll copy [their code] quite a lot, just because I want to figure [it] out. (A)

> [If] you go to a collective live coding session together, you could just copy and paste that stuff, and then take it home and continue to play with it. (C)

> ...live coding resists this idea of ownership, because you're literally protecting your code and anyone can take that if they want. It doesn't make sense in live coding to be like "no, this is my code and I'm not going to tell you how it works." Literally, you could write down someone's performance, [use] it later and play with it. I think there's something really strong in live coding, that's really explicitly saying I don't own this, take it [and] do what you want with it. (D)

Learning the language

With regards to engaging in collaborative performance, two informants point to the fact that in order to collaborate in these settings, some sort of learning has to take place on an individual level, with one particular statement pointing to the multi-disciplinarity of collective live coding.

> …the logic of coding is - it always made sense to me - it's just a matter of learning new languages. (E)

> As long as you're not learning or mastering the language, it is not going to be understood the way that you want it to be understood. You've got to respect that learning process and be surprised by it also. (A)

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...it's a really great learning environment in terms of code, music and visuals. It is painful at the beginning. It's like speaking in a language you don't know, and you feel so dumb sometimes, but you suffer through it. (E)

Communication

Two participants pointed to the various communications that occur in collaborative live coding. These take various forms including communicating through the code that each member writes and the sound that the code generates.

Our communication is just through Estuary, which is [great]. (B)

What I found really interesting about the group is [that] it's such a weird group in some ways, because our main communication is through code. Well, also through sound.. (D)

Participant B pointed to a potential restriction in communication in online spaces, where it is challenging to interact with others in the way you would when performing in person.

At the same time there's no time to [talk]. I [tend to] miss [some things].. (B)

I understand that people have pretty busy schedules [right now] and nobody wants to be online, but what happens with online communication is that you miss those parts in which you [fully] interact with people. (B)

Since communication can become a challenge in online spaces, one way to circumvent this is by actively making a point to communicate with the other members of the ensemble. In doing this, lines of communication are constantly open and therefore expressing ideas for moving in another direction becomes more possible.

...especially if the group is really busy at the time, what any individual does, doesn't make so much of a difference. Then it becomes necessarily more of a question of reaching out to people and talking about it, which is a unique possibility as the live coding ensemble. (C)

Sub-Theme 3: Paradigmatic shift

A third sub-theme that emerged was the idea that a paradigmatic shift had occurred in participants when they spoke of their past and present experiences regarding restrictions placed on their creativity in general. Each came from a very specific background that emphasised one particular way of approaching and expressing creativity. Referring to classic contemporary composition, Participant E pointed to the cultural restrictiveness of the art form, while also complementing its rigour and structured way of composing.

> ...it's somewhat restrictive with your supervisors and what is accepted as contemporary classical composition or whatever. Even though it's supposed to be open and innovative it's not exactly open. It's very traditional, in some ways. Although it's experimental and it goes far in terms of the sonic world, the structure and the way of composing are not really free. Not really. I mean, they're definitely rigorous. That's fine. I think rigor is great, but they're also extremely culturally restrictive. (E)

Participants expressed a further shift away from contemporary compositional practice and performing in general, and more toward a collective and shared creation.

> As music students you're always presenting compositions, and there was a very intense scene of performing for each other and discussing compositional issues and stuff like that. (C)

> In general, I kind of put away this idea of performing and composing. (E)

> Before I did network music I was a composer, but also a composer who was uncomfortable with the idea of being a composer. I always felt weird about imposing my music on people... (D)

Restriction and rigidity

As participants A and D expressed, not only is rigidity and restriction an issue in composition, but also in many other systems, such as education and technology.

> I think that the whole education system around technology is really based on the Western way of thinking. I've worked in cultural contexts that were a lot more complicated. [For

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example], I was teaching groups of women that come from very religious background[s]. I think that in these kinds of contexts live coding can be really beneficial because you take away this notion of right and wrong. (A)

When I go into a DAW [Digital Audio Workstation] I always feel so restricted, because I'm just like, "why wouldn't I just code this? Why are you imposing all these controls on me?" (D)

This paradigmatic shift is also reflected in another statement made by participant A, who suggests a more general approach to expressing creativity; one that is interpretable by many individuals and less restrictive than specifying exact aesthetic objectives. In counteracting the specificity of any one particular aesthetic, members of SuperContinent developed various collective live coding strategies to circumvent this, allowing for each person to interpret the creative direction in any which way they choose.

...why not just give [an] "aliens are landing on earth" kind of idea? Then it's not so restrictive as to say 180 [beats per minute] in E minor. It's a creative direction, but at the same time it's not too restrictive and we can each interpret it in our own way. (A)

Live coding on the other hand, as participant D suggests is a rather radical shift from traditional compositional practices in that it is far more open to constructing knowledge collaboratively.

...in a lot of academia [here] I feel like live coding is quite radical in that sense. (D)

With regard to the electroacoustic tradition, one respondent acknowledged that they are aware of a sort of exclusivity in terms of sharing knowledge, and in terms of gender and culture.

I found that in electroacoustics there was a little more freedom for me. Electroacoustics itself is structured and has its own culture, don't get me wrong. It's very strongly narrow in gender and culture. It has its own issues of course. (E)

In shifting from roles that originate from the classical tradition, such as the composer and performer, participant E once again draws attention to the role of collaborator. This points to the culture of constructing a shared knowledge as opposed to one that has clearly defined roles.

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I wouldn't even say it's a performer thing. It's more like a collaborator thing that I'm looking at, which to me is the same. I'm not interested that much to be "the performer." (E)

Accessibility and inclusivity

An important finding discovered in the data was the particular consideration and thoughtfulness for cultivating spaces that are more accessible and inclusive, not just technologically but also with regard to other genders and cultures. Participant E spoke to the continuing efforts of students and faculty alike in creating opportunities for those who have experienced a form of marginalisation or exclusion.

[A] student came with a group of other students who were women, transgender, and non-binary, and awakened us (the faculty members) to the nature of feeling/being marginalised in the [programme]. I realised that the gender problem was not just general and worldwide. Yeah, there is a worldwide problem in this field, but I realized there are some things that are immediately actionable right here. Students don't feel comfortable in the classroom sometimes, when they're the only woman in the class of 25 or 30 people, and it's because of stupid jokes that may be going around. It's because of the [male] camaraderie culture that's happening that is very exclusive. This stuff can change. She really made a difference [in] that she created this whole culture of transformation in our [programme], starting with this important meeting. (E)

More importantly, in creating these accessible spaces it is essential for all who are involved to actively continue to cultivate a culture of inclusivity, although as both participants E and C point out, this requires careful consideration of the ways in which this is approached. One way to do this is by partnering with institutions that are already equipped to create an awareness of issues of exclusion and collaborating with them to create these open and accessible spaces.

...because the field is so lopsided, you need men to speak up sometimes too. It's been getting better [here], by the way. The numbers have grown and the culture has improved, but it's definitely a process. It takes time and requires keeping the momentum of change. (E)

Often as scenes form, in particular local areas, they unwittingly reproduce particular patterns of exclusion too. There's this enormous potential in the activity of live coding to

not do that, and to engage in a more productive way. To engage in a more generative way, with people who are positioned differently. But it does take thought, and it takes energy, and it takes time. It's not easy. With the caveat that it takes thought and takes time, and it's not easy, one thing I noticed here, and I've noticed it in other people's stories about how their scenes have gotten started, is that there's a lot of collaboration with institutions that are already positioned in different ways. (C)

The practice of live coding lends itself to cultivating environments that enable the construction of shared knowledge and in the process creates an opportunity for those who do not have the means, the resources, the opportunity, or the time to engage in learning to master an instrument.

It's cool because we're all on the same instrument. In a way it's not like a band where one person plays guitar, one person plays this [and] one person plays that. We all [have] the same instrument so we can all learn from each other a lot more than when we're playing with individual [instruments]. (A)

You're playing with the exact physical material situation, that the other, perhaps more experienced, perhaps just experienced in a different way, person was playing with. If you compare this to the violin situation, it's as if you sort of snuck into the body of the expert violin player during their performance. Everything was frozen and now you could kind of look at the parts, look at the muscles, and look at what kind of acoustic feedback they're getting. You can tweak the system before letting it go again. I think that's one of the fundamental powers of live coding, and I think it's why it was so attractive to continue to explore it as a group. (C)

The only real barrier for some might be that they do not have the proper access to a computer or a network connection. Regardless, as participant D stated, the practice of live coding is far more accessible to a wider range of individuals in various disciplines than some traditional forms of music.

That's what I love about live coding; how open it is and how literally anyone can [do it]. Well not literally anyone, because you have to have a computer. But the breadth of people who it's available to is much broader than traditional academic forms of electronic music making. (D)

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Furthermore, the Estuary environment which was made accessible through open source licensing, was developed with the intention to create an easily accessible platform that does not require that a user install any additional software.

> ...especially with Tidal, because it's so hard to install. I've used Estuary a couple of times where I've taught a little bit of Tidal in a workshop just because you just don't have the time to do the Tidal install. (D)

> I thought, wouldn't it be cool if we open it up fully and make it into a fully telematic jam session. We didn't have Estuary back then. It wasn't as open [where] people can just jump in and start making sound. (E)

Developing tools

There is also a common agreement between SuperContinent members that developing tools by means of programming in other computer languages is essential for a number of reasons.

> ...there is a community that focuses on telematics as its main research and research creation. Part of it had to do with developing tools. (E)

> I feel like, socially, collectively, in terms of computational play, right now we're only using 2% of our collective brain. I'm really interested to see what happens when we start using the other 98%, which I think takes developing tools. (C)

For participant B, developing tools in this way means more possibilities for expression, once more pointing to the restrictions set by some software that is already available to use.

> I usually use the normal video and sound editing platforms like Final Cut Pro, Photoshop and Illustrator. For live video I was using Arena. I don't remember the full name, [but I use it] for VJ'ing [real-time visual performance]. It's similar to Ableton Live. I was using [Arena] for that and also for mapping. It's a very intuitive platform, but obviously, has a cost and is expensive. Those were the platforms that I used to use. I still use the Adobe suite for my work in general and even if I'm working with live coding, I always prepare my video or audio recordings. I use Reaper for audio now and I still use Final Cut for normal editing of videos. Once I tried with VDMX [which] is also a platform that used to be free for VJ'ing, but then it had [added costs] and the learning curve was longer than

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[with] Arena. If I'm going to learn [VDMX], I [would] rather learn [to] code because at least I have more possibilities. I can just create my own platforms.. (B)

Participants E and C both agree that for collaboration purposes developing tools is also essential. Not only does this apply to the live coding community but also in general. It allows those who want to collaborate the opportunity to do so using software that is more suited for collaboration, especially since most software that does exist was created for use by individuals and not groups.

> [In collaborating] with [my friend], we thought about ideas of how to automate this. I created this PD patch where, on JackTrip, we use one audio track with a sweeping tone, and you could basically recognize the frequency and assign it to a point in the musical bar. If everybody was running that – a full bar from a sweeping tone [and] from top to bottom with the same frequency - everybody could share that one track and basically the matching of the monitoring delays could be automated by frequency identification. (E)

> …developing tools that can then be used in live coding situations, particularly collective live coding situations. (C)

Sub-theme 4: Developing a musical identity

Another sub-theme that emerged from analysing transcripts was that an individual's musical identity is connected to one's personal aesthetic in that an individual's personal preferences dictate how you define your musical identity. Two respondents attested to this, and one indicated that their personal preferences often need to be adjusted to suit the overall group aesthetic.

> I think my identity as a performer now is not very far from my identity in real life. I've stopped fighting who I am in real life, for the sake of giving myself a different identity, because I feel I have to when I'm performing. (A)

> In this context [group performance], I have to have a different aesthetic or perform in a different way. (D)

In order to establish a musical identity, or simply an identity as an artist according to participant A, it is essential to remove oneself from any potential restrictions that may hinder the development of that identity. This is significant given that participant D states that an individual is always influenced by the way of thinking they are first introduced to.

> If you want to have a clear identity, you kind of need to forget all of the things that you [learned]. It's good to learn the rules, but ultimately you want to learn how to break them. Breaking the rules is what is going to give you a personality as a creator. It's going to give you a sound that no one else has. (A)

> I think it's always what you start with [that] informs the paradigm of thinking that you come with... (D)

Individual identity

The individual identities of each of the members of SuperContinent differ widely. When participants were asked to describe themselves in terms of identity each provided interesting insights into how they construct their identity as creative individuals.

> ...the identity of [an] artist programmer is also what's kind of fun about it and claiming it, is that it's not a commonly legible one. I didn't grow up knowing of the existence of artist programmers, although they certainly did exist and have existed for a long time now. (C)

> I've always been really active as a performer of live coding and network music, as a teacher, and as someone who talks about music technology to various audiences. (D)

Participant B for the most part identifies as a designer, visual artist and researcher, but is careful to define themselves as a musician. It is only through interaction with others and their experiences that they are able to identify themselves as someone who experiments with sound.

> ...officially [and] professionally, I do present myself as a designer, as a visual artist, [and] a researcher. Those are the three words that I use. I do a lot of things with sound, but I'm very hesitant of having that as [a] professional tag. I'm not really a musician, or didn't really study anything related to sound. It's more [the case that] through practice, through my life and my work experience that I have been experimenting with sound. (B)

Participant E felt strongly about not defining any particular identity, but recognised that when in a collaborative performance setting they view themself to be adaptable and open to exploration in the process of discovering new ways in which they can communicate with others through code and sound.

> In a way, I don't look for an identity that's established. I do not want to develop a style. That's never been my interest. If I'm sort of idealizing what I would like my identity to be as a performer, it would be this adaptable, constantly experimenting, constantly collaborating mode of operation where it's kind of like being playful within a group. (E)

Participant A, on the other hand, feels that when creating an identity, one needs to place oneself within the parameters one has identified for oneself. This must not be confused with the idea of restriction mentioned earlier, but rather that one should be able to decide what those parameters should be as opposed to being prescribed which parameters are important and which aren't.

> In order to get there, where you can just play, you need to have a very firm identity as a musician. If you tell me [to] just play, I'll play something, but I will put myself [in] the parameters according to the identity that I know I have as an artist. (A)

Suggesting two ways of going about discovering one's musical identity, participant A acknowledges the importance of learning about existing musical traditions, but that too much emphasis on what is considered acceptable may hinder this process of discovery.

> It's either you learn the rules really well until you figure out ways that are good to break them. Or, you just work to be really in tune with who you are, what you like, how you feel things, hear things, see things, and express that without being concerned [whether it's] right or wrong. It doesn't matter. If it feels right to you, it's right. (A)

By allowing a person the opportunity to discover for themselves who they are as a creative, and to express themselves creatively in whichever way they choose, is essential for developing a sense of one's own identity.

> If you're an artist that has an identity - someone who knows your own internal parameters of what it means to you to just play - [and] you have the confidence to affirm that identity, [you'll be] fine. A lot of musicians, even very good musicians, have an incredibly hard

time with that. Just because they've never developed it. Musical identity is not something you learn in school. Developing your own sound, [or] your own personality, is not what they teach you to do. (A)

Overcoming obstacles

In the process of discovering a personal identity as a creator, participants indicated that in order to do so, one needs to find ways to overcome obstacles that seemingly prevent that process of discovery. Instead, embracing the obstacle you are faced with and deliberately using that as motivation for exploration is more beneficial to the creator.

> I was often told that telematic performances have to be very well planned, otherwise they're going to fail. That automatically motivated me to do a big spontaneous jam session performance in which anyone, anywhere could join in freely. (E)

Recognising that we all have some sort of weakness, it is more advantageous to use those weaknesses as strengths in the process of discovery, as participant A suggests. Exploring areas of our identities that we initially deemed to be a weakness may yield discoveries that were never considered to begin with.

> You take that weakness, and you put it to the other extreme and learn to use it. You develop something that is a sound that is proper to you. [Don't] be afraid of weaknesses. Learn how to look at them head on, and see what you can do with them instead of fighting them all the time. A lot of the times they're the key to your true identity because these are the things that you have the easiest time doing, so why not use them. (A)

Embracing failure

The above points to another prominent theme; that of embracing failure. Participant E recognises that with an exploration of the unknown, one has to be open to the possibility of failing at something.

> I think it's just always looking ahead for what I don't know, which also requires this openness to fail and to mess up. (E)

Imperfection and a willingness to fail is something that is accepted among the members of SuperContinent and in the process of discovering oneself, it is important to acknowledge that

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imperfection is a way of demonstrating what it means to be vulnerable and willing to be open in sharing parts of oneself with others.

> For me, imperfection in music is a relief. When I hear someone singing slightly out of tune, [and] it's done in such a sensitive way, to me it opens [up] that space to allow us to be imperfect as well. Daring to be imperfect, vulnerable and sensitive and not [being] this [show-off type of] person. (A)

For example, overcoming an obstacle by embracing it in this way may lead to an enormous sense of fulfilment for some.

> One thing that I can point out in relation to that idea of overcoming obstacles, which is an interesting thing [and] fun in itself, [is] just a sense of fulfilment. (E)

Setting aside what is deemed appropriate by some and not by others will allow one to embrace and accept that failure is imminent. Striving for perfection at all times is unrealistic and, therefore, acknowledging that failure is imminent allows one to let go of the fear that is associated with failure.

> With taking out this definition you can really work on eliminating fear of failure and building confidence, which are also really important to teach to people if you want them to get into the job market. (A)

Aesthetics of technology

In developing an identity as a creator, it is essential, as participant B suggests, to be aware of the aesthetics associated with the technology that is used to create. In the case of using a programming language such as TidalCycles or Hydra it is often that the aesthetics of the platform will manifest as the aesthetics of the creator.

> ...the learning curve is [quite high] when you want to [incorporate] some of your aesthetics. [It becomes challenging to avoid] the aesthetics of the code imprinting on your work or [even] the aesthetics of the platform. (B)

This too was the case for telematic music where the latency produced by networks, often places substantial limitations on the aesthetic one is able to achieve.

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...going into beat making after doing all these abstract telematic performances especially when you have latency, by default you're going into more abstract non-metric things. (E)

Through the development of platforms such as Estuary that are open and easily accessible, one can overcome such obstacles which do not serve a collective.

There is this big obstacle to making contacts with other people and collaborating with other people, and we found a way around it. (E)

...making software that makes it easier for people to play together as a group. (C)

Embracing uncertainty and inconsistency

Being a member of a group such as SuperContinent requires that its members embrace inconsistency and uncertainty. This is owed to a number of unpredictable aspects of networked live coding, including the unpredictability of network connections, unpredictability of one's thoughts, and at times the unpredictability of everyday life.

I love doing that in a collective setting where there is a lot of unexpected stuff to handle and build on. (E)

...like everyone, I think that my thoughts and my attention are not consistent, strategic and under my own control all the time. In a performance, I'll be paying attention in different ways, and maybe my mind is wandering at other times too. There's a lot of variability there. I don't think any of us come into a collective live coding performance as an improvising machine that's 100% on the job ready to do what it does. We come into those things as people with minds that behave in all kinds of different ways from each other, but also, different ways with respect to ourselves from one moment to another. We go through different states... (C)

It doesn't always work this way, because [of] a bunch of things that are sometimes hard to predict, like power dynamics. Sometimes technologically, it's not really working... (E)

Creativity is not an on and off thing. [You can't just] press the button [and be] creative. It doesn't work like that. [We should] respect ourselves in the process. (A)

For some, consistency is a hindrance to their creativity and at times prevents them from discovering anything new.

> Consistency is not the best for my creativity. Sometimes I feel, because I get into too many habits, I get a little bit bored [and] then I get to the point where I'm not discovering anything else. I need to switch it up a little bit. I can't be playing all the time [and] I can't be exploring all the time. I need to switch it up between [the] technical and [the] creative [aspects of live coding]. (A)

Adaptability

Engaging in live coding practice requires that an individual let go of any preconceived ideas about what it is that they want to create. Instead, emphasis should be placed on developing skills that allow for adaptation to any situation.

> It's always been [that] I want to develop skills so I can quickly adapt. (E)

> ...take programming and [shift the focus away] from achieving a specific result. You bring it to the realm of expressing something, exploring something, or achieving a result that is subjective - that is, not right or wrong. (A)

4.2.2 THEME 2: NEGOTIATING A COLLECTIVE LIVE CODING PRACTICE

The following theme concerns the ways in which individuals navigate collective performance in online technologically mediated environments such as Estuary. Sub-themes that were identified include exploration, dynamics, negotiation, rehearsal to performance ratio, and autonomous systems. Underlying themes for this section include developing strategies, group dynamics, understanding position and power, maintaining awareness, maintaining balance and rehearsal to performance ratio.

Sub-theme 1: Exploration

A prominent theme to emerge during analysis was the idea of exploration within a set of agreed-upon creative directions. Making use of collective strategies for these explorations, participants expressed a sense of curiosity in exploring what is possible within a particular constraint.

[I] was curious [and] exploring. I'm always just searching for different things - I don't know where it goes.. (E)

Start with an idea of a process and give that process to your computer in the form of a line of code or a function that you want to call. You're not sure what it does, but you just want to explore it and then see what it does. (A).

In this process of exploring, an important point raised by a few participants was that one of the goals of the group is to explore new ways in which they can collaborate with each other in order to find new inspiration and in the process advance from what has already been achieved creatively.

..developing new ways of collaborating, new ways of playing to make those connections, and [learning] to play together in new and different ways. (C)

[We're] not [necessarily motivated] to build something that does something, [but we want to] explore it and hear what it does if you do this instead of that. There's not one [approach] that is better than the other. (A)

...it's sort of like discovering potential new ways of collaborating with other people, new ways of making art, new ways of inspiring ourselves. (E)

Exploration during a rehearsal is particularly important to participant A, who makes use of this time to explore the musical content in ways that a performance does not always allow.

When it's a rehearsal context, sometimes I'll try look at [other people's] code and I'll I want to try [to do something similar], and so I'll see how [they go about doing] this. I'll copy and try to do that because this is what rehearsal is for. It's for exploring and trying to grow. (A)

During a performance participant A will explore areas in which they are more comfortable, although they suggest that this is not always the case for them. It is more that they practice a certain amount of sensitivity to the overall sonic space, and in doing so create an awareness of how they can place their code within the space or in relation to whatever else is being played by the rest of the group.

Usually, my approach in any kind of music, whether it's playing an instrument or live coding with people, is to try and be as sensitive as I can to what's going on and [finding] a place [where] I can fill a certain gap. Most of the time it's listening to the overall soundscape and just being sensitive to, not necessarily what I feel is missing - I don't think missing is the right word - but where there's gaps and there's room there for something to fill in that space. Sometimes, if it's [a] performance context, I'll go [into] safer zones. (A)

As participant E suggested, exploration can be practised in both rehearsal and performance contexts, provided that one maintains an awareness of the sonic space as participant A mentioned above.

I want performances and rehearsals to be exploratory. Finding new sounds. Finding new modes of collaboration. Finding new fun technological things. (E)

Developing strategies

When members of the group engage in collaborative performance, there is a common agreement that in order to facilitate explorations in the group, some strategies should be developed. This is once more associated with a creative direction determined by the group. Making note of these strategies are useful for future reference.

All these explorations become things that I can [place] in my toolbox [for later]. (A)

Part of it had to do with developing methods... (E)

For others, strategies might be slightly different. Referring to a collaboration with another group that they were working with, participant B specified that one strategy that worked for them was to engage in discussions before and after a rehearsal. This would give the group an opportunity to discuss what their intentions for the rehearsal are and once the rehearsal is completed, the group then discusses whether their intentions were met or not.

...we [used to] talk at the beginning, in the middle we played and then we [would] talk about what we just [played]. (B)

In SuperContinent this is slightly more challenging due to the time constraints the group has set for itself. A rehearsal and post-rehearsal discussion last only a total of one hour, but this

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constraint is required since everyone involved has other commitments that need to be attended to. This shows that this strategy may not be well suited for a group such as SuperContinent, although may prove useful for ensembles in other contexts.

> At the same time there's no time to [talk]... (B)

For participant A, who here refers to their own strategy for solo performances, will rehearse previously prepared code in preparation for a performance. This prepared code is usually generated through experimentation which is then further developed to create fragments that are then assembled to ensure they can be blended together to suit the performer's overall aesthetic for the performance.

> Usually, [in] the days before a performance I'll do [what I call] "runs," especially if someone tells me [I have to] play for half an hour or 40 minutes. I'll do [this] to see [if] my ideas [are] stitched together. I take it that way or that way, and then I practice running through my ideas. These are the stages I go through; exploration, development, and then [practicing] running through [the ideas I've stitched together]. (A)

Sub-theme 2: Dynamics

Sub-theme 2 points to the social, political, ethical and aesthetic aspects of live coding in a group. Recognising this theme in the data indicated that the participants are conscious of the ways in which they act within the group, how they navigate being in the group, and how they present themselves as individuals in a collaborative setting.

Group dynamics

In terms of social interaction, the members of SuperContinent agree that there is a general sense of endearment between the members of the group in that everyone respects each other, their creative process, and their aesthetic preferences.

> I love the friendship element that develops through the years. It's in some ways slow because we don't personalize that much, but I do feel that there is a general kind of affection going around. It's nice and it does seem to evolve towards this ideal setting that I've been looking for; this collective. (E)

I feel we're a really solid group in terms of having a really good group dynamic. Everyone's very respectful and supportive, and I really enjoy that our discussions are always very positive. (D)

…no one is judgmental. Everyone is super open. (A)

It was interesting to see how the problems are being handled in a group setting. When it's two people [it's] a fun thing, but when you have a bunch of people there is, beyond the technology, this whole dynamic that's interesting as well. Everybody has a voice and everybody can contribute no matter at what ability level you are. To provide each other with respectful feedback when necessary without it feeling [judgmental]. (E)

Live coding collaboratively is also applicable for generating sociality within individuals and preparing them for the establishment of social relationships.

I believe it's a great tool when you're teaching for teaching people skills. (A)

Understanding position and power

The participants demonstrated a comprehensive understanding of what it means to engage in collective live coding activities in terms of their position within the group. This is demonstrated in several ways, whether it has to do with rehearsals, performances or a general awareness of their position within their respective professional environments, each member who participated in interviews showed that they have a degree of awareness of their power as participants of a collective.

I always wondered what my role could be in making a difference. It's not exactly MY fight. I didn't feel it's right to take the lead in something [where] I'm not the person who is marginalised (at least where gender is concerned). (E)

Sometimes, if it's [a] performance context, I'll go [into] safer zones. My comfort zone is more in textures and in spaces and melodies. This is more the zone [I operate in]. I'll stick to my zones, that I know I can deal with, when it's a performance context. (A)

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One reason for understanding one's position and power within a group is that when there is a perception that different members are not on the same level, it becomes challenging for some to express their preferences and can potentially lead to feelings of exclusion.

> When you have these kinds of ensembles I think everybody has to have the sense that you're [on] the same level. If there's some power dynamics then it's difficult to propose or even try to do things. (B)

Although this is not always the case in SuperContinent this is something that happens in other contexts, particularly educational contexts. Therefore, it is essential that educators and instructors maintain an awareness of their position as figures who have attained more knowledge in their field than those who have not yet done so, particularly maintaining sensitivity toward those interactions with others who are in different stages of attaining knowledge.

> I love that with [the university orchestra] as an environment. In being the teacher, as much as I do everything I can to soften the power dynamic element, I'm still a teacher. In SuperContinent, I don't have to deal with that [as] much. (E)

Sub-theme 3: Negotiation

It is always the case that when one live codes music with others that their personal preferences will influence how another party is presenting themselves in the group.

> ...I find it interesting how our personal aesthetics are morphed by other people's aesthetics, because it's literally all in negotiation. (D)

This cannot be avoided, as participant D suggests, due to the complex nature of the environment which facilitates these interactions. Group members often practice withdrawing and returning at various stages of the performance.

> I also find it interesting how those negotiations happen through the interface as well. We were both talking about that idea of coming forward and dropping back. I feel like that's something that's within our group dynamic, but [has] evolved quite fluidly. (D)

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In these negotiations members of the group, according to participant A, need to be able to permit others in the group the opportunity to express themselves.

> They have to relinquish creative control to the machine [similar to interacting with] another musician [or] giving the other party space to breathe and do its thing. (A)

Maintaining awareness

Participants showed that a certain amount of awareness of how they are negotiating their personal aesthetic at all times is essential. Maintaining this heightened sense of awareness allows the members to practice withdrawing and returning and in doing recognising when is the right time to do so.

> Just through rehearsing together a lot that we're all quite conscious of giving space to other people and not hogging the bandwidth all the time. But also, having the confidence, if you make something that's really cool, to stick with it and be like "I'm taking the space now because I really like this sound." (D)

> I think the mark of a true musician [is] to know when to stay silent. That is true professionalism. You'll hear amateurs. They'll play whatever just to play something because they feel they have to, but once you've been in that situation [and] you've experienced the stage so much, the group [and] playing with different people, then you can truly understand the moments where it's time for you to stay silent. (A)

Participant E admits that in these collaborative settings it is still possible for one individual to fade into the background, but stresses that an awareness of one's surroundings is most effective and one of the few ways to prevent this from happening. Unfortunately, this is not always the case due to constant unpredictable factors, such as different members dropping out and returning.

> Everybody has a voice, but I find it doesn't always happen as I want to. It rarely does. Actually, there's always people who get lost in the mix and people who don't feel comfortable as I think they would. That's what I'm constantly looking for. (E)

Maintaining balance

In these negotiations some sort of balance is necessary. Through the practice of removing oneself from the environment, and retiring when the time is right, one can begin to explore what balance in a group such as this entails.

> Of course, there's balance. You can feel it if someone is too shy to do anything, but that's not what's happening there. I think that we all have our moments where we feel we can truly express ourselves. Then we have our moments where we feel like this is my time for listening - to absorb - because we're not inspired. (A)

One way to approach maintaining the balance in a group setting, whether the group engages in live coding or not, once more, is to actively practice awareness of what everyone in the group is doing at any given time.

> …one state is where one is watching what the rest of the group does. Particularly in the case of live coding, I think that I'm often put into this state when something gets my attention and I don't know where it came from. There are these moments where I'm like "there's something happening" [or] "there's a sound [and] maybe it's dominating the foreground attention a little bit", or "perhaps it's because it's new". (C)

> Sometimes I listen and I don't hear that gap where I can add something. If there's nothing for me to add, I'm not going to throw the whole balance of the music off just because I want to do something. It's not serving the music. It's not serving the sounds that we're creating [or] the experience we're creating. (A)

In moments where the group loses a sense of direction or inspiration, returning to the collective strategies the group has compiled is always one way of beginning to recreate balance within the group.

> I think we're going to find our balance. There [are] moments where we feel very creative as an ensemble, and it's okay to let loose and see what happens. [Then] there's other moments where we feel we're kind of becoming redundant, then strategies can help [us keep] pushing the boundaries a little bit of what we've already done. (A)

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Taking it to the other extreme where no strategies are used at all is a challenging task for any creative person. Therefore, placing limitations on the creative process also assists in generating new ways of expressing creativity.

> ...for every musician free form improvisation, free form in all senses - I'm talking [about] free from anything - is the hardest form of improvisation there is. For people to start [with improvising], it's always easier when you have certain parameters. Creativity needs certain parameters. (A)

Sub-theme 4: Rehearsal to performance ratio

Participant D highlighted an important aspect of performance preparation. The group, for the most part, aims to be as consistent in their rehearsals as possible. As mentioned earlier this does not always happen as consistently for everyone. The group has a standing arrangement that for one hour a week, depending on who is available, there will be a half-hour rehearsal and half-hour discussion. Members also actively source opportunities for performance which motivates the group to meet as regularly as everyone's schedule allows. This construct was referred to as the group's rehearsal to performance ratio.

> …it's probably the group that I've been part of that has the highest rehearsal to performance ratio. I find that really interesting as well, because we have so much time to work out how we're negotiating this practice together before we do a performance. Whereas, almost every group I've been in before you have a couple of practices, and then you perform something. (D)

Sub-theme 5: Autonomous systems

An interesting aspect of live coding collaboratively that often materialises toward the end of a performance is when a group collectively arrives at a point where no one is able to discern how the code produced a particular result.

> It's interesting because you navigate it collectively as well, where you can arrive at a point where no one in the room understands what the code is doing anymore. You've created some weird synthesis network in Punctual or something like that, and people understood the individual steps that they were taking. Yet somehow, because your attention hasn't

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been 100% on it all the time, or maybe even if it was, you would still lose the thread. In any case, you lose the thread, and you don't really know how it's working anymore. You have this sensation that you've built this kind of machine that has a mind of its own [and] you don't know how it works. I think that's an interesting state of mind, even by itself, but it's especially interesting when you have that as a group. When the group is working on this thing and there comes a moment where the group recognizes collectively, that it doesn't understand what it's doing anymore. (C)

4.2.3 THEME 3: CULTIVATING CONNECTIONS

The final theme identified during data analysis was that of cultivating connections. Participants vehemently expressed their motivation for engaging in collaborative live coding as being related to the interactions and connections that are formed between people. Beyond the musical and artistic aspects of live coding, participants agreed that cultivating relationships and building connections was extremely important to them. One sub-theme was identified namely, local and global narratives, with two underlying themes referred to here as human co-existence and human connection.

Sub-theme 1: Local and global narratives

In an increasingly technologically mediated and online social world, which was intensified by the global pandemic, the members of SuperContinent expressed an extraordinary interest in finding new ways of making connections with people.

> I think [live coding is about] exploring different ways of interacting [with] each other and just creating music. (B)

> I think that for me, it's the magic of being able to connect with other people without them physically [being] there. There's just something so magical about tuning [into] a platform and being able to make music with a whole bunch of people around the planet. It sounds so surreal when you think about it. (A)
> I realised there are new channels to make friends. Artistic friends. It really is about making connection, creating together and discovering together. (E)

A distinctive aspect of the group is that its members are located across multiple continents, and because these individuals are not in each other's immediate proximity, it becomes the case where members are exposed to other forms of creativity.

> …it's an interesting experiment in making music with people who by virtue of where they are, you wouldn't have otherwise made music with them. (C)

> …we are people living in different geographical and political situations. It's also great to learn from them. Those are the interactions that I think will be very useful for us to create [a bond] and [an understanding of] how people use [code]. I think it's reflected in the way you use [or] you create your code, and [how] you interact with those languages. (B)

Referring to the practices of a local ensemble, participant B expressed that before the global pandemic, developing relationships with others was easier. Although this may be the case on a local level, SuperContinent was already active as an ensemble before the pandemic, and so in the case of local collaboration it becomes important to find alternatives in order to continue to cultivate these relationships.

> Pre-Covid we used to meet at [the university] for two hours every week. It was great because even though [some were] very "don't waste your time", [it was a] space in which you [could] talk to people about random things, or joke about the code. (B)

Two participants also raised an important point in cultivating relationships on a local level, and addressing potential issues on a local level before attempting to do so globally.

> It's possible to form these musical friendships and to learn from people around the world, but I think it has to go hand in hand with things that are not around the world. Things that are just where we are as well, too. Because, in a way, a lot of the biggest differences are always right on our doorstep. Right around us. (C)

> I realised there are some things that are immediately actionable right here. (E)

In contrast to addressing problems on a local level, globally there are concerns that defining particular narratives in rather specific ways could potentially come across as reinforcing the opposite of the essence of what it means to collaborate.

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It's good that people bring their existing relationality into music with them. But I think our existing relationalities can also be limitations, can also be problematic, can also be ways that privilege and oppression are extended through time and stereotypical ways. One of the problems is that when international collaborations are framed as collaborations across national borders, that way of framing things can actually objectify or reify, or bring into reality, the very thing that you're trying to step over. (C)

Human co-existence

Participant E further extended the notion of cultivating connections into the realm of human co-existence, where engaging in a collective practice will allow for deeper understanding and a sensitivity toward the ways in which individuals from differing backgrounds construct knowledge and exist in the world.

To constantly grow and get better at seeing other people and their ways of being, their ways of knowing and their needs. To me that's crucial. It's always been the main drive for me to be with other people and to be on a journey together. To grow together and to find how to be happy together. (E)

Human connection

In combining technological and artistic practice in a similar way in which networked environments allow, groups can begin to cultivate relationships that are more meaningful.

People do crazy [things] with technology all day long without really caring about it, but then you tell them [you're] playing with a group of people through the internet and we're playing shows across the world from our living room, people are [very surprised]. [People] talk on Skype and on Zoom every day, and they have complex algorithms running on their phone that tell them what to buy, where to go and whatever. That doesn't bring in that [same] sense of magic. Technology related to art somehow does and that's something really precious. (A)

Sound, music and visuals is to me the side issue. It really is about people. Of course, the sound, music and visuals are fun and beautiful. They have joy in them, but really they are to me a means for connection. (E)

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As participant A suggests, art in general is essential for the collective growth of a population. Expressing ourselves through art is a way of arriving at a point where individuals become more connected with others as well as with themselves.

> To a lot of people, art is something that you do for fun. Which it is, but we forget the benefits of art as well. The benefits to our culture. The benefits to having it as a tool for human growth and for the growth of our society as a collective. This is something I'm really passionate about [and is] mostly what I talk about when I'm invited [to] conferences to talk about my work. (A)

In consideration of the audience watching a live coding performance, participant C pointed out a challenge of live coding that may cause confusion for some audiences, especially those who watch a live coding performance for the first time.

> One of the difficulties of collective live coding performance is making dramatic, unified changes. I really think that those dramatic unified changes are in some sense necessary. In musical performance it's very hard to find, anywhere in the world, a tradition of music making that doesn't have dramatic, unified changes. Including, for example, when things start and stop. [There are] all kinds of musical forms around the world where the nature of the form is that the performers know that, at this moment, exactly this moment, it's over. There's a punctuation to that. Those moments, in all of these different musical cultures, I think are so nice for the audience and the performer, both. Because they create this unified sensation that the thing is over. Perhaps people clap, or perhaps they do whatever other thing it is that people do to mark that moment, at the end of the musical performance. In collective live coding performance, because our practices don't support that very well, we often have things that drift away. We're not really sure when they're over or not. It makes it hard for everyone, therefore, to celebrate the musical event, including the audience. (C)

## 4.3 COMMUNITY SURVEY ANALYSIS

The following sections present the findings of the online survey administered to the networked live coding community. These include a discussion of networked community roles, the most popular live coding languages that the community uses to perform with, the live coding languages that are most popular in educational contexts, and members' motivation for joining

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the community. The final two sections discuss the attempt at measuring two constructs that were identified during the analysis of Group 1 interviews in order to discern whether the community shares these conceptualisations or not.

4.3.1 NETWORKED COMMUNITY ROLES

When respondents were asked to describe themselves in relation to their involvement with the networked live coding community (question six), three responses were of interest. All twelve indicated that they would refer to themselves as live coders, while ten said that they would refer to themselves as musicians and sound artists. Not many of the respondents indicated that they see themselves as visual artists.
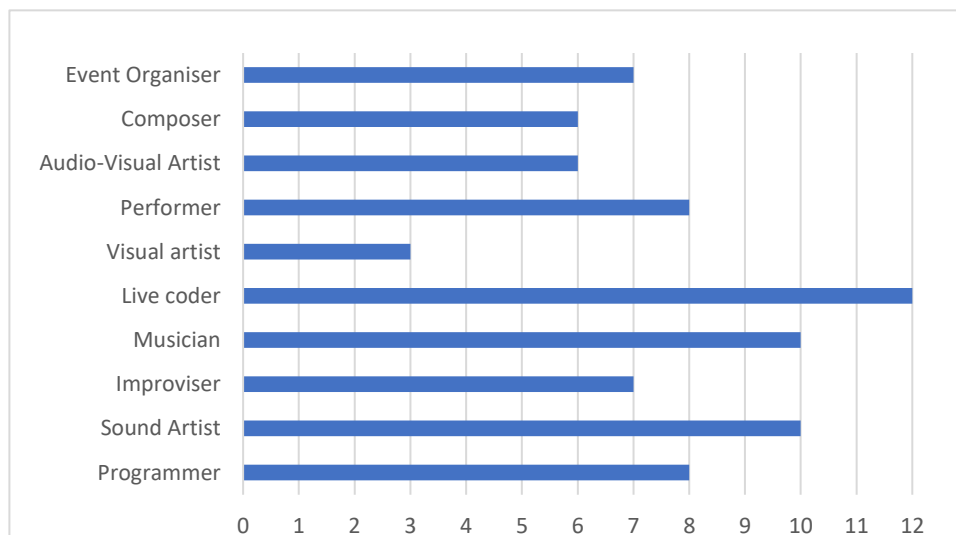
Figure 1: Networked community roles

4.3.2 MOST POPULAR LIVE CODING LANGUAGES

Question nine asked respondents to indicate which programming languages they make use of the most. Ten out of the twelve respondents indicated that they use TidalCycles/MiniTidal, eight said that they use Hydra and seven respondents said they use SuperCollider. All twelve respondents indicated that they use more than one of these languages indicating that they are not limited by one single language.
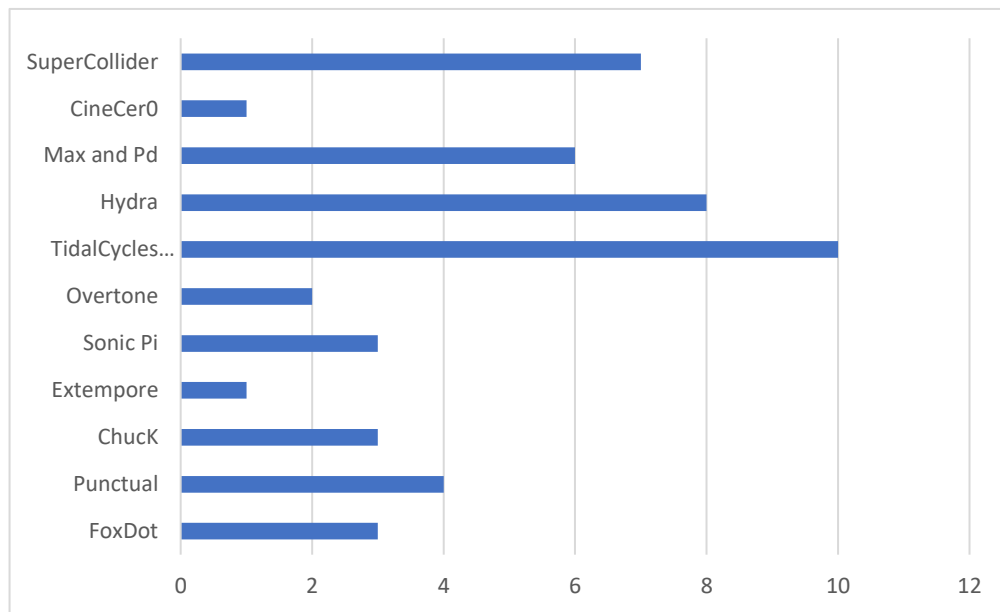
Figure 2: Most popular live coding languages

4.3.3 PROGRAMMING LANGUAGES FOR TEACHING LIVE CODING

Respondents were asked to indicate which live coding environment they would use for teaching others to live code (question ten). The majority indicated that they would recommend TidalCycles/MiniTidal as the preferred environment. Using the other option provided, two respondents indicated that they would recommend using Estuary as their main tool for educational purposes. An important differentiation needs to be made here between *environments* and *programming languages*. One respondent elaborated and suggested that all other platforms mentioned here be viewed as programming languages rather than environments, since Estuary is an environment that hosts some of these languages mentioned in the survey.

Figure 3: Programming languages for teaching live coding

4.3.4 MOTIVATION FOR COMMUNITY MEMBERSHIP

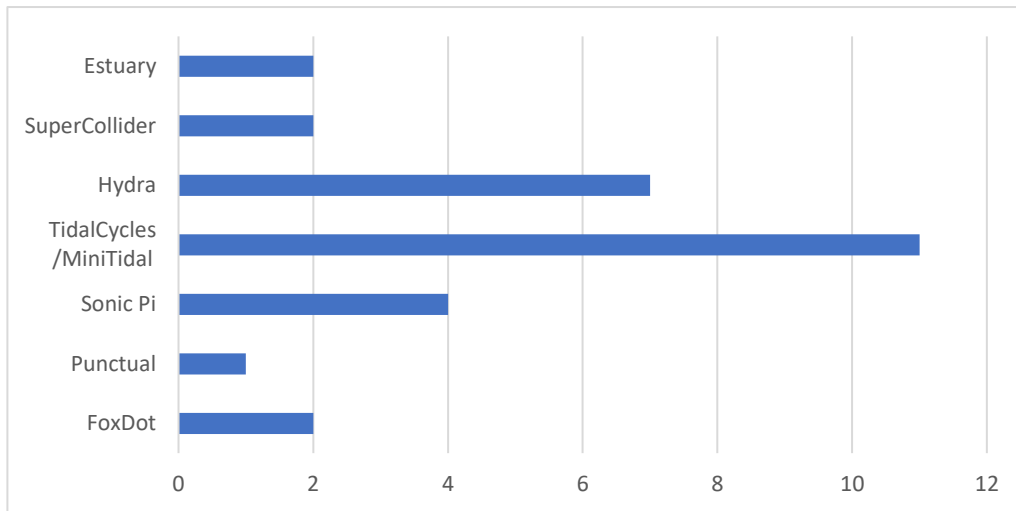When asked to provide one reason as to why they decided to become involved in the network music community, responses yielded some interesting results. One respondent said that they "like to feel part of a community," while two others said that they joined the community purely for the sake of having fun and making friends. Another said that when performing collaboratively, it is far simpler to obtain more interesting results than one would when performing solo (refer to question thirteen).

4.3.5 REHEARSAL TO PERFORMANCE RATIO

Based on a construct identified in Group 1 interviews as *rehearsal to performance ratio*, I attempted to measure the amount of preparation that respondents engage in before a collaborative live-coded performance. Respondents were asked to provide a rough estimate of the amount of time they prepare as well as the time they spend performing collaboratively (question eleven and twelve). From these two questions we can deduce that for the sample N = 12, a collaborative live coding performance typically does not last longer than an hour.
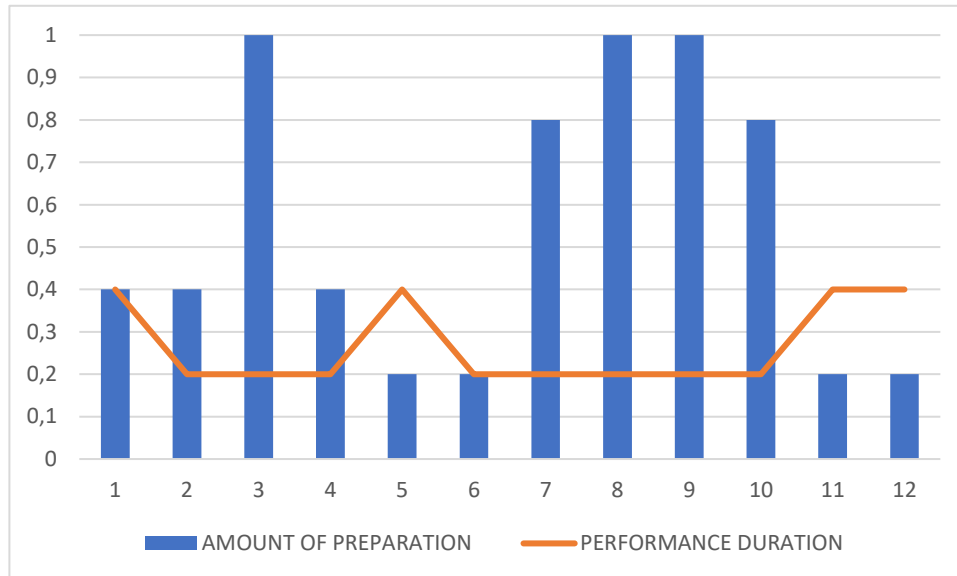
Figure 4: Rehearsal to performance ratio

4.3.6 NEGOTIATION IN COLLABORATIVE LIVE CODING

In an attempt to measure whether members of the networked performance community negotiate their personal aesthetics when performing in a collaborative setting, respondents were asked three questions related to the idea of negotiation. Three independent variables were identified during the analysis of Group 1 interviews. These included *maintaining awareness*, *adjusting to the group aesthetic*, and *detecting openings in the material*. Survey respondents were asked to indicate whether they perform these tasks in a similar manner as the approaches to which members of SuperContinent refer in their interviews. These were administered in the form of three 5-point Likert-scale questions (see questions 21-23) (Maree & Pietersen, 2019b).

A descriptive statistical analysis revealed that the sample N = 12 indicates that a degree of negotiation is present when members of the networked live coding community perform collaboratively. The mean ($\underline{x}$) of the first independent variable, *maintaining awareness* was 0.86. The median ($\tilde{x}$) was 1 and the mode (Mo) was also 1. When respondents were asked to indicate whether they adjust to the group aesthetic when performing, results showed that the mean was 0.86, while the median was 0.8 and mode was also 0.8. For the third independent variable, *detecting openings*, the mean was equal to 0.83, while the median and mode were both

0.8. The standard deviation (s) of each of these were 0.17, 0.13 and 0.14 respectively. The sample variances (s^2) for each variable were 0.03, 0.01 and 0.02.

Table 3: Negotiation in collaborative live coding

Maintain awareness		Group aesthetic		Detect openings	
	0,8666666		0,86666666		0,83333333
Mean	7	Mean	7	Mean	3
Median	1	Median	0,8	Median	0,8
Mode	1	Mode	0,8	Mode	0,8
Standard	0,1775250	Standard	0,13026778	Standard	0,14354811
Deviation	7	Deviation	9	Deviation	3
Sample	0,0315151	Sample	0,01696969	Sample	0,02060606
Variance	5	Variance	7	Variance	1
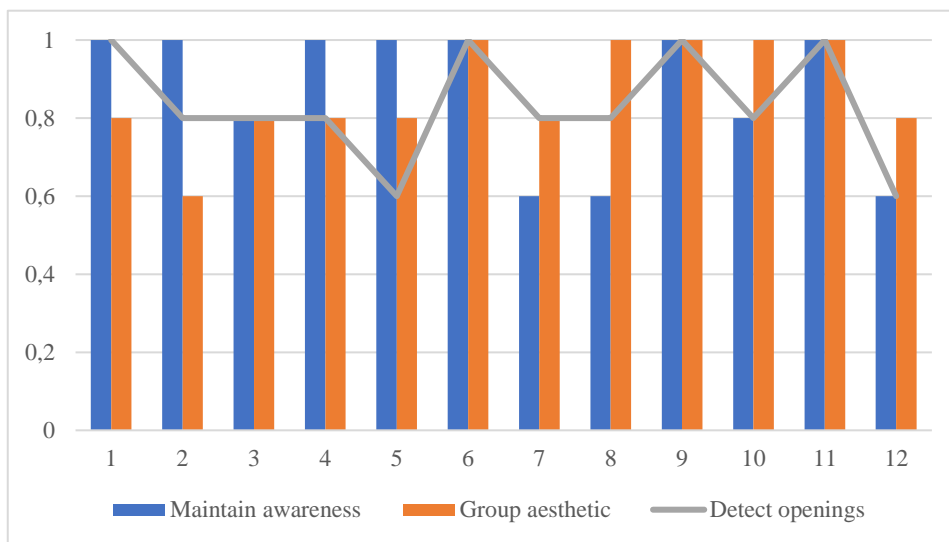
Figure 5: Negotiation in collaborative live coding

4.4 INTERVIEW DATA ANALYSIS: GROUP 2

Conducting interviews with the members of UPLOrc allowed me to familiarise myself with the challenges of conducting online interviews and also my role as the coordinator of the group. However, during this process some issues were encountered due to a number of reasons. Firstly, in capturing these interviews some technical difficulties were experienced due to unstable network connections, and in one particular case the interviewer's audio was not captured. I also recognised that the interview questions could have focused more on the

participants' experiences relating to their understanding of collective live coding practice, as well as more in-depth questions concerning their individual musical identity. Some participants also did not respond in ways as I expected they would. However, the next section presents some significant participant experiences related to the practices that were implemented in the ensemble.

4.4.1 CHALLENGES OF LIVE CODING

In terms of difficulties that the participants experienced with live coding, each expressed a wide variety of challenges.

Logistical challenges
At times it was challenging to organise for all members to meet at the same time, therefore at the time, it made most sense to meet with members on multiple occasions.

> We [struggled] to meet all at the same time. You, [another member, and myself]. Eventually, we organised so that you met with [us] separately. (H)

Difficulty memorising function capabilities
Participant I stated that they often struggled with memorising what a particular TidalCycles function is capable of doing, and at times what the order of execution entails in terms of where a function is meant to be placed.

> For me, it's really just remembering the things that [the functions] do. I remember how to write the code, and I remember the phrases [syntax]. Sometimes the format is a little bit iffy [referring to where a function is placed]. I forget what they do [sometimes]. There's some basics that always fall back on, [for example, `every 2 (slow 2)`], `gain`, sound samples and `stack`. Those [types of] functions. Those are easy to remember, but some of them - like [`jux rev`], or something like that - I can't remember for the life of me what they do. So sometimes I end up just adding functions there and I don't even know what they do. I just add them. (I)

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Difficulty memorising the sound palette

Participant F expressed difficulties with remembering what a particular audio sample sounds like.

> Usually what happens with me is, sometimes I'm still unfamiliar with some of the
> sounds. I know the code for it, but I forget how it sounds. (F)

Structuring code

Due to the complexity in terms of the ways in which TidalCycles code is often structured, Participant F said that they struggle to keep track of where they are syntactically.

> When patterns get really complicated, it gets intimidating, and it's like I don't know where
> I am. I think the only thing I really still find difficult is if I look at someone else's pattern,
> to actually understand what they're doing in that pattern and how to break it up. (F)

Reference documentation

Coming from a background in music, some of the technical language used to describe how TidalCycles code is compiled was, for one participant, a difficulty that they experienced.

> Some of the descriptions that I read on that [TidalCycles Reference] document that you
> sent us, felt like you had to already understand the program to understand the descriptions.
> I didn't understand a lot of the stuff until we started doing those workshops. That helped
> a lot more because then [I started] understanding what functions would do and what
> specific things interacted with the sound [sample] that I typed. (H)

Inattentive to group dynamics

Referring to the group dynamics in terms of the musical gesture, participant H drew attention to that the fact that the group as a whole has not yet established a way of negotiating their sound as a collective.

> …a lot of the things that that I had issue with was the dynamics, where someone would
> play something too softly or too loud. Then I'd feel like that's really shifting the whole
> vibe of the music. It's changing. Now everyone has to make their music louder or softer
> or whatever. When I was there very long ago, perhaps a month ago, I thought we needed

to work on dynamics and [developing a sense of] each other's dynamics. I don't know [what it's like] now. (H)

Impersonal interactions

Two participants pointed to the lack of personal interaction that sometimes occurs when live coding together.

It could take some of the personal feeling out of it for some people. It could be [that] you're putting up an extra barrier between you and the people you're collaborating with [since there's already an] abstract [element to live coding]. We're not sitting next to each other and playing a string that vibrates. It's not tangible, really. That could be one of the [drawbacks]. (G)

…if there was a way to have [more] of a personalised [interaction]. (I)

4.4.2 BENEFITS OF LIVE CODING

Exploring modes of communication

While engaging in collective live coding, participants were able to explore and develop various modes of expression, including but not limited to improving difficulties experienced with improvisatory practices. Two participants spoke about their difficulties with improvisation, and that live coding collaboratively provided them with an opportunity to explore expressing themselves and becoming more comfortable with improvising.

I think I mentioned to you when I started, that I was very uncomfortable with improvising, and with not knowing exactly what I was going to do next. I've found that, that kind of insecurity around improvising, hinders a lot of other things that aren't improvising. I didn't realize that until I started being more comfortable with the whole idea of [improvisation]. When you're performing [and] when you're sight reading you're basically improvising, because you're improvising all of the dynamics, all of the musicality, and all of that stuff. When you're literally improvising because you forgot something [or] you forgot the next part, you just play random things until to get to the next part you remember. It helped so much in being comfortable improvising. I think UPLOrc helped so much with that aspect of music, because I was very uncomfortable with it in the beginning. (H)

I like performing, I also don't have stage fright or anything, but I don't think I'm a performer in terms of jazz. It just stresses me out too much. Normal pop music or any other genre of music [is fine]. It's mainly the improvising, because I just always doubt myself. (F)

Open to experimentation

Participant F further expressed that not only did they feel their openness to improvising improved but so too did their interest in exploring and experimenting with their code.

I notice stuff and I can just apply it and just play around with everything and experiment. So, it obviously is like an improvisational thing, but I think I've come to that point where [I'll] just try something new today. (F)

Recognising other forms of music

For one participant their involvement in the ensemble allowed them to understand music on a higher level and which brought about an appreciation for the ways in which other forms of music are created.

…it's made me realise [or think of] music as a concept in general… music [is] so varied, and just understanding how different musics are created, [how they] are played around with or explored, how other creative processes are different for different music. It's just been really interesting and really eye opening. (I)

Breathing space

For two participants, their involvement in the ensemble allowed them the opportunity to express themselves creatively away from their usual activities as musicians.

So obviously, we're all busy, especially [if you are] studying music, and sometimes the burnout is real. Sometimes I would just get home from practice and campus and I would just be tired. The ensemble gave me the opportunity to take my mind [off of it]. Still being a musician, but not studying music. (F)

It felt like it was my relief from classical music. Like I said, I love it so much but I do need some time where I'm not just focusing on Bach's 15th Sinfonia. I can't do that all the

time. For me, [being a part of UPLOrc] was really just a way to create music that wasn't classical. (H)

Shared practice

With regard to the Estuary environment, participants expressed a particular fondness for the platform due to the ease with which code is shared between members.

> Especially because I'm still learning, it's nice to see what the other person is doing, and then I can kind of copy it and put my own twist on it. I think if I had to do it alone, I wouldn't know what to do. (F)

Immediate feedback

Another benefit of live coding involves the immediate feedback one receives from executing a line or block of code.

> A lot of it was very straightforward. It was very much like; you type this and I know exactly what's going to happen. (H)

Shift in thinking

Participant G at several stages of the interview expressed that engaging in live coding performance allowed them to think about how technology is used in collaborative settings.

> I think it opened my mind a bit to the collaborative qualities of technology and music, as well as the collaboration possibility. (G)

> I think it gives us a different way of thinking about certain things about technology. (G)

4.4.3 CONSIDERATIONS FOR FUTURE DEVELOPMENTS

Each participant was asked whether there was anything that could be improved on in terms of ensemble activities as coordinated by myself. One participant said that they felt there was a lack of personalised interaction in the ensemble in terms of mentorship.

> …if there was a way to have [more] of a personalised [interaction]. I feel if there was some sort of way that it's a weekly [session where we] learn to use these functions. There

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was some of that but not a teacher-student kind of situation where there's an exchange of communication [through playing together]. Even if they're [held] once a month for 30 minutes that you know it's going to be a one-on-one thing and where a student learns from [the] teacher. I feel like that would really help to play on the dynamic of mentorship that's widely seen in music. (I)

Two participants pointed out that they experienced my instruction as being open in terms of how I was facilitating the sessions in which we met for developing our practice.

I honestly think there's nothing wrong with the way you explain things. You're open to questions, even in performances or rehearsals. Even last week, when you said "when you have any questions just ask." If I didn't ask the stack question I would still be hanging on to one line of code. (F)

…the classes [workshops] never really did feel like we're there to learn from you or something. Like you're this master full of knowledge and we're just sitting there, taking in whatever little bits of knowledge you can give us. No, so I always felt it was a collaborative thing as well. I never felt that I couldn't contribute ideas or anything and I think it's important with something like UPLOrc where it is still being explored. I think it's important to not have a very fixed way of teaching people. I think the way in which you incorporated ideas from SuperContinent was also good never saying this is the way to do it. Let's do it because it works for them. [You were] always trying to find out how other people might think of it and I think that's important. The material you sent us; it was never a fixed recipe or something. I feel there [were] always suggestions to be heard for how we can improve our understanding, or ways in which you can help us further. in any collaborative [setting], it's important to bring the information that you've acquired to the table and make it available, but not impose it upon other people. That's something that would definitely have to be important going forward in UPLOrc as well, and live coding in general. (G)

Participant H indicated that I was also learning alongside the rest of the group, which shows that in some ways the group collectively worked at constructing their knowledge of live coding practice. In contrast to this, there is this misperception that the coordinator is the teacher and everyone else in the group are students. Although each member is less experienced in the field, it is essential to acknowledge that the ensemble was not established to operate with such hierarchies.

In the beginning, I think that you were also learning alongside us. I was quite confused a lot of the time. Though now, I feel like you have grasped it better so you can teach it better. You can help us a lot easier, [and with] more confidence. At the beginning you were learning as well and now I think you're much better at explaining what you mean. (H)

4.4.4 LEARNING TO LIVE CODE

In the process of learning to live code as an ensemble, some impressions of the process were expressed. Unfortunately, due to the line of questioning and technical difficulties I was only able to capture sufficient responses in this regard from one participant.

Learning the language

For example, participant G stated that although at times it was overwhelming for them to be exposed to something so new, they felt it was a necessary aspect that formed part of the process.

…we're plugged into this server and everything. It's kind of similar to whenever I am exposed to a new genre of music, or starting to learn a new genre of music where you're suddenly exposed to this whole plethora of new things. It's a bit overwhelming, but in a good way that makes you want to dig into it and get to know all the ins and outs of it. [Learning] how to speak the language of this new genre. (G)

Maintaining awareness

One out of the four participants expressed that when they're live coding they always attempt to listen to what everyone else is doing at any given moment, and expressed that this is not only limited to live coding performance, but should be applied in any type of collaborative performance.

In any jam session you try and listen to what the other people are doing, not just focusing on what you are doing. Very simply put, if one person comes to the front, or their sounds or samples [take] up a lot of space, it would make sense for me to pull back again - to use a very simple example. Being aware of the space that different people take up is definitely one of the things that I look out for. I think [the space] will [become] more complex, the further I get along with coding in TidalCycles. You start hearing what I would imagine [are] more complex things that you can play around with, [whether that's] playing along with it or playing against it, for example. [As with] any normal jam session the

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collaboration gets more and more complex, when you're just playing a couple of chords and you're jamming with a mate. It's also just playing a couple of chords. It starts very simple, [by] just using dynamics or something. Then when you get into jazz ensembles and [such], trying to listen out for specific chord substitutions and things like that [can quickly grow] in complexity. That's what I imagined it would grow to, but that's definitely one of the things I listen out for. Then, [in terms of] general strategies that we discussed beforehand, the specific sound pallets that I'm using for example, plays a role. My experience with [those] sound samples [and] how they interact with what the other people might be doing [is something I might think about]. Or a general idea that we're using [similar to] a build-up that we're [attempting to create]. General mood is also something that I try to keep in mind. (G)

4.5 CONCLUSION

The analysis of interviews and survey data provided informative insights into the processes that performers of live-coded music implement into their practice when performing collaboratively. In the first section of this chapter, the findings of interviews held with five members of SuperContinent were presented, after which the findings of online survey responses from networked live coding community members were presented. The third and final section presented the findings of interviews held with four members of UPLOrc. The next chapter will present a discussion of the findings in relation to existing literature.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

The research set out to inquire into the practices and procedures of laptop ensemble performance, and the necessary requirements for establishing such an ensemble in South Africa. Chapter 1, introduced the subject matter of this study, the experiences and motivation of the researcher, and the purpose of the research. The research questions, and a brief description of the research methodology were presented. An overview of the literature that pertained to this study was provided in Chapter 2. In Chapter 3, the research methodology and design were presented. The role of the researcher, data collection methods and procedures, and ethical considerations were explained. Chapter 4 presented the data analysis and results. The data analysis process presented a more thorough understanding of the findings. Through this process, a more thorough understanding of the findings was obtained. The focus of this chapter is to discuss the findings and the emergent themes with reference to related literature. The stages of data collection presented in Chapter 4 indicated the dynamics between and within the themes.

An essential aspect of this research has involved two kinds of interactions in two distinct environments; my interactions as a member of the SuperContinent network ensemble, and my interactions as both the coordinator and a member of UPLOrc. The sections that follow present the findings of this research in terms of my experiences in both these contexts, and in relation to my understanding of live coding performance practice. In some ways, it could be said that this chapter presents the way in which I was able to construct my own musical identity through engaging in these interactions in both contexts (Hebert, 2009). Thus, I present three main themes derived from the data analysis and results presented in Chapter 4 – the student, the teacher and the collaborator. The first theme discusses the findings of chapter one in terms of my experiences as a member of SuperContinent, while the second theme does so in relation to UPLOrc. The final theme provides a synopsis of the entire experience and where I find myself as a creative individual with an emergent and evolving identity among those around me.

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5.2 MAIN THEME 1: THE STUDENT

Similar to the majority of the members in SuperContinent, I also became involved with live coding through music, specifically through music technology.[18] After completing a two-year certificate in sound technology, I felt the technological aspects of musical creativity alone were not sufficient enough for me to understand the tools and techniques available for capturing and reproducing music. I considered that I required an in-depth understanding of music and more specifically the cultural aspects thereof, and so I decided to complete a Bachelor's degree in music. At the time, I had not understood what the meaning and role of cultural influences are in relation to music in general, and more specifically in relation to musical creativity (Bishop, 2018). In spite of that, I was committed to determining ways in which I could express myself creatively with the assistance of technological tools. A year into the degree, I quickly realised that performing was not for me. Not only was I a nervous wreck, but I also thought that I was being held back by a physical limitation I had little control over. When I first encountered live coding, that perception of myself slowly began to change, and the more I experimented the more I realised I had found in live coding what I had been looking for in all the wrong places. Due to a number of intersecting moments that have led me here, I found in live coding a sense of fulfilment and confidence in my own abilities as a musician and artist.

One of the few distractions from what the world was facing during the Covid-19 pandemic was the ability to spend hours watching YouTube content concerning the TidalCycles live coding language created by Alex McLean (2014), in collaboration with many others (McLean & Wiggins, 2010). Shortly after the lockdown began, I was invited to join SuperContinent, which uses Estuary (Ogborn et al., 2017) as its main tool for performance. This would be the only other form of ensemble activity I had ever engaged in, apart from playing the guitar in the departmental jazz ensemble at the University of Pretoria. I had little experience in collaborative performance, even before joining the jazz ensemble, and most of my time in the departmental jazz ensemble did not involve a whole lot of time spent actually playing my instrument. This is predominantly due to the fact that in some ways I felt I simply did not belong there. To understand why, I need to return to the year 1996, when I was diagnosed with tibia vara (Smith, 1982) at the age of three, a genu varum deformity more commonly known in the medical community as Blount's Disease (Sabharwal, 2009). It is a deformity or bowing of the knee

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[18] Sub-theme 1: Multi-disciplinary

affecting 1% of the general population and in most cases, though not all, require surgical intervention. Unfortunately for me, I required multiple surgeries over the years, some of which were focused on correcting my lower extremities, and some for which the causes were completely unknown.

Without going into too many details about what some of my experiences were, I mention it here since it has in many ways brought me to where I am today, in that I still experience morbidities related to the condition as part of everyday life. This requires careful management of my daily activities so as to not cause myself unnecessary pain or injury. In what I experienced as a rather isolated upbringing, I had few opportunities to engage in any sort of social activities in school, let alone practice my guitar for any extended period of time. Admittedly, this might never have been the case, still, not being able to play my guitar at the skill level of those around me invoked a negative sense of incompetency in terms of my abilities as a musician. In fact, I could not even identify as such. The writings of Skuse and Knotts (Skuse & Knotts, 2017) affirmed to me the very thing I had not only experienced as a guitarist, but also as a queer, non-gender specific individual in the audio technology industry in South Africa. Becoming a member of SuperContinent set in motion a process of discovery which I never imagined would lead me to define myself as a musician and now live coding performer (henceforth live coder). During this time, I assumed the role of the student attempting to learn as much as I possibly could from the other members of the group.

5.2.1 AN INTRODUCTION TO TIDALCYCLES AND ESTUARY

As indicated by the responses gathered from the networked live coding community, TidalCycles is among one of the most popular live coding languages in current use, alongside Hydra and SuperCollider.[19] The TidalCycles language is constructed atop, or rather embedded in (McLean & Wiggins, 2010), the Haskell programming language (Thompson, 2008) and uses a functional programming paradigm which refers to the way in which the language behaves (Krishnamurthi & Fisler, 2019). The Estuary environment features a miniaturised or condensed version of the TidalCycles programming language named, and commonly referred to as MiniTidal (Laubscher, 2021; van der Walt et al., 2021). Both languages, although accessed through different technological means, provide the user with inexpensive means to achieve

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[19] Refer to *Figure 2: Most popular live coding languages*

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immediate feedback in the form of musical patterns (McLean & Wiggins, 2010; Ogborn et al., 2017). Referred to as Mini-notation (McLean, 2020; Roberts & Pachon-Puentes, 2019), this capability lends itself well to the practice of live coding, which is defined as "the art of programming a computer under concert conditions" (Nilson, 2007, p. 112). This essentially means that in a performance context, a live coder aims to achieve an audible result as rapidly as possible, particularly at the start of a performance. As one interview participant stated[20], it is often that from the audience's point of view, one may be uncertain as to when the performance has started and when it has ended. In SuperContinent, whenever we were about to start, the person responsible for streaming the performance would let everyone know in the terminal chat window in Estuary[21] that it was now time to start. Since it is not always possible to avoid any potential confusion from the audience, the most acceptable approach then was to, as promptly as we could, type our code into the boxes of the interface.[22] Having said that, the majority of SuperContinent performances I was a part of were held for audiences who already had some familiarity with live coding practice. For audiences who are not yet as familiar, this is something to be aware of as live coders (Zmölnig, 2016).

Similar to learning an instrument, learning a live coding language is a process that some might refer to as arduous, and forms a necessary part of becoming a live coder. As uncomfortable as it was for me at first, as with many other things I learned, there are certain processes and procedures that with practice will develop over time. Participants A and E both demonstrated this[23]:

> As long as you're not learning or mastering the language, it is not going to be understood the way that you want it to be understood. You've got to respect that learning process and be surprised by it also. (A)

> ...it's a really great learning environment in terms of code, music and visuals. It is painful at the beginning. It's like speaking in a language you don't know, and you feel so dumb sometimes, but you suffer through it. (E)

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[20] See *Underlying theme: Human connection* – Participant C.

[21] See Image 1 (Number 1) – Terminal chat window.

[22] See Image 1 (Number 2) – a block of MiniTidal code.

[23] Taken from *Underlying theme: Learning the language* in chapter 4, pages 43-44.

Encountering live coding for the first time was somewhat new given that my experience with capturing and reproducing sound was limited to working with Digital Audio Workstations (DAW) such as Apple Logic Pro, Steinberg Cubase, Avid ProTools and PreSonus Studio One. Most of these types of software platforms are expensive and unattainable for many in South Africa who do not have the economic freedom to make such a purchase. Furthermore, students often rely on institutions to provide access to tools required to perform domain-specific tasks. A number of alternative free versions of these platforms exist, the majority of which are created by members of the Free and Open Source Software (FOSS) community. The FOSS community was originally formed in a radical move to oppose the exclusivity of the commercial software industry, thereby providing free and accessible software tools in a diverse range of fields (Fitzgerald, 2006). Similarly, the code compiled resulting in Estuary and Tidal, as with most of these types of platforms, is freely accessible via GitHub.[24] An opportunity exists to make use of these freely accessible platforms in educational contexts where there is also a desire for developing tools that better suit a wider variety of personal preferences and practices.[25]

Participant D, during interviews, made the following statement, which allowed me to reflect on how I was approaching my own process of creative expression:

> When I go into a DAW [Digital Audio Workstation] I always feel so restricted, because I'm just like, "why wouldn't I just code this? Why are you imposing all these controls on me?" (D)

Reflecting back on my own experiences with these environments, one of the reasons I could never express myself creatively was that I was incorrect in assuming that I required expensive equipment and a studio space to be able to create and reproduce sound. I assumed that I had none of the resources to do anything I wanted, which automatically coerced me into thinking that I was never going to produce any music, therefore, restricting myself in a similar way to what was expressed by participant D above. Emanating from my experience with sequencer-based technology, I never viewed myself as a composer or performer, and so becoming acquainted with live coding provided me with the necessary accessibility and freedom to create whatever I desired. Accessibility, in this context, refers to the cultural practices of those who make use of technology that has the potential to be exclusive to a particular user, particularly those who do not have the ability to use them (Skuse, 2020; Skuse & Knotts, 2020).

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[24] https://github.com/
[25] See *Underlying theme: Developing tools*, page 49.

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In terms of creative musical expression in academia, and as expressed by participants A, D and E,[26] Truax (2015) predicted a paradigmatic shift from the traditional representation of what it means to be 'the composer,' to one that he had not yet fully defined. Expanding on the ideas of Laske's (1989) compositional theory, Truax referred to this shift with reference to the graphical representation of music. Traditionally, the musical score has been considered as a primary form of documenting and representing music, whereas now other forms of representation are also observed as such, particularly in live-coded music (Magnusson, 2015). Consider the block of code below, which was written by me during a SuperContinent performance:[27]

```
stack [struct (binary ("205 215 220 200 210")) $
      every 2 (trunc 0.3) $
      s "[bassb]" #gain 0.8 #n "[6 5 3 4]/7" #pan saw
      #vowel "[a e ~ u]",
      struct "t*2 ~ f t" $ striate 4 $
      s "etPadA7" #gain 0.7 #delay "0.4"]
```

According to Magnusson (2015), a code excerpt such as the one above demonstrates a particular approach to musical thinking (i.e. a paradigm), as well as a visual representation thereof. The TidalCycles language represents a particular approach to musical thinking in that it allows for the temporal exploration of musical patterns within a particular set of constraints. Constraints, as Magnusson (2010) indicates, are essential for defining limitations for expressing musical ideas, and is a topic I briefly discuss in other work (Laubscher, 2021). Referring to the improvisational component of live coding practice in laptop ensembles (Albert, 2012; Collins et al., 2003), one member of SuperContinent put forward that while restriction to one particular way of musical thinking is never advised, certain parameters must be in place in order to facilitate creativity in any form of musical thinking:

> ...for every musician free form improvisation, free form in all senses - I'm talking [about] free from anything - is the hardest form of improvisation there is. For people to start [with improvising], it's always easier when you have certain parameters. Creativity needs certain parameters. (A)

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[26] See *Sub-theme 3: Paradigmatic shift*
[27] See Image 1: Number 3 on page 88

Image 1: SuperContinent in action using the Estuary environment

5.2.2 A PERSONAL AESTHETIC

Entering into SuperContinent as a new member, I hadn't really understood what it meant to have a personal aesthetic, let alone how to perform with others who evidently understood what the words meant. In my interactions with the group, I found myself as being unsure of whether I was able to add anything meaningful to the group at all. I somewhat knew what my personal tastes were and which music I had an appreciation for, but until recently I did not consider that my personal preferences and tastes are what most are referring to when using the term aesthetic. Weinberg (2005, p. 37), makes reference to this:

> This aspect of the design bears a subjective aesthetic core, as different composers and designers would have different ideas, tastes, or artistic interests when determining the precise control parameters. The musical content and transformation decisions are informed by the higher-level design decisions.

This might be self-evident to most, but for someone who had little opportunity to engage in any form of collective music-making, the idea simply had not occurred to me. It was only through exploration with others in this collaborative environment, and following subsequent interviews, that allowed me to understand what Weinberg refers to in the above extract. Exploration was a central theme in the interviews, and was something the members of SuperContinent greatly encouraged and embraced. In the process of exploring the unknown, which for me was my personal aesthetic, one has to be willing to embrace failure (Armitage, 2018).

Few authors make adequate reference to what is meant by aesthetics (Barbosa, 2003; Gresham-Lancaster, 1998; Weinberg, 2002). Instead, Armitage and Thornham (2021) suggest that historically much of the discussion has focused on the technological aspect of live electronic music, and not enough has been directed toward the individuals responsible for realising their personal aesthetic with the aid of technology (Armitage, 2018). Only when one participant revealed that in collaborative performance they often have to adjust their aesthetic to that of the group, did it become evident what Weinberg (2005) was referring to. In group performance therefore, it is not necessarily the case that one has to adjust to the overall group aesthetic, but rather it is the case that as a consequence of live coding collaboratively, a performer has to adjust to a number of unpredictable aspects due to the nature of an environment such as Estuary.

This requires that the live coder be adaptable to what occurs at any given moment in the environment, as well as embrace the inconsistencies they are presented with. These unpredictable aspects include the network typology that Estuary uses, which according to Weinberg's framework can be considered to use a client-server configuration (Ogborn et al., 2017; Weinberg, 2005). Other inconsistencies are present in the form of decisions made by other performers in the ensemble, which are discussed in the section that follows.

5.2.3 UNDERSTANDING THE SOCIAL AND POLITICAL

Soon after joining SuperContinent, it became apparent that its members were fortified in various converging disciplines. A similar example of this can be found in the ethnographic work of Valiquet (2017), who points to the interdisciplinary nature of networked laptop orchestra performance, as well as Magnusson (2014, p. 8) who wrote:

> Numerous live-coding systems, festivals, conference tracks, journal issues, research projects, and club nights have appeared and introduced the practice to diverse fields of art, music, and science (in particular, computer science). As an arts practice, it has its roots in musical performance, but live coding has become common in visual arts, light systems, robotics, dance, poetry, and other art forms that operate with algorithmic instructions.

My experience from the outset as an incoming member of SuperContinent was that everyone exhibited a general openness to sharing their knowledge with me[28]. This was also reflected in the platform we were using to collaborate (Ogborn et al., 2017), in that everyone's code was visible for all to see, including the audiences we were performing for. This points to an inherent cultural practice of the networked live coding community commonly referred to as "show us your screens" (Magnusson, 2014, p. 9). The practice involves the display of multiple layers of visual content, including displaying code that is being typed in real-time, as well as visual art also generated by typing computer code (Rodríguez et al., 2019). As one participant pointed out in their interview, the practice of sharing one's screen with the audience automatically makes it accessible to anyone[29], and is also necessary in order for the audience to understand

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[28] See *Underlying theme: Openness in sharing knowledge*

[29] See *Underlying theme: Openness in sharing knowledge* - Participant D.

how audio and visual output is generated. Without this sort of visual stimulation, the audience is left wondering where the output originates from. This brings about issues of gesture and embodiment in live coding performance practice as expressed by Salazar (2017), who agrees with Ogborn (2014) that embodiment in live coding is present in the form of typing code. Armitage and Thornham (2021) extend this idea of embodiment in live coding into the realm of creative expression, and are careful to place too much emphasis on the cultural practice of "show us your screens," referring to the fact that the code itself is often an over-appreciated aspect of live coding. Termed the "fetishisation of code," this refers to the mediating role of technology between human and computer in the act of coding music live (Armitage & Thornham, 2021, p. 93).

A central aspect of negotiating a collective live coding practice involves making decisions about how to act based on the decisions made by others in the ensemble (Knotts & Collins, 2014). As mentioned above, these decisions are not predictable since we cannot know what any other individual's thoughts are. Cocker (2016, p. 102) suggests that live coding practice can be thought of as "the performing of 'thinking-in-action'" which is, on an individual level, a non-linear process as participant C describes:

> ...like everyone, I think that my thoughts and my attention are not consistent, strategic and under my own control all the time. In a performance, I'll be paying attention in different ways, and maybe my mind is wandering at other times too. There's a lot of variability there. I don't think any of us come into a collective live coding performance as an improvising machine that's 100% on the job ready to do what it does. We come into those things as people with minds that behave in all kinds of different ways from each other, but also, different ways with respect to ourselves from one moment to another. We go through different states... (C)

Power dynamics is another form of unpredictability (Armitage & Thornham, 2021). The group members of SuperContinent agree that they practice being open to any individual's proposition, provided that everyone else is respectful toward those ideas.[30] One participant placed emphasis on the fact that it is essential to practice an awareness of any potential power dynamics that may be present in a group (Armitage & Thornham, 2021), otherwise it may possibly lead to the exclusion of an individual who may feel as though they cannot propose any ideas in group

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[30] See *Sub-Theme 2: Dynamics*

deliberations or during collective decision-making processes.[31] Similarly, engaging in a collaborative performance of any kind, to some extent destabilises an individuals' musical identity in the process of establishing a collective ensemble identity. In the context of collective live coding some of these may include, as pointed out by Tsabary (2016), technical issues, ego depletion, and emotional and social obstacles.

Truax (2001) suggests a model for understanding the social and political aspects involved in musical creativity. Emphasising a communicational approach to understanding the complexities of soundscapes in particular, Truax (2001) places listening at the core of this approach. In collaborative live-coded performance, the individual live coder similarly engages in listening attentively to the sounds selected and transformed by others in the ensemble. In order for the live coding ensemble to maintain a balance between the often complex combinations of sounds and patterns that are generated, maintaining an acute awareness of the environment and the actions of others is essential. [32] In terms of Truax's (2001, p. 11) communicational approach, collaborative live coding may be considered as the constant communication and "exchange of information" between members of an ensemble (Bishop, 2018). This statement reminded me of the types of communications members of SuperContinent pointed to in their interviews, indicating that their primary form of communication is through code and sound. [33] Thus, communication between members of a live-coded ensemble goes far beyond that of the more easily observable exchanges that occur during pre- and post-rehearsal discussions, and is rather concerned with the context from which each member's code and sound originate. Truax (2001, p. 12) writes:

> The communicational significance of any sound can only be judged within its
> complete context in the broadest environmental, social and cultural sense. In fact,
> it is through context that we understand how sound functions.

In other words, the sounds that live coders select to perform with are reflective of their individual aesthetics and by extension their socio-cultural and geographical environments. If live coding is approached from this communicative framework, then it could be argued that

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[31] See *Underlying theme: Understanding position and power*

[32] See *Underlying themes: Maintaining awareness and Maintaining balance*

[33] See *Underlying theme: Communication*

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those who live code collaboratively are essentially communicating and presenting their personal aesthetic to others, which needs to be constantly negotiated in a group setting due to the unpredictable aspects previously mentioned.[34] Although this is not researched in great depth, negotiation in live coding has been a topic of interest for the members of SuperContinent, who wrote about their experiences as members as well as the strategies they implement into their practice as a group (Knotts et al., Forthcoming; Marie et al., 2021).

Truax (2001) further suggests that sound itself is a mediating force between a listener and the environment in which they find themselves. An example of this was provided in a statement made by participant B:

> …how do I know this person through their code and through their interaction with the code?
> (B)

The above reflects the fact that a number of communicative processes are in continuous interaction with one another when performing live-coded music collaboratively. Not only is each individual's code representative of their thinking process, but their code is used as a means to communicate to others in the group what these processes are. The resulting sounds, as proposed by Truax (2001), act as a facilitator for cultivating relationships between a listener and their environment. In the context of live-coded performance, the listener is both the live coder and the audience, whilst the environment is Estuary.

In an attempt to measure whether members of the live coding community also engage in negotiation when performing collaboratively the results showed that, to a large extent, respondents do perform these tasks when collaborating. Although respondents indicated that they actively maintain awareness of the environment, adjust their aesthetic to suit the group aesthetic and listen for openings in the material, the results of the survey are not representative of the community as a whole. This is attributed to the survey not yielding the amount of responses that were expected, nor did it prove to be a reliable measurement of these constructs (refer to 3.9.1). Still, this provides some initial insights into what live coders may be thinking of when collaborating with others, and may be used as a starting point for further research.

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[34] See *Sub-Theme 3: Negotiation*

5.3 MAIN THEME 2: THE TEACHER

Online survey respondents were asked to indicate which live coding language they would recommend for teaching others to live code, with the majority of those that responded preferring TidalCycles. This selection is perhaps indicative of the ease with which one can achieve interesting and unexpected results with TidalCycles, and how the language may be used to teach live coding in a variety of contexts. The inherent nature of TidalCycles, or the ease with which patterns can be constructed and explained, is an appealing aspect of an educational context. On the other hand, if one wanted to incorporate one's own aesthetic when performing with TidalCycles, it is essential to consider the aesthetics of the language itself. One SuperContinent member indicated that with programming languages such as TidalCycles and Hydra it is often the case where the aesthetics of the technology being used could easily present itself in the process of attempting to achieve a particular aesthetic.[35] To avoid this, one has to develop a particular amount of technical knowledge in order to cultivate a relationship with the technology in use to render it as aesthetically meaningful (Brown, 2016).

As the coordinator of UPLOrc, my experience as a music educator proved useful in teaching incoming members how to live code with MiniTidal (henceforth 'Tidal', as it refers to both versions of the language). At times, it was a process of trial and error and for the most part involved the preparation of material for those in the ensemble. Our weekly sessions were separated into two sessions; workshops, which I named UPLOrcShops since they were intended for the members of UPLOrc, and our weekly rehearsals. Our main performance tool is Estuary, although in the first few months of our time as an ensemble we attempted the full install of Tidal onto each member's computer. When we heard of Estuary it made complete sense to make use of the platform, which we did start using shortly after I joined SuperContinent. This eliminated the need to go through the timeous process of installing SuperCollider, TidalCycles, and all its accompanying dependencies, which can become rather frustrating when having to troubleshoot the entire installation process. A complete description of all our activities as an ensemble is presented in the article titled *UPLOrc: A Networked, Live Coding Laptop Orchestra based in Southern Africa*, which was presented at the Digital Humanities Association of Southern Africa conference in December 2021 (Laubscher, 2021). The section here describes some of the challenges and affordances of live coding as experienced by the members of

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[35] See *Underlying theme: Aesthetics of technology*

UPLOrc, including myself. I further present some future considerations in moving forward with the ensemble and attempt to draw some parallels and differences between the practices of UPLOrc and SuperContinent.

5.3.1 CHALLENGES OF LIVE CODING

A few challenges were encountered by the members of UPLOrc, one of them being the difficulty of arranging for everyone to meet at the same time.[36] Due to the busy schedules of all the members, all of whom are music students at the School of the Arts, we decided that it made the most sense to divide our time into two separate sessions. This was mainly to accommodate everyone's busy schedules during the pandemic. In an ideal situation, we would have preferred having one session that lasted for two hours, as this could potentially facilitate an environment that is less dependent on my role as the coordinator and more conducive to a collaborative environment in which members work together to construct knowledge as a group. Being a member of SuperContinent enlightened me to the fact that I had become too involved in coordinating activities in the sense that I was the only person involved in developing material in preparation for upcoming performances. I also allowed the other members of the group to view me as the person assuming the role of the instructor when it was not my intention to do so. Despite what the members indicated in their interviews about my handling of the logistical aspects of the group, I felt as though I was the only one contributing the knowledge I had obtained, not only as a member of SuperContinent, but also the time and effort spent teaching myself how to live code with Tidal. Two members indicated that they felt there was not sufficient personal interaction between the members of the ensemble, one referring to the lack of in-person interactions and the other to the lack of a student-teacher relationship between myself and the members.[37] I felt this was an interesting observation since I attempted to avoid being seen as the teacher and rather as a fellow ensemble member. This was not possible since the other members simply did not have time allotted to experiment with Tidal as I was able to.

Other challenges that the group experienced were, for the most part, related to the technical aspects of live coding with Tidal. One difficulty in particular was that of memorising the capabilities of a particular function. Functions are the entities that are applied to the patterns in

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[36] See *4.4.1 Challenges of live coding – Logistical challenges*

[37] See *4.4.1 Challenges of live coding – Impersonal interactions*

Tidal, which generally consist of pre-recorded audio samples. A function's purpose then, is to transform the base identity of an audio sample (Smalley, 1993) into something that is different from its base identity (McLean, 2020). My aim moving forward in this regard, is to place less emphasis on what a particular function effectuates and more on experimentation with each function, so that members may be less restricted in choosing a function simply because they do not understand what its purpose is. Reflecting back on my time with SuperContinent, no one spoke of or demanded that any person use a particular function, it was more the case that if a member noticed a function that they would make note of it and experiment with it in their own time.[38] As a group, UPLOrc should be making more use of the fact that code is displayed for everyone to see, but not necessarily to discuss outright.

A second technical issue experienced by participant F was the compilation of complex blocks of code.[39] It is often the case that a single line of Tidal code will evolve into an extremely complex and dense piece of code, to the point that it becomes challenging to understand how the code is performing. This was something a member of SuperContinent also referred to, which I termed *Autonomous systems*, but is also described as the "autonomous creation of musical pattern" in Wilson et al. (2021, p. 77). At this point in a performance, as participant C states,[40] it is advisable to either let the system run on its own for a short period of time and then proceed to fade out, since it may be detrimental to interfere in something that one does not fully understand. My initial assumption was that participant F was referring to the syntactic nature of the code, which is still a possibility, but in reading their statement it could be inferred that this is more likely the case.

When interviews were conducted with the members of UPLOrc, one problem that emerged was the language used to describe the capabilities of the Tidal language. I had compiled a resource document exclusively for UPLOrc since there were very few sources that sufficiently explained how to make use of the language. Since then, the creator of Tidal has spent significant efforts on creating more accessible resources in the form of a website,[41] which is intended to assist the users in grasping the technical aspects of the language. In addition, a full course is now available

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[38] See *Underlying theme: Openness in sharing knowledge*

[39] See *4.4.1 Challenges of live coding – Structuring code*

[40] See *Underlying theme: Autonomous systems*

[41] Visit https://tidalcycles.org/

to view on the website, alongside mini-tutorials or "How-tos" that take the user through a step-by-step process in learning how to work with the language. Going forward, this will be our main resource to which new members will be referred to.

A term we have adopted as part of our collective practice as members of UPLOrc is that of a *sound palette* (Jensenius, 2013).[42] An issue experienced by one member was the memorisation of the wide variety of audio samples that members have available to them. As suggested in the writings of Jensenius (2013), members of UPLOrc need to spend time understanding the sound palettes available to them in order to grasp what their relationships are to these sounds and how they may use them in a live coding context. Although, all the sounds that UPLOrc use were produced digitally, spending time discussing the attributes of a particular audio sample will allow for an improved understanding of how to make use of these sounds in relation to one another. The action-sound approach put forward by Jensenius (2013) where members are made aware of their relationships to acoustic instruments, and more specifically action-sound combinations, might prove useful for future experimentation that the group undertakes.

The final challenge that was detected in the interview data was particularly important, and will be moving forward as a group. Participant H highlighted that at one stage they felt UPLOrc had not yet understood how to navigate or negotiate their aesthetic as individuals in relation to the overall group aesthetic.[43] Firstly, being able to do so requires that members collectively develop strategies that facilitate these interactions in terms of the aesthetic the group is attempting to achieve. Learning from the strategies that SuperContinent members have created, has provided insight into the process of constructing them through collaborative efforts, and while these have worked for one group they may not work elsewhere. Still, there will be benefits in exploring a similar approach where members are provided with high-level concepts that are open to interpretation, as one member of SuperContinent pointed out:

> ...why not just give [an] "aliens are landing on earth" kind of idea? Then it's not so restrictive as to say 180 [beats per minute] in E minor. It's a creative direction, but at the same time it's not too restrictive and we can each interpret it in our own way. (A)

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[42] Visit https://github.com/djmelan3/UPLOrc-samples for a complete downloadable list of all UPLOrc audio samples.

[43] See *4.4.1 Challenges of live coding – Inattentive to group dynamics*

UPLOrc as a collective, has the capacity to develop a similar approach with alternative aesthetic motivations to that of SuperContinent, particularly since this approach is well suited to the Estuary environment.

5.3.2 AFFORDANCES OF LIVE CODING

Interview participants also pointed to various affordances of live coding that they experienced in becoming members of UPLOrc. Comparable with the work of Biasutti (2015), who explored modes of communication in collaborative online performance spaces, Estuary provides its users with the opportunity to express various forms of communication (Bishop, 2018). For two members of UPLOrc, the ability to express themselves through improvisatory practice (Albert, 2012) improved their attitudes toward and confidence in their abilities to improvise music.[44] By means of communication through code and sound, members were able to express themselves through interactions with each other. This required a certain amount of openness in experimenting with their code based on the code written by others, which once more points to the negotiation that occurs between those who live code in Estuary (Cocker, 2016) and the decision-making process that goes along with it (Knotts & Collins, 2014). [45]

In becoming members of UPLOrc, two interviewees expressed that they experienced a sense of relief from their time as music students in that it allowed them to express themselves in ways that their usual music-making activities do not allow.[46] While it is important to learn traditional forms of music, there is also the opportunity for exploration of other forms of music-making which could allow one to think of music on a much higher level than purely in relation to a particular cultural practice. Live coding practice, in particular, exhibits the potential for exploring the sonic possibilities of sounds originating from a variety of cultural contexts (Sorensen et al., 2014).

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[44] See *4.4.2 Benefits of live coding – Exploring modes of communication*

[45] See *4.4.2 Benefits of live coding – Openness to experimentation*

[46] See *4.4.2 Benefits of live coding – Breathing space*

Reminiscent of statements made by the members of SuperContinent,[47] one member of UPLOrc alluded to the inherently shared practices ensembles are able to develop when using the Estuary platform, simply through the display of code on screen:

> Especially because I'm still learning, it's nice to see what the other person is doing, and then I can kind of copy it and put my own twist on it. I think if I had to do it alone, I wouldn't know what to do. (F)

This in many ways points to the immediate feedback that Estuary, and to a great extent live coding languages, provide the user and is an advantage especially for educational purposes. Affordances such as these allow for a greater flexibility in teaching others the practice of live coding, since the only technique involved in learning to live code is limited to learning how to type faster on a computer. According to Ogborn (2012), this takes into consideration a far wider consortium of people who could potentially become involved in shared music-making. In comparison to having to learn and master the technique of an acoustic instrument, this is far more appealing to a wider variety of individuals.[48]

5.4 MAIN THEME 3: THE COLLABORATOR

The final section of this chapter speaks to the principal outcome of this research; that of cultivating connections. Establishing relationships with others has always been an obstacle for me over the course of my life and was something I've had to overcome as an individual in the creative arts. More importantly, as someone who is continuously searching for a way to express myself both creatively and in all facets of life, including social interactions, I felt I had much to learn in terms of collaborating with others. Throughout the entire research process, inclusive of discovering live coding practice, collaborating and conducting interviews, understanding myself and my core identity as an artist (Chryssochoou, 2003), have all led me to this concluding section. In it, I discuss how the establishment and cultivation of relationships have reshaped the way I approach and think about interactions between myself and others, not only when performing live-coded music, but also in everyday interactions. The following section is

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[47] See *Underlying theme: Openness in sharing knowledge*
[48] See *Underlying theme: Accessibility and inclusivity*

further combined with theoretical perspectives concerning transformational education, in which I attempt to highlight the importance of collaboration, in all aspects of human life.

5.4.1 SELF-TRANSFORMATION THROUGH COLLABORATION

A common theme that presented itself throughout this research is the concept of accessibility and inclusivity, which has both referred to the accessibility of technology and the inclusion of all genders across all cultures. One participant, in particular, referred to the worldwide culture of exclusion which continues to keep women, and any person who is not attuned to cisgender male perspectives, from occupying – to use a popular term – a seat at the table.[49] This is something I personally experienced in a variety of spaces in South Africa, both in educational and professional contexts related to the music and audio technology industries. Likewise, considering that South Africa has been a democratic state for only twenty-eight years, there are still unaddressed inequalities that the country faces, including economic, political, cultural, social and particularly educational inequalities (Nevhutanda, 2005). As Allsup (2003) argues, tensions exist within the music education sector which asks questions about the variety of music that should be presented to students in order to make music more culturally inclusive. There are particular tensions between what is aesthetically acceptable and the ownership of particular forms of music. The practices of the live coding community are a potential starting point in cultivating more inclusive spaces and strengthening human relationships, not only globally but on a more local level.[50] Since live coding practice challenges the very idea of ownership through the sharing of ideas, art, code and practice, it is an appealing multidisciplinary art form that has the potential to cultivate multicultural relationships between South African live coders. [51]

In order to begin to affect any change in existent societal imbalances brought about by Apartheid (Gibson, 2015), careful consideration and thought must be given toward the approach taken in cultivating those relationships between groups whose cultural backgrounds differ. As a starting point for collaborative live coding practice in South Africa, and particularly moving forward as an ensemble, the members of UPLOrc have an obligation for allowing each other the freedom to express themselves in the group without the fear that anyone will be judged for

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[49] See *Underlying theme: Accessibility and inclusivity – Participant E.*

[50] See *Sub-Theme 1: Local and global narratives*

[51] See *Underlying theme: Openness in sharing knowledge – Participant D*

their choices. In my experience, this was particularly important in reconstructing my own identity as an artist, having reached a point where I now view myself a performer of live-coded music. Through exploration, improvisation, and a safe space for collaboration (Albert, 2012; Cocker, 2016; Collins et al., 2003), I experienced liberation in how I viewed myself and what I am truly capable of (Allsup, 1997). In so doing, I was able to explore and develop my own sense of a musical identity – that of the live coder.

5.4.2 HUMAN CONNECTION AND CO-EXISTENCE

In the process of cultivating human connection, continuous negotiation transpires between individuals in any social situation where the common goal is to achieve peaceful co-existence of differing viewpoints and ideologies (Born, 2005). In the context of collective music-making of any kind, the act is merely a means for building trust, a sense of community, and finding ways in which humans can co-exist. This was expressed by one participant who views the music-making process as secondary to the human relationships that emerge as a result thereof:

> To constantly grow and get better at seeing other people and their ways of being, their ways of knowing and their needs. To me that's crucial. It's always been the main drive for me to be with other people and to be on a journey together. To grow together and to find how to be happy together. (E)

This speaks to the mediating role of networked live coding (Valiquet, 2017) afforded by the technology used to establish connections between people (Born, 2012), and in this particular instance, the Estuary environment (Ogborn et al., 2017). All forms of communication between various forces, as Silverstone (2002) proposes, are exposed to a mediating agent and therefore have the latent quality of facilitating the development of a musical identity (Born, 2005, 2011; Turkle, 1997).

5.5 CONCLUSION

In determining my role as the coordinator of UPLOrc and as a collaborator in both ensembles included in this research, I have arrived at the conclusion that each member is responsible for negotiating themselves and their personal aesthetic in relation to the aesthetic the group is attempting to achieve. The role of technology, on the other hand, acts as a facilitator or mediator

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between the individuals attempting to negotiate these relationships. Since the mediator's role, as the term implies (Valiquet, 2017), is to divert its attention away from interpretation of any kind, it also serves to expedite the multiplicity of experiences brought about by those who make use of its functionalities. The final outcome of the findings of this research is that in technologically mediated relationships, such as those emanating from collaborative live coding performance, require a collective understanding of the negotiating role that the live coder embodies when engaging in collaborative performance (Born, 2005).

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The research presented here has aimed to discover what the logistical, technological and musicological aspects are of establishing a live coding laptop orchestra at a South African university. I attempted to do this through the long-term observation of the interactions between members of two networked live coding ensembles, including those initiated by me. This research was presented from the point of view of the insider, and since I was invited to perform with other live coding artists in the community, this provided me with the opportunity to observe and engage in collaborative live-coded performance. In the process I was able to understand what it means to be a member of the community, which was accomplished through the construction of my own identity as a live coder. This concluding section summarises the information gathered throughout this study, and describes how I interpreted becoming a member of the live coding community through the answering of each research question put forward in chapter one. Thereafter, I discuss potential avenues for further research into collaborative live coding performance before concluding the chapter.

6.2 RESEARCH QUESTIONS

This study aimed to answer the following main research question: What are the logistical, technological and musicological criteria or parameters required for the establishment of a laptop orchestra at a South African university? From this, three secondary research questions were identified in order to account for an in-depth understanding of the primary research question. The proceeding sections answer each of these beginning with the secondary questions and concluding with the primary research question.

6.2.1 SECONDARY RESEARCH QUESTIONS

Question One

In the context of a networked live-coded music performance, how do laptop orchestras organise themselves and express collective creativity through the use of browser-based technology?

The research participants exhibited a number of community-accepted practices of live coding that act as facilitators for developing a shared performance practice, among other things. Most notably, the focus participants placed on their intention to collaborate with one another regardless of the skill level a member has procured is indicative of the attentiveness of the community toward accessibility. This is also reflected in the technological environment which connects those who participated in the research. In such an environment as that mediated by Estuary, it falls upon a group to take collective responsibility for maintaining the balance of the group's dynamic. Members must practice maintaining an awareness of a number of aspects of the environment, particularly the actions of the other members in the ensemble.

Although some may argue that live coding is a disembodied practice in terms of audience-performer interaction (Bishop, 2018),it is not so in terms of the interactions that occur between those who live code. Members of SuperContinent, for example, have had ample opportunity and time to acquaint themselves with the programming languages used to communicate with others in the environment, which forms a part of becoming accustomed to learning something new for the first time. As a consequence of Estuary being what it is – accessible in terms of knowledge production, among other aspects – the environment lends itself well to the educational context and permits the development of collaborative knowledge production. Over time, as these communications continue to develop between members, they develop a sense of the ways in which others communicate with them through their code and through sound. According to Armitage and Thornham (2021), live coding is an embodied practice during which a live coder expresses their thoughts in the act of typing and compiling their code. It is a "thought experiment," to use the words of Cocker (2016, p. 103) who put forward questions relating to the aesthetic and ethical practices of live coding. Live coding performance is further considered to be a process-driven practice (Armitage & Thornham, 2021; Lin et al., 2022) in which live coders are negotiating relationships, not only with their computers but also with whom they collaborate. Cocker (2016, p. 102) attests to this describing live coding practice as:

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> …the live negotiation between receptivity and spontaneity, between the embodied and intuitive, between an immersive flow experience and split-attention, between human and machine, the known and not yet known.

Live coding practice, in accordance with what Cocker (2016) describes above, is an accurate representation of what this research has revealed. Live coders, in order to negotiate their practice collaboratively, are required to have a certain amount of receptiveness toward others' aesthetic choices, while also having to respond to unexpected aspects of the environment. Whether that involves an unpredictable network connection, an unexpected creative direction presenting itself during performance or rehearsal, or one individual domineering the bandwidth by implementing too many functions in their code. A live coder has to be prepared to adjust to these unpredictable aspects of collective live coding. Members of an ensemble ought to work together to ensure everyone has the opportunity to express themselves. Spontaneity, on the other hand, refers to the improvisational aspects of live coding, better known as *blank-slate* live coding (Brown, 2016; Collins, 2011; Nilson, 2007), where none of the code written during the performances was prepared beforehand, as is the case with the practice of SuperContinent, and to some extent UPLOrc (Laubscher, 2021). Opposite to blank-slate live coding, ensemble creativity is also approachable in a three-phase process. Experimentation is used, in order to discover what is not yet known. Development of what was discovered, where the material compiled is developed to fit a more coherent overall aesthetic, and finally, the rehearsal of the now structured material in order to fit the time constraints of a typical live coding performance, generally limited to 30 minutes.

What was new and surprising in this study was the way in which SuperContinent collectively devised strategies acting as general creative guidance to members, who then interpret the strategy according to their own understanding thereof. At some point in a performance, the group will enter what Cocker (2016) and Bishop (2018) describe as flow, where one is induced into the immersive experience that is live coding. In contrast to this, and similar to any sort of communication with sound, a live coder must also maintain an acute awareness of their surroundings in the environment. Moreover, the beginner live coder initiates a relationship between themselves and the computer, frequently referred to as Human-Computer Interaction or HCI (MacKenzie, 2012). An essential part of live coding requires that the live coder effectively communicates to the computer what it is they aim to achieve, and this should develop as the relationship is cultivated through learning a programming language. Since a

computer is only able to interpret a language based on instructions set by humans, one cannot take syntactical errors for granted in live coding. If syntactical errors are present in the code, the computer simply will not understand what is being communicated. Therefore, in the process of learning the language one also has to communicate precisely as the computer would expect by learning the syntactical aspects of the language (McLean & Wiggins, 2010).

Question Two

What are the benefits and disadvantages of performing collaboratively in a live-coded network ensemble using browser-based technology, and how is this significant for contemporary collaborative ensemble performance?

As with several other commodities, the research revealed that live coding practice also precipitates negative and positive connotations. Participants from UPLOrc expressed that they found the lack of physical proximity to one another to be one particular drawback of live coding. In the context of an ensemble such a SuperContinent, this aspect is not of any relevance since the motivation for the formation of such groups are different to that of an institutionally affiliated ensemble. Physical proximity with other members is important in these cases and can perhaps assist with more efficient and rewarding communication that otherwise is not obtainable remotely. Despite this, online discussions and communication through code and sound are especially rewarding where international collaboration is concerned.

One drawback of particular importance is that, in order to participate in networked live coding, one is required to be the owner of a computer or device that enables access to a browser. Research conducted by Oyedemi (2012), in which a survey was conducted among university students, showed extant inequalities in terms of the access students have to personal computers. Since then, no new research has been conducted demonstrating current inequalities and whether this was improved due to the changing necessities of students induced by the pandemic. Regardless, addressing issues of accessibility in terms of equipment is essential to remain as inclusive as possible to those who express an interest in pursuing collaborative art forms such as live coding.

In terms of the benefits for pedagogical instruction, collective live coding practice exhibits the capacity for teaching students how to engage in meaningful ways that are increasingly productive and beneficial to a wider proximity of people (Kallaway, 2010), where the aim is to

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prepare students for civic engagement as members of society. If framed in a way that allows for multi-disciplinary collaboration, thus reaching a wider group of potential participants, live coding laptop performance can be motivated as such (Ogborn, 2014; Tsabary, 2014).

Question Three

How and to what extent do the social activities of collaborative live coding, including political, ethical and aesthetic decisions made by performers, facilitate individual and collective musical identities?

My personal experiences in engaging in collaborative live coding, in addition to the data that was obtained and analysed, speak to the inclusive culture of those active in the networked live coding community. Unfortunately, due to the sample limitations and unsuccessful lines of questioning of the research I cannot speak to whether this was experienced by others in the community. However, participants indicated that the improvisatory nature of live coding practice has proved promising in terms of becoming comfortable with expressing themselves spontaneously. Likewise, I was able to shift my perceptions of my own abilities as an artist, and in the process I developed an understanding of the intricacies of collaborative performance. These included exposure to a wide range of aesthetic preferences (Bell, 2013; Cascone, 2000) and artistic practices (McLean, 2015). In addition to this, I have obtained an understanding of the political (Knotts, 2015; Knotts & Collins, 2014), social (Knotts, 2018; Skuse, 2020; Skuse & Knotts, 2017) and cultural aspects of collaborative performance (Armitage & Thornham, 2021) and their implications for live coding practices.

As expressed by Born (2011), I consider my experience as both ensemble member and coordinator to have impacted my understanding of my own identity, in that it exposed me to the perspectives of others, also allowing me to become more receptive towards ideas proposed by others. In building relationships in the past, I found it challenging to navigate them due to an imminent fear of rejection paired with the perception that I had inadequate control over a particular situation. Moreover, engaging in live coding performance considerably supported me in becoming more attuned with my body and realising that it is, and I am, more capable of being creative than I initially considered. Learning that of myself in combination with drawing a connection between my role as an ensemble member, and especially as a coordinator, introduced me to the concept of *power*. I have used the term *coordinator* many times in the text to signify that I do not deem the term *instructor* as appropriate in describing my involvement

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with UPLOrc. The concept of power, defined in terms of a collective power (Dowding, 2012), alluded me to the level of sensitivity that should be practiced in all socially mediated interactions (Born, 2011). On a practical scale this does not always develop as expected, due to a number of unpredictable aspects mentioned throughout this research. One in particular is that of power dynamics. Managing situations in which a power dynamic is present is currently something I have yet to be acquainted with, however, as Valiquet (2017) points out, mediation deflects the meaning of power and instead is used as a mechanism for calling attention to a multiplicity of experiences exhibited through collaboration (Aveling & Gillespie, 2008; Magnusson, 2014).

In answering the question of how a musical identity is cultivated through social interaction, one can conclude that being more inclusive of a wider variety of perspectives, and creating spaces in which others are able to freely express their ideas without judgement, is one point of departure. This not only requires actionable work but also requires a culture that is maintained collectively and falls upon those active in the community who have the responsibility toward others to ensure equal and fair access to its practices. As an example, this is achieved by way of compiling a manifesto (Zmölnig & Eckel, 2007), as was implemented by TOPLAP (Transnational Organisation for the Proliferation of Live Artistic Programming), a global organisation representing the live coding community and its practices.[52]

6.2.2 PRIMARY RESEARCH QUESTION

What are the logistical, technological and musicological criteria or parameters required for the establishment of a laptop orchestra at a South African university?

The notion of mediation, and its purpose in relation to social interaction, is at the forefront of research concerning collective laptop ensemble performance. It is my view that the kinds of interactions that occur in an environment such as that brought about by Estuary is an allegory for the multiple perspectives that exist in our society, and a facilitator for developing an understanding of one's own musical identity - particularly through the exploration of the musical and communicative properties of sound.

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[52] See https://tidalcycles.org/docs/around_tidal/toplap_manifesto/

6.3 FURTHER RESEARCH RECOMMENDATIONS

Further research should consider the full extent to which collaborative live coding practice is able to facilitate the development of musical identity, with more focused attention on answering questions concerning how others are able to construct their own sense of a musical identity in these interactions. In addition, further investigation into the practices of the networked live coding community requires additional time spent in the community as an active member. The practices of live coding, referring to blank-slate live coding versus prepared live-coded material, require further exploration to determine what the shortcomings and affordances of these are, and so doing a further investigation of environments that make these practices possible is also necessary. Finally, the development of a more reliable measurement tool for determining the complex negotiations that occur in an online environment such as Estuary is also needed.

6.4 CONCLUSION

The findings of this research revealed that, from the point of view of the live coder, negotiation is considered the primary aspect of collaborative networked performance. This is owed to the fact that all involved in an ensemble of this nature, including those who do not engage in live coding practice, are required to manage their position in the sonic space so as to ensure that everyone is afforded the opportunity to express themselves creatively. Alongside this notion of negotiating one's personal aesthetic, and by extension one's musical identity, a central theme emerged throughout this research; that of mediation. As various scholars have suggested, including those interviewed in this study, mediating relationships are omnipresent in the interactions and communications between human and machine, and more importantly, between the members of a group. By means of mediating technology (Valiquet, 2017), in this case Estuary (Ogborn et al., 2017), programming languages such as TidalCycles used for generating sound (McLean & Wiggins, 2010), as well as the generated sound itself (Truax, 2001), all act as mediating tools that live coders have at their disposal for cultivating meaningful relationships between themselves, their fellow group members and their audiences. My experiences as a group member of SuperContinent and coordinator of UPLOrc, have enlightened me to the potential of collective live coding practice as an incubator (Hewitt et al., 2010; Tsabary, 2014) for cultivating transformative spaces in which individuals may express themselves freely and without judgement. This research has further presented an opportunity to reflect on the need for

cultivating more inclusive collaborative environments in educational contexts in South Africa, alongside the responsibilities that fall upon individual agents in the collective effort to construct these environments in which collective creativity may be explored.

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APPENDICES

Appendix A: Participation information letter

Appendix B: Informed consent

Appendix C: Research design: Intersecting secondary method

Appendix D: Group 1: Interview guide

Appendix E: Group 2: Interview guide

Appendix F: Community survey questionnaire

APPENDIX A: PARTICIPANT INFORMATION LETTER

RESEARCH TOPIC: ESTABLISHING A LAPTOP ORCHESTRA IN SOUTH AFRICA: AN EMIC-CENTRED INQUIRY INTO COMPUTER MUSIC PERFORMANCE

Dear ensemble member,

I have recently obtained ethics clearance from my institution, the University of Pretoria, to begin with data collection for my master's dissertation. This will include, with your permission, the collection of data from ensemble members, among other sources. Before I begin with collection and data processing, I will need to obtain your consent for me to use this information as part of my research paper. In this letter I will clarify a few things to make sure you are completely informed of the research process that I will be following, and what you will be consenting to.

The aim of the research is to obtain a better understanding of computer network ensemble activities through gathering information relating to the musical processes that individuals are able to express using a platform similar, but not limited to, Estuary. My research will follow a mixed-methods research design, and will be presented from a network music performer's perspective (i.e., my own). This stage of the research will focus on collecting and using netnographic data, for which I require your consent. The second stage, which is of no concern to potential participants here, will include scheduled interviews and an online quantitative survey that will be completed by other network music performers outside of SuperContinent. SuperContinent members will be approached individually for interviews at a later date. These

two methods will then be combined to present and report the research findings. Participants will have the option to review and approve the research report before the final submission date, to ensure that information is accurately represented (including direct quotes). A draft will be made available to participants for review by the end of August this year. The data I will be collecting and using in this research paper will include:

1. Archived/recorded conversational information posted by SuperContinent members on Slack and in Estuary's Terminal Chat.
2. Audio-visual rehearsal and performance archives/recordings from SuperContinent.
3. Observational field notes compiled by the researcher.
4. Elicited information emerging from interactions relating to ensemble activities between members, including those initiated by the researcher.

This data will be limited to the time I have spent with the ensemble (just over a year at the time of writing) and will not include information prior to this period. However, it may be the case where I need to gather more information in the months to come. Any data that can be used to identify an individual will not be included in the processed data and will be excluded from the research. The researcher ensures complete confidentiality throughout the research process. Raw data will not be published directly alongside the research paper, but will be securely stored with restricted access through my institution's data repository for safe keeping. Institutional policy requires that it is stored there for a minimum of 10 years.

The dissertation resulting from this research will be made publicly available at https://repository.up.ac.za/handle/2263/2392 once the degree has been conferred. It should be noted that no raw data will be available at this link, only the final approved document. Persons who may require viewing raw data will be limited to the researcher and possibly the examiner, should it be requested. It is highly unlikely that this will be the case. Otherwise, processed data will be made available for review by the examiner, alongside the final submission of the dissertation. In addition, the researcher may intend to use this data in subsequent conference/journal articles that discuss the same work. Participants also reserve the option to review and approve how their words and ideas are represented in subsequent publications completed by the researcher.

Providing the researcher with permission to use this information, will contribute toward a greater understanding of the musical processes that network musicians engage with through the use of technology. Should you have any concerns about the usage of this data, you may contact me at m.laubscher@tuks.co.za

Best regards,
Melandri Laubscher

INFORMED CONSENT

RESEARCH TOPIC: Establishing a laptop orchestra in South Africa: An emic-centred inquiry into computer music performance

- I confirm that the person requesting my consent to take part in this study has told me about the nature and process, any risks or discomforts, and the benefits of the study.
- I have also received, read and understood the above-written information about the study.
- I have had adequate time to ask questions and I have no objections to participating in this study.
- I am participating willingly and I am aware that the information obtained in the study, including personal details, will be anonymously processed (should it be preferred) and presented in the reporting of results.
- I understand that I will not be penalised in any way should I wish to discontinue my participation in the study. My withdrawal from the project will not affect me in any way.
- I have received a signed copy of this informed consent agreement.

_____   _____

Participant's Name (Print)   Researcher's Name (Print)

_____   _____

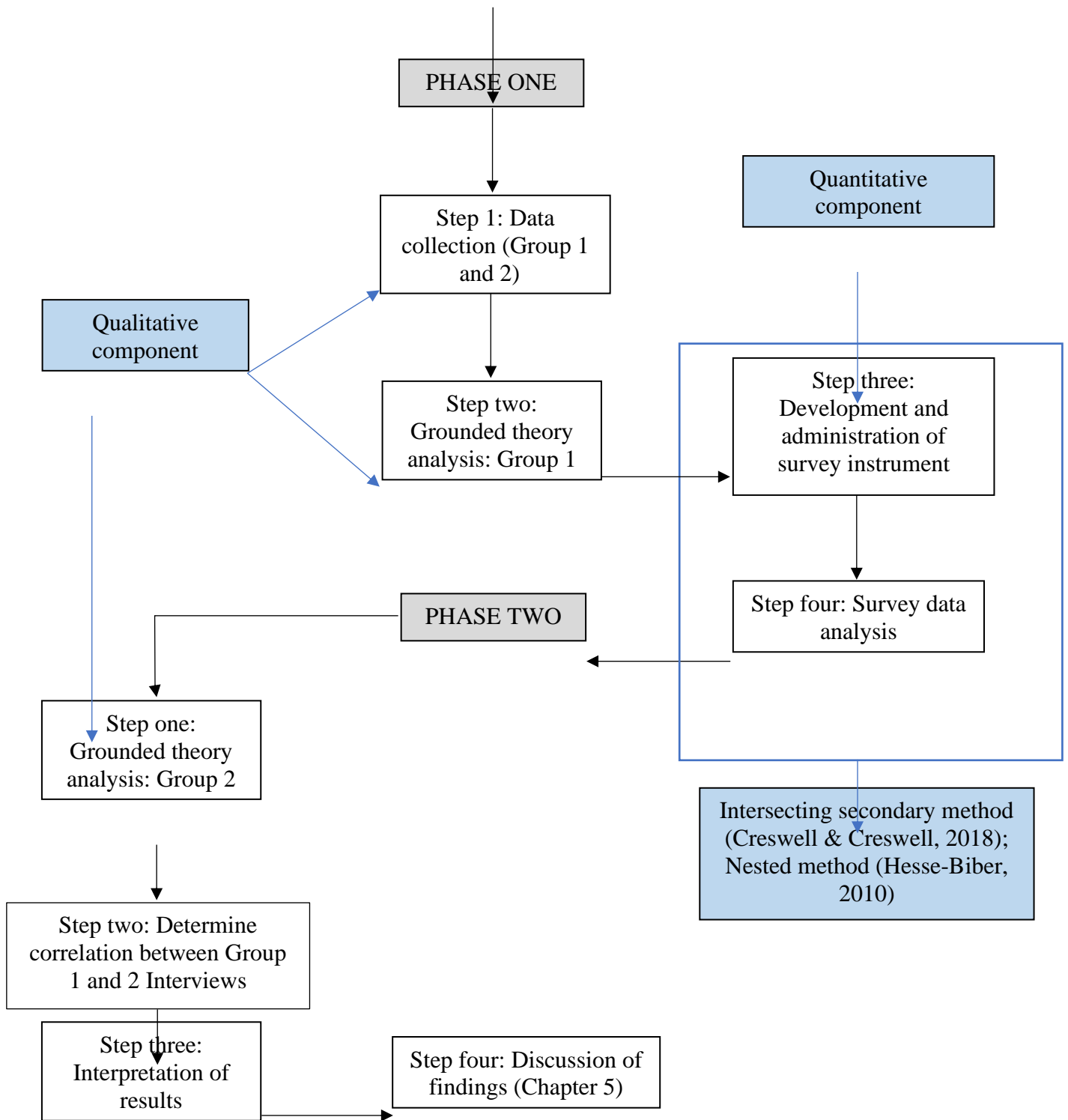Participant's Signature   Researcher Signature

_____   _____

Date (DD/MM/YYYY)   Date (DD/MM/YYY

INTERSECTING SECONDARY MIXED-METHOD DESIGN:

PHASE ONE

Step 1: Data collection (Group 1 and 2)

Quantitative component

Qualitative component

Step two: Grounded theory analysis: Group 1

Step three: Development and administration of survey instrument

Step four: Survey data analysis

PHASE TWO

Step one: Grounded theory analysis: Group 2

Intersecting secondary method (Creswell & Creswell, 2018); Nested method (Hesse-Biber, 2010)

Step two: Determine correlation between Group 1 and 2 Interviews

Step three: Interpretation of results

Step four: Discussion of findings (Chapter 5)

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Background:

I want to understand network music performance (more specifically live coding) from the perspective of a performer such as yourself. I wish to understand your experience in your own words without imposing my own experiences onto yours. I may, from time to time, ask you to clarify something or ask for more details to understand what you mean when discussing a particular topic. I will be asking you open-ended questions, some of which I have prepared, others which will likely emerge as the interview progresses.

1. General questions about the participant:
   1.1. What is your current official job/career title?
   1.2. What would you say is, or how would you define, your main area of research?
   1.3. How did you get into or discover live coding?
   1.4. What about live coding led you to get involved and learn how to live code?
   1.5. Does live coding performance intertwine with your profession in some way?
   1.6. Prior to your involvement in live coding performance, did you have any other performance experience or musical training of any kind?
   1.7. Which live coding languages, apart from MiniTidal (or Punctual), are you familiar with?
   1.8. On average how many hours per week do you spend engaging in live coding activities?
   1.9. What kinds of live coding activities do you engage in?

2. Participants' individual live coding practice:
   2.1. How did you go about learning how to live code? (if not programmer/developer)?
   2.2. On an individual level with regards to performance, do you structure your performance in a particular way? If so, how?
   2.3. Would you say you have a particular process when live coding?
   2.4. Whether live coding solo or collaboratively, how much of the code that you produce is prepared, and how much would you say is completely improvised?
   2.5. Referring to the collective live coding ideas spreadsheet we use to determine live coding strategies for rehearsals etc., how would you describe your approach to implementing a particular strategy into audible (or visual) results?

2.6. If this is too general a question perhaps I can refer to a particular strategy and ask you to define it in terms of your approach to live coding?

2.7. Could you walk me through how you would construct a line of Tidal code, given that you have a particular strategy to work off of?

2.8. What kind of skills, if any, do you think you have developed as a live coder?

2.9. How would you describe your identity as a performer?

3. SuperContinent (collective practices):

3.1. More or less, how long have you been a member of SuperContinent?

3.2. Do you only live code with the members of SuperContinent, or do you engage in other collaborative activities? If so, how are these experiences different or similar to participating in SuperContinent?

3.3. How would you describe your role as a member of SuperContinent?

3.4. What would you consider to be your responsibilities as a member of the group?

3.5. What does participating in SuperContinent mean to you as a performer/live coder/network musician?

3.6. What are some of the things you think about when you engage in networked performance?

4. Ending question

4.1. In what ways, if any, have your experiences with collaborative network music performance influenced or impacted your life?

1. Questions about the participant:

   1.1. Tell me a little bit about yourself. Your interests.. specifically with regards to music.

   1.2. How would you describe your musical training thus far? What is your main instrument?

   1.3. Why do you think you chose the particular instrument? What was appealing to you about this instrument?

   1.4. How would you define yourself as a musician? For example, are you a performer, composer or teacher?

2. Being introduced to live coding

   2.1. What were your expectations coming into UPLOrc as a new member?

   2.2. Do you remember what your first impression was of live coding in general? Had you heard of it before?

   2.3. Was there something specific that interested you or that you were drawn to?

   2.4. Do you remember what went through your mind when you saw TidalCycles code for the first time?

   2.5. What were some of your impressions of what you heard when you first became familiar with how Tidal works?

3. Learning to use TidalCycles/MiniTidal

   3.1. What about live coding do you find most challenging?

   3.2. What about live coding did you find less challenging?

   3.3. When you started learning how to live code with Tidal, what did you find most challenging?

   3.4. When you started learning how to live code with Tidal, what did you find less challenging?

   3.5. What would you still like to learn about live coding?

4. Current impressions of live coding

   4.1. Would you be able to reflect on some of your experiences over the past 6 months as a member of UPLOrc?

4.2. Do you think your time as a member of UPLOrc has benefitted you as a musician in any way?

4.3. In your own words, what do you think some of the drawbacks are of live coding together?

4.4. How did you experience my instruction as a member of UPLOrc? I'd like to hear about how you found the content I was presenting to you and whether you felt there was anything that could be improved upon.

Networked Performance Community Survey

Please answer each question to the best of your abilities. If a question does not apply to you, you are not required to answer it. Questions are asked in random order and your response will be limited to one only. Your email address will not be recorded and your response is completely anonymous. Thank you for participating in this survey.

1. Do you play a musical instrument? If so, which instrument(s) do you play?

   _____

2. Which gender do you identify as? (If you do).

   _____

3. Which country were you born in?

   _____

4. Which country do you live in?

   _____

5. Do you live in a rural or urban area?

   _____

6. Which of the following would you use to describe yourself? (Please select all options that apply).

   Programmer   Composer

   Sound Artist   Event organiser

   Improviser   Other: _____

   Musician

   Live coder

   Visual Artist

   Performer

   Audio-Visual Artist

7. How would you define yourself as a member of the network music community?

   _____

8. What is your occupation (job/profession)?

   _____

9. Which of the following live coding environments do you use? (If any were not included please add them to "other").

   FoxDot

   Punctual

   ChucK

   Scratch

   Extempore (previously Impromptu)

   Cyril

   Sonic Pi

   TimeNot

   Overtone

   TidalCycles/MiniTidal

   Hydra

   Max and Pd

   Seis8s

   Gibber

   CineCer0

   SuperCollider

   Other: _____

10. Which of the following live coding environments do you think is best to use for teaching other how to live code? (If any were not included please add them to "other").

   FoxDot

   Punctual

   ChucK

   Scratch

   Extempore (previously Impromptu)

Cyril

Sonic Pi

TimeNot

Overtone

TidalCycles/MiniTidal

Hydra

Max and Pd

Seis8s

Gibber

CineCer0

SuperCollider

Other: _____

11. Could you provide a rough estimate of the amount of hours you spend live coding in a collaborative performance setting per week?

Less than an hour

1-2 hours

2-3 hours

3-4 hours

More than 4 hours

12. On average, how much time do you spend preparing for a collaborative live coding performance?

Less than an hour

1-2 hours

2-3 hours

3-4 hours

More than 4 hours

13. As a member of the network music community, if there is one reason as to why you have become an active member, what would that reason be?

_____

14. For newcomers into the network music community, what do you recommend an individual would need in terms of technology to be able to participate in a group performance?

    _____

15. In your view, what are some of the benefits of being a member of the network music community?

    _____

16. Have you organised at least one event in which a variety of individuals have presented and performed a form of network music?

    _____

17. As an organiser, which areas (technical, logistical etc.), do others in the community assist you with when preparing for an event?

    _____

18. What are some of the drawbacks of performing live-coded networked music with others?

    _____

19. What are some of the benefits of performing live-coded networked music with others?

    _____

Rate the following statements:

20. I prefer playing a live performance on my own rather than in a group with other people.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

21. In a collaborative performance setting, I often try to maintain awareness about what others in the group are doing while everyone is performing.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

22. Based on what others are doing during a performance, I adjust accordingly to suit the overall group aesthetic.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

23. When I perform live-coded network music with others I try to detect openings in the material that could be filled in some way.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

24. I am able to jump between audio and visual live coding environments during a performance.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

25. In a collaborative performance setting, we work together to solve a collective problem one or all of us are experiencing.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

26. I attend and support various community organised events including festivals, conferences, events and performances.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

27. I am able to use both audio and visual live coding environments outside of a performance context.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

28. The visual element of a network music performance is equally as important as the audio element in the overall experience of the performance.

    1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always