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UNIVERSITY OF CALIFORNIA,
IRVINE

Ghost Structures

Cyclic Temporal Schemes and their Implications for Notation, Improvisation, and
Technology

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Integrated Composition, Improvisation, and Technology

By

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2023

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FIELD OF STUDY

Real-time notation technology, improvisation, intercultural music, jazz studies, circular notation, music cognition.

ABSTRACT OF THE DISSERTATION

Ghost Structures:

Cyclic Temporal Schemes and their Implications for Notation, Improvisation, and
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By

Antonin Fajt

Doctor of Philosophy in Integrated Composition, Improvisation, and Technology

University of California, Irvine, 2023

Professor Kojiro Umezaki, Chair

This research *arrives* at a unique real-time notational framework in Max MSP through transcription-based analysis of musical works around the subject of hidden rhythmic phenomena. Dialogue between contemporary improvisational musical practices and non-western approaches to non-linear temporality reveals that there are many kinds of hidden schemes that have profound effects on the music as it is being performed and conceptualized of. Through uncovering these hidden schemes, which I call ghost structures, we can arrive at more apt notational vocabulary for the representation of such musical practices, understand more closely the performer's perception of non-linear temporalities, and also explore new creative applications. Through this dissertation, I experiment with the application of interculturally-minded

scholarship surrounding meter and cyclic rhythm, such as Justin London's *Hearing in Time*, to the notation of 1) meter and 2) cyclical rhythmic schemes in specific musical examples. I support these experiments with a discussion of the ghost symbolism across several distinct musical practices and its entailments in hauntology and anthropology. Transcription of recorded works is an important method used throughout this dissertation, because the majority of the studied musical sources are largely performance-based and have not been analyzed before in the context of academic research. The transcriptions include: the improvisation of Thelonious Monk on his composition, *Evidence*, Craig Taborn's trio polyrhythmic work *All True Night / Future Perfect* (2013), Tyshawn Sorey's trio composition *Awakening* (2009), Carlo Costa's *Oblivion* (2016), and Homayun Sakhi's performance of *Raga Yaman* (2006). These transcriptions and analyses bring new insight into the composers' and performers' practices at the boundaries of contemporary classical music, avant-garde improvised music, and intercultural music, while also providing the testing for the experimental notational vocabulary. The concept of ghost structures connects these practices with my own improvisational practice.

In the accompanying creative work, I explore three innovative subjects: the application of circular notation to new works for improvisers, the application of the concept of ghost structures to emergent structures within collective improvisation, and the development of a real-time animated notation software for notating and performing

musical materials created within improvisation using MIDI input. These creative developments can serve as additional resources for other composer-improvisers whose work is created largely in real time, and who wish to integrate non-western approaches to rhythm and temporality into their compositions. On a musicological level, the findings in this research may help other transcription-based research in studying and representing works with non-linear, improvisational, and otherwise ephemeral musical processes.

PREFACE

My practice in making creative work as a pianist, composer, improviser and electronic tinkerer has informed the making of this dissertation. In the process of writing, the creative experiences I've had provided a testing ground for applying the concepts encountered in academic research. Other musicians-researchers speak to how the principle of "resonance" can form meaningful connections between the inner and external subtexts (Swaminathan 2021). The nature of this process presents some difficulties for the traditional format of a musicological dissertation, because "resonances" connect beyond isolated disciplines and musical practices. Nevertheless, some of the intercultural musical connections discussed around the creative work were initialized by such resonances. In approaching the transcription process, I have taken a more creative and experimental approach than is common in, for example, transcription in jazz studies or ethnomusicology. This approach is informed by past experiences working with other composer-improvisers and engaging with their compositional approaches, particularly in UC Irvine's ICIT program and in the New York improvised music scene. The piano itself — its specific performance practices, its visual layout, its utility in MIDI performance, and the history of its repertoires — has influenced the visual format of the circular notation and the mechanics of the real-time notation tool.

My personal background in growing up in Czech Republic has allowed me to access and reference a handful of sources written in Czech and Slovak languages. On the downside, English is my second language, and there are some linguistic and syntactic difficulties that are present in the dissertation. Additionally, my experience of hearing and performing Moravian and Slovak folk songs since childhood has been an important element in my creative work. It has informed my understanding of other folkloric musics in Eastern Europe at large and the ways they form a counter-current against western classical music. At the same time, I am not an expert in traditional

Moravian or Slovak folk song performance. It's important to note these practices are not as widely present in the Czech cultural sphere as some other traditional musics are in other countries, and their present form has been confused by decades of influence of the communist regime in Czechoslovakia.

My experience as a performer is rooted in western classical music, jazz performance, and improvisatory arrangements of Czech and Moravian folk songs. Beyond this, I drew on my experiences performing and learning from teachers and practitioners of several non-western practices to whom I am indebted to: Balinese Gamelan - Nyoman Suadin, Afro-Brazilian marching band - Carlos Valdez, Georgian polyphony - Carl Linich, Balkan traditional music - Maria Sonevsky, and Persian Classical music - Niloufar Shiri. While these practices are each distinct and extremely unique musical systems and don't support a singular "non-western" approach to temporality, these experiences have provided an introductory, embodied insight into various non-linear models for approaching temporality.

INTRODUCTION

Overview

This dissertation has three main goals. The first is to present a hybrid notational vocabulary for analyzing music that integrates elasticity, variation, improvisation, and otherwise indeterminate elements in relation to cyclic structures. This vocabulary provides interculturally fluid devices for notating an elastic approach to rhythm. It reimagines the representation of temporality, pulse, meter, “core” motifs, and larger rhythmic vocabularies around a single work. I draw on the visual and conceptual ideas in Justin London’s *Hearing in Time* (2004) around representing meter and apply them to revisions of the western common practice (w.c.p) notation of meter, and to representation of underlying musical temporal schemes (e.g. ostinati, cyclic patterns). I also draw on Mitchell Ohriner’s analytical approach to visualizing rhythmic cycles in unique grids in *Rhythm in Contemporary Rap* (2019). The vocabulary is also inspired by various historic and contemporary examples of circular notation and circular visualizations of time that have become archaic. I reference vocabularies in traditional and folkloric musics that involve rhythmic elasticities within cyclical structures. I connect structural elasticities implicit in jazz improvisation (Boyle’s flexible ostinato) in Afghani raga performance (Homayun Sakhi), and temporal elasticities in non-western traditional musics (Daniel Goldberg on Bulgarian traditional music).

Second, I formulate a theory of ghost structures, which I define as underlying reference structures that function as temporal schemes against which music is created and organized, but which are — or become — hidden, removed, or otherwise obscured. Ghost structures grew out of my improvisatory language at the piano and exploration using materials that arise in improvisation as recurrent referents, which accumulate and integrate over time in the performance and may conjure up iterations of past memories and new syntheses. The ghost metaphor is rooted in the creative concepts and rhythmic vocabulary of the pianist, composer Craig Taborn, and finds resonances in other contemporary composer-improvisers in the New York city's jazz and improvised music scenes and beyond. The term draws on existing related concepts in jazz improvisation scholarship, formulated by Jeff Pressing (1984, 1987) and Sean Smither (2020), and global concepts of underlying “skeleton” structures, such as Marc Perlman's unplayed melodies in *Javanese Gamelan* (2004). It places the processes of composition and improvisation on level ground, enables formal connections between different global musical practices, and provides pathways to the cognitive (i.e. perception), psychological (i.e. memory), and embodied dimensions of music making. Humanistic and anthropological studies on ghosts — particularly the scholarship surrounding Jacques Derrida's notion of hauntology — are also considered to further inform my work on ghost structures through the lens of cultural studies.

The concept of ghost structure allows connection-making between underlying reference structures that are composed and those that are improvised. I unpack the temporal representation and performance practices surrounding ghost structures by analyzing several examples across musical traditions through transcription. These sources allow me to test both w.c.p. notation and the hybrid notational vocabulary around transcriptions of recordings that have not been notated before, add new notational developments around the specifics of each example, and draw on the temporal and rhythmic processes of relating to ghost structures in each performance.

I organize these analyses around the distinctions between synchronous and diachronic relations to ghost structures and other referent structures. Synchronous relations refer to textures where an improvisation or variation occurs simultaneously with the ghost structure. Diachronic relations refer to textures where an improvisation or variation occurs temporally independently of a ghost structure. Diachronic relations have a more linear quality.

Lastly, I present a software program that I created (2022) for real time notation of musical materials from improvisation that can be sight-read during the instance of the improvisation. This MaxMSP-based software tool allows its user to notate what they play in real time using the MIDI keyboard, and represent it in a hybrid, circular notational framework together with staff notation. The circular notation builds off of the research of representing cyclic rhythmic processes presented in this dissertation and the

notion of underlying ghost structures. It allows the user to provide metronome-like guidance to performing rhythmic material. The staff notation allows the user to notate melodic and harmonic material that can then be applied to the circular score. The full score can be visualized on any number of screens, allowing for this notation to be read and performed simultaneously by an ensemble in the moment of the performance. The framework references Ryan Ross Smith's screen-based compositions using animated notation, Lavanya Kukkemane's real-time visualization of tihai in tabla performance using MaxMSP (2020), and Morton Subotnick's concept of ghost scores. The tool is first of its kind in notating musical material into an animated visual framework that is both created and performed in real-time.

This tool can be used by others to notate musical referents that arise from improvisation (i.e. generated in real time) in collective improvisational performance situations, and also to create an archive of their own musical referents that can be saved and loaded into the software. The tool is specifically designed for MIDI input, which makes it particularly useful to pianists and others who play MIDI-based instruments. It is designed to allow those whose work is largely improvisational and relational created in relation to interplay and to real time music-making, and whose corpus of works is largely embodied, relational, and is otherwise difficult to catalog as scores. It can facilitate intercultural musical engagement and provide space for integrating specific musical vocabularies from more traditional and folkloric practices.

Motivation

The musical examples I'm referring to in this dissertation have historically been under-represent in Western academic literature on music, not only because these practices tend to come from culturally "othered" spaces but also because these practices are difficult to study with conventional w.c.p. analytical tools and instead invite new frameworks. It is difficult to base new academic research on practices and works which are not already discussed in the academic context. This research synthesizes several useful tools from multiple analytical and creative sources and applies them to the analysis of recordings of works which have not been previously discussed — with the exception of Thelonious Monk's *Evidence* and Steve Lehman's *Echoes* — in academic literature.

The existing research on improvisational musics and intercultural musics lacks in analytical studies of formal and structural elements on the same degree at which analysis appears in the context of western academic literature on western classical music and more recently on jazz. Instead, there is an overemphasis on social and cultural dimensions around these more recently institutionalized practices. These dimensions are relevant, but for a western audience, they reinforce the idea that these "other" practices are not theoretically-oriented and that they somehow have to exist in dialogue with social and cultural discourse more-so than western classical music does. In particular, the research on contemporary improvisatory practices is deeply engaged

with critical studies, philosophy, and social theories, but significantly lacks in formal, theoretical analyses of rhythm, harmony, and structure. The exceptions to this are, for example, Kaja Draksler's dissertation on structure in Cecil Taylor's music (2013), Christian Ferlaino's dissertation on confluences between free improvisation and Calabrian folk music (2018), Jesse Stewart's analysis of Steve Coleman's music (2011), Antares Boyle's analysis of Craig Taborn's improvisation (2021), and Chris Stover's work. Many of these researchers are themselves musicians and improvisers.

In constructing this research, it was crucial to make connections between contemporary improvisation and non-western musical concepts. Though generalized, these two worlds have a lot to benefit one another in the context of academic research. Many of the challenges and discoveries in the area of ethnomusicology surrounding notation of rhythm and indeterminate elements are applicable to analysis of improvisation and composition for improvisers. In particular, traditional ritual musics involving forms of trance and other liminal states have application to improvisation via the liminalities that exist in both the relationship to referents, and the phenomenological quality of liminal states surrounding the dialogue with the "unknown." While the study of formal elements of trance music lies beyond the scope of this research, an exploration of liminality as a connecting agent between the two areas is integrated into the concept of ghost structures.

Contemporary composer-improvisers like Craig Taborn, Steve Lehman, and Tyshawn Sorey discussed here have frequently drawn on non-western traditional practices and rhythmic concepts for inspiration and have extended those rhythmic practices in infinite ways in their work, to make new kinds of practices. In this dissertation, I am doing a similar kind of work with the creative aspects of the research by creating a new tool that can be used with improvisers who share the sensibility for making music that is "interculturally open."

Chapter Breakdown

Chapter 1 explores the topic of alternative notation of rhythm, primarily surrounding the representation of meter and rhythmic units, around the dialogue between certain African and Afro-diasporic rhythmic concepts, traditional Balkan rhythmic concepts, and free improvisation. The notational developments are directed towards creating a vocabulary to be used in the real-time notational tool in MaxMSP, in analysis of improvisational and intercultural musics as presented in the subsequent chapters, and composition of new works for improvisers.

In Chapter 2, I discuss the concept of ghost structure and its connection to existing scholarship in the areas of jazz analysis, Marc Perlman's research on Javanese Gamelan, Gerhard Kubik's discussion of Ugandan amadinda music, and the concepts of Craig Taborn. I discuss the entailments of ghosts in the humanities and anthropology. In

the second part of Chapter 2, I trace the concept of ghost structures and synchronous relations in three different forms in Thelonious Monk's *Evidence* (1957) Steve Lehman's *Echoes* (2009), and Craig Taborn's *Future Perfect / All True Night* (2013), and develop experimental tools for transcription and analysis around the rhythmic vocabulary of each example.

In Interlude, I analyze Homayun Sakhi's performance of Raga Yaman (2006). I discuss the issues with using w.c.p. notation for analysis of non-western improvisational practices around the example of Sakhi's engagement with Afghani rubāb performance and North Indian classical music concepts. I approach the analysis as a creative exercise of applying the circular notational framework and other creative notational devices around the transcribed materials from recording and around their implications for representation of temporality. I center the transcription around the cyclic melodic theme in Raga Yaman, which demonstrates elements of a ghost structure.

Chapter 3 is organized around discussing non-linear temporal schemes in works which feature diachronic relations. I analyze the work of Tyshawn Sorey, *Awakening* (2009) and the work of Carlo Costa, *Oblivion* (2017). In these works I analyze the rhythmic vocabulary and trace the ways that cyclic patterns and elasticity are employed in conjunction with finding what constitutes the ghost structure(s) and other referents therein. I discuss the themes of iteration and non-linear narrative in both works, and dissect some of the structural processes that make up such textures.

Chapter 4 describes the real-time notation technology project that I developed around the concept of creating inaudible, cyclic reference structures for improvisation. It integrates elements of the rhythmic notational vocabulary of the works analyzed in previous chapters into a circular framework for real-time note input from a MIDI source. I discuss the technical aspects of the MaxMSP programming, and how the patch operates. I also discuss the other creative technologies that have informed this tool, particularly Ryan Ross Smith's *Study no. 40.2* (2016), and its application to improvisation.

In Chapter 5, I discuss the creative works presented at the capstone concert in June 2022 that incorporate the ideas presented in this dissertation document. In building the concept of meter around specific musical phrases and their temporal idiosyncrasies, the creative work explores these uneven and elastic fringes of cyclic musical phrases, largely in the context of emergent, improvised material. I discuss the notation, improvisational practices, and real-time notation technology and their use in the creative work. The chapter features transcription and formal analysis in tracing the application of the research concepts and refining the notational vocabulary, similarly to the methodology used in Chapters 2, 3 and Interlude.

CHAPTER 1: NOTATION FOR REAL-TIME COMPOSITION

Western common practice notation has several issues in representing other kinds of music, particularly those which come from aural, pre-industrial traditions, and those involving improvisation.

In this dissertation, I develop a hybrid notational vocabulary that has elements of both w.c.p. notation and alternative notational vocabularies derived largely from Justin London's circular representation of meter (2004), Mitchell Ohriner's approach to creating grids and notating rhythmic units (2019), and transcription solutions created around notating traditional, non-western music. The development of this notation is centered around its application to: (1) a software-based dynamic, animated real-time notational tools that can be sight-read by improvisers, and (2) transcription of cyclic, elastic patterns in Chapters 2, 3, and Interlude. Both applications are supported by the performance practices surrounding *ghost* structures, which are discussed in Chapter 2. In this chapter, I discuss the notation developed specifically in relationship to addressing the limitations of western common practice (i.e. w.c.p) notation to represent elasticity, cyclicity, and semiotically flexible musical materials. I support this discussion by ways non-western classical musical practices and traditions enrich these kinds of challenges.

Open Framework

Because liminality and elasticity are key components of many non-western musical practices and improvisational practices, the notational vocabulary has to somehow create supportive conditions for them to arise. In effect, this has motivated me to explore lower prioritization of specific rhythm, despite the fact that much of the analysis is focused on specific and detailed rhythmic patterns. The approach I've taken is to not over-prescribe.¹ Certain key aspects of the rhythmic vocabulary have to be negotiated through playing as an ensemble (e.g. the exact placement of the note, the distribution of the parts across multiple instruments). The notation is meant to be "filled in" by the musicians.² By this, I'm trying to preserve a sense of ephemerality and intangibility for the musical materials itself. This aesthetic is a response to the use of w.c.p. notation in transcription of Eastern European folk songs and non-western traditional musical repertoires. Often in these transcriptions, the mystery and the unique musical identity of the folk song is undermined, because of how fixed and prescriptive the notation is. Such notation can be counterproductive to the transmission of the musical material accurately, because the student or the performer is not reliant on the aural architecture of the material as it is communicated from a person or person(s), and may misconstrue the piece with the rigidity suggested by the aesthetics of w.c.p

¹ I'm interested in exploring notation as a place for integrating the *unknown* as well as the *known*.

² This does not preclude the music from being *compositional*. The ensemble can configure their musical vocabulary in rehearsal through dialogue and exchange of musical materials.

notation. Consequently, I think that it's better to allocate certain elements to the aural sphere and non-notational ways of learning the material, and visualize the elements — e.g. a) aspects of rhythm and pitch and b) processes — that are more fundamental to the aural architecture, even if they are more abstract.

There are several reasons for using lowered specificity on the level of rhythmic units, which are informed by the contexts of improvisational and intercultural music-making:³

- It allows the musicians to insert a more diverse rhythmical vocabulary, including the culturally-specific rhythmic vocabulary in the research — i.e. 2-based (2/8) or 3-based (3/8) pulse — or elastic rhythmic elements.
- It doesn't prioritize the conception of rhythm based in one particular cultural music over another.
- It enables open interpretation of what constitutes the primary rhythmic units.
- It enables insertion of multiple divisions of the pulse without any imposed hierarchy.
- It circumvents the hierarchy set up by meter and stems in w.c.p.
- The circular representation of meter and form allows for certain culturally specific rhythmic practices to happen more smoothly; these include, for example: engaging in multiple divisions of the circle (e.g. polyrhythmic cycles in Tamasheq music, certain

³ In the real-time composition tool where many of these notational experiments became realized, the cursor is quite rhythmically prescriptive, so that other levels of rhythmic specificity are not necessary for playing quite specific rhythms, and may not need to be represented visually.

West African musical practices) engaging in multiple layers of rhythmic density (e.g. Javanese Gamelan), rhythmic elasticity (e.g. microtiming in Bulgarian tupan drumming, microtiming in Tunisian *ṣṭambēlī*).

- The rhythmic conception in the patch is intentionally incomplete. It is to be completed by the ensemble's feeling of the time in their own way, with musicians negotiating each other's temporal interpretations and becoming attuned by listening to one another.
- It enables rhythmic liminality (i.e. the feeling of *being* in between multiple different rhythms or different temporal rates at once). If the notation was more specific, it may not have been able to allow for this kind of liminality.
- It enables rhythmic elasticity (i.e. micro-timing, playing a rhythmic pattern in non-isochronous timeflow).
- It promotes the practice of variation upon a cyclical rhythmic structure, rather than linear generation of non-similar material.

In essence, the lowered specificity allows for the *delegation* of rhythmic values to happen elsewhere. In staff notation system, a note's rhythm is visualized in relationship to the meter, and as a fixed value in relationship to a certain subdivision stratus.

Therefore, the meter can neither be elastic, nor can it represent multiple values on multiple scales. What I'm looking to represent is the note's symbolic duration that can be translated into multiple subdivision strata and multiple timescales. These processes

seem complex, but can be made simpler through a selective non-prescriptiveness and greater semiotic openness. The implicit values in w.c.p. prohibit meaningful representation of practices of interpreting rhythm, so finding a language that is more semiotically open can help cross some of those aesthetic boundaries.

On a practical level, the sight-reader can more easily read values that don't have a great deal of rhythmic specificity. It is much more difficult to sight-read notes that are transcribed exactly in staff notation, particularly if transcribed against a pulse. This generally produces extremely complex rhythms, using fractions of values and complicated tuplets (e.g. other divisions of the pulse). The reason is that a human tries to play a phrase exactly against a grid, there will be deviations. In order to visualize notes played in real-time, at least some degree of non-specificity has to be incorporated into the system. The quantization is one option for simplification. It allows for a higher degree of specificity, especially in notating shorter values. The disadvantage is that commonly, quantization uses a single regular temporal grid. It imposes a mechanical time as opposed to a felt time onto the material that's played. More importantly, the reason for moving away from either of these strategies is to be able to conceptualize the rhythmic values in a relative way, and to symbolize these relationships visually to some extent. The other option after quantization within the w.c.p. framework is to simplify the set of symbols for note durations. For example, one can use the system developed by Dariush Talai for notating *radif* (1997). Here, he uses three main rhythmic categories:

specific fast, unspecified shorter, and unspecified longer notes. In the example below, sixteenth note and eighth note are the specific values he uses, the non-specific shorter (or medium) length is a stemless quarter note, the non-specific long note is a stemless half note. They represent useful in-between points between specificity and semiotic openness.



Figure 1 - Rhythmic values in Dariush Talai's notational system

Another reason for the rhythmic non-specificity is that the rhythmic values represented less specifically can be more easily mapped onto rhythmically different patterns that are created in real time. For example, if a melody is notated in *short - short - long - short*, it can be translated to different scales, into different meters, onto different rhythmic patterns, etc. Such compositional elasticity is helpful in the improvisational domain.

System for Sight-readable Notation

In constructing a notational language in the context of software-based, dynamic, animated real-time notation, there are several unique aspects which this modality

affords. For example, there can be an alternative system or sub-system that counts the duration between each note event onset and converts this to visual information. One possibility is to visualize the notes in different sizes depending on the duration. This technique draws again on the transcription and computational system used by Ohriner to visualize degree of recurrence in hip hop *beats* (2019). While he uses the number of recurrences to calculate the note-head size, one can map the durational value to the size the same way. For example, the product could look like this:

t= unit of duration

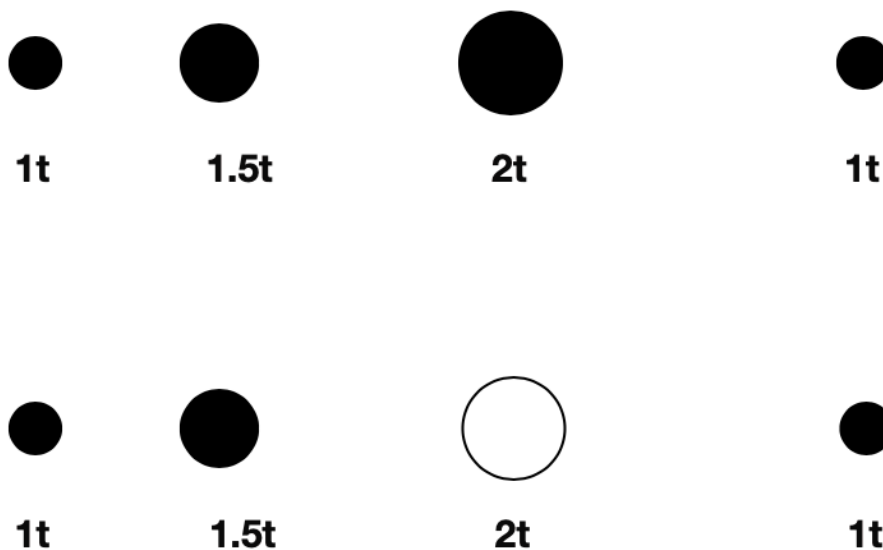


Figure 2 - Example of note-head size differentiation

In Fig. 2, time t indicates the temporal unit that is fixed, for example 1 second. Each dot's size is determined by its duration, using a direct correlation; the longer the

note, the bigger the dot. For example, the dot 1t is 10x10 points and the dot 2t is 20x20 points. The visual example shows a few alternatives. The first one is on a linear time-scale with using black color for dots of all sizes. The one below differentiates the longer value of 2t by white color, referencing the quarter note - whole note visual distinction in w.c.p. (e.g. all notes of rhythmic values below a half note have filled, black note-heads, all rhythmic values of half note and above have open, not colored note-heads). In both cases, the distance between the note-head is equivalent to their duration and their size. Practically speaking, in sight-reading these notes as they appear one may be swayed to think of the size differentiations as indicative of volume or structural importance. It may create an implicit hierarchy between shorter rhythms and longer rhythms, in which longer rhythms appear more rhythmically and structurally significant. It may be difficult, for example, to play the shorter rhythms louder than the longer rhythms.

Figure 3 shows an example of how the note-head size differentiation looks in the circular format. In Fig. 3, the durational values are translated to note-head sizes. Instead of their distance appearing on a linear time-flow as in Fig. 2, they appear on a circular time-flow. In the circular framework, the scaling of note sizes would need to be addressed, so that notes that are of much longer duration than others don't move beyond the bounds of the circle itself, and also that the space within the circle won't get visually crowded too quickly when inputting material over multiple cycles.

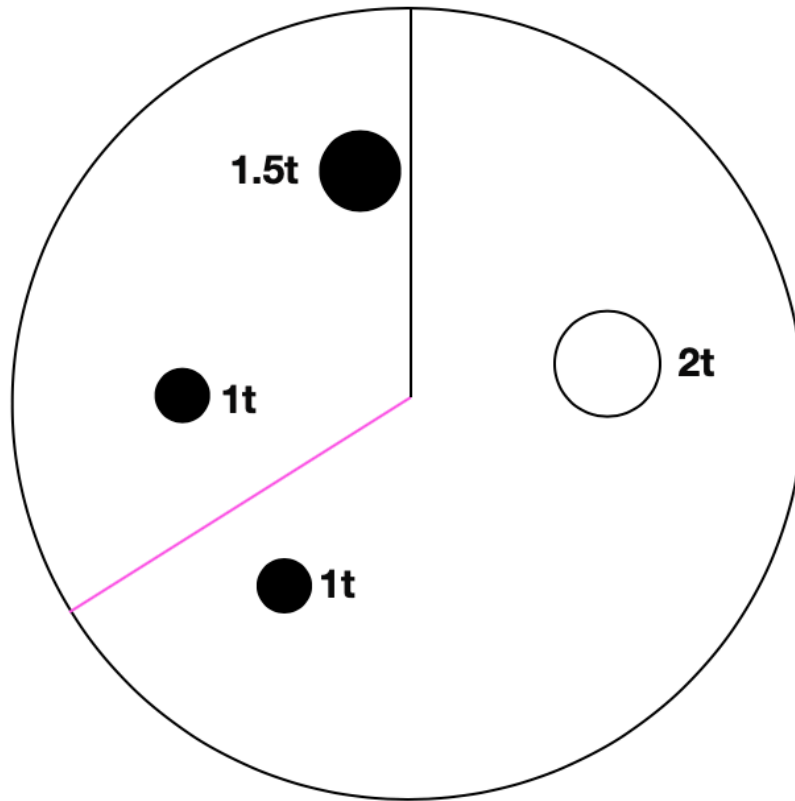


Figure 3 - Example of note-head size differentiation in circular format

In theory, the main technological issue in applying this system to a real-time notation software is altering the size of the dot after it has been played. Since in my MaxMSP patch (hereafter referred to as a patch) the note is being input instantaneously when the MIDI key is pressed, the software does not have the durational information about how long the note is until the next note. Two potential ways the technological issue can be circumvented are: a) by altering the note size of the first note after the next subsequent note is pressed, and b) by increasing the size incrementally from the point a

note is input to the point when next note is pressed. More details about the patch are presented in Chapter 4.

Another alternative way of introducing more rhythmic specificity while using the same notational system is through the introduction of grids. A grid on a linear plane would look like vertical lines per each subdivision unit. See example below:

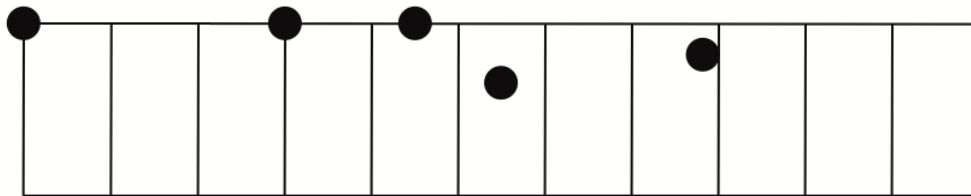


Figure 4 - Grid-based representation of subdivision units

In the example in Fig. 4, the cycle is an arbitrary amount (11) of equidistant temporal units long. The notes in it include rhythmic information by both their distance to another and in relationship to the grid. Their pitch is represented by their height. Using the grid as a reference, the sight-reader can derive approximate durational values of each note without needing to see stems or other w.c.p. notation symbols. In staff notation, this could translate to something like these two examples (Fig. 5), if we chose relative pitches quite loosely; the upper version with sixteenth notes and the lower with triplets.



Figure 5 - Two possible translations of Fig. 4 into w.c.p. notation

Since a degree of elasticity is essential for representing temporally liminal rhythms, I would hesitate to introduce greater detail in rhythmic subdivisions into the real-time notation system (i.e. grid for every sixteenth note). It's conceptually important for the grid itself to allow for rhythmic elasticity in the performance because rhythmic elasticity is an important aspect of feeling time in certain non-western musical frameworks (see Goldberg on *Elenino Horo* and Jankowsky on *ştambelî*). I try to illustrate this through two possible interpretations of the last note in the phrase as landing on either a sixteenth note or a triplet in Fig. 5. These kinds of ambiguities serve at least two purposes: they promote the use of rhythmic vocabularies that involve micro-rhythmicality and polyrhythmic ambiguity, and they also push the ensemble to negotiate timing together, abandoning some of the more automated and regularized approaches to feeling time.

The same linear grid-based system proposed in the example in Figure 4 can be seen in the transcription approach of M. Ohriner (2019: 199). Certain contemporary classical composers, such as Iannis Xenakis (see manuscript for *Metastaseis*, 1954), Morton Feldman (see *Intersections 1-4*, 1951) and Horațiu Rădulescu (see *before the universe was Born*, 1993), among many others have also used graph-like grids for representation of time in their compositions and manuscripts. The practice is quite established in graphic scores and alternative notation systems used in contemporary classical music at large. However, most of these examples use predominantly a linear representation of time.⁴

Circular Framework

Let's consider the application of the grid to a circular framework. A linear grid can be represented in a circle by lines drawn from the center to the circumference. The lines divide the circle into a designated number of equal parts. The way this can translate to w.c.p. notation; four lines can symbolize a measure of 4/4, 4/8 or 4/16, twelve lines a measure of 12/4, 12/8 or 12/16, etc. Figure 6a uses 32 equal divisions of the circle as the grid.

⁴ Rajna Swaminathan's composition *Precipice* (2021) features a unique grid-based notation of a polyrhythmic structure that is ultimately intended to be cyclical and performed with improvisation.

In the circular framework in Fig. 6a, each line from the center indicates one equidistant temporal unit. The circle is read clockwise, starting at the top of the circle, moving to the right, upside down, and back up. When employing this in the patch in real time, the notes can be input on top of the 32t grid.

In reality, the input will produce a mixture of alignments and non-alignments with the grid. Nevertheless, the grid of this definition will enable the performer to read quite specifically how many units separate each note, and to approximate the deviations from the grid with relative accuracy. The rhythmic values will be approximated relatively to the grid, and most likely also relatively to each other (i.e. one note is further from the grid point than another). The presence of these two elements: 1) relative approximation of duration based on the values that constitute the cycle, and 2) elastic interpretation of the in-between spaces are both positive factors to the aims of this project. They leave some gray area for the performers to negotiate these rhythmic moments by listening to each other, and to insert rhythms that are elastic or liminal.⁵

On one hand, the presence of the grid with a fast subdivision-pulse referent applies well to certain musical language included in this research, including the contemporary jazz works and certain West African musical practices. For example, a number of Craig Taborn's compositions and improvisations involve references to a fast subdivision grid, which Boyle calls the "density referent" (see Boyle's analysis of

⁵ Liminal rhythms are rhythms that seem to exist in the area in between two definable rhythms, and which are difficult to define on their own, in particular in notation.

Taborn's solo piano improvisations in *Avenging Angel*, 2020). In much of Taborn's work, he derives polyrhythmic structures from sub-organizations on top of this grid, and equidistant in-between points between odd groupings of the grid points (i.e. five eighth notes divided by two notes of equal duration). For example, his left hand pattern may align with every two grid points, while his right hand aligns with every five. Similarly, the compositions of saxophonist, composer-improviser Steve Lehman are also based on a single, fast, subdivision-pulse referent. In *Echoes* (2009), analyzed in Chapter 2, he divides a variety of quarter-note based odd and even meters (i.e. 5/4, 6/4, 7/4, 9/4) into equal, equidistant parts using fractions of sixteenth notes on a sixteenth note grid. In certain West and North African conceptualizations of rhythmic framework, the variety polyrhythmic structures and complex, seemingly polytemporal rhythms all align with a single fast pulse referent (roughly at the scale of 1/16th or 1/24th note). The pulse referent is so rapid that it allows for a host of possible polyrhythms without them needing to reference a different pulse referent.

On the other hand, the presence of a single grid may be an issue for other rhythmic languages that have more metric and rhythmic elasticity. The grid introduces the designation of a single, primary pulse referent. That may create hierarchy in the performer's conceptualization of the time-flow. The simultaneity of two or more different pulse referents (i.e. 2/8 against 3/8) will be more difficult to produce or suggest visually. Nevertheless, the grid does have the advantage of representing

rhythmic values with almost the same degree of specificity as common practice notation, without imposing a sense of any particular grouping bias (e.g. down-beats are more significant than off-beats), or metric bias (e.g. a measure of 15 rhythmic units long is divided into three 4/4 measures and one 3/4).

One solution for circumventing the primary pulse referent designation is by introducing another grid of a different color, so that they can be visually distinguished from one another. This enables the musicians to have at least two primary pulse referents to engage with, which can lead to polyrhythmic spaces and rhythmic liminality. In the example below, the black grid divides the circle in 16 equal points, and the green grid divides the circle in 12 equal points. They create a polyrhythm of 4 (black) : 3 (green).

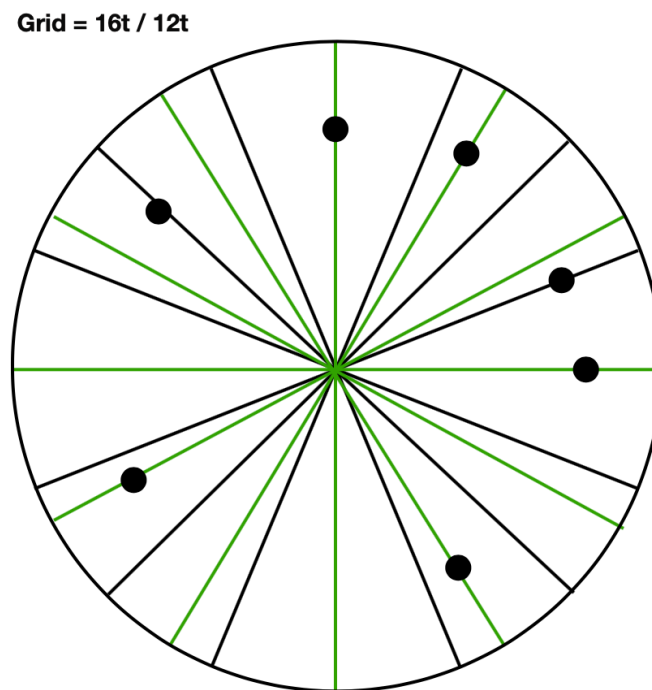


Figure 7a - Representation of two pulse referents in circular visualization

The circular representation in Fig. 7a can be translated into w.c.p. in at least two ways: using a dotted quarter to quarter note relationship (fig. 7b) or a triplet to eighth note relationship (fig. 7c). The scale at which this relationship operates is open to interpretation; the whole figure can be written in a twice faster subdivision level, half slower, etc. The same flexibility applies to the ensemble interpretation of the grid. The advantage of the two grids in the circular notation is that it allows the performers to read the material in reference to both subdivision levels (i.e. green and black) more-or-less equally. It also provides some accuracy for visualizing rhythmic values that align with either of the two grids. The disadvantage is that it introduces another level of symbolic-visual information for the sight-reader to deal with and internalize. Visually, it may be easy to get lost in the circular scheme since the rhythmic relationships between the two grids are not stated. Therefore, it might be helpful to continue developing this framework further, and perhaps visualize the numerological relationship with additional clues.

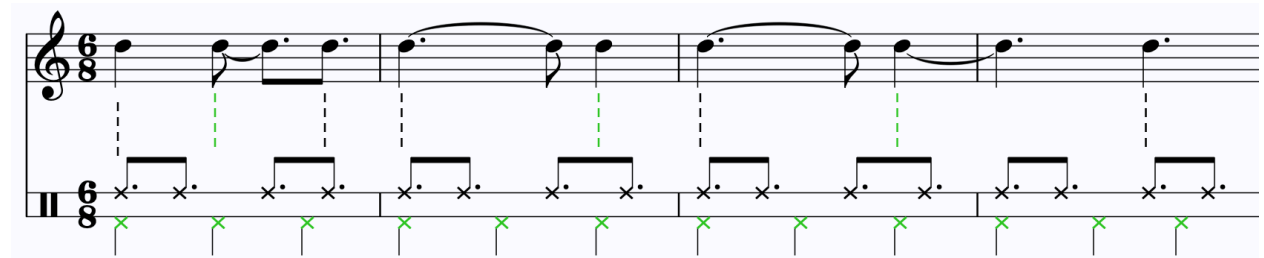


Figure 7b - Staff notation representation of Figure 7a using dotted eighth note & quarter note streams as references

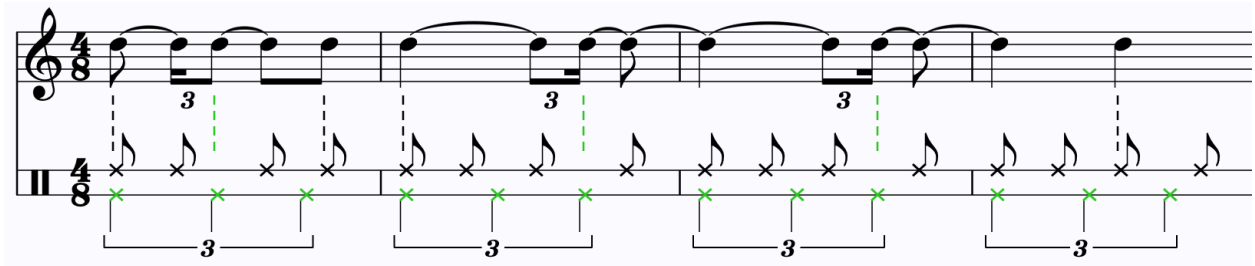


Figure 7c - Eighth note & quarter-triplet representation

In an ideal scenario, the grid will represent the rhythmic reference points in the way that they are conceptualized by the performer. In certain kinds of music, for example in Bulgarian traditional folk dance music, the rhythmic phrase (i.e. the rhythm of a melody) denotes the primary rhythmic reference points, not the pulse itself. In a different but related way, a central rhythmic pattern in Afro-diasporic time-line based musical practices can denote the primary underlying rhythmic reference, in addition to the pulse.⁶ In effect, to be able to refer to an underlying rhythmic pattern as both a musical phrase and an underlying grid-like reference is important to negotiate notationally.

In thinking through translating this particular relationship visually, I imagine creating a non-equidistant grid, in which the grid points are the rhythmic referent structure, and can be considered as an inaudible rhythmic pattern. The notes input from the MIDI keyboard are played/composed in relationship to it, either as variations or as

⁶ The majority of recent studies of meter that incorporate concepts from outside of western art music arrive at the idea that meter is better conceptualized as a particular rhythmic and often also contoural pattern, rather than a sequence of isochronous units.

reinforcement. In other words, the grid would have the structure of, for example, the *clave* rhythm, while the notes actually played will be visualized and performed against that grid. It sacrifices rhythmic specificity for the sake of representing with more accuracy in what constitutes the rhythmic reference structure for the performer. Figures 8a and 8b show the 3-3-4-2-4 *clave*-grid represented as a metric structure in the circular framework.

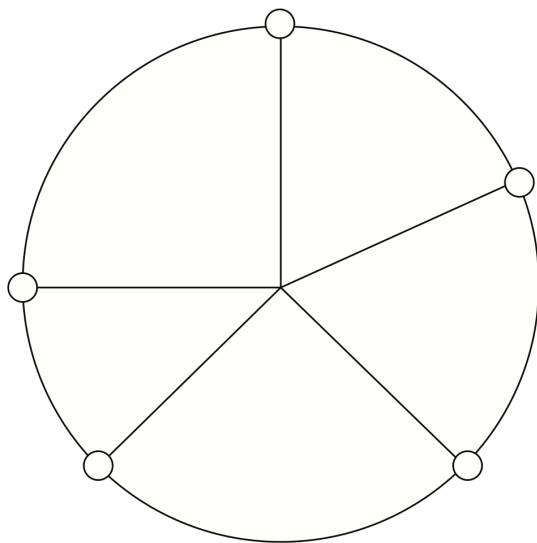


Figure 8a - Circular representation of *clave*

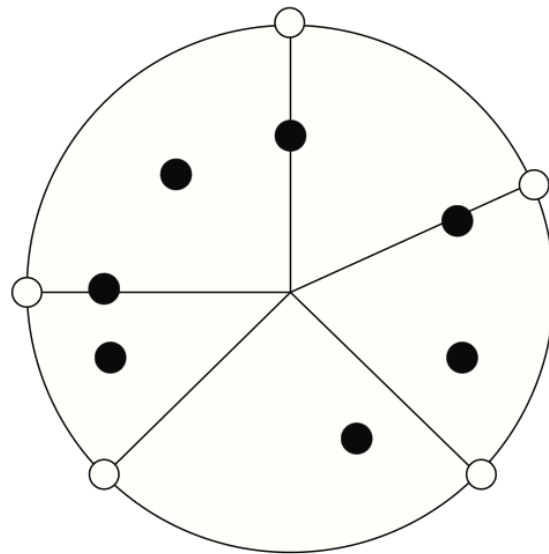


Figure 8b - Circular representation of *clave* together with a superimposed pattern



Figure 8c - W.c.p notation version of Figure 8b

The left example in Fig. 8a shows the grid by itself. I've added open dots at the ends of the grid-lines to create a sense of absent "ghost" pulses that would otherwise make up the *clave* pattern, since the grid is based on a real musical pattern and not a theoretical reference structure. In the right example in Fig. 8b, I've added a few notes to demonstrate how a real-time input could look like in the patch. In this case, the notes are all quite perfectly aligned with the pulse in the cycle.

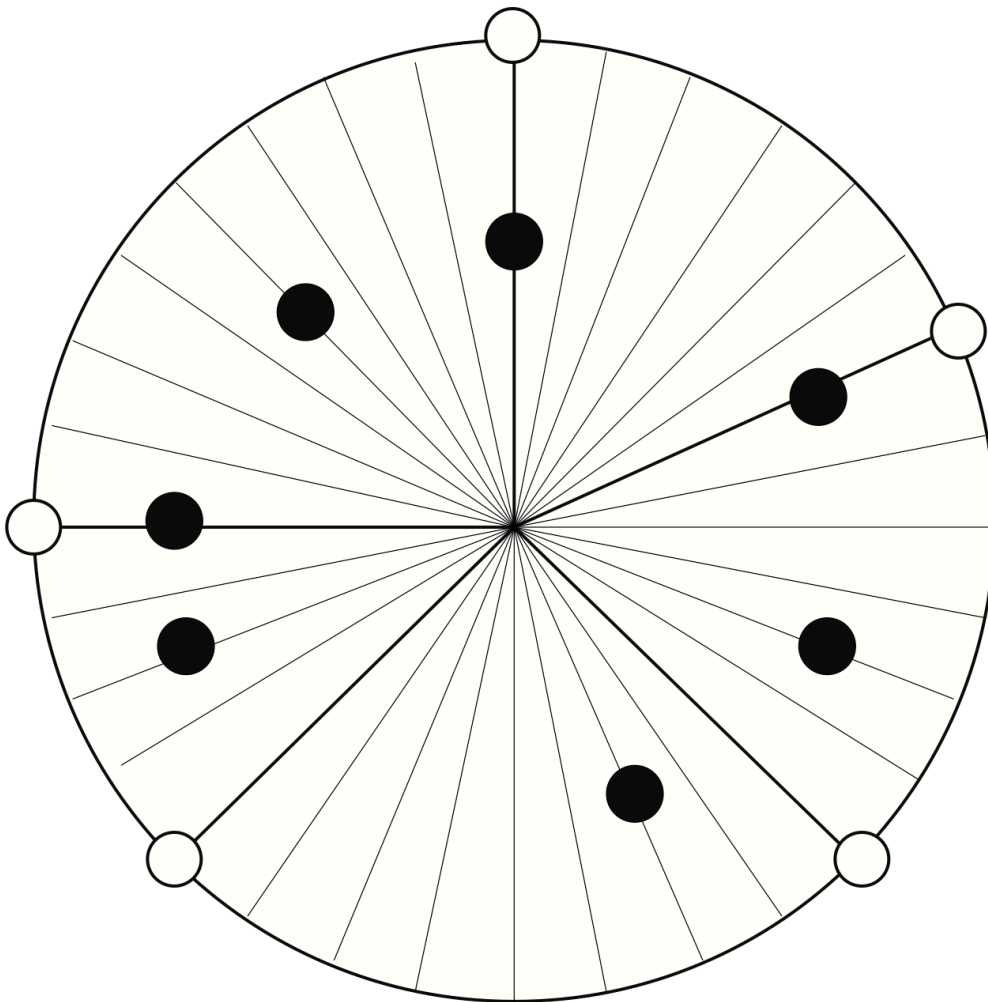


Figure 9 - Circular representation of a *Clave* grid with an equal subdivision referent grid (32t)

The advantage of using lines for significant rhythmic anchors within the circular grid is that it communicates to the musician that the rhythmic pattern is simultaneously a musical entity and a metric structure. The performer or sight-reader (in case of the real-time notation framework) can “play” both the grid and the notes, while being able to distinguish them based on their quality of referentiality. Finally, Figure 9 shows one additional variation of the *clave* grid with an equal subdivision referent grid (32t).

Reflections on the Application to the MaxMSP Real-time Notation Tool

To reflect on the application of these notational experiments into a software-based real-time notation tool, I will reference aspects of the tool I’ve developed in MaxMSP and hypothesize the technical possibilities and impossibilities. For more details on the tool, see Chapter 4.

While the earlier strategy for visualizing rhythm with note size may not be easily realized within a real-time notation technology (discussed in more detail in Chapter 4), the circular grids can be added quite easily. As the patch draws the main circle, it can consequently draw any number of lines into it from the center to given x, y coordinates. These lines can theoretically be organized to create any kind of grid. For the sake of having a compositional agency in using these grids in relationship to music that is being created in real time, it will be useful to have the ability to input a variety of grids, or to take them away. A feature can be added on the MIDI interface level that would connect

a MIDI *control* value (controlled by a knob on the MIDI keyboard) to the number of equidistant grid points. For example, value 2 of the *control* knob would create a line dividing the circle in two halves, value 3 would create three lines, dividing the circle in three thirds, etc.

Surely more specificity can be added to represent more complex rhythmic values using grids. With increased rhythmic detail in the grid, the visual field of the sight-reader becomes more dense. At some point, high grid densities become intelligible (e.g. they become impossible to count). They also may work against the conceptualizations of the rhythmic material as liminal and elastic. Choosing the grid density that reflects the grain of “density referents” in certain African and contemporary jazz vocabularies that exist in alignments to polyrhythms and liminal rhythmic spaces is a potential solution for incorporating a finer-detailed grid. Alternatively, using specific rhythmic patterns, such as the *clave*, as grids may be more conducive to creating music with greater rhythmic elasticity. The quality and aesthetics of the grid should ideally be tailored to the music’s culturally-specific — or culturally hybrid — rhythmic and temporal underpinnings. Allowing for elasticity if needed with non-isochronous grid, or polyrhythm with a fine, non-prescriptive pulse “density referent” are at least two unique ways for navigating these musico-cultural differences.

Primary Sources for Circular Notation

The references for the circular notational vocabulary are derived from several sources, some of which I have applied, some of which have overlapping applications, and some of which I have not yet fully explored. The foundational sources are Justin London's *Hearing in Time* (2004) and Godfried Toussaint's *Geometry of Rhythm* (2019). The visual presentation of their frameworks is almost identical. Additionally, London's work includes foundational conceptual underpinnings for formulating and developing this notation (i.e. the influence of entrainment on perceiving meter and rhythmic patterns) that is particularly relevant for building notation for improvisation. Toussaint provides an expansion of the circular graphic vocabulary to various useful visual and geometric iterations as well as to various non-western traditional rhythmic patterns. They both arrive at a circular framework for visualizing time and rhythmic events through a cognitive focus in their research.

Both London's and Toussaint's circular notation schemes operate under the same premise. The points at the circumference represent specific rhythms, while their duration is represented by their distance along the circumference of the circle, relative to the duration of the cycle itself. The time-flow is clockwise. Toussaint's example also includes a grid, which I have applied to the earlier notational examples. From Figure 12 one can derive both the visual approach of referencing a pulse referent by equidistant lines, and non-isochronous polygons that can be used to represent patterns as meters.

London's and Toussaint's visualizations include additional possibilities that I have not yet applied to my research. London's schemes in Figures 13 and 14 show additional, parallel subdivisions of a continuous cycle by the outer semi-circles (London 2004: 66-67). It can, at the same time, be also used by composers to denote accentuated nested rhythms, or temporal alterations.

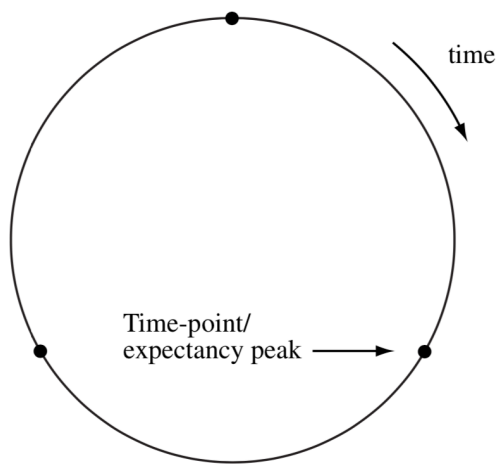


Figure 10 - Visual representation of entrainment (London 2004)

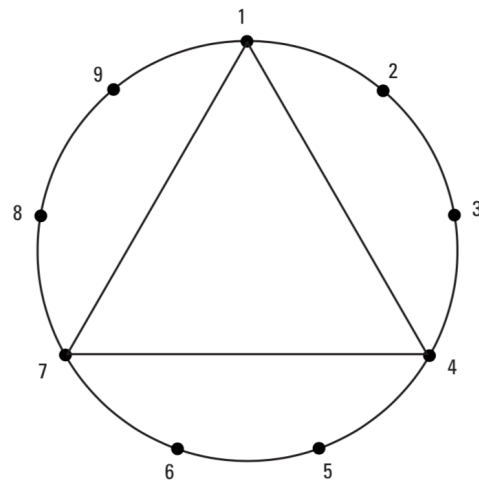


Figure 11 - Circular representation of a rhythmic cycle (London 2004)

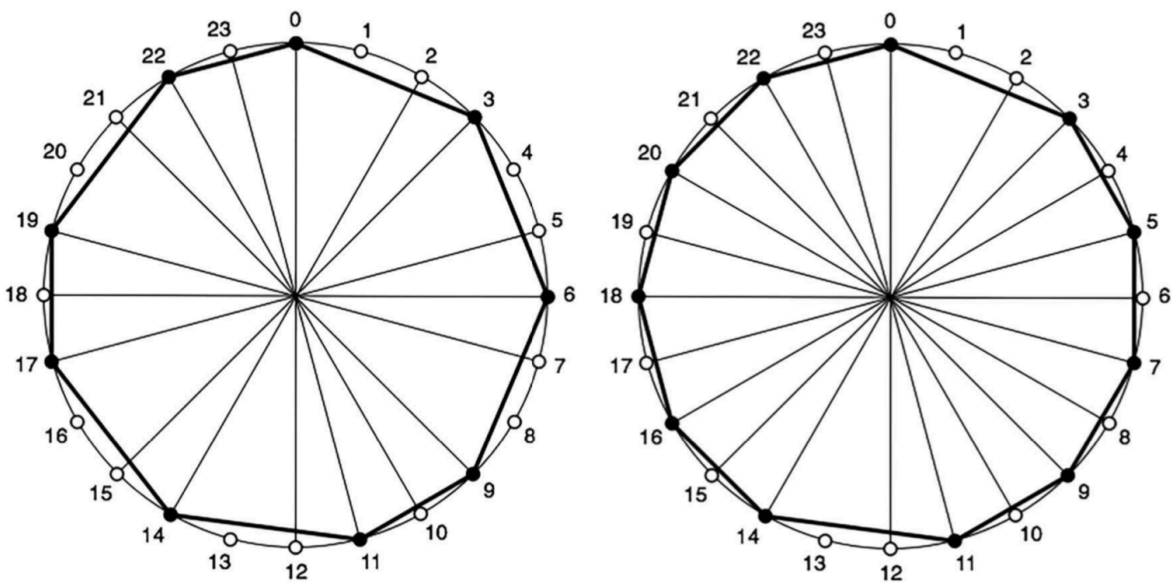


Figure 12 - Circular representations of rhythmic cycles (Toussaint 2019)

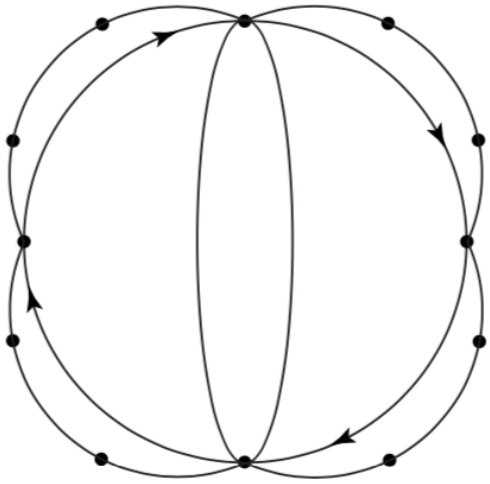


Figure 13 - Circular visualization of two subdivision schemes (London 2004)

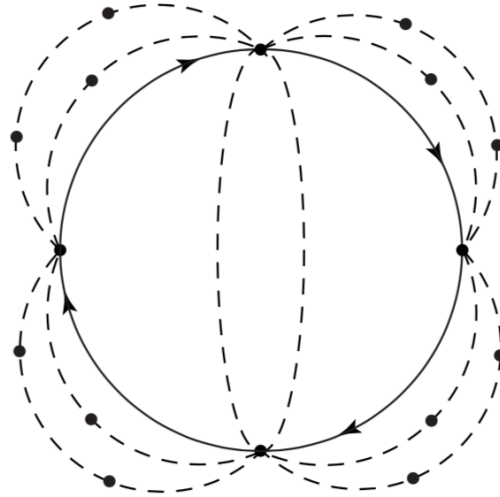


Figure 14 - Circular visualization of three subdivision schemes (London 2004)

The second main notational element comes from Ohriner's model for transcribing hip hop beats (e.g. instrumental track underneath rap vocals, usually providing the rhythmic-temporal scheme for the composition). His model is particularly helpful for analyzing cyclic music and underscores the intricacies of rhythmic processes specific to cyclical music. In much of his work he uses a similar computational process to represent the size of the visual elements (i.e. note-head size) based on the number of occurrences that the corresponding note or sound occurs within the primary cyclic pattern. Each rhythmic and sonic event is considered in relationship to its position in the cycle over multiple repetitions.

Instead of thinking of the piece as a linear whole, Ohriner layers the composition on itself. The elements that are particular relevant to this research are:

(1) visualizing cyclic music within the temporal segment of one primary cycle, (2) creating a custom grid to represent the pulse referent (e.g. without a staff or visual indication of meter such as 4/4), (3) altering the size of the notational components to represent variables from the analysis in direct mathematical relationships (i.e. altering note size to distinguish higher occurrences from lower occurrences), and (4) using height to represent register. In the example in Fig. 15 of Kendrick Lamar’s “GOD”, one can see the kick drum on the bottom as squares and snare on top as circles. The smaller notes denote less frequency. The grid shows each sixteenth-note, which is the fastest pulse referent in this particular pattern, and includes thicker lines for each quarter-note. The rhythmic value (e.g. duration) for each note is derived from its placement on the grid, rather than from the note symbol itself. In developing the score-based notation, I arrived at the circular system by moving Ohriner’s vocabulary onto a circular grid.



Figure 15 - Ohriner’s visualization of the drum sequencing in Kendrick Lamar’s “GOD” (2017)

The final core notational concept comes from Darius Talai’s notational vocabulary for transcribing and representing the *radif* mentioned earlier in this chapter. I’m adopting from it the visualization of rhythmic units using three main categories: specific fast, unspecified shorter, and unspecified longer notes.

Other Models for Circular Notation

Fernando Benadon's "circular plot for rhythm visualization and analysis" (2007):

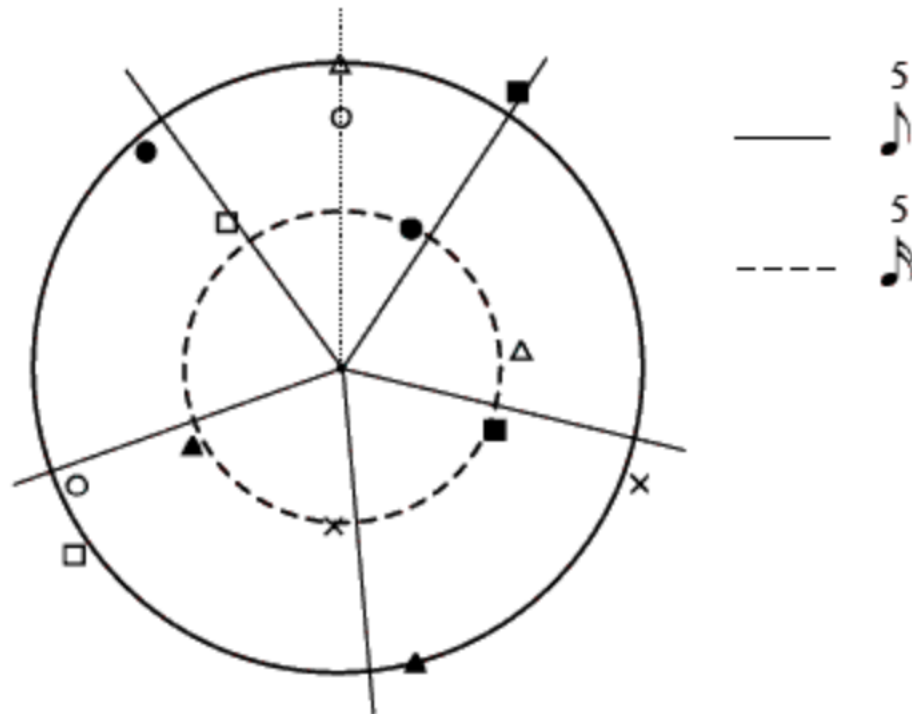


Figure 16 - Circular visualization of Bob Miller's trumpet solo in "Creole's Love Call" (Benadon 2007)

Jesse Stewart's cyclical frameworks used for analyzing the music of Steve Coleman:

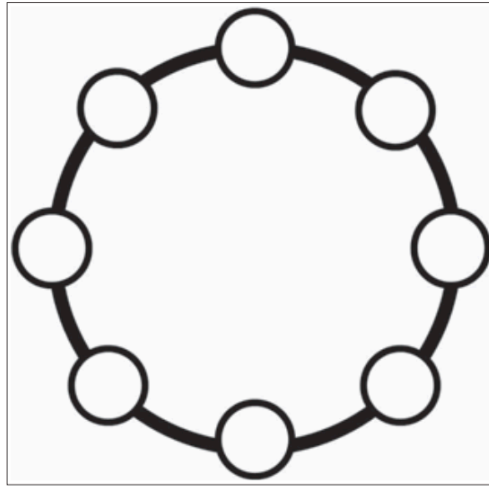


Figure 17 - Jesse Stewart's cyclical eight-pulse framework (Stewart 2011)

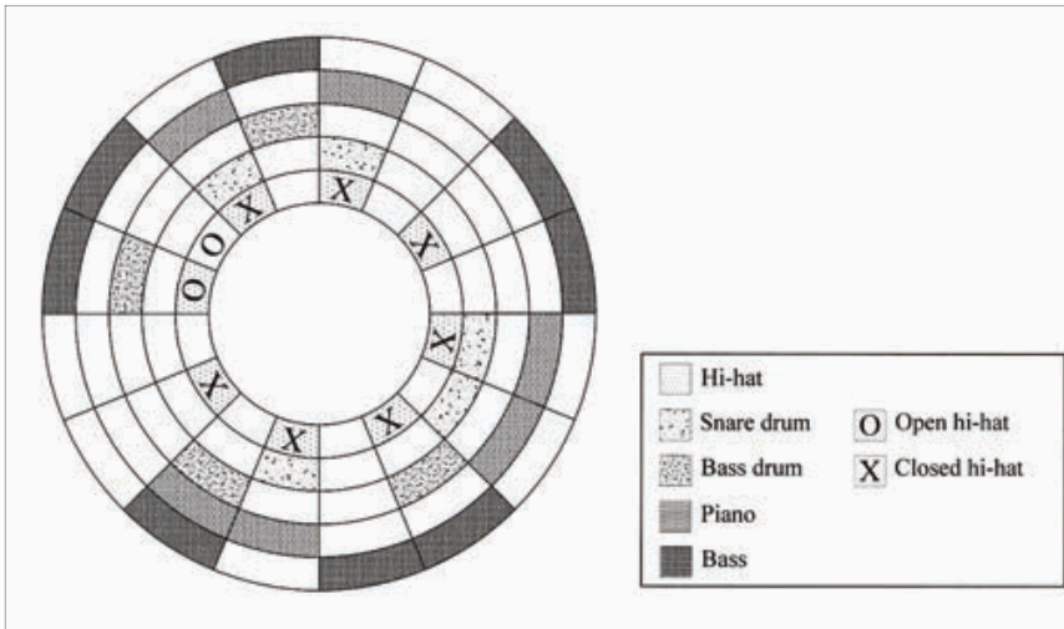


Figure 18 - Jesse Stewart's transcription of Steve Coleman's "Freestyle" (Stewart 2011)

Thirteenth-century circular notations used by the musician and theorist, Şafī al-Dīn al-Urmawī in his book, *al-Risāla al-sharafiyya* (trans. by George Sawa 2002):

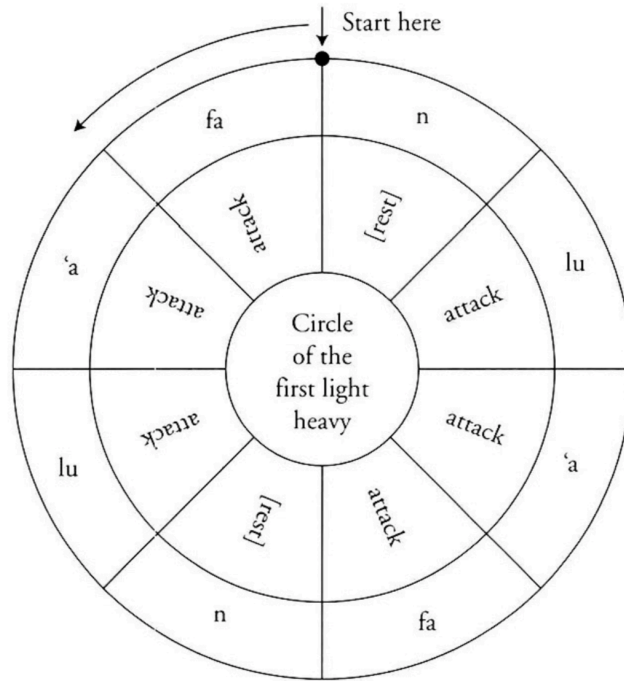


Figure 19 - Circular visualization used by Şafī al-Dīn al-Urmawī (Sawa 2002)

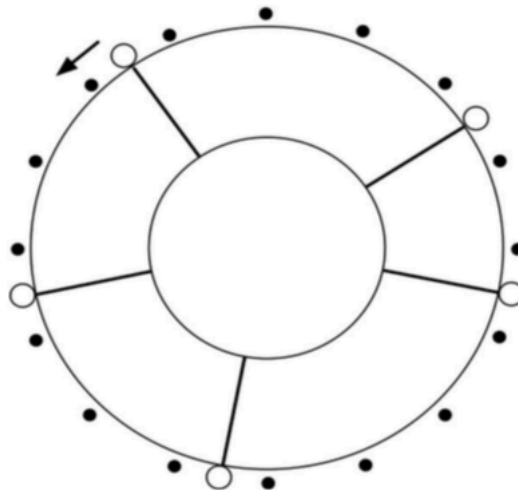


Figure 20 - Şafī al-Dīn's circular representation of the rhythm *al-thaqīl al-awwal* (Toussaint 2019)

“Aural mandala,” a creative superimposition of Judith Becker’s transcription of a Javanese Gamelan composition onto a mandala. (Becker 1981: 168):

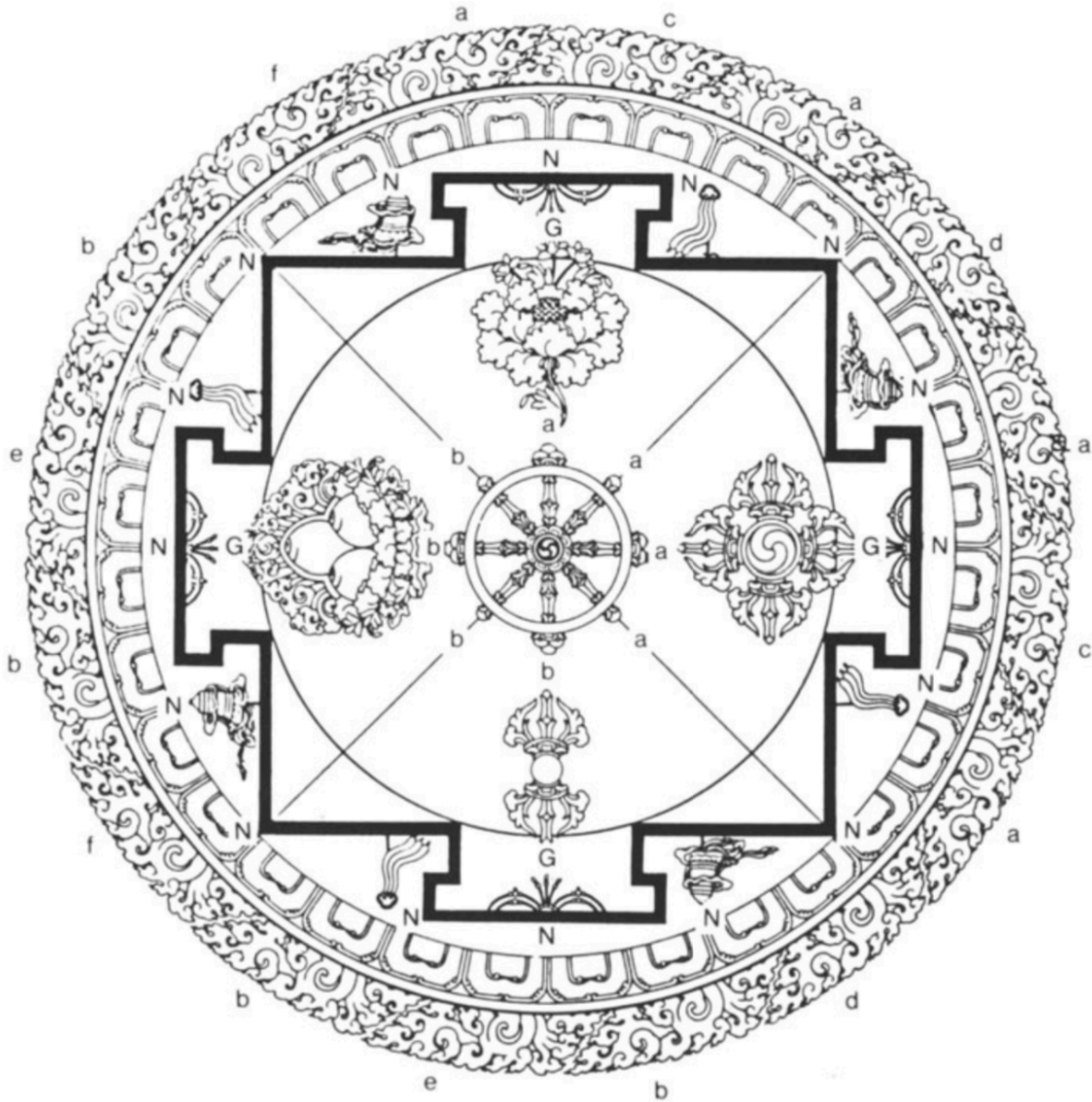


Figure 21 - Judith Becker’s “Aural mandala” (Becker 1981)

George Crumb's composition "The Magic Circle of Infinity" for amplified piano from Makrokosmos, Vol. I (1972):

8. The Magic Circle of Infinity
(Moto Perpetuo)
[SYMBOL]
Leo

Luminous [$\text{♩} = 156$]

A

B

Joyously, like a cosmic clock-work, with mechanically precise rhythm [$\text{♩} = 226$]

very persuasive [let third finger nk.]

B sempre

PI sempre (hold down throughout)

PI (hold down throughout)

N.B. After playing [A], proceed to [B] and play $3\frac{1}{2}$ revolutions of Circle-music (ending at "Fine")

[let vibrate out!] [C.D. or.]

The score is a circular arrangement of musical staves. At the top, it is titled "8. The Magic Circle of Infinity (Moto Perpetuo) [SYMBOL] Leo". A central section is labeled "Luminous [$\text{♩} = 156$]" and contains a section marked "A". To the right, a section marked "B" is described as "Joyously, like a cosmic clock-work, with mechanically precise rhythm [$\text{♩} = 226$]" and "very persuasive [let third finger nk.]". The score includes various performance instructions such as "B sempre", "PI sempre (hold down throughout)", and "PI (hold down throughout)". A note at the bottom states: "N.B. After playing [A], proceed to [B] and play $3\frac{1}{2}$ revolutions of Circle-music (ending at 'Fine')". On the right side, there are additional instructions: "[let vibrate out!] [C.D. or.]". The score is densely notated with various musical symbols, including dynamics like *ppp*, *pp*, *f*, and *ff*, and articulation marks like *acc*, *tr*, and *nk.*

Figure 22 - George Crumb's score for "The Magic Circle of Infinity" from *Makrokosmos*, Vol. I (1972)

The scores and excerpts above show several unique notational frameworks in which time is represented as a circle. Stewart's visualization of Steve Coleman's "Freestyle" and Judith Becker's *Aural Mandala* were particularly useful because they provide models for representing instruments belonging to different classes in different regions of the circle. At the same time, the mandala is also an object for meditation. The idea of the score as allowing for a state of meditation, reflection, and imagination was important, in particularly considering the cognitive openness and looseness required in relating to ghost structures improvisationally. Benadon's circular plot's have further possible applications that are useful for representing liminality between multiple tempi, but are beyond the scope of this dissertation.

This chapter described ideas behind the notational devices, practices, and possibilities that serve as foundational concepts and tools for real-time composition frameworks explored in creative works, and processes that are central to this dissertation project. These ideas help to support the analysis of what I call ghost structures. Chapter 2 will explore the concept of ghost structures and examples of synchronous relations, and Chapter 3 will explore diachronic relations to ghost structures.

CHAPTER 2: GHOST STRUCTURES AND SYNCHRONOUS RELATIONS

This chapter will begin with a general discussion on what I call *ghost structures*, how they relate to existing concepts in music, and how the discourse on ghosts in the humanities enriches ghostlike phenomena in music. I then explain the differentiation between *synchronous* and *diachronic* relations to such structures. This discussion will be followed by analyses of three works by others that highlight what I call the synchronous relations to ghost structures.

Ghost structures is a term I use for describing underlying reference structures that function as temporal schemes against which music is created and organized, but which are — or become — hidden, removed, or otherwise obscured. The kinds of ghost structures that this research traces are generally recurrent (e.g. cyclic), but also have a degree of elasticity or indeterminacy. This conjunction of cyclic and elastic organization of musical material provides a window into similar processes in many different kinds of musical and non-musical sources (i.e. iteration, micro-variation, non-linear approaches to development).

The *ghost* metaphor is useful because of its entailments in the humanities and critical discourse, as well as its use by certain contemporary musicians in both compositional and improvisational musical domains. It has useful connections to, for

example, the areas of liminality, temporality, memory, cognition, ritual practices, religion, anthropology, and architecture. It has not been defined before, but similar terms have been used, for example in discussing the relationship between the compositions and other reference structures and improvisation in jazz. It's breadth is useful too; the *ghost*-ness can refer to translucency of a structure as well as to a spirit of a past experience or a person. It has an animate and anthropomorphic quality.

Improvisation at large can be interpreted as a relationship to ghost structures of various kinds. Some are more concrete, such as sequences of bars and chord changes, while others are more abstract. At the same time, ghosts can also serve to disrupt and undermine Western biases. The existence of a ghost is non-objective; it disrupts conception of linear time, it's often connected to emotion and sensing rather than quantitative observing, and its effects on reality are indirect. These implications are in some way iconic of issues surrounding discussing improvisation in an academic discourse, including the issues with theorizing, analyzing and transcribing improvisation.

Ghost Structures in Music

For the purposes of this study, I define ghost structures as referential structures that have indirect and elusive effects on the music that is being performed in

relationship to them, while being central to the music-making process. The referential structures may be inaudible, or in other ways hidden or implicit. They may also be audible, or move into or emerge out of inaudibility. The primary definitive characteristics are that they exist in the performer's imagination, they are used implicitly by the performer, they are or become hidden, and are in some way fundamental to the music-making process. Ghost structures open pathways in discussing form in improvisation in a new way, and expanding our understanding of the unique artistry and processes that go into performing improvisational music.

The concept of ghost structures shares similar characteristics with Jeff Pressing's *referent*, "an underlying formal scheme or guiding image specific to a given piece, used by the improviser to facilitate the generation and editing of improvised behavior on an intermediate time scale" (Pressing, 1987). It's a foundational structure based in musical or sonic material from which — and against which — other materials are related. In addition to those characteristics, ghost structures are not solely pre-existing and can emerge out of improvisation. They are not only musical forms, but can involve the spectral dimensions of sounds (i.e. overtones). They can be undefined and contain indeterminate aspects, and be expressed through emergent textures between instruments.

In reality, there is often more than one *ghost* structure in improvisation. Improvisation can be described as a liminal process of engaging with multiple kinds of

ghost structures, such as an underlying meter, a hidden pulse, a motivic *referent* or multiple motivic *referents*, or materials integrated from others' playing; all with elements of elasticity and definition. Using this term enables a conversation of the interactive, transformative and fluid relationship between overlapping reference structures in improvised music. For example, we can formalize some of the more elusive aspects of improvisation: an elastic temporal cycle can be analyzed as a product of liminal relations between two ghost structures, rhythmic elements of one ghost structure become translated onto a melodic ghost structure, an iterative rhythmic texture can be explained as a product of cyclic ghost structures at different timescales, and so forth. These aspects are more fully discussed in Chapter 5.

The concept is also connected to *contrafact* in composition, in particular in jazz composition. This term refers to a new composition that is built on top of one or more layers of an existing composition. A common example of this is the use of George Gershwin's *I've Got Rhythm* (1930) harmonic structure for other compositions, such as Charlie Parker's *Anthropology* (Owens, 1996:17-19). In composing upon a *contrafact*, the underlying composition functions as a background scheme upon which a new structure is created, essentially forming a palimpsest. While the use of *contrafact* is a compositional device, it also facilitates an engagement with the past (i.e. through memory of hearing the original work) and the present simultaneously, conflating the two temporalities within a single time plane.

Sean Smither introduced the idea of *avant-text*, building upon Pressing's concept and expanding on the idea of *contrafact*. His term is borrowed from the field of genetic criticism, in which it denotes "a network of sketches, edits, and drafts that represent the genesis of a text." (Smither, 162) Applying this to music, Smither describes the process of accumulation and decentralization a single work in the jazz cannon may undergo through its subsequent interpretation by numerous artists and their individual *signifying* on past versions.⁷ *Avant-text* is an accumulation of past performances, including both the original material and its re-interpretations, as it exists in the performing musician's mind in the creative moment. Compared to the palimpsest quality of the *contrafact*, the *avant-text* has a network structure; modular in nature, and composed of elements from multiple temporalities assembled in more elastic manner during improvisation.

Beyond jazz, a ghost-ness can be traced in inherent and implicit musical structures in non-western musics. Two important examples of this are Marc Perlman's study of the concept of *unplayed melodies* in Javanese gamelan (2004), and Gehrard Kubik's study of *inherent patterns* (1962) in Ugandan Amadinda court music. In both cases, the terminology represents a musical structure that "emerges" or rather has the potentiality to be "heard" from the sum of multiple performers' parts playing together,

⁷ See Henry Louis Gates Jr. on the principle of "signifyin(g)" in Black literary and musical aesthetics (1988: 52). S. Smither describes the musical aesthetics of "signifyin(g)" as "revision, ambiguity, transformation, indirect commentary, and repetition with a difference" (2021: 160).

Figure 23 - Gerhard Kubik's example of inherent rhythms in the composition "Basibira malaika" (1962: 35)

but is not present in any one part. An *unplayed melody* is a theoretical idea that Perlman explores in a comparative study of several Javanese gamelan teachers' works as well as in Indonesian culture and philosophy, and to cognitive aspects of music-making.⁸ The concept — though never singularly defined — relates to a guiding melody in the middle register around which the multi-part orchestration is constructed, which can be hummed by the performers (2004: 17), emergent from hearing all the parts altogether, or derived from a *balungan* melody (e.g. "skeletal melodic outline" played by mid-register instruments). The *unplayed melody* is elusive and fluid, but at the same time it is central to the music-making process and to the identity to the piece. These two characteristics make it an example of a *ghost* structure.

⁸ Gamelan is a multi-part, contrapuntal, percussion-based ensemble and can also describe a genre of contemporary works for such ensemble practiced in Indonesia and Bali.

Kubik's *inherent melodies* or *inherent rhythms* are psychoacoustic phenomena. They are musical patterns that emerge from listening to multiple interlocking parts, neither of which actually containing those patterns. He describes them as "rhythm patterns which automatically emerge from the total musical complex, delighting the ears of both listeners and players, but which are not being played as such" (1962: 33). Performers and composers are consciously aware of what they, even if they are not played on a single instrument. They are ghost-like; not produced directly, but influential to the music-making process and to the identity of the piece. They have an element of volatility and elasticity — one listener may not hear the same melody as another. Like *unplayed melodies*, they are mid-register, relatively simple and singable melodies embedded within a complex, interlocking, multi-part texture. *Inherent melodies* or *rhythms* are ghostlike in the sense that they exist fleetingly in the audible sound and not in any single part; they emerge from the performance. It's a specific case of ghost-like structures that differs from the definition that stems from referents and underlying structures in jazz practices. For this reason, it's useful to delineate between hidden referents that emerge after-the-fact, such as *inherent melodies-rhythms*, and the ones that involve retrospection and memory, even if they are created within improvisation, such as referents. The latter is the definition I am working with in this dissertation. It's important because of their engagement with memory and polytemporality.

Ghosts in Craig Taborn's Works

My use of the term *ghost* resonates most strongly with the contemporary concepts of the African American pianist, improviser, and composer, Craig Taborn. The *ghost* theme is present throughout his work, through song titles like "Saints," "Silver Ghosts," "This is How You Disappear," "Phantom Ratio", "Daylight Ghosts", or "Shadow Plays." Taborn's ghost symbolism can be connected to several distinct elements: ritual music, liminality, memory, and listening. Taborn says that this theme reflects his desire for engaging with the "spaces beyond", the "unknown", in the similar way that music functions in traditional cultures' ritual and liturgical practices (Paulson, 2018). His work creates a bridge between the role of referential schemes in African American classical and experimental musical practices and psychology, culture, and acoustics.

The vehicle is the sound itself. Taborn says that "listening to the sound die away can take you there": into a liminal space. In the process of listening to a sound die away, the memory is engaged. One is remembering what the sound sounded like, or what the melody sounded like, after it fades away. Taborn points out that as a musician plays a note, that note is gone, and the next note is influenced by the memory of the previous note. This memory "shifts and alters" even in the process of recalling the past of what he or she has just played. Specifically talking about improvisation, the musician is engaging with these memories of sounds and melodies that have just passed, as if they

were real and animate. This recursive (e.g. looking back into the past), liminal, and change-ing relationship between the memory of a sound and the present during improvisation is an essential aspect of what Taborn calls the “ghost”. It is the memory of sound passing away, the imagination engaged through that process, and the engagement with the unknown.

Taborn’s concept resonates with Oliver Sacks’ research on music and memory: “When we “remember” a melody, it plays in our mind; it becomes newly alive . . . We recall one note at a time and each note entirely fills our consciousness, yet simultaneously it relates to the whole.” (Sacks 2007: 227) In engaging with memory there is a process of re-animation. Whether this is a process of acting with an animate entity or reanimating the decayed is not certain, but regardless, the translocalization of the entity out of the audible domain activates its inner life. There, it exists slightly differently, with greater elasticity perhaps.

There is a parallel between the process of engaging with the memory of passing sounds within an improvisation, and the process of engaging with underlying composed referent structures. When the performer improvises on a referent structure, there is ultimately an ebb and flow between remembering, forgetting, re-formulating, and referencing, regardless of whether the referent is improvised or composed. Both subjects can become ghosts. Their ghost-ness is facilitated through the freedom of the performer to engage with the memory — and imagination — even as it transforms, and

for that transformation to become materialized in the music. While the ghost structure can come from composed or improvised material, the freedom of improvisation as a performance mode is a key element in engaging with it in a way that facilitates its *aliveness*. A ghost structure is ultimately alive; it's shape-shifting.

The idea of ghost structures is indebted to Taborn's artistic practice, but because his ideas have not been fully engaged with in the scholarly domain, this chapter and others explore its resonances with other disciplines and other works. Taborn's ghost resides somewhere in the relationship to the memory of sound or melody, engaging with its aliveness and alteration in the realm of imagination, and the liminality in listening (e.g. liminality between sound and silence). Relating to reference structures in the music-making process often has the same quality; the referents are actually not fixed, they facilitate movement between repetition — remembering — and exploration — imagination. They remain implicitly influential of the music being made while being absent; they lead to liminal spaces and liminal experiences. Taborn's concept includes compositional material and also improvised material that is just being created. This step is crucial in talking about reference structures that arise out of improvisation. As opposed to the delineations of the concepts of *referent* or *avant-texte*, a ghost structure can emerge within improvisation and can function as a foundation for subsequent improvisation.

There are thus two strands of thought that make up the idea of ghost structures, and are significantly different from one another. Taborn's ideas draw a connection between musical material that had just been created in real time, and its formative influence on the material that is played into the future. The relationship between two is dialogical; the present recurrently refers back to the past, which shape-shifts increasingly more with time, and acquires an animate quality, generating new reformations in the present. The relationship is also liminal; the point of passing away beyond the threshold of audibility engages the imagination. The new material is — or can be — based in the traces of the past material.

On the other hand, the concepts of referents, contrafacts, and *avant-textes* have stronger formal connotations and point to specific musical materials. They are, for example, rhythmic schemes, melodies, or fully through-composed pieces. The integration of the two strands is much more clearly manifested in Taborn's composed music, discussed later in this chapter, which features what Antares Boyle describes as *flexible ostinati* (i.e. ostinato patterns with strong polyrhythmic aspects that bend the lines between repetition and development).⁹ The idea of obscured and variable cyclic patterns around which new material is created, and which are referenced in elusive and

⁹ A. Boyle describes *flexible ostinati*: "...they comprise a repetitive, omnipresent stream within the overall texture, provide a rapid isochronous pulse, and imply higher-level metric levels... In the material domain, flexible ostinati are often varied significantly across repetitions, while in the interpretive domain, they simultaneously suggest multiple possibilities for pulse, meter, or cyclic beginning/ending." (Boyle 2021)

abstract ways, as well as their integration with emergent, improvisational ideas that come about, is at the center of where these two contrasting strands of thought come together. At the same time, there are numerous other ways in which the two can be integrated, but these lie outside of the scope of this dissertation.

Hauntology and Beyond

Lastly, the subject of ghost structures in music, specifically regarding the idea of temporality, is also illuminated by discourse surrounding hauntology. Jacques Derrida invented the term *hauntology* specifically to discuss the “spectre” of Marxian ideality (Derrida, 1994). While this term was perhaps a passing linguistic play in support of a greater argument, it has been appropriated by cultural theorists in various different ways to discuss the metaphor of haunting. For this research, the idea of the haunting properties of ghosts are less important than their relationship to time and experience on a phenomenological and conceptual level. Buse and Stott discussing Derrida's notion of hauntology, write:

Ghosts arrive from the past and appear in the present. However, the ghost cannot be properly said to belong to the past.... Does then the 'historical' person who is identified with the ghost properly belong to the present? Surely not, as the idea of a return from death fractures all traditional conceptions of temporality. (Buse and Stott 1999:11)

Ghosts create temporal warps. They rub against the western concept of temporality as a linear, measurable phenomenon. They suggest a temporality that is not quite in the past, or the present; it is liminal. Ghosts connect to the past, but not to a specific point in time. Instead, the temporality they suggest is more akin to the way *avant-textes* function: traces of multiple layers of time accumulating in a single being to produce a semi present, semi imaginary experience. In the same way Derrida uses the concept of the *spectre* to disrupt the notion of linear, chronological time in Western conceptualization of it, the idea of ghosts as underlying, hidden structures in music undermines certain Western musical biases towards linear time and linear musical relationships, and their expressions in notation, composition and analysis.^{10 11}

In anthropology, there are many directions into which studies of ghosts and spirits have gone. They have been discussed in the context of studying their embodiment of a specific larger cultural and religious framework, in the contexts of spirit possession and trances that accompany ritual performances (Judith Becker 2004), as symbols of sociological and political movements in certain specific regions and time-periods (Aihwa Ong 1987), or in relationship to processing traumatic events (Hoenik

¹⁰ To describe Western musical thought as only linear would be to disregard all the levels at which it is cyclical; the use of repetition brackets, the repetitive qualities of *sonata* form, the recurrence of motifs. However, the effects of “Western” thought at large on other “non-Western” cultures in America is in part manifested through a superimposition of linear approaches to time flow on other approaches to time flow.

¹¹ Similarly, ghosts also disrupt rationalist ontology. Colin Davis writes “Derrida’s spectre is a deconstructive figure hovering between life and death, presence and absence, and making established certainties vacillate. It does not belong to the order of knowledge.” (Davis 2005: 376)

Kwon 2008). Anthropologist Patrice Ladwig writes more broadly about the subject: “located in a realm that is often between visibility and invisibility, present and past, and between the material and immaterial, the oscillation between these poles constitutes the framework in which the agency of spirits unfolds.” (2013: 428) Her words resonate with the approaches in *hauntological-y* oriented discourse mentioned earlier; the metaphor of ghosts challenges the notions of known and unknown, present and the past, and in order to explain them we end up building pathways between these contrasting realms. Nevertheless, Ladwig reminds us to also observe the ghosts not purely metaphorically, but also as who and what they are. She writes:

Before we construct more abstracted representations and interpretations, it is worth keeping in mind that ghosts can be beings with desires, with taste, with biographies. They appear in specific ways at places at a certain time; they slip into objects, they live in them, they consume things, leave material traces and demand a certain treatment as social beings. (Ladwig 2013: 428)

In this realm of ghosts’ existence, there are processes which relate to the musical ghost structures. On one level, each foundational musical structure has in some sense a cultural identity and origin, similarly to a ghost’s biography. Some structures appear to be more clearly identifiable while others can seem more culturally elusive and even wholly *new*, but whatever the cultural and historical connections are, they are contained within the structure. We can see this in, for example, the ability of *avant-textes* to carry the traces of past musicians’ who have performed a particular piece.

On another level, the ability of ghosts to transmute into other objects is also comparable to how a referent structure can become integrated into other musical structures. In particular in the case of improvisational relations to ghost structures, as one part of a musical whole is removed or inaudible, there is a space for other, new materials to become added around its absence. While the removed part — the ghost structure — is inaudible, it remains alive through its influence on the audible parts for as long as it has informed the structure of the audible parts, or it remains in the improviser's imagination. In essence, it transmutes into and continues to live through what's created in relation to their absence.

Additionally, the transmutational process also reflects the phenomenon of multiple motifs integrating together in improvisation. There's scarcely only a single ghost structure in improvisation. As improvised material accumulates, multiple motifs from multiple points in the past may become integrated. The rhythmic qualities of one may combine with the melodic qualities of the other. In such case, we can speak of one as a ghost structure that transmutes into the other. The ghost metaphor is useful here, because it allows us to speak of the "identity" or "spirit" of the past structure living through and being preserved in the new structure. It allows us to trace the journeys of such traces, and hypothesize about what stories they tell about culture or temporality. Because of that, we can also analyze improvised works in a way that still shows formal connections similarly to western music analysis, but which also has the free and poetic

aspects of phenomenological analysis, without relying solely on the subjective domain of the listener's or performer's perspective.

The orientation towards the past in Taborn's concept and in the ghost metaphor in cultural discourse, paired with a cyclic approach to time in performance of underlying structures resonates with indigenous approaches to temporality. For example, we can see this in the Maori-Scottish-German artist George Nuku's description of Maori concept of space and time. He describes it as *moving backwards on a spiral path with our backs towards the future and our faces to the past... as we regard the past, it unfolds in front of our very eyes, forming our sense of reality*.¹² In effect, one is moving backwards into the future. Speaking more broadly, in Maori culture the orientation towards the past is a source of knowledge and strength for approaching the future. The past is something to be in dialogue with continually. Taborn suggests a similar process, while Marx talks about the traces of the past living through systems created in relation to them. In many "non-western" cultures, the orientation towards the past is a source of knowledge and strength for approaching the future.

In certain strands of free improvised music and for certain improvising artists, the process of looking back is eschewed by the ethos of being fully and completely in the present to the point of actively resisting retrospection. At the same time, there is

¹² From the interview with George Nuku on *First Voices Indigenous Radio* broadcast hosted by Tiokasin Ghosthorse, May 21, 2021. <https://firstvoicesindigenousofradio.org/program/20210604>

something about retrospection that is valuable. On the level of cultural signifying, the process and practice of retrospection in improvisation opens up the vocabularies built around recurrence and retrospective creation of structure. It also opens up the larger processes, such as the engagement with memory or engagement with the history of a particular musical subject that can lead to an embodied polytemporal experience. As this engagement is unlocked, multiple temporalities from the past accumulate and start to interlock and fuse together. Musically, the experience of this process is deeply engaging on a phenomenological level, going beyond what it represents conceptually. It's an artistry and technique of its own, outside of the virtuosity of *Western* performance standards that emphasize execution and speed, and exists uniquely in the domain of improvisatory practices and real-time composition.

Synchronous and Diachronic Relations to Ghost Structures

In the following sections, I focus more acutely on the formal and technical aspects of ghost structures.

For the purposes of organizing the analyses in this dissertation, I separate the ghost structures on the basis of the way they are related to in time into two categories: synchronous (e.g. vertical) relations to ghost structures and diachronic (e.g. horizontal) relations to ghost structures. Synchronous relations describe ways of referencing

underlying cyclic structures synchronously with the cyclic structures happening; in a way stacking new or variational material on top of them.¹³ A simple example of this is improvising on a cyclic ostinato pattern, while the ostinato pattern is either played, or continuously imagined by the performer. Its exo-structure (e.g. meter) remains intact, but its endo-structure (i.e. internal content) is varied.

In Figure 24, the blue box represents a particular ghost structure repeated twice. The dots represent the rhythmic units that make up the ghost structure, and the dotted lines represent where they are in relation to what the improviser is playing. The top line in black represents what is improvised in relation to the ghost structure. We can see that the improviser is shifting the placement of their notes around the reference placement, sometimes anticipating, or sometimes omitting. There can be any degree of abstraction as long as the cycle is imagined underneath and synchronously with the improvisation.

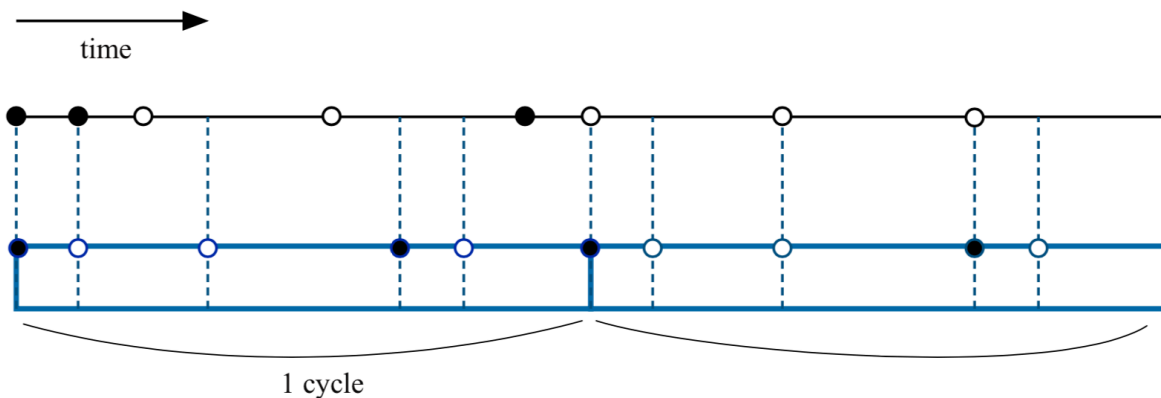


Figure 24 - Example of synchronous relations

¹³ Examples of ghost structures that traditionally elicit synchronous relations include *isorhythms* in Renaissance European music, *tala* rhythmic patterns in North Indian classical music, *time-lines* in Afro-diasporic musics, or 12-bar form in the blues.

This process resembles creating a palimpsest, and can involve many layers of ghost structures that are being referenced on top of one another, as I will discuss in the analysis of Thelonious Monk's *Evidence* later in this chapter. Just as in a palimpsest drawing, multiple tracings in multiple points in time are placed upon a single page, vertical relations are juxtapositions built upon a single temporal architecture. In such premise, some of the ways complexity is created is by referencing longer cycles, or by grouping cycles into longer sequences. The musician's expertise is in their ability to internalize these ghost structures, *geolocating* oneself in them as pianist Nik Bärtsch says. Furthermore it can lie in developing improvisational vocabulary through practice of creating patterns on top of multiple cycles (for example, see drummer Ari Hoenig), of moving into rhythmically liminal spaces (i.e. polyrhythms), or of superimposing nested rhythms or timeline-based improvisational vocabularies (Guerra 2019).

Diachronic relations describe linear connections to referent structures, where the variation or reference is temporally separate from the ghost structure and does not happen in conjunction with the ghost structure.¹⁴ In continuing the palimpsests metaphor, a diachronic relation is created by drawing the same image from memory on another sheet of paper as opposed to drawing on the original sheet of paper. Their connection is exposed by looking at both drawings side by side. In music performance,

¹⁴ Examples of ghost structures that traditionally elicit horizontal relations include the *rag* in North Indian classical music or the *leitmotif* in western classical composition.

diachronic relations exhibit higher degree of freedom; the exo-structure (i.e. the temporal envelope of the referent) can change, the endo-structure (i.e. the internal elements) can change, and the connections can be made over longer periods of time. This kind of referentiality leads to processes like *misremembering* that Taborn alludes to, where a memory of a melody changes in one's mind and when one plays it again, it may sound different; a tone may be added, the duration may change, it may be in a different register or scale. Thus these relations accompany changes in multiple musical dimensions: harmony, rhythm, timbre, etc.

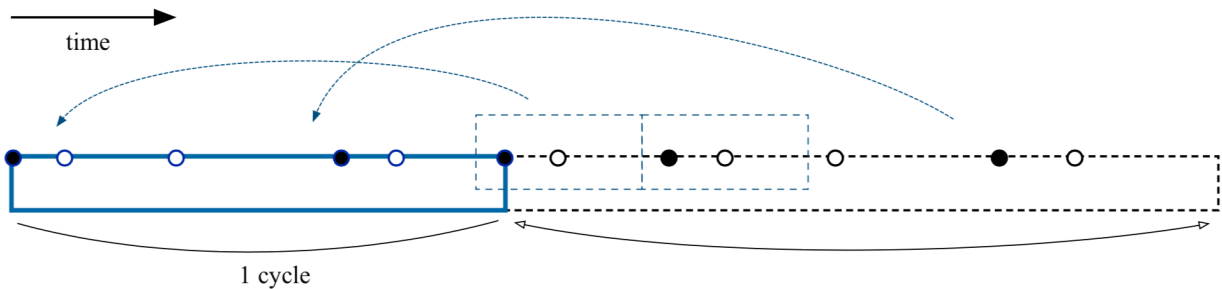


Figure 25 - Example of diachronic relation

The example in Fig. 25 shows how a ghost structure may be referenced diachronically. The ghost structure is represented in blue and the variation in black. The arrows show retro-active connections between the new material and the reference structure. The variation uses the same rhythmic values from the ghost structure, but repeats one of its component phrases, which in turn extends the whole phrase beyond the duration of the original. As is shown above, in this process, we can often see that the units or formal identifiers that make up the ghost structure become especially important

in creating a sense of referentiality. Improvisational practices involve the incorporation of the materials of the ghost structure into one's improvisational vocabulary, and the ability to work economically with those materials to construct continually changing and *new* forms. While in synchronous relations, the improviser or composer is mentally oriented towards referencing the time-points of the ghost structure (i.e. its temporal architecture), in diachronic relations, the improviser or composer is oriented towards referencing the building blocks of the ghost structure.

Both of these categories are theoretical, and do not describe two different kinds of improvisation or different kinds of ghost structures. In many of the analyses in chapters 2 and 3, there are both synchronous and diachronic relations present at the same time. Furthermore, improvisers and composers generally relate to a multitude of ghost structures simultaneously, some of which are vertical and some of which are horizontal. These include, for example, the pulse, the meter, the underlying referent rhythmic pattern, a central melody, the emergent improvisational referents, etc.

However, such organizational distinctions are helpful because they allow for exploration of different kinds of notational tools and for more systematically discussing the improvisational and compositional techniques that are closely related to one or the other. At the same time, the recognition of these two processes as both examples of cyclicity is important in creating the argument that ghost structures appear in music

that is not cyclic in traditional way. In this chapter, I discuss relations that are primarily synchronous.

The following section is based in tracing and analyzing ghost structures in musical examples, discuss their temporal and rhythmic features, and in the process developing notational schemes and tools for their representation. I trace several examples of ghost structures in the works of Thelonious Monk, Steve Lehman, and Craig Taborn. I discuss how they are functioning as ghost structures through primary vertical relations and how they build upon the ideas of *contrafacts*, *referents*, and *avant-textes*. And in each example I take a creative approach to transcription in order to arrive at tools that are useful not only for analysis, but also for composition.

Thelonious Monk's *Evidence*

Monk's music is about the experience of music — about itself; as Hersch says, it is “about a rhythm or motive or two.” (Solis 2008: 39)

There are two kinds of ghost structures that can be observed in Thelonious Monk's *Evidence*. In this case, *Evidence* is an example of a composition created on top of an existing composition. Monk uses the chord structure of an earlier standard, *Just You, Just Me* by Jesse Greer. The harmonic changes are almost identical, with a few

exceptions.¹⁵ Monk's approach to composing over changes in a standard has been a common practice in jazz composition, used for example, by Charlie Parker in *Snapple from the Apple*. It reflects the real-time compositional artistry of the jazz musicians of that time when improvising over chord changes translated to composition. Monk's original title for Evidence was *Justice*, which has been interpreted as a play off of *Just You, Just Me*. At the same time, there is a clear oppositionality in the way the two titles compare, one being a lighthearted love song, and the other being more sobering in its allusion to ethics and law. In contrast to the older *standard*, the melody and the rhythm are very different. So much so that it could be argued that the musical relationship too has an oppositional quality.

Evidence not only fills in the empty spaces in *Just You, Just Me*, but it also has a markedly uneven rhythmic profile, which was uncommon for even the modernist jazz compositions of that time. The rhythmic values of the A section have an interesting numeric-temporal profile. Landing on the first off-beat eighth-note, the sequence of note durations that follows is: 7 5 6 7 2 5; 7 4 6 5 2 7 (numeric values are in eighth notes). These rhythms are, on one hand, reminiscent of later composers, such as György Ligeti, in some of his piano etudes. On the other, they call to mind additive and subtractive rhythmic improvisatory processes, which can be heard in, for example, in North Indian

¹⁵ Ends of phrases end on the V7 chord, instead of resolving back to I. Bar 5 in the A section has A7(b5), which is a tritone substitution of the original Eb7. In bar 6, the Ab-7 is a parallel minor to the Ab major 7 chord in the original.

classical music. A larger temporal - rhythmic interval is subdivided into various smaller, often odd, groupings.

The second kind of ghost structure can be traced in the way Monk improvises over the rhythmic-melodic structure set in *Evidence*. On a recorded live performance on the 1958 album *Misterioso*, he furthermore displaces and re-structures what he sets out as the rhythmic profile within the improvisation, taking segments of one to three note-long phrases that reference the original melody, and placing them in alternative spaces in the overall structure. The foundation of *Evidence* functions as an invisible and unheard reference point, as it would in any kind of improvisation within the jazz tradition. What's interesting, however, is the rhythmic values with which Monk improvises. In the performance, Monk is the only one of the quartet who uses and re-structures the rhythmic profile of the composition in the solo section. The saxophonist, Johnny Griffith, on the other hand, seems to improvise in closer melodic referentiality to *Just You, Just Me* (possibly in response to Lester Young's recording of the standard), and his solo features very little of the odd and asymmetrical rhythmic elements, instead favoring fast, melodic runs and symmetrical phrase structures, and melodic quotes of the earlier melody [3:15]. The way Monk improvises paves a way for a less idiomatically-centered approach to improvisation, which is to use the rhythmic and contour elements of the composition as its main ingredients. It places more emphasis

on the language of the composition, and less on the more historical referentiality that Griffith's improvisation exemplify.

A section

Just You, Just Me

Evidence

[7:30] Monk's solo

anticipating

anticipating

anticipating

aligned & shortened

5

anticipating

aligned

anticipating

9

delayed

anticipating

anticipating or aligned with bar 4

aligned

anticipating

anticipating

with drums

13

anticipating

anticipating

2 B section

17 $B\flat m^7$ $E\flat^9$ $A\flat^6$ $D\flat^9(\#11)$ $D\flat^7$

$B\flat m^7$ $E\flat^7(b5)$ $A\flat^{\text{maj}7}$ $A\flat m^7$

8

10[♩]

7[♩] 9[♩] 7[♩]

delayed & integrated delayed shortened delayed delayed etc.

elongated shortened elongated

21 $E\flat^6$ G^7 Cm^7 F^{13} $B\flat^6$

$E\flat^7$ $Gm^7(b5)$ F^7 $B\flat^7(b5)$

8⁰⁰⁰

9[♩] 9(4+2+2+1)[♩] 3[♩] 9[♩]

delayed delayed anticipated

A section

25 $E\flat^6$ C^7 Fm^7 $B\flat^7$

$E\flat^{\text{maj}7}$ Gm^7 C^7 Fm^7 Fm^7 $B\flat^7(b5)$

7 5 6 7 2 5

6[♩] 8[♩] 4[♩] 3[♩] 7[♩] 10[♩]

29 $E\flat^7$ $A\flat^6$ $D\flat^7$ $E\flat^{\text{maj}7}/B\flat$ $B\flat^7$ $E\flat$

A^7 $A\flat m^7$ $D\flat^7$ Fm^7 $B\flat^7(b9)$

7 4 6 5 2 7

4[♩] 7[♩] 4[♩] anticipated

Figure 26 - Transcription of Thelonious Monk's *Evidence*

In many ways, Monk paved the road for how current creative music composer-improvisers are creating; the experimental rhythmic materials that are built around an implicit groove, the intertextuality embedded in the composition, the emphasis on sound as a building block of harmony and technique, and the economic, compositional approach to improvisation.

The transcriptions above experiment with visual superimposition of the *contrafact* composition - *Just You, Just Me*, the primary composition — *Evidence*, and Monk's improvisation within one complete cycle of the form. They show how Monk may have been engaging with the two materials from two distinct points in the past.

The superimposition shows how important the negative space around each of the three iterations is. Rhythmically, Monk composes the melody of *Evidence* primarily in rhythmic contrast to *Just You, Just Me*. In the improvisation, he seems to play off the rhythmic and contour structure of *Evidence* and the empty spaces it leaves. There is frequent anticipation — playing “just before” a reference note — in the A section, and delay — playing “just after” a reference note. In both cases, the variation is grid-based. Both processes express a close referentiality of the underlying composition's rhythmic profile. Through playing “around” the profile, Monk is bringing it alive; he is reinforcing its existence. It suggests that he is imagining the underlying melody while he is improvising.

This analysis shows one way of applying the metaphor of a ghost structure to musical structure and transcription. In the performance of *Evidence*, there are elements of both *avant-textes* in Griffith's referentiality of *Just You, Just Me*, and real-time referentiality to the rhythmic-melodic structure of *Evidence* in Monk's improvisation.

Steve Lehman's *Echoes*

The following analysis explores traces the ghost structures in Lehman's work, which is created in dialogue with his research into the intersections of spectralism and afrological improvisation (Lehman 2022). The idea of tracing a ghost structure in a spectral compositional process differs from the previous analysis of *Evidence*. I discuss some of the harmonic dimensions, structural aspects, and the rhythmic vocabulary in the work as examples of a hidden referent relates to a larger compositional vocabulary.

In Steve Lehman's "Echoes," (from *Travail, Transformation & Flow*, 2009) the primary ghost structure used in his compositional process is the spectral profile (i.e the overtone spectrum of a sound over time visualized on a spectrograph). This process works quite differently from the previous analysis. Drawing on this practice in the works of French spectral composers, such as Grisey and Murail, Lehman recorded the spectral profile of a low vibraphone note, and then structured the harmonic "changes" in the piece based on the overtones that are the most audible. These are the pitches of the first chord at measure 1, and their relationship to the fundamental [E-1]:

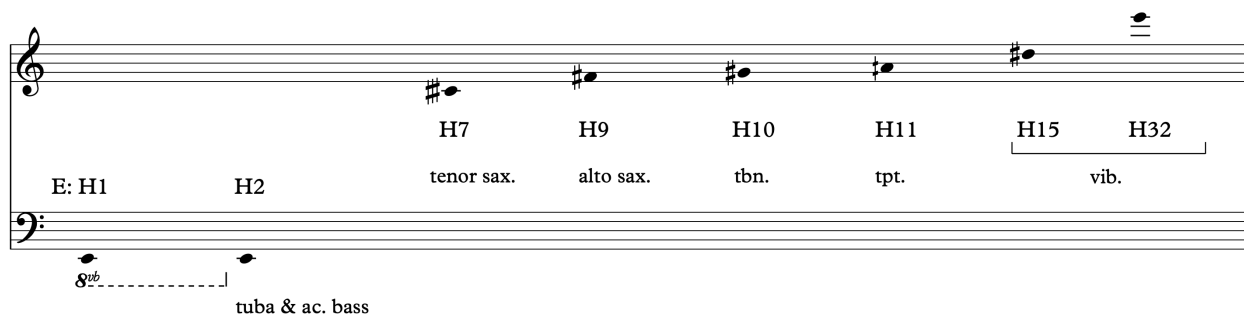


Figure 27 - Pitch collection used in measure 1 in Steve Lehman's *Echoes*

The resultant chord of this collection is an E major chord with both b7th (lower register) and #7th (higher register), 9th, half #11th, and the root doubled in the high register. A chord that Lehman points out in Thelonious Monk's vocabulary (Lehman 2023). In this example, the pitches are organized spatially with respect to their natural order in the harmonic spectrum, with no or very little transposition. It is likely, nevertheless, that the low vibraphone note (41.2 Hz) that was recorded was actually transposed down. It is a double-ghost, in a sense, because it's never played by the vibraphone, and it doesn't even exist on the instrument, and yet it creates the main structural idea used throughout the entire composition. It's a true ghost in that it is not audible in the piece, but its influences are heard.

Looking at Lehman's organization of the pitches, one can see an interesting symmetry, where the notes at the outer ends of the register are spread further apart, and the the notes in the middle are closer. This is something that characterizes almost all the chords. In part, it's due to the effective use of the 7ths and 9ths in the vibraphone above all the other instruments, making the vibraphone itself sound microtonal at times, and in the close voicing between the four horns in the ensemble. Additionally, the frequent placement of a doubled root as the highest note of the vibraphone completes a harmonic model that contrasts the standardized approach to voicing in jazz, and in romantic classical harmony, where the upper voices generally outline the further extensions of

the harmony (11th, 13th, et. al.). Instead, Lehman’s voicing — and that of the vibraphone’s spectra — is palindromic.

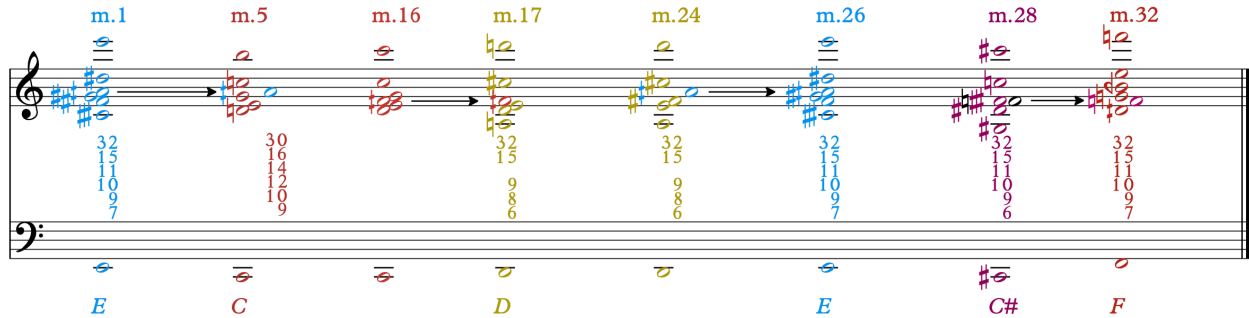


Figure 28 - Harmonic progression in measures 1-32

Figure 28 shows a visualization of the chords in the registers in which they are played differentiated by colors depending on their fundamentals. The numbers denote the partial numbers, using figured bass notation. The prime partials are in their first occurrence in the harmonic series, while the non-prime partials are higher occurrences of fundamental partials: 10 ~5 [M3rd], 9 ~3[P5th], 32 ~2[1]. Each chord has an almost symmetrical construction: generally a cluster of seconds in the middle, a mid-size interval such as a fourth below and above, and a larger interval to the top and bottom. However, not all of the chords involve the same partials. Their distribution in space changes, in particular when one chord is repeated for a number of measures. It’s at once an iterative harmonic technique, and also an extension of the spectral process unfolding. When playing the same note twice on any acoustic instrument, it is likely that different

partials come into foreground, and some fall into background, especially with changing dynamics.

As Lehman writes, the way he transforms from one harmony to the next is through the use of pivot notes or common tones around which the harmony re-rotates; usually single pitches that are shared by the two chords. In the case above, the pivot note doesn't always fit into the harmonic spectrum of the new chord, and in those moments it changes in the following measure. This can be seen as a suspension, or an echo, of the earlier frequency.

The concept of the echo in the piece is another kind of ghost structure-process; a process of ghost-becoming. The first measure of 6/4 is followed by what Lehman calls an echo; a measure of 5/4, in which the same harmonic material repeats at a slightly different periodicity, quieter dynamic, and for a shorter duration. In their many occurrences, echoes are sometimes shorter, and sometimes longer than the non-echoes, and sometimes it becomes difficult to tell what is an echo and what is not. The density of the instrumentation usually decreases at each subsequent echo, creating a sense of the sound fading away. This is further emphasized by the accent on the downbeat impacts that start off each measure.

While Lehman doesn't write about this specifically, it seems that the rhythmic structure he's using is related to the sonic character of the vibraphone, although not in

terms of frequency alone, but in terms of any oscillation that may occur in its decay. For one, the vibraphone has a motor that creates volume oscillations at different rates. The sound itself, too, involves beating between partials and strong enharmonic overtones.

The construction of the entire piece uses equal subdivision of each measure into 8, 4, or 2 equal parts, sometimes multiple that are played simultaneously by different instruments. This way, there are almost no written rhythms that don't have a steadily repeating periodicity within a given measure (besides the drum part, the improvisations, and the through composed individual interjections). For example, see Figures 29a and 29b.



Figure 29a - Representation of rhythms in measures 3-4



Figure 29b - Representation of rhythms in measures 19-20

Figures 29a and 29b show how each measure is subdivided into two polyrhythmic parts. The transcription represents rhythms played by the horns in the top voice, which

subdivide each measure into four or eight equal parts, and the rhythms played by bass & tuba in the lower voice, which subdivide each measure into two equal parts, relative to what the meter is. Lehman connects this technique to the *afrological* aspect of his compositional practice; the division of any measure into two isochronous parts. This technique is also audible in the music of Craig Taborn, and other contemporary jazz-adjacent musicians. We can also relate this back to the harmonic series, where each fundamental repeats an octave above with a doubled periodicity of oscillation. What Lehman does through these several different ways, is to show a pathway between physics of sound and music that relates the barely audible — the “liminal” — to the audible sound, and compositional structure in both the rhythmic and harmonic dimensions.

Craig Taborn’s *Future Perfect*

In the following section, I discuss a recording of a work, *All True Night / Future Perfect*, which oscillates at the edge of composition and improvisation, composed by Craig Taborn (2013) and performed by his trio. I focus primarily on *Future Perfect*, which occurs at the second half of the recording. In discussing the work, I first walk through its emergence from a perspective of a listener. I discuss the improvisational processes; their formal aspects, and their relation to the composition. I trace the ghost-like qualities of how the composition functions in this performance and experiment with their

implications for notation. I analyze the rhythmic qualities of the composition in demonstrating the qualities that make it an effective structure for improvisation.

The structure of *Future Perfect* emerges gradually over time, as if from thin air. Its arrival retroactively contextualizes everything that has led up to it. The recording begins with another composition, *All True Night*, that emerges from and subsides into improvisation in the first five minutes.¹⁶ In between minutes five and eight, the trio of Taborn, Thomas Morgan, and Gerald Cleaver transitions from this as the primary ghost structure into the harmonic and rhythmic language of the second structure, marked primarily by its unique temporal profile. The transition is most clearly established at [9:26], when Morgan begins playing the bass-line of *Future Perfect*. Even so, once audible, the group references the structure only loosely, it remains to be collectively abandoned and returned to, while remnants of the first structure are very gradually abandoned altogether.

At the same time, the rhythmic-temporal profile of the new structure (speeding up and slowing down) remains and functions as the key reference point until the end. Since we [the listeners] are not yet familiar with the “head”, what is most audible is the abstraction - or the ghost - of its temporal shifts. It’s as if a speed dial was turned up and down on a group deeply engaged in free improvisation, with all three musicians

¹⁶ The recording used for this analysis is the piece “All True Night / Future Perfect” from the Craig Taborn Trio - *Chants* album (2013, ECM).

moving in tandem. This perceptual trick is further aided by our memory of the first composition as the primary referent, knowing little of what's yet to come; there is no "primary memory" established of the second composition. In this transitory period, Cleaver plays in reference to both the written structure played by Morgan and Taborn's elastic improvisation on top.

Each one of the improvisors' approach to the ghost structure is different. Cleaver's approach can be described as throwing pebbles on a lake, hitting the rhythmic anchors every once in a while. He moves in between what the other two musicians are playing, at times referencing the structure, at times engaging on a faster and free-er rhythmic level with Taborn. Morgan uses displacement, omission and rhythmic-temporal variation primarily, re-structuring the pitches in within the structure. In certain moments, for example, he divides a temporal distance between two structural points in approximately equal steps. His improvisation is closely connected to the composition, a quality which Taborn has pointed out, in the sense of using its inner language and concepts. Taborn's approach is more generative; it is as if he multiplies each of the structural points upward, creating sequences on a faster subdivision level of each temporal zone. His playing expands the contours and harmonic elements present in the structure. He seems to let Morgan dictate the harmonic motion and progression of the pattern and stays away from overtly referencing either of the two written structures in his playing, while keeping tightly in sync with the temporal changes.

The compositional structure of *Future Perfect* is such that it multiple rhythmic and metric interpretations. In one example, the relationship between the two temporal zones can be seen as: a) 2:3 as quarter-note being the primary pulse, or b) 2:3 as dotted quarter-notes being the primary pulse. In Fig. 30a, the smaller subdivision units are eight-note triplets, and in Fig. 30b the smaller subdivision units are dotted eight-notes. The advantage of the dotted quarter division is that all values are sub-divisible on a sixteenth note grid.



Figure 30a - Dotted quarter-note scheme

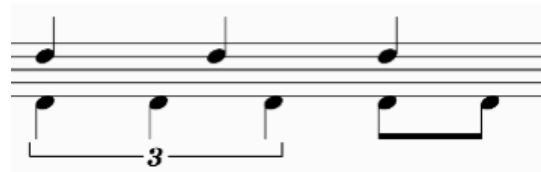


Figure 30b - Triplet scheme

Figure 31 shows a full transcription of the underlying pattern when it appears in a fully audible form at [11:58], using the polyrhythmic framework in Fig. 30a.¹⁷ Much of the pattern aligns with 4/4 meter, which corresponds to what is known about Taborn's compositional process (based on conversations with Taborn's collaborators). The lower line seems to function as the primary temporal ghost structure that grounds the improvisation. The upper line splits each measure in two and its presence makes various points of displacement in the lower pattern audible. In the transcription, I noted

¹⁷ The transcription is an interpretation of the author and may not reflect Taborn's conception of the piece. The top line played by Taborn's right hand is a simplified version of what he plays.

when a polyrhythm (i.e 2:3) didn't align with a quarter-note grid by a displacement value $[D + ()]$, which specifies the amount by which the polyrhythm was shifted.

In this interpretation, the metric division seems disconnected from the way the phrases are grouped. It doesn't correspond to phrase beginnings and endings.

Figure 31a - Transcription of Craig Taborn's *Future Perfect* using a scheme in Fig. 30a

On the other hand, it allows us to see plainly the kinds of rhythmic values that Taborn is working with on one subdivision level. The 2:3 sections create a feeling of a slower tempo. The 1:2 sections create a feeling of a faster tempo. This feeling is emphasized by Cleaver's playing through decreasing and increasing the density of the rhythmic materials he plays in each shift. It's interesting to see that where these tempo shifts

happen is irregular and offset. They appear at mid-measure, or mid-phrase. Both attributes help obscure the sense of when these shifts happen, and allow for an elliptical connection between the two “tempi.”

Let’s consider another version of the same transcription in Fig. 31b, in which the temporal scheme in fig 30b is applied. Here, the whole structure appears in perhaps a more clear and simple way. We can also see recurring phrase structures in measures 3, 4 and 7, as well as a slight symmetry in measures 5 and 8. The rhythm in m. 6 is also a parallel of m. 1, but displaced off the downbeat.



Figure 31b - Transcription of Craig Taborn’s *Future Perfect* using a scheme in Fig. 30b

The metric relationship between the two systems seems compositionally more coherent. The first system seems to be an expanded version of the second system, both using a combination of the following meters: 2/4, 3/4, and 5/4. This structural correspondence reflects Taborn’s concepts of memory; the first system is a kind of re-visiting of the second system with alterations and additional materials embedded within.

On a smaller scale, there are the repeating rising eight-note sequences that appear in measures 3, 4, and 7. In cycling through this form, the listener can easily *lose* themselves in where the pattern repeats itself and where it's adding variations because of these cyclic features. Additionally, in comparing the two systems, the 5/4 meter appears to be one of the underlying temporal schemes to this composition, as 3/4 and 2/3 are both components. The full structure does not align with 5/4, because of the addition 3/4 measure, but much of its component parts combine to make 5/4.

Improvisation

There are several elements in the composition that may function to hold the trio together with the underlying structure even when it is referenced in improvisation. Many of these reflect an afrological approach towards improvisation, as discussed by Lewis (1996) and Lehman (2022). They are: 1) melodic "calls" that function as cues, 2) groove-ability that allow for multiple improvisatory interpretations of the meter without necessitating "counting", 3) high-density pulse referent that all of the composed rhythmic values can align with, and 4) recognizable registral spaces that indicate different points of the cycle (ex. low C, high D). Each can be extrapolated further.

Register: the registral mapping can relate to the possibility of Taborn using a limited collection of pitches rhythmically, similarly to a multi-part drum texture in certain cases of traditional West African percussion music. This collection in *Future Perfect* spans a 10th between a low B and high D. The lower and higher notes have a greater structural importance (emphasized by the lower likelihood of occurring). In the improvisation between [8:00 - 11:58], the occurrence of the lowest pitches and the highest in Morgan's playing help indicate and potentially to re-constitute where we are in the cycle. In a sense, his choice-making is not always entirely *freely* improvisational, but rather references to the ensemble where they are in relationship to the composition.

Fast pulse referent: according to Boyle (2021) and Taborn himself (2013), Taborn frequently uses a high-density pulse as a referent for majority of the rhythmic values in his work. It can often be represented as a sixteenth note grid in several of the pieces from this particular album, however, in this piece, the pulse is unusually obscured by the bi-temporal character of the structure, as discussed earlier. Even so, both tempi can be subdivided by the same fast-moving unit. For more information, see Boyle's *Flexible Ostinati* (2021).

Groove: besides the fast pulse referent, there are multiple ways of feeling the pulse, or the groove on top of the structure. These are in the order of dotted-quarter / triplet quarter, quarter, and dotted eighth-note / eighth-note. The interpretive possibilities this openness allows for is exemplified ingeniously in Cleaver's playing. He signifies on

swing in the the triplet quarter sections (e.g. each triplet becomes a quarter in a swing feel) and switches to metrically precise sixteenth note grid in the quarter-note sections, at times very abruptly, at other times as if speeding up and slowing down. The whole structure is played while feeling a sequence of equidistant pulses (e.g. 28 quarter-notes). This allows for a sense of groove to be preserved regardless of the rhythmic complexity. At the same time, the polyrhythm between the upper part and the lower part, as well as the multiple rhythmic orders engaged allow for relating to the rhythmic structure in multiple different ways, in the same way that the transcription process has lead to at least two different interpretations.

Alternatively to the suggested possible interpretations of the pulse as the main unit for coordinated rhythmic improvisation, the group may well be feeling the melodic-rhythmic profile of the phrases, and subdividing each individually. Instead of solely feeling a groove, they may be using the melodic-rhythmic phrases as temporary microcosms and orient their playing in relationship to them as the primary temporal referents.

Calls: there are at least two melodic “calls” in the pattern that are consistently used as cues to indicate return to structure. Calls are recognizable melodic phrases with an iconic rhythmic and contour profile that can be easily recognized in the context of an improvisation to mark a groups location in the cycle. The segments that resemble calls most close are in measures 1 & 5:



Figure 32a - Call in
measure 1



Figure 32b - Call in
measure 5

At different points, these two calls can be heard being played by Morgan, Cleaver, or Taborn on their respective instruments. This egalitarian approach is something Taborn mentions in his interview with Philip Bither (2013). It may allow for more ease for the three musicians to depart from the structure, even if the structure becomes abandoned altogether, because one of the three can use the call -- or a segment of the composition -- to locate the rest of the group in the temporality of the composition.

Circular notation

In the transcription process, I experimented with a different notational approach that takes into an account these formal concepts and what they reveal about the way the structure might live in the musicians' minds and in an embodied way. This has lead to an integration of cyclic visual frameworks discussed in Chapter 1.

I used the circle to indicate the time flow of the cycle and lines to indicate approximate temporal distance between each note (see Fig. 33) . The circle is divided with lines into 28 roughly equal parts to denote the equidistant pulse units in the upper

voice pattern. The pitches are represented by distance from the center of the circle, the closer being the lower pitch. The small white circles on the perimeter indicate the upper-part's polyrhythmic pulse, played by Taborn in the right hand. The two contrasting temporal shifts are further illustrated by the lines extending beyond the circle, in order to indicate what might be felt as a slower flow of time. The extension also connects this second temporality with specific phrases. The two thick lines dividing the circle roughly in 2/3 and 1/3 sections indicate A and B sections of the cycle.

The
is to

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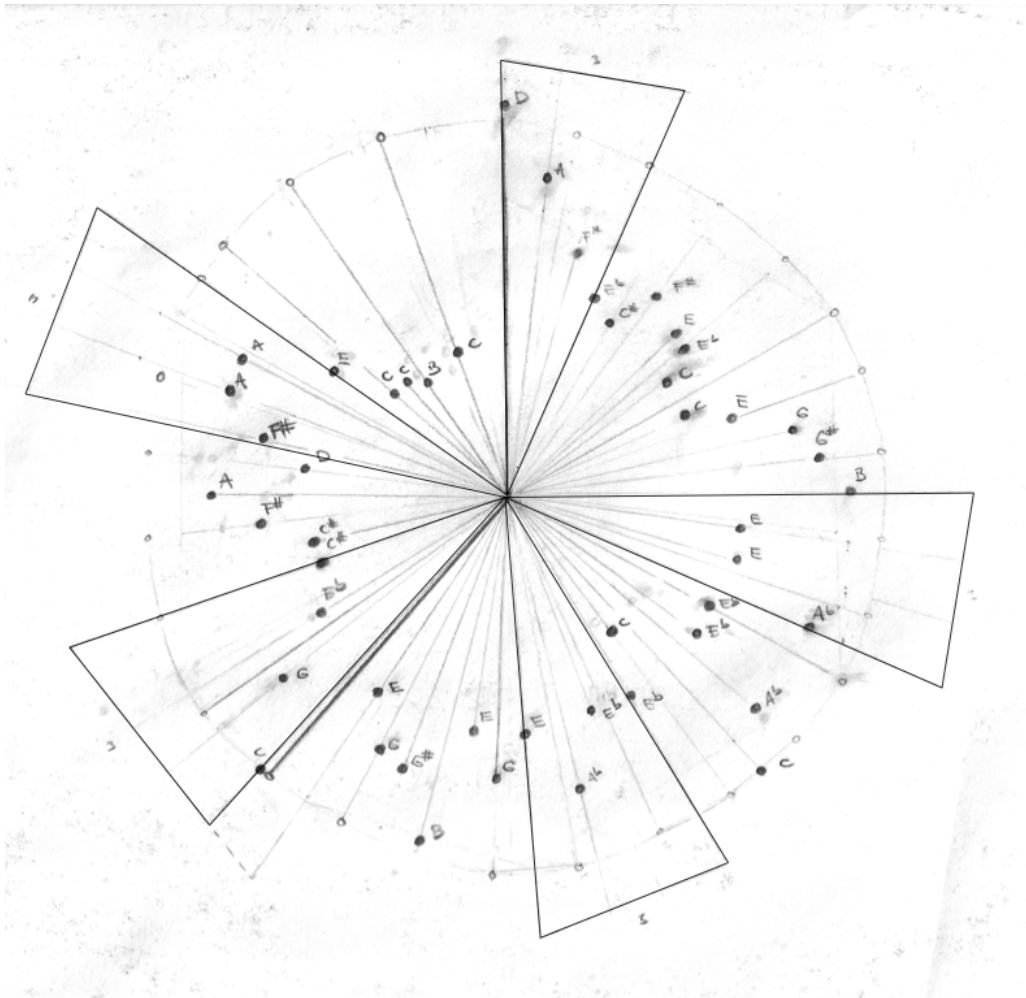


Figure 33 - Circular transcription Craig Taborn's *Future Perfect*

reflect the way the performers might be conceptualizing of the ghost structure while improvising. It brings up some of the priorities in relating to a ghost structure: the architecture of how the rhythmic units are distributed in space and their durations relative to one another, the position of the notes in register, the moments of shifting between the two temporal zones, and the temporal position of each note in relation to the cycle as a whole, as well as to its various parts. Furthermore, this visualization enables seeing structural and temporal symmetries across the circle, and allows for multiple interpretations of the pulse and polyrhythms.

The absence of rhythmic values in the notational language might reflect the way this structure is felt while improvising. In performing polyrhythmic textures, one does generally not think of “quarter notes” and “dotted quarters” or “triplets”, but rather of the two contrasting rates of motion, each constituting a kind of equally important reference unit of time, and the iconic rhythmic shape produced by their juxtaposition. The absence also reflects working with additional subdivisions of spaces between notes, playing with various rhythmic groupings imposed on the sequence, moving between pulse units of different lengths, feeling one’s position in relationship to the beginning of the cycle.

Summary

In these three analyses of Monk's, Lehman's, and Taborn's compositions, I discuss how ghost structures can manifest differently. In each case, the ghost structures that are traced are primarily compositional.¹⁸ I experiment with transcriptional and notational approaches around the rhythmic vocabularies and improvisational practices in each work. Both *Evidence* and *Future Perfect* demonstrate aspects of synchronous relations to ghost structures. These are representative of a larger improvisational vocabulary in afrological improvisation and jazz-adjacent practices. These involve displacement, anticipation, omission, or variation around an underlying cyclic pattern. In some cases, they also involve engagement with polyrhythmic frameworks and moving between reference of one rhythmic referent to the other rhythmic referent. Furthermore, Taborn's example shows how some of these processes associated with jazz improvisation can be translated to to modernist, avant-garde, highly rhythmically complex compositions that are not simply a continuation of an idiom, but build their own intercultural and personalized idioms. In these relations, a cyclic form is imagined or otherwise internalized underneath one's improvisation. Such relation supports the reasoning for using circular notation to reflect how the underlying form may be conceptualized by the performer.

¹⁸ While improvisational or emergent ghost structures could be traced in each performance, I focused on the compositional examples to show more of the vocabulary of each composer and to test out the experimental notational vocabulary.

Steve Lehman's *Echoes* has examples of diachronic and synchronous relations to ghost structures. The use of spectral analysis to create a new musical structure can be best described as a diachronic process. The sound that is being translated is not simultaneous with the musical structure, and is also modified and stretched out. The sonic spectrum is imprinted into the first measure of the composition, but consequently, the kinds of modulations and alterations of meter exemplify diachronic relations more strongly. On the other hand, the structure of the resultant composition and the subsequent improvisation around it is specifically built to facilitate synchronous relation; at the end, the drummer Tyshawn Sorey improvises around the structure as it continues to cycle underneath. In certain cases, the division between synchronous and diachronic relations is purely for theoretical neatness. Nevertheless, diachronic relations, explored more in depth in Chapter 3, are helpful in that they allow for an exploration of interesting non-linear processes around hidden structures in works that are fully improvisational, and those that are composed with serialist, minimalist, or algorithmic techniques.

INTERLUDE: CREATIVE ANALYSIS OF RAGA YAMAN

Western common practice (w.c.p) notation, or staff-based notation, presents several important issues surrounding the notation of rhythmic and temporal elements of traditional, folkloric, and non-western musics. W.c.p notation is the dominant notational system used in European classical composition. It has become used globally, not necessarily as the main system, but as the lingua franca of notation in the way that no other system has. Besides the performance and compositional context, w.c.p notation is commonly used for music analysis in transcription, and often in ethnomusicological research and folk song collections. Because of its prevalence, it's important to consider the ways w.c.p. notation can be altered to better fit practices outside of western art music, so that their musical concepts can exist more fully in the fabric of the compositional space. Looking at the fringes of notation in multiple cross-disciplinary directions, including theoretical sources, is a helpful way in developing these alternatives.

One of the pieces that I have transcribed in the experimental notational vocabulary is *Raga Yaman* in the rendition of the Afghani rubāb player and one of the contemporary masters of the instrument, Homayun Sakhi, and the Afghani tabla player Toryalai Hashimi (2006). *Yaman* is one of the more introductory North Indian ragas, based in what in western harmony is approximately the lydian mode. Some of the

musical elements I'm analyzing are representative of the larger practice of raga performance, and many are specific to Sakhi and Hashimi. The particular core melody played in this recording — *astai* — seems to be specific to the Afghan rubāb repertoire, and many of the rhythmic patterns come from Sakhi's unique and intercultural explorations of strumming patterns.¹⁹

There are three primary reasons for choosing this piece: 1) it exemplifies how performers relate to a cyclical structure over longer periods of time, 2) it includes improvisatory variation on this core melody, and 3) it exemplifies a variety of rhythmic techniques including elasticity of the rhythmic content (e.g. not necessarily temporal, but structural). A key element of this performance is the variety of rhythmic patterns that Sakhi develops and the virtuosity of his playing, as well as the fact that he references the *astai* underneath for extended periods of time.

In my transcription process I start by transcribing isolated sections of the work that demonstrate the rhythmic concepts at hand in w.c.p. notation. I focus primarily on rhythm, in case of percussion foregoing some pitch information, but keeping a sense of registral tone differences (high, mid, low) that are important for understanding its multi-voice relationships. I try to focus on identifying the "core" pattern, and distinguishing from it its variations. After this process, it becomes more clear which elements don't quite work in w.c.p. notation. These often include: micro-timing, starting

¹⁹ From liner notes in CD booklet written by Theodore Levin (2006).

point of the cycle, meter, improvisation, variation, and non-linear connections across the performance. At the same time, the w.c.p. transcription is a good entry point into the fabric of the work, that then supports the more experimental transcription processes. In *Raga Yaman*, the core pattern begins most clearly at [10:51] with the entrance of the tabla. In the notation below is the skeleton of the melody in the top staff, and the primary form that's introduced at its onset on the lower staff. Since in this example the core structure is a melodic one, there is no high-mid-low simplification applied.

♩ = 114

Figure 34 - Transcription of the *astai* in Homayun Sakhi's performance of *Raga Yaman*

I represent the core melody simplistically in the top line because rhythmic patterns Sakhi is playing in reference to the core melodic contour keep changing and developing. It was helpful to use a more rhythmically bare version of the melody - one that is never

played in the way it's written - so that these rhythmic variations and patterns could be more easily applied into it.

In moving from w.c.p. notation, I apply the experimental notational system. Once it becomes clear what constitutes the "core" pattern, I focus on transcribing this first. Some guides for recognizing the "core" pattern are: predominance through repetition, unity of melody and rhythm, a place of return, and continuous reference and alignment during improvisation, variation, etc. The idea of representing the skeletal melody is not explicitly coming from this particular musical example, but from Perlman's research on implicit guiding melodies in Javanese Gamelan. While there are several differing models that he suggests function in this role, they are generally rhythmically simplified, and indicative of the foundational harmonic-melodic motion. In the overall orchestration, one would commonly hear many layers of rhythmic densities of higher and slower speeds. The implicit melody generally operates on a whole note or half note value. These are three examples of guiding melodies (2004: 160) :



Figure 35 - Examples of "guiding melodies" (Perlman 2004)

The three melodies above are two different theorists' and teachers' versions of an underlying melody and *balungan*, the skeletal melody of the composition. Suhardi's *lagu*, which appears on the lowest staff, is the most relevant for this analysis, because it is most connected to a *melody* ("lagu") that someone would sing or hum (2004:136). Thus distilling a bare-bones version of the melody in a similar way, I draft it onto the circle. The reason for applying these is analytical and notational, and not for relating the musical practices in the *Raga Yaman* recording and Javanese Gamelan at large. It shows that in representing a skeletal melody, we are forced to decide between greater and smaller degrees of rhythmic and melodic specificity. At which temporal level do we notate the melody? Do we use whole notes, half notes, or quarter notes? How do we distinguish variation and elaboration from the skeletal melody, and how much detail is actually important to maintain in communicating the full character of the musical structure? Perlman's comparison of the three approaches helps show the range of possibilities and the kinds of rhythmic values that could be used, and guide the process of choosing the right level of specificity that's applicable to *Yaman*.

Figure 36 shows the circular transcription of the *astai* melody. The starting point of the pattern is at the A on top of the circle. From there the time-flow moves to the right and around the circle clockwise. In the experimental notation system, I first draw a

circle of adequate size. I divide this circle based on the length of the “core” pattern.²⁰ If it is, as in this example, four measures of 4/4 long, I divide the circle into four equal parts. I then chart the notes of the “core” pattern onto the circle as points in time, moving clockwise. They are positioned along the circle in the same way the would be

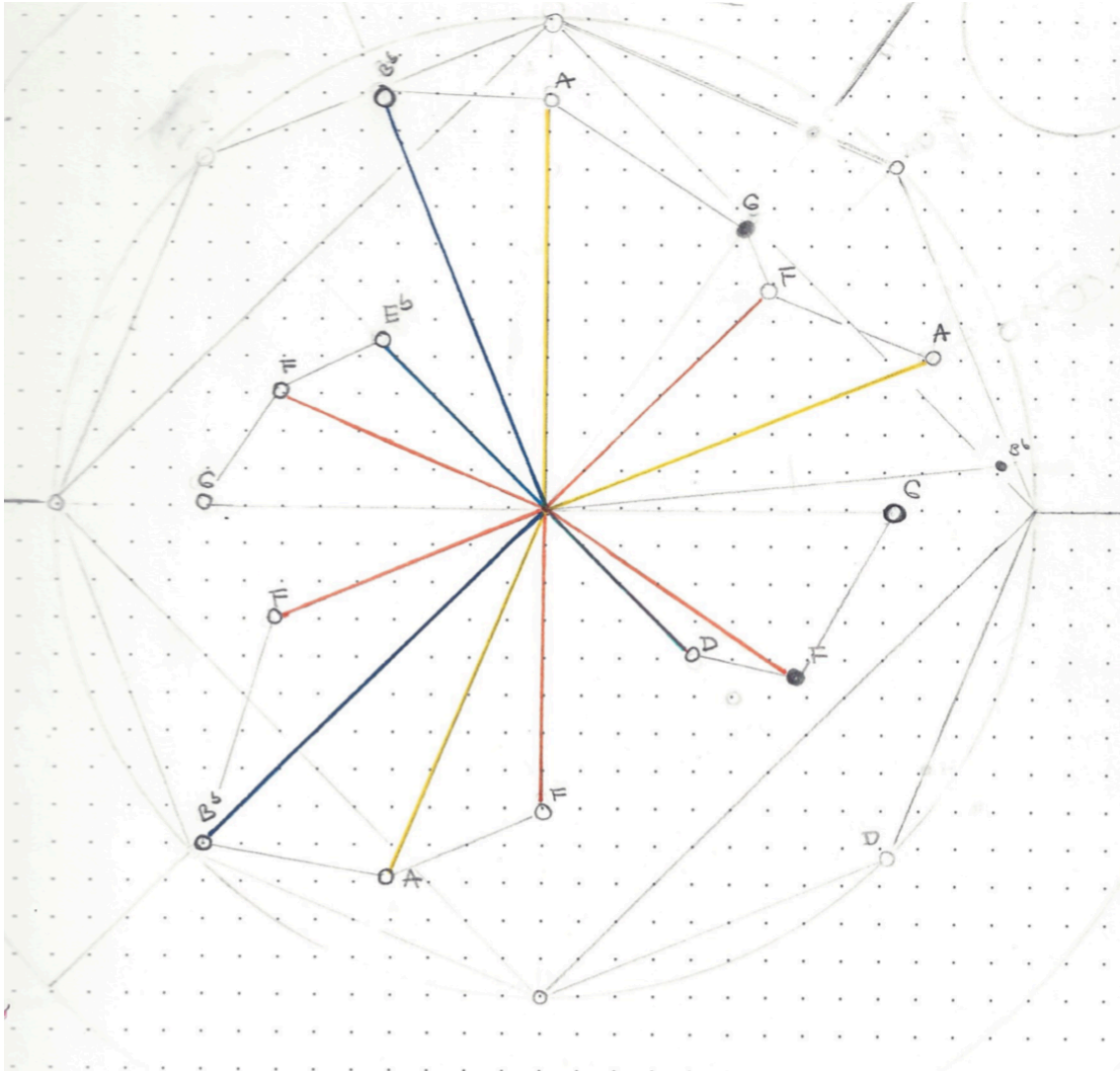


Figure 36 - Circular transcription of the *astai* melodic cycle in *Raga Yaman*

²⁰ This notation framework is based on the circular notation in Justin London’s notation in *Hearing in Time* (2004) and his research *entrainment*, as well as Toussaint’s research on geometries in cyclic rhythms (2020), and Jesse Stewart’s research on afro-diasporic cyclic rhythms (2010).

positioned on a linear staff. Their visual distance from one to another, however, becomes the most important indicator of their rhythmic value. If there is a primary pulse referent, for example the quarter-note, I notate four equidistant lines with empty circles at the circumference for each quadrant to serve as a reference point. This is quite a subjective part of the process. In this particular piece, most phrases are sub-divisible by a half note, and even if the music becomes very rhythmically dense the tabla player seems to accentuate to this subdivision level more strongly than the quarter tone level. Since the melody itself has a slower cadence to it, the half-note value seemed appropriate.

The register of each note is represented by its placement between the center of the circle and the circumference. The greater the distance from the center, the higher the pitch; the closer to the center, the lower the pitch. In this example, the use of height is relative to the pattern, so that the reader can visually see the contour of the melody more clearly. Bb is the highest note of the melody, so it is drawn the farthest away from the center. D is the lowest so it is drawn closest to the center. Each note is color-coded based on its pitch-class. Since the melodic materials of the core melody are so foundational for the improvisation, it seemed appropriate to study the architecture of how the melody moves through the modal space. The colors show the proportions of each pitch within the pattern more clearly (i.e. there are three A's, creating a kind of triangular relationships; Eb and D appear only once and at symmetrically opposite

points of the cycle). There are two types of note-heads used: clear for longer rhythms and full and shorter. rhythms This feature is based on Dariush Talii's notation discussed in Chapter 1. All these elements are used to help create the imagined and embodied architecture of the pattern as one navigates through it in the modality of improvisation. The transcription omits several layers of information, including the specific rhythmic values Sakhi is playing, the various drone tones, or the great variety of melodic patterns.

In brief, there are several advantages of the circular score regarding representation of meter and cyclical structure. While the starting point is shown as the top point of the circle, there is no other visual designation that makes it visually or semiotically more dominant than other points of the cycle (e.g. bar-lines, down-beats). There is no single meter. The circle itself could constitute one hypometric whole. Then there are the loosely drawn polygons near the circumference of the circle: a square and an octagon. These indicate primary equidistant pulse divisions. They could be translated to 4/1 or 8/2 meter. There are two so that, again, a hierarchy is not easily established. It's quite a unique advantage that, in the circular framework, the notational vocabulary allows one to visualize multiple meters simultaneously. Lastly, there are lines drawn from the center to each of the note to signify on the concept of bar-lines in w.c.p. Representing them as such may condition the performer to conceive of the

melody (in its skeletal form) as the metric-temporal structure, rather than any other, theoretical division of the cycle. All of these elements allow for inner elasticity of the smaller rhythmic values. Each segment between the individuated note-lines and in between the outer polygons can be subdivided in multiple different ways, for example in triplets or sixteenth notes. Since Sahki engages in these multiple subdivision levels, it was appropriate to leave that space open.

There are two ways I've experimented with visualizing the variations in this framework. One is using Ohriner's technique of representing variations as smaller-sized notes on the staff. (2019) In that model, the score would consist of several layers of transcribed variations of the cycle. The more frequently a note occurs in the same position in the cycle, the larger the note-head. Since this particular performance is very rhythmically dense, using this model would result in a very information-heavy score. It's a lot more applicable to musical examples that have less variation on a grid-based referent structure. Therefore, I experimented with notating the variations as modules isolated in time and separated from the score itself. These modules can then be mapped onto the circle. This is in part because the variations themselves seem to be approached modularly. Sahki moves gradually and improvisationally between various rhythmic patterns that are cyclical, but also continually transform. There are several points in the recording where he returns to the simplified rhythmic iteration of the melody before developing again, suggesting a non-linear structure of development and return.

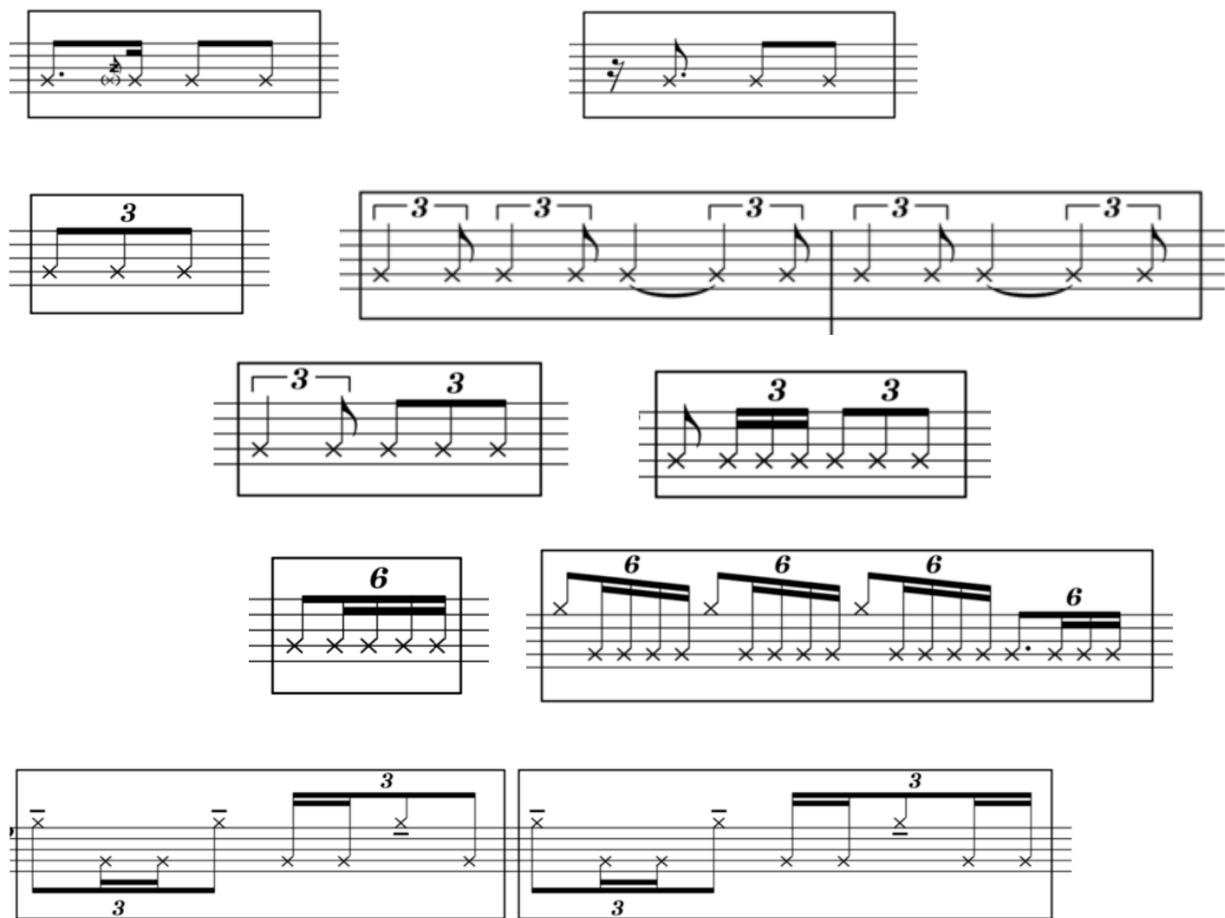


Figure 37 - Repeating rhythmic modules traced in Sakhi's improvisation

The way these modules are distributed in space reflects loosely the way these rhythms appear over the course of the performance, from left to right and from top to bottom. Pitch is not represented here. The only pitch information that is represented is the general difference between higher and lower register. The rhythmic modules in Figure 37 are to be applied to the skeletal melody and combined with the pitches therein. In Sakhi's performance, the pitches he uses often depart from the skeletal melody; it is by no means the only pitch content of the improvisation. The resultant

music is somewhere in between the skeletal melody, the rhythmic patterns, and improvisation around the harmonic space of the composition. I tried to show loosely the linear progression of the rhythmic modules from left to right and top to bottom. Each module is usually repeated multiple times and other smaller variations are added to it. Since most of these are quite short, the way to translate the melody can look something like this:

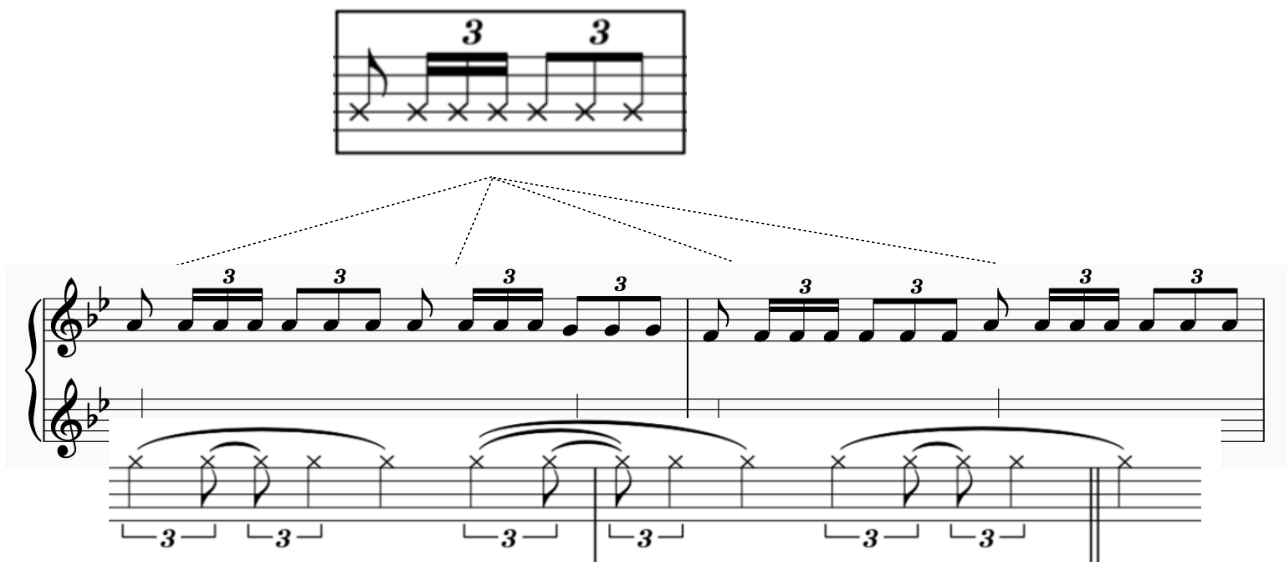


Figure 40 - Example of a *tihai* in Sakhi's improvisation

Among these variations, there are several unique examples. Some of these transitions from one rhythmic pattern to another bend the boundaries of either pattern in interesting and complex ways. There is one particular moment where a pattern seems to be in a rhythmically liminal space between two patterns.

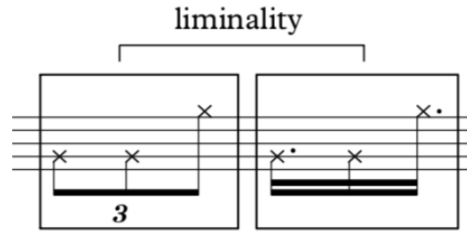


Figure 39 - Liminality between two rhythmic modules

One possible way of representing that is by visualizing the two standard rhythms that it most closely relates to, and suggest that the performer is in the rhythmic space in between them.

Another unique element is the *tihai*, a rhythmic pattern that repeats three times and often cues the ending or a climax of an improvisational section. Since the pattern happens only once in this performance, it's visualized without the box notation:²¹

The notational elements in Figures 36-40 imply an intertextual relationship between multiple kinds of materials. The score should be read together with listening to the recording or learning the piece aurally. It is meant to supplement and be completed by the aural version. The reason is that the wealth and accuracy of information that is communicated aurally surpasses that of the score. What the score can serve to do, however, is a) provide the foundation for how one navigates the space of the cycle and b) instigate the creation of new material and new modalities in relationship to it. The

²¹ For the modular notation, I've drawn on two main sources. Box notation is also used in Dariush Talai'i's notational vocabulary for the *radif*. Another source within *creative music* and contemporary improvisational practices is Michael Dessen's composition "where does the time go" from his *Resonating Abstractions* cycle (2012), which uses boxed modules distributed in space to represent the general time-flow without prescribing a singular linear sequence.

absence of the specifics of the original material leave more room for filling it, and necessitate one's creative process to be engaged. Each return to the score can facilitate a new, distinct iteration.

In the following chapter, I discuss the works of Tyshawn Sorey and Carlo Costa, who are both drummers and percussionists whose work spans across the practices of free improvisation and composition. In these works, I discuss relations to ghost structures that prompt the investigation and representation of diachronic temporal connections.

CHAPTER 3: GHOST STRUCTURES AND DIACHRONIC RELATIONS

Diachronic relations describe linear connections to referent structures, where the variation or reference is temporally separated; it does not happen synchronously with the ghost structure. Diachronic relations have a more free and open-ended applicability to musical examples. The examples below demonstrate variational techniques that unfold over time; continual change embedded into cyclical approach to core compositional materials. In this chapter, I analyze the work of Tyshawn Sorey, *Awakening* (2009) and the work of Carlo Costa, *Oblivion I* (2017). In these works I analyze the rhythmic vocabulary and trace the ways that cyclic patterns and elasticity are employed in conjunction with finding what constitutes the ghost structure(s) therein.

Tyshawn Sorey's *Awakening*

Awakening is a minimalist, highly rhythmically complex composition recorded on Tyshawn Sorey's *Koan* (2009) album, and performed by a trio of musicians: Sorey on drum set, Todd Neufeld on guitars, and Thomas Morgan on bass. The composition is marked by creating a sense of timelessness through its repetitive and mostly static harmonic content in a primarily diatonic collection, in juxtaposition with complex and rhythmically elaborate and structured ensemble interplay that changes continually without disrupting the overarching sense of timelessness and non-progression. As such,

this piece and its performance offer a model for analyzing variability and elasticity of recurrent patterns in reference to multiple temporal schemes within a grid-based rhythmic framework (i.e. created in relation to a stable, isochronous pulse referent). Aesthetically the composition is also a model for subverting the idea of growth in western culture as a process of progress or development (see Nisbet's 1980 *History of the Idea of Progress*), and instead expresses a more rhizomatic and iterative process within which depth is created by *embedding* and *revising*, rather than *overcoming* or *metamorphosis*.²² By the virtue of this same aesthetic, *Awakening* maintains the semblance of an improvisation; a meditation on one theme where there is no collective harmonic modulation that is commonly understood as an identifier of a pre-composed work.

The structure of *Awakening* is in a ternary form when considering the organization of rhythmic content and orchestration.²³ The material in the first and the third section repeats — although with variation in the latter — and the material in the second section introduces a new, more dense and rhythmically defined, interlocking compositional structure played by the full trio. Harmonically, the second section is based around one of the two oscillating chords played by the guitar in the first and third section. Therefore, we cannot speak of, nor hear, a real semblance of departure within the form overall in a way that would resemble traditional forms in western classical

²² Nisbet, Robert A. *History of the Idea of Progress*. London and New York: Routledge, 1994. Originally published in 1980 by Basic Books, Inc.

²³ Ternary form is A-B-A. *Awakening* can be, however, also described also as A-A'-A.

composition. Rather, elaboration and development appear primarily in the form of embedding within the compositional materials present; much of the development happens on a rhythmic level, while the harmonic material remains static throughout most of the piece.

In this analysis, I trace different kinds of rhythmic structures that Sorey is composing with and discuss how these may be represented notationally in a modular, non-linear framework. I also explore the idea of diachronic ghost structures. In *Awakening* these include recurrent motivic themes (i.e. repeating guitar harmony) and rhythmic patterns (i.e. guitar, bass, and drum patterns) that are modified iteratively on one hand, and subliminal metric and rhythmic schemes on the other. I will analyze the patterns structurally and discuss the balance of repetition and variation. Through this I present a strategy of creating continual variation on a limited set of ghost structures that can be applied to improvisation and real-time composition. I will also discuss the liminal and perceptual aspects of this composition which are particularly palpable from listening to it (i.e. liminality between composition and improvisation, between repetition and movement, between one pulse level and another pulse level, between free time and grid based time), and how these are created and reinforced by what is happening on the structural level (i.e. polyrhythm, displacement, metric modulation, iterative repetition, timbral connections, layering).

Iteration in Guitar Solo

The introduction of *Awakening* is a prolonged guitar solo, which sets up the trio section for paradigm shift of sorts through its extended length, and iterative, enigmatically spaced two chords. These chords are Eb 5 9, and AbΔ7/Eb.²⁴ There is continual micro-variation on the rhythmic spacing of these chords as well as their voicings, which I will discuss later on. Additionally, there are other harmonies that occur less frequently and are generally embedded in the sequence between the two chords.



Figure 41a - Guitar chord 1



Figure 41b - Guitar chord 2

Upon listening to this section, we are left guessing whether this is an improvisation or composition, and whether Neufeld is reading a score or creating his own timing; a feeling that persists throughout the piece. We also may be confounded as to whether he is playing in relationship to a pulse, in free time, or something else, in the way he is rhythmically moving between the two chords. All those ambiguities and suggested

²⁴ The exact frequency of the root Eb1 is cca. 40 cents above Eb1, or 60 cents below E1. It suggests that there is a scordatura on the guitar, as well as the bass.

liminalities (i.e spaces in between potential reference frameworks) help set up that same ambiguity for the subsequent section and throughout the piece. I hypothesize that there are three possible processes that produce this texture: 1) Neufeld/Sorey is repeating the same sequence iteratively at different timescales, 2) the durational intervals are played — or composed — in relationship to a through composed rhythmic scheme within which patterns operate on macro-rhythmic (e.g. larger) timescales and never clearly come to a point of alignment, and 3) the durational intervals are played (or composed) in relationship to a hidden temporal scheme, creating variation by the means of omission against this scheme.

In my transcription process, I first translated the timing of the guitar chords to time stamps using a labeling tool in an audio editing software *Audacity* (see Fig. 42).²⁵ I labeled the starting point of each of the two chords, and did not take note of any of the other distinct pitches or alternative chords or voicings that happen after the onset point. This is to abstract the music only to the fundamental durations of the two harmonies in order to visualize any patterns, repetitions or the lack thereof, and symmetries across this section. From listening to this section, it's clear that the harmony is the only recognizably stable and consistently recurrent element.

²⁵ I started with this step because it was not clear whether there was a pulse referent that could be applied to the transcription at large.

Fig. 42 shows the sound file of *Awakening* with a *Label Track* below. Letters F and G refer to the top notes of the two main chords in this section, indicating the two chords: F = Chord 1 = Eb 5 9, and G = Chord 2 = AbΔ7/Eb.

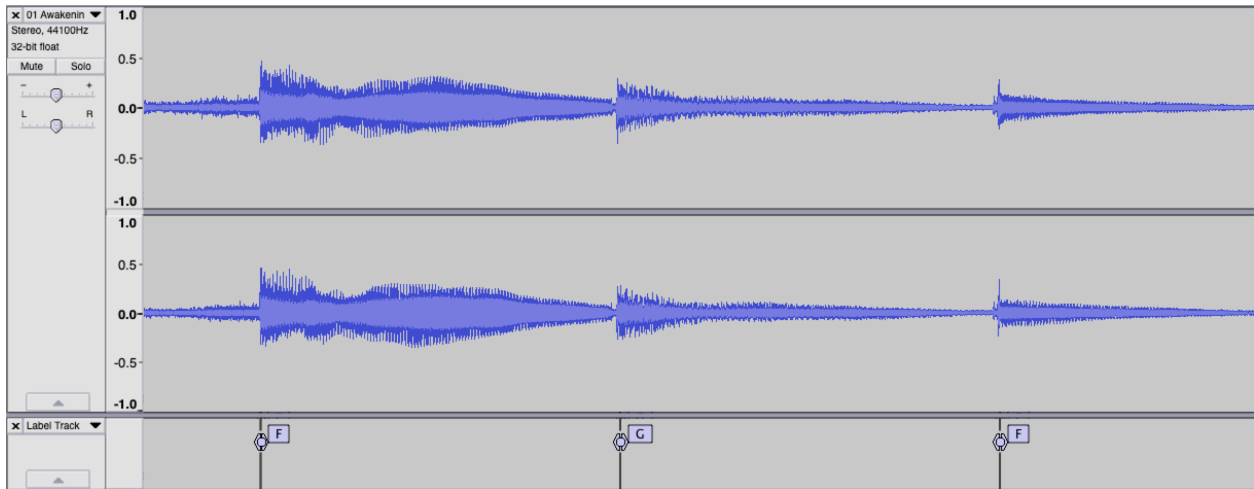


Figure 42 - Screenshot of audio file and *Label Track* in Audacity

Fig. 43 shows the timestamps from the “Label Track” imported onto a spreadsheet with labels and with calculated durations in seconds for each chord.

Timestamps	Chords	Chord durations
5.94044	F	5.633
11.57321	G	5.940
17.51365	F	4.142
21.65540	G	6.816
28.47152	F	5.017
33.48895	G	7.692

Figure 43 - Timestamps on a spreadsheet

After noting the timestamps in *Audacity*, I transferred the values (in seconds) to a spreadsheet, and calculated their individual durations, rounded to 3 decimal points. From this spread sheet, I translated the individual durations into a vector graphic software *Graphic* and created a rectangle for each timestamp by applying the duration number n to the width (or horizontal length value) of the rectangle, using slight scaling ($n/5$). The process of scaling is a technique rooted in statistics and used previously by Mitchell Ohriner in transcription of hip hop recordings (2019, 2020).

Analyzing these durations reveals that there is continual variation that surpasses the margins of expressive timing. On average, chord 1 durations are more constant and vary within a smaller margin than chord 2 durations. On average, chord 2 is longer than chord 1, and extends more significantly at several points. At the same time, there doesn't appear to be any repetition of the same sequence of durations (even approximately). It's possible that either this section is through-composed and Sorey varied the duration of each chord. Or, equally likely, Neufeld improvised the durations, given the two chords as main materials to work with. If this section is in fact not improvised, the implications are that either there is a complex, larger scale through-composed pattern, or that Neufeld is referencing an underlying temporal structure and omitting pieces of it.

Fig 44 shows a graphic representation of the durations for each chord in section 1 in seconds. Certain particularly long durations are visualized by a larger box size. The section ends with a repeating module, where the drums and bass enter soon thereafter.

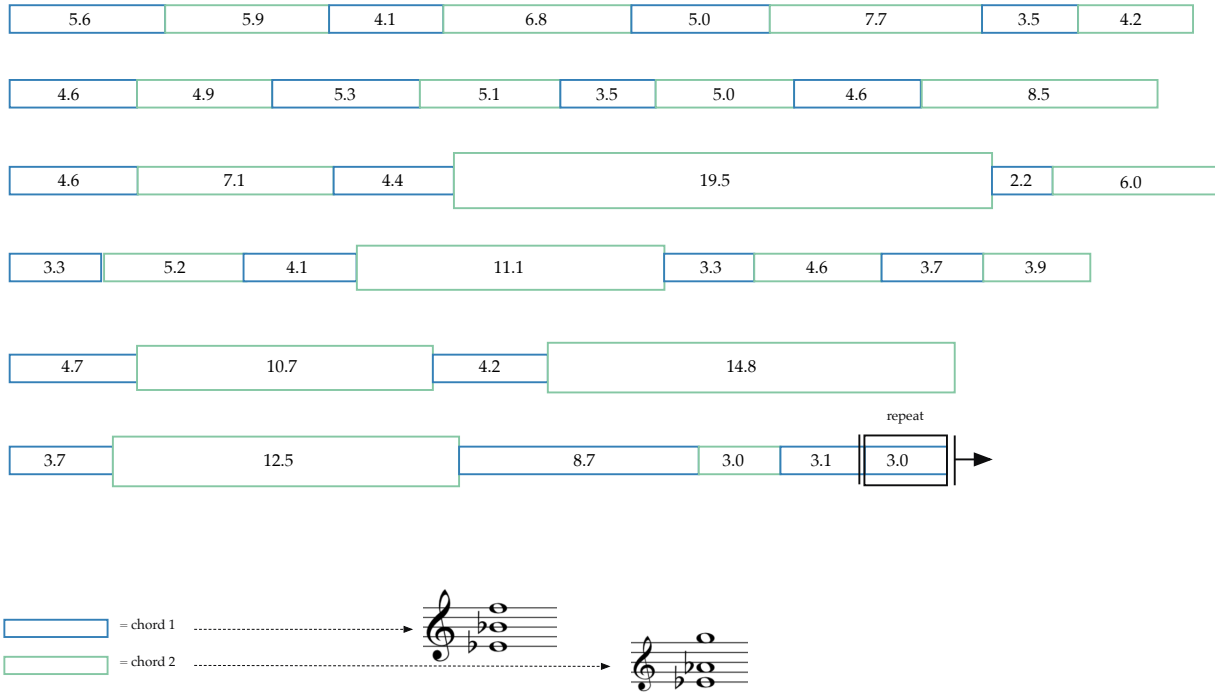


Figure 44 - Transcription of solo guitar section in *Awakening*

From a listener's perspective, the texture in this section suggests that there's a repeating phrase that is being translated it into different timescales. In some iterations, the ratio between the two chords is preserved; for example, the ratio in pair 1 = {5.64 - 5.94} resembles the ratio in pair 5 = [4.62 - 4.90]. In other iterations, one chord is being substantially extended while the other may be compressed; for example in pair 8 {4.59 - 8.54} and pair 10 {4.35 - 19.50}.

Diving more deeply into the timestamp values, there seems to be both repetition on both near-exact level and on a symbolic level. Values around 5.0 (+- 200 milliseconds) occur five times throughout. There is a higher prevalence of medium durations — that is between 4 and 6 seconds — over other classes of durations. Longer durations between 6 and 12 seconds occur semi-frequently. Longest durations between 12 and 20 seconds occur three or four times and are distributed throughout this section. Very short durations below 4 seconds occur less frequently. Overall, all these relative durations are engaged multiple times over the course of this section, but each one with a distinct value. The level at which recurrence occurs creates a sense of *compositionality* and reference to patterns; most durations (+- 200 milliseconds) never appear only once, but three, four, or five times.²⁶ At the same time, each value is temporally distinct beyond the margin of expressive timing. This makes it difficult to observe any actual repeating patterns or references to isorhythmic grids.

This section primes our listening habitus to attend to temporal structures that unfold over longer time scales. Since whatever the cyclic pattern or underlying rhythmic temporal structure there may be, it never resolves or comes to a point of repeating itself again in a clear way, which leads the listener — albeit a listener of certain analytical disposition — towards extending their perceptual buffer infinitely and

²⁶ By compositionality I am referring to the the aesthetics of music that's being created with intentional organization and structure in mind, as opposed to creating fully and solely in the moment, and exhibiting little sign of consistency.

indefinitely forward, overlapping and dovetailing onto the next section when the trio enters.

Additionally, the transcription of this introductory section serves as an example of how an iterative rhythmic texture looks like, what are the aesthetics and elements thereof.

The Polymetric Scheme in the Trio Section

An early draft of the trio section shows the guitar and bass parts represented as rectangles, the guitar in orange and the bass in burgundy. Bass pattern starting points in the bass are shown in light turquoise.

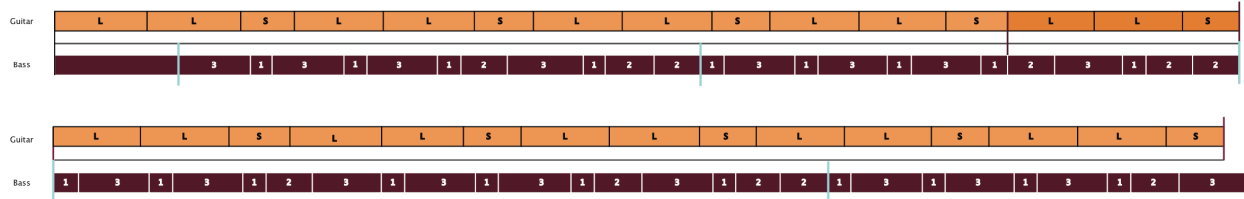


Figure 45 - Transcription of guitar (top line) and bass (bottom line) using timestamps from 4:32 - 5:30

The transcription in Fig. 46 shows the point where the trio begins to lock into a consistent pattern for the first time. There are two clearly looping layers: the guitar in 10/4 cycle, and the bass in 23/4 cycle. They both seem to function as *anchors* of sorts. It would be reasonable to consider the bass as the main anchor, because of its traditional role in ensembles, its low frequency, and the non-syncopated character of the rhythmic

cycle. However, the guitar is the first instrument we hear and we may entrain to the temporal scheme it references. Its patterns are spacious enough and repetitive enough that the instrument can act as a separate anchor.

The image displays a musical score for three instruments: guitar, drums, and bass. The score is divided into two systems, each containing three staves. The top staff is for guitar, the middle for drums, and the bottom for bass. The guitar part features a series of chords and melodic lines, with a bracket indicating a repeating pattern. The drum part shows a complex rhythmic pattern with various note values and rests. The bass part consists of a steady, low-frequency line. The score is written in a key signature of one flat (B-flat) and a 4/4 time signature. The first system is numbered 1-4, and the second system is numbered 5-8.

Figure 46 - Transcription of *Awakening* at 4:33

The tom patterns played by Sorey are more modular and variable, filling in the spaces between the bass hits. The added layer of pitch contour created by the various tom frequencies adds complexity; we can speak of rhythmic patterns, but also of melodic patterns. In the transcription, there are three main instruments grouped as

“toms”: the floor tom, a middle tom, and a snare drum with the snares off. Later on, and sporadically other toms appear, suggesting that there is a total of 4 or 5 toms (including the snare) that Sorey plays. I represented the melodic contour loosely using the three lines as relative low, mid, and higher tones. The ride cymbal is closely tied with the guitar. In this section there is no moment when the guitar plays that the cymbal doesn't play with it, but the cymbal patterns also fills in more of the space outside of the guitar patterns, at times aligning with the toms and at other times aligning with the bass. The rhythms played on the cymbal allude to cyclic patterns, like the toms, but they are not clearly discernible, suggesting either more complex structures, higher variability, or a more linear compositional approach.

Each layer can be described as having its own rules, or expressing a set of behaviors within a limited set of variables. The guitar layer uses a single chord, there is no melodic variation to speak of. It starts in a pattern of: (5/8) - (15/16) - (15/16), or in symbolic terms *short - long - long*. It is displaced against the starting point of the bass pattern by an initial interval of 5/8, and then remains in the cycle of 10/4 or 20/8. It operates on a 1/16 - note grid together with the cymbal in this particular section. The guitar notes always align with cymbal, though they sometimes align with the toms.

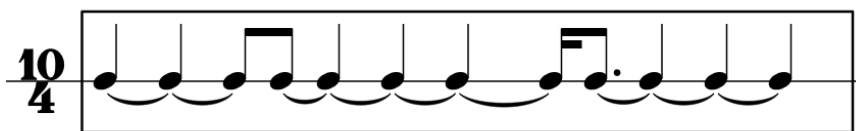


Figure 47 - Primary rhythmic pattern played by the guitar

The cymbal functions as an inter-part *negotiator*, rooted around the guitar, but also aligning with all the other parts in the drums and bass. On initial listening, the cymbal rhythms suggest polyrhythms, such as 5 over 4 and 3 over 4, but never quite continue these polyrhythms in consistent isochronous units. That rhythmic language is reminiscent of Steve Lehman's polyrhythmic divisions of measures in *Echoes* where we see a lot of odd groupings of sixteenth notes dividing a measure in equal parts (see Chapter 2). However, because the cymbal pulses never continue equidistantly for long enough to become true polyrhythms, we are left guessing that there maybe are hidden polyrhythms that they reference to, which in fact there are. This technique creates a liminality between rhythmic cycles that are pattern-based and ones that are polyrhythm-based. The third possibility here is that Sorey is additively expanding a pattern. The first phrase is 5 - 5 - 10, the second phrase is 5 - 10 - 5 - 10 - 10, the third phrase is 5 - 8 - 3 - 6 - 3 - 20. Just in comparing these three, there seems to be a hidden logic, in for example the use of 5, 10, and 20 values, all factors of 5, but this gets quickly complicated by the third phrase with 8 - 3 - 6 - 3. Is he varying around the 5 as a hidden reference - an underlying ghost structure? The sum of $8+3+6+3$ is 20, which is divisible by 5, therefore it's possible that he is displacing and extending around a 5 - based referent pulse. At the same time, solely listening to those rhythms in addition to hearing the other instruments, it becomes quite elusive to note the 5 beat referent as a listener, and it's easier to hear the other values (i.e. 3, 6, 8) as actual departures from any 5 beat-

based repetition set up earlier. The fact that they line up with 5 beat pulse, but don't sound like they do, may contribute to the successful liminality between a polyrhythmic sound and a rhythmically variable sound.

It's therefore possible that Sorey is composing this section with two meters, which are functioning as ghost structures: one that's a factor of 5/16 against which the guitar and the cymbal are composed, and another that's a 1/4 - based meter, or perhaps 4/4, against which the bass and toms are composed. Further analysis explores whether these are the case, or whether the ghost structures are more pattern-like rather than metric.

The bass pattern re-iterates a single pitch, with no melodic variation. It operates on a 1/4 grid, and uses the values 1/4, 2/4, and 3/4. It generally doesn't align with the guitar, it occasionally aligns with the cymbal, and more often aligns with the toms. The bass starts with a pattern in 23/4, visualized in Fig. 48.

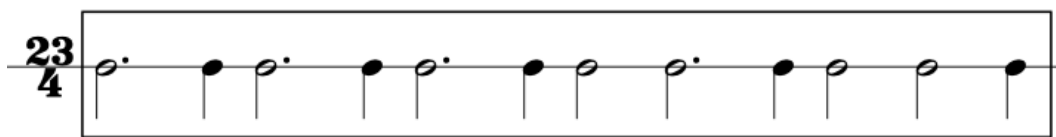


Figure 48 - Primary rhythmic pattern played by bass

We can also represent the pattern as a result of several processes with a mix of modules and variables. For example, 1/4 and 3/4 have a high likelihood of occurrence, while 2/4 has a low likelihood of occurrence. 1/4 and 3/4 are often paired together. 1/4

often precedes 2/4. Neither 1/4 and 3/4 repeat in a sequence (for example 3/4 followed by 3/4), while 2/4 can repeat individually once. Out of these behaviors we can construct an alternative representation of the pattern that distills these temporal processes. Fig. 49 is a hand-drawn interpretation of some of these processes. The arrows between rhythmic-unit-modules indicate likelihood of motion, and possible pathways, which present one way of addressing the issue of representing probability in a modular structure. The circular graph in Fig. 49 shows the likely location of the rhythmic-unit-modules across the larger cycle; the 3/4 and 1/4 units happen roughly in the first half, the 2/4 units happen roughly in the second half. The whole circle constitutes the 23/4 cycle. On the lower right corner in the figure is an indication of the duration with

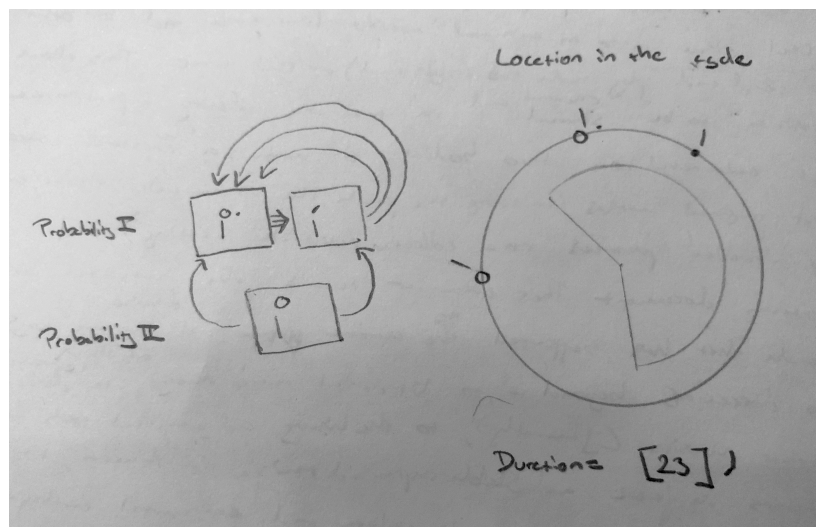


Figure 49 - Drawing of a modular representation of the bass patterns

[23] in brackets to denote that this number is central, but variable — as we can see later, and quarter-notes to signify the pulse referent.

The tom patterns use a set of 3 or 4 tones in this first part of the trio section, forming combinations resulting in melodic patterns. They operate on a $1/4$ grid together with the bass. They align with the bass, the cymbal, and occasionally with the guitar (although least frequently). The guitar part is often displaced off of the tom part or anticipates it in $1/16$ or $1/8$ values. The toms start in general a $1/4$ after the bass. They build patterns using the 3-4 tones, extending and compressing, generally bracketed by rests. They can be separated by 1-3 rests. They operate somewhat more linearly than the other parts, featuring more variation, and continually changing. At the same time, an identical grouping of tones and notes that was played before can be repeated. Often, a pattern is built additively and iteratively by adding notes at each iteration and again cycling back to a shorter pattern. The addition in this process, however, doesn't necessarily happen by adding after the phrase, but by embedding into it (i.e. in the middle of the phrase, in between the tones previously played).

Hidden Grids

To explore the polyrhythmic aspects of this section further, I transcribed an excerpt into graphic notation that uses some of Ohriner's grid-based visual vocabulary. In the transcription in Figure 50, the top line shows only guitar and cymbal in relationship to a 5-based grid ($5/16$), and the green bottom line shows only bass in

relationship to a 4-based grid ($4/16 = 1/4$) at [4:53].²⁷ Each line in the black grid corresponds to a duration of $5/16$, and each line in the green grid corresponds to a duration of $4/16$.

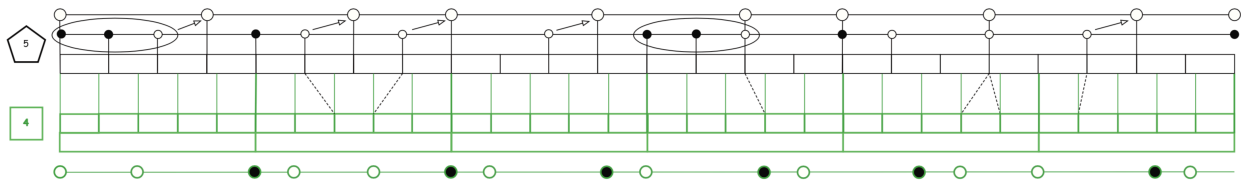


Figure 50 - Grid-based representation of the guitar (top-most), cymbal (top), and bass (bottom) at 4:53

This visualization shows that the guitar and cymbal rhythms consistently align with a $5/16$ grid. One reason why this relationship may elude the listener is because Sorey divides this reference between two different instruments. If we start to pay attention to the cymbal patterns alone we hear them continually changing, and using wider amounts of space. Another reason is that the whole structure is likely heard against the $1/4$ reference in the bass, and since the two rarely align, the 5-based parts can be heard as displacements and various polyrhythm-like patterns built against the $1/4$ pulse. In reality we see that the guitar and cymbal fill in most of the 5-based *pulse*

²⁷ The 5-point polygon around number 5 and the 4-point polygon around number 4 are visual guides to help internalize the two rhythmic values, as they may seem quite abstract as only grids. The arrow symbols are used to show patterns in how the guitar follows the cymbal in the 5-based grid while the cymbal is silent. The note-unit notation uses the previously referenced visual vocabulary of representing shorter values as filled dots and longer values as empty dots. In both layers, the shorter values are always consistent while the longer values are more variable.

units; their connection to this grid is consistent. We can see that overall, the 5-pulse functions like a ghost structure, not directly stated but continually referenced, while the 4-pulse is more of an audible referent reinforced by the bass and the toms.

The polyrhythmic relationship between the two parts (guitar and cymbals against bass and toms) can be represented as a 5:4 polyrhythm, visualized in Fig. 51 in w.c.p. notation.

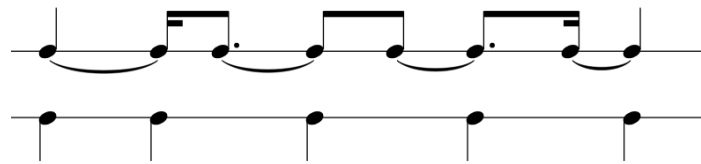


Fig 51 - 5:4 Polyrhythm

Summary

The analysis shows that there likely two simultaneously negotiated metric referents: 5/16, and 1/4. 5/16 is a *ghost structure* for the guitar and cymbal, and occasionally for the toms. 1/4 is a *ghost structure* for the bass and the toms. In effect, Sorey is composing and performing against two overlapping *ghost structures* of different temporal durations (e.g. that form a polyrhythmic relationship). These are referenced in primarily synchronous relations. There are also more elastic and variable *ghost structures*: the specific rhythmic values that he repeats in varying sequences, the patterns in each instrument. These are audible, motivic, and are referenced in primarily

diachronic relations. The 23/4 pattern in the bass is a variable *ghost structure*. The pattern is repeated twice, then altered as a 19/4 pattern, and then repeated again as a 23/4 pattern. Later on it changes slightly as the piece rhythmically modulates, but maintains similar elements. Its inner components function as a limited set of variables that is repeated and reordered in variable ways that at the same time resemble one another. The tom patterns seem to use more contour-based and melodic *ghost structures*. The relations involve serial, additive processes. They also involve non-repetition. No sequence in tom patterns is repeated twice. There are similar and almost identical elements, but the sequences keep changing.

Carlo Costa's *Oblivio*

The solo works of Carlo Costa, an Italian percussionist and improviser, presents an interesting contrast to Sorey's and Taborn's rhythmic language and allows further exploration of diachronic relations to ghost structures in a non-grid-based rhythmic space. His musical practice resonates with environmental rhythmic concepts and musical aesthetics in the context of New York-based free improvisation community. He can be heard on releases by the *Neither/Nor* label, or playing with the likes of Sean Ali, Flin van Hemmen, Frantz Loriot, and Tony Malaby. He is a drummer and percussionist whose pallet is heavily timbral and sonically innovative. At the same time, his work also engages deeply with concepts of memory and poly-periodicity, that expand beyond timbral research and move into the areas of real time structure and temporal

organization. I've chosen his album *Oblio* (2018) to analyze, which is a solo percussion work composed of two pieces, "Oblio I" and "Oblio II."²⁸ There are techniques there that provide opportunities for discussing and visualizing variable periodicities in free rhythm and pulse-based rhythm in the same musical space, for engaging with simultaneous and contrasting periodicities, the relationships with environmental sound and aesthetics, the role of memory in this process, the fluidity between composition and improvisation, and play with flexible motives diachronically. The techniques express more strongly to horizontal relations to referent structures, as they unfold and transform over time and periodicities are threaded over longer durations.

The outcomes for transcription and notation are: representing cyclicity in a free rhythmic space, representing multiple layers of different temporal processes that occur and cycle simultaneously, representing flexibility and variability of distinct motives, and representing timbre. The outcomes for performance practice and improvisation include: allocating different processes to compositional (i.e. pre-determined) and improvisational (i.e. real-time) modalities, and performing with different periodicities simultaneously. Supplementing this, I will discuss the ways environmental sound and research thereof can enrich this topic, how can notation of free rhythm in other modalities support this, and how Carlo's musical language relates to his larger musical community in New York and free improvisation at large.

²⁸ Costa, Carlo. *Oblio*. Neither/Nor Records, 2018. <https://neithernorrecords.bandcamp.com/album/oblio>

In *Oblio*, Costa's sound pallet consists of a drum set, concert bass drum, singing bowls, bells, triangles, wood blocks, tiles, styrofoam, cymbals, violin bows, marbles, chains, knives, etc. Each track is about 20 minutes long and resembles a field recording through its texturally and iterative approach to emerging new sonic-rhythmic events (and absence of fixed repetition). Costa is improvising within "composed structures," stringing together a "a shifting landscape of textures that overlap, morph and cut into one another." (liner notes) Looking more closely at "Oblio I", the first piece in the album, we can take note of three main layers:

1) a sustained texture, either in the form of a drone or a soft noise, that sits in the background, and operates on a seemingly timeless scale

2) squeaky, rubbing, or other extended-technique-based sound events that enter in and out in the foreground, reminiscent of animal sounds

3) rhythmically-defined strokes on the drum set, for example concert bass drums, operating in the middle ground, most clearly implying metered time

Fig. 52 shows an initial take on the general processes that are going on at 3:54 - 5:58. Numbers 1-3 denote the distinct layers, but also the order in which these layers are introduced (i.e. layer 1 being the first). One can hear the three layers in the way they operate on different overlapping time-scales. This creates a sense of a very loose polyrhythm that emerges over longer durations of roughly 10-20 seconds in length. Costa sequences these in recognizable, but mutable patterns, while the duration and

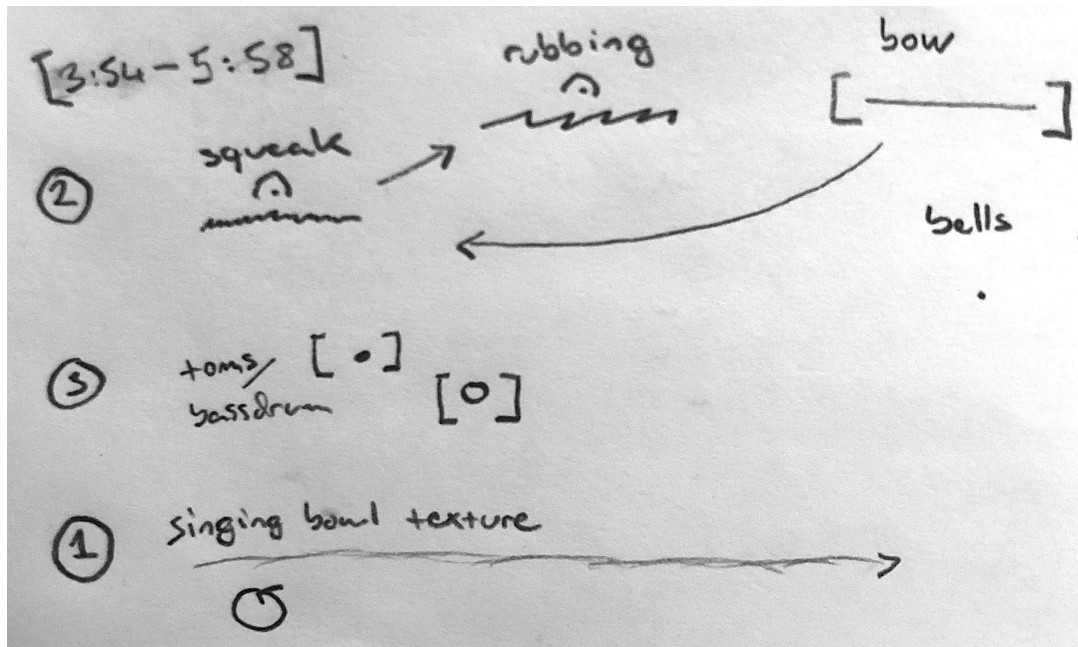


Figure 52 - Sketch of three temporal layers in *Oblivion I*

re-iteration of each event is open. In this transcription, fromats indicate that the duration is open. The square brackets indicate that the event can be re-iterated.²⁹ Arrows in layer 2 indicate patterns in Costa's sequencing.

In layer 2, there are other sounds and textures that Costa plays, but it becomes difficult to distinguish between applying the same technique on multiple objects, therefore, the three main sound icons are more symbolic and open-ended. In terms of some of the variations that happen, the rubbing gesture and sound happens at several frequencies, suggesting using the same technique on multiple objects. The "squeak" sound is at times short, and at times prolonged. The three layers likely correspond to different limbs; the bass drums are played by feet, the singing bowl is likely played

²⁹ By re-iteration I mean repetition that is quite consistent, but involves small variations (e.g. micro-variation) on the level of duration.

by one hand and the various sonic gestures are likely played by another. In this transcription, the amount of space is left undefined and there are no indicators of exact rhythms or durations. This may help reflect a more intuitive approach to timing and “space.”

The bass drum layer suggests most clearly a sense of iterative, loosely measured time. The motif uses one of durations between the two strokes: “short” = cca 1 second, and “long” = 1.5 seconds. The resultant pattern is S S L S S L L. As we can see it’s not repeating exactly, but there is an element of repetition and a playful asymmetry. The full phrase occurs in the following succession of intervals: 14 - 11 - 19 - 16 - 14 (seconds). It seems that Costa is working with shifting relative durations within repetition, so that repetition is established, but is never of the same duration in terms of total pulse units. Considering the overall aesthetic, it may be a reference to the natural randomness in the temporality of environmental sounds. It may also be a reference to the iterative approach to varying metric durations used by Morton Feldman, (whom Costa cites as an influence) in a similar way that it may be manifested in Tyshawn Sorey’s example.³⁰ In contrast to those examples, Costa is creating this variation in free rhythm and likely without counting, using more-so relative durations and embodying the iterative techniques on a more intuitive level.

³⁰ From personal conversation with Carlo Costa on Zoom in January 2021.

In the transcription in Fig. 53, I incorporated more detail about the distinct sound modules and timing upon closer analysis using the *Capo* transcription software and *Graphic* drawing software, slightly revising the elements in the first transcription. The score uses a hybrid vocabulary of symbols and notational devices, and shows a variety of symbols that can be used for different kinds of notational challenges. As with the previous transcriptions, numbers 1-3 show the distinct temporal layers, but also loosely represent the order in which these materials are introduced.

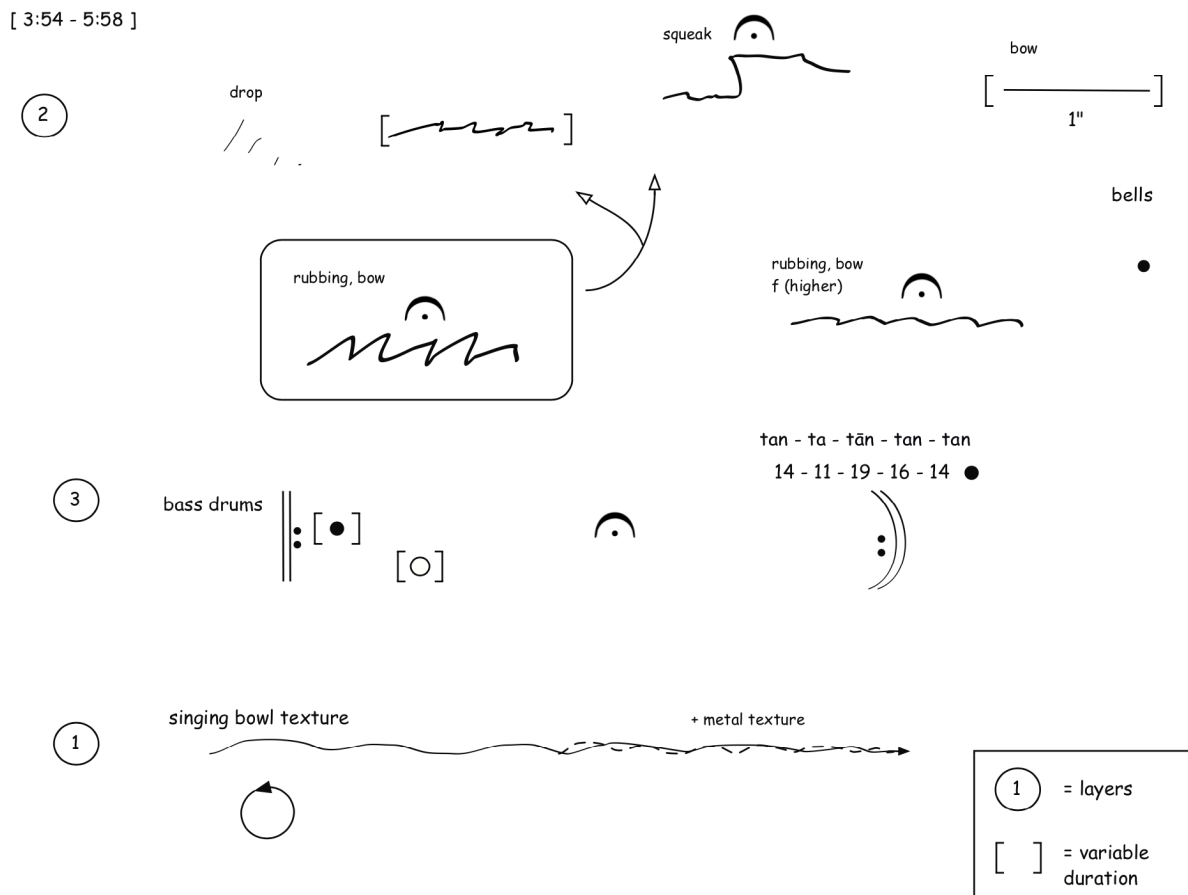


Figure 53 - Transcription of three temporal layers in Costa's *Oblivion I* at 3:54 - 5:58

Layer 1 shows the singing bowl texture in a similar way to the first transcription. There is a soft, metallic, detailed, high-frequency texture that is added to the singing bowl texture, which may be where Costa drops a small chain onto the singing bowl, represented by the dotted waving line. It is at the bottom to denote background, not frequency. There is no indication of when this happens.

Layer 2 has a wider array of sound icons. I tried to distribute them in space to denote very loosely the order in which they appear from left to right, their general frequency relationships from bottom (lower) to top (higher). I also arranged them in a way that references the motion between them; gestures nearby are more likely to happen in succession. For example, the bells seem to only happen after the straight bow sound, although not always. Since there are two similar rubbing textures likely created by bowing, but they don't generally happen in succession, I added the arrows to reflect a motion to the upper quadrant sounds first. The rectangle around "rubbing, bow" denotes that this gesture is somewhat central to the structure here, and slightly more consistently recurrent. The "drop" and the "bells" are on the periphery to symbolize slightly that there are less frequently occur or less likely to be embedded into sequences, as opposed to the more central icons. The second "rubbing, bow" gesture in the right quadrant has a sign f (*higher*), where f = frequency or pitch. The one icon with no descriptive word is there to represent a gesture that's more fluid and can sound in different ways and in different durations, loosely around a gesture similar to the others.

While layers 1 and 3 are generally non-improvisational, layer 2 is much more diverse timbrally and rhythmically than is presented in the score. It seems the most improvisational of the layers (in terms of how Costa is approaching his performance).

Layer 3 shows the bass drums in a unique *iteration bracket*.³¹ Here I thought about how to represent the kind of flexible temporality or temporal vessel that the phrase inhabits. Where in the cycle is the flexibility and where is the fixity? Is the flexibility grid-based (i.e. pulse-based) or is it in free rhythm? Here, the straight brackets at the beginning of the phrase represent a standard repetition bracket, referencing fixity and grid-based time. The circular brackets at the end of the phrase symbolize flexible temporal envelope and fluid, non-grid-based time. Overall, the brackets mean that the pattern is to begin in the same way, but has variable duration afterwards. This variability, however, is not wholly random, but is connected to the idea of iteration explored in this chapter; a dance around an approximate central variable that has some degree of consistency, reflecting an organic kind of variation that occurs in the natural environment. Costa would not likely go suddenly from a period of 10 seconds to a period of 1 second in this recording, but rather vary the amount in a closer range, tending to a kind of wave-like symmetry of “higher than the last” and “lower than the last”, and asymmetry of not falling into predictable patterns.

³¹ Iteration bracket is a modification of the repetition bracket to represent a specific iterative process; a process of variation or micro-variation around a central musical phrase.

Lastly, the durational values 14 - 11 - 19 - 16 - 14 in layer 3 show the sequence of durations in seconds for each repetition of this particular gesture. Above them is another symbolic representation of the process, applying the three general poetic rhythmic units that are used in Persian classical music to show “shorter” = ta “medium” = tan and “longer” or “prolonged” = t̄an. They are applied quite loosely and primarily metaphorically to the set of durations to show an alternative way of visualizing an iterative pattern that is more open-ended and symbolic, so that one does not start to involve counting or measuring in the process. I’ve kept the small iteration brackets around the individual bass drum notes to reflect that Carlo is using two durational values for the higher bass drum. The duration of the lower bass drum is defined by the amount of space, which is variable, so I included the iteration bracket around it as well.

As another experiment in creating a modular representation, I transferred the same elements onto a circular score in Figure 54. Since layers 1 and 2 are played by arms, and layer 3 is played by feet, layer 3 is positioned lower in the visualization. In layer 2, the distance away from the center roughly represents gesture’s centrality to the texture; the further away, the more tangential and less likely to occur it is. The singing bowl is placed in the center to symbolize its foundationality to the whole collection of materials as well as its more timeless temporality. The bells are at the periphery, outside of the second circle to show their tangentiality to the other gestures that are more recurrent. I tried to arrange each gesture to show the possible sequences that one might

trace in moving through the circle in either direction. The “bow” seems somewhat oppositional to the “rubbing” and the “squeak” in terms of where it’s placed, for example. The bent brackets around “rubbing” show, as previously represented by the rectangular box, a kind of centrality, or higher consistency in it being repeated. Layer 3 is represented outside of the circle and below, to show that it is temporally independent and its rhythms are performed independently of layers 1 and 2.

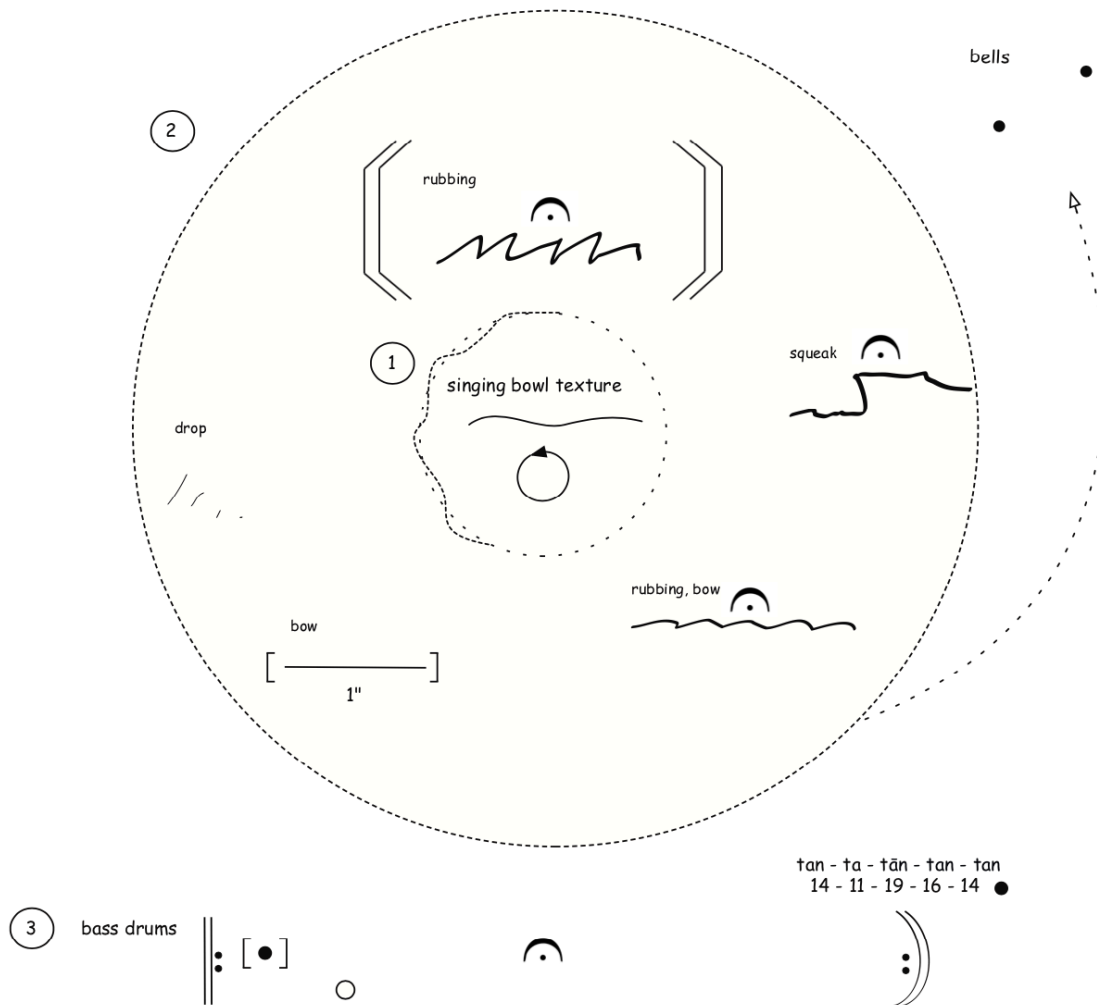


Figure 54 - Circular representation of Fig. 53

The effectivity of either transcription approach remain in question, but they can be helpful in moving towards representing environmental temporality and temporality in improvisation with fluid cyclicalities and polytemporal structures with a mix of free rhythmic gestures and pulse-based gestures.

In *Oblivion I*, there are multiple musical motifs that are organized relatively simultaneously into different temporalities. There are accented sonic events at the foreground which are played rhythmically *freely* in a variable sequence but at the same time cycle back in a general sense. Underneath, there are background drone textures which remain static and span large time intervals of several minutes. And there are rhythmically defined pulses played on the concert bass drums at the middleground, which suggest a reference to an isochronous pulse grid. These form longer patterns that repeat in variable ways. The presence of these polytemporal cyclicalities speaks to an underlying framework in Costa's performance practice, the nature of which eludes this dissertation, but which may be relate to a compartmentalized embodied feeling of multiple periodicities around distinct sound-making techniques.

The recurrence of multiple themes at different periodicities within a large-scale performance suggests diachronic relations. There does not seem to be an underlying musical reference scheme against which the rhythms are organized, besides moments of isochronous pulse and emergent pulsations in the static textures. The cyclicity is largely linear and *free*; it spans variable durations, and is not necessarily measured in

time units. We can talk about each cyclic element, such as the bass drum patterns, as a referent that is being remembered and performed with micro-variations, not exactly the same, but not fully “developing” either. Elasticity is implicit in this process, requiring openness in the transcription and notation vocabulary. At the same time, cyclicity of this kind can still produce entrainment in the listener and the performer.

The next chapter presents the technology developed to implement many of the ideas discussed thus far.

CHAPTER 4: REAL-TIME NOTATION TECHNOLOGY

This chapter describes the real-time notation technology project that I developed around the concept of creating inaudible, cyclic reference structures for improvisation.³² It draws inspiration from the rhythmic vocabulary of the works analyzed in previous chapters, and in particular the idea of engaging with multiple tempo referents and cyclical periodicities simultaneously, as well as the study of non-western approaches to temporality in music. The technology uses the circular scheme for representing musical time-flow discussed in Chapter 1. In this chapter, I focus primarily on the technological aspects of the tool; describing the inner workings of the tool, its component parts, and the other creative technologies that have informed this tool. The other creative technologies include Sean Ryan Smith's *animated scores* among others. Lastly, I discuss the ways this tool draws on the concept of ghost structures.

The purpose of this tool is dual: 1) to provide an adjustable poly-temporal guidance for group improvisation, and 2) to notate music from the piano in real-time. In the context of free improvised music, it is often difficult to engage in specific rhythmic and polyrhythmic vocabularies that are cyclic and groove-based. It's even more difficult to enter into polyrhythmic relationships. Whether an aesthetic choice or an aspect of the improvisational modality, this predisposition can exclude certain non-western rhythmic

³² A link to the MaxMSP patch can be found in Appendix B.

vocabularies for entering into the improvisation — West African rhythms and traditional Balkan folk dance rhythms, for example. On the same account, the establishment of rhythmically or otherwise temporally defined themes that involve specific engagement with cyclic rhythms and polyrhythmic structures can be difficult to facilitate with an ensemble. In designing this tool, I am trying to find a pathway for incorporating traditional and groove-based rhythmic frameworks into pitch and rhythmic content that's created in real-time. The other function of the tool is to be able to notate musical material in real-time from the piano to other instruments (i.e. drums, bass, saxophone, string instruments) and for that material to function as underlying structure for improvisation.

Technology Overview

The tool is created in MaxMSP, a software designed for creating custom, experimental tools for audio processing, event-based processing such as MIDI, and graphical/visual media. The MaxMSP patch I created contains an animated circular score upon which notes are input in real-time and visualized as dots. The flow of time is represented by three cursors, which rotate clockwise at variable speeds. There is one main cursor — in pink color — and two secondary cursors — in black color. The patch allows me to input notes using a MIDI keyboard in real-time. When I press a note on the keyboard, a dot appears on the score at the position of the main cursor representing the

snapshot of when the note was pressed. The pitch of each note is represented by distance from the center of the circle. In this version, the pitch representation serves to show relative differences (e.g. approximately low, middle, or high register; higher than a previous note; etc.). It does not show exact pitch. The cursors tell the performer when to play each note. When the cursor hits the note, the performer plays a note in that approximate register. Whether that note is pitched, non-pitched, sustained, or short is up to the performer. The dot represents primarily the onset point of the sound; its subsequent trajectory open to the performer. Since there are three cursors, the performer(s) can decide whether they individually read one, two, or all three simultaneously.

The rate of the cursors is adjustable in realtime using a knob on the MIDI keyboard. The cursors denote three distinct time rates. The main cursor is 1t (t=tempo), the second cursor can be adjusted to create a fraction of 1t (i.e. 1t/3), and the third is set at 1t/8. In effect, the main cursor is the

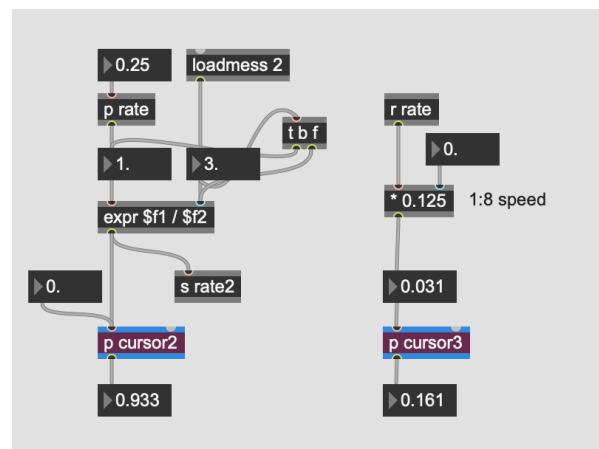


Figure 55 - Control of cursor rates

fastest, second cursor has an adjustable rate in 2:3-related polyrhythmic relationship to the main cursor, and the third cursor is eight times slower than the main cursor. The use of the three simultaneous tempi at different rates as well as the values of cursor 1 and 3

are inspired by the temporal density relationships in between multiple parts in Balinese Gamelan (i.e. 2t : 4t : 8t).³³ The middle cursor enables the user to create, polyrhythmic relationships, for example, 2:3 or 3:4 polyrhythms, inspired by the simultaneity of the 2-based and 3-based pulse referents in Craig Taborn's compositions (see Chapter 2) as well as in many West African musical practices (Agawu 2016: 28). The feature has multiple potential uses. Since the notated material is the same for all cursors, in its current state, a performer reading all three cursors simultaneously with strict temporal precision would play a simultaneous canon of the same phrase in three different temporalities (i.e. cursor 1 = phrase A within 1 measure, cursor 2 = phrase A within 3 measures, cursor 3 = phrase A within 8 measures).

The main object used for visualization of the circular score is *jit.mgraphics*, a Jitter-based, 2D vector graphics object in MaxMSP. It allows one to draw various shapes into a rectangular window that functions as a blank canvas. The object is run by a *qmetro*, which is a metronome-like object that refreshes the window at a high periodicity. *Jit.mgraphics* functions like a stop animation film, with isolated snapshots of time juxtaposed at succession high enough that gives it the semblance of being continuous. The information from *jit.mgraphics* is sent to another object called *jit.pwindow*, which displays Jitter data and images. The other patch components consist of the "dot" input

³³ The practice of evenly divided polytemporal orchestration in Balinese Gamelan is described by Michael Tenzer in *Gamelan Gong Kebyar: The Art of Twentieth-Century Balinese Music* (2000). Additionally, the internalization of the 2t:4t:8t division is supported by the author's experience in performing and studying *Balinese Gamelan* under the direction of Nyoman Suadin at Bard College in 2010-2011.

and the three cursors. The main mechanism for rotating the cursors, and for providing x and y coordinates along the circular grid used in various parts of the patch is located in the main cursor *subpatcher* object. The rate input for each cursor can be seen on the right side of the screenshot. The value is in fractions of a second (in the example in Fig. 56, the main value is set at 0.25).

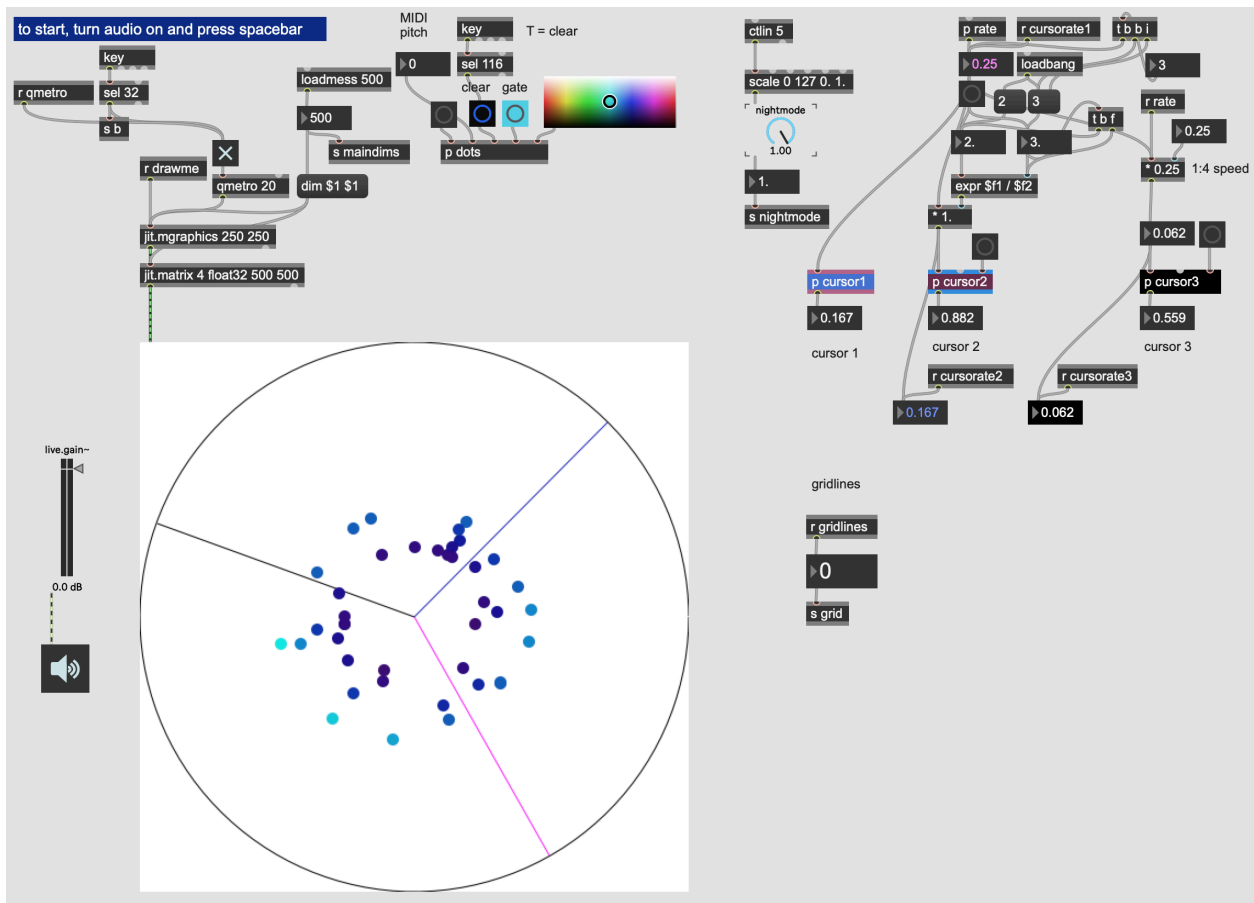


Figure 56 - View of the *Ghost Structures* patch in MaxMSP (2022)

The following screenshot in Fig. 57 shows the main cursor *subpatcher*. On top is a *phasor* object, which generates values from 0 to 1 at a given rate. These values are then multiplied by 2π and converted into polar coordinates to generate continually circulating points along the circle and draw the circulating elements. The *message* boxes send drawing instructions for all the distinct elements (e.g. “ovalarc” = circle, “line” = cursor) into the *jit.mgraphics* object. The other cursors use the same model.

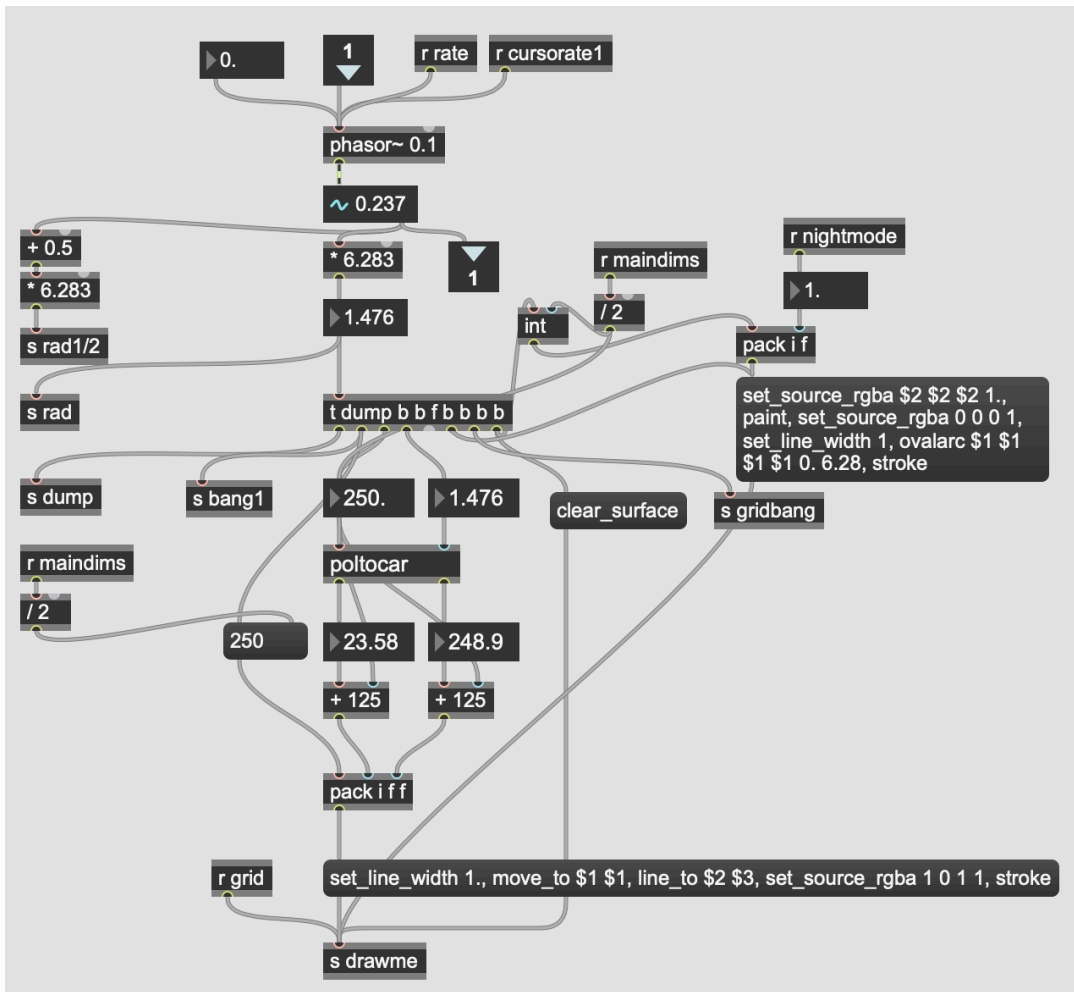


Figure 57 - Subpatcher for cursor 1

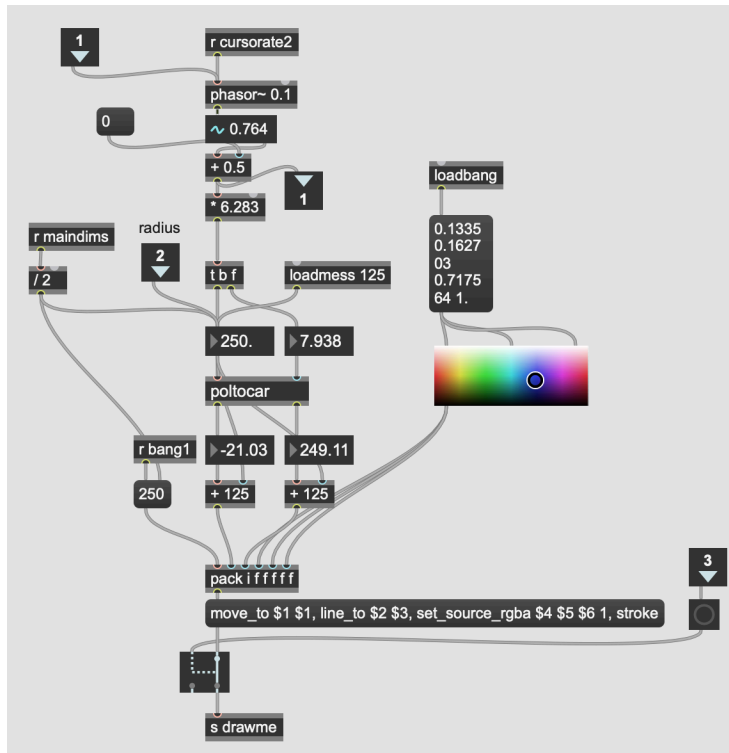


Figure 58 - Subpatcher for cursor 2

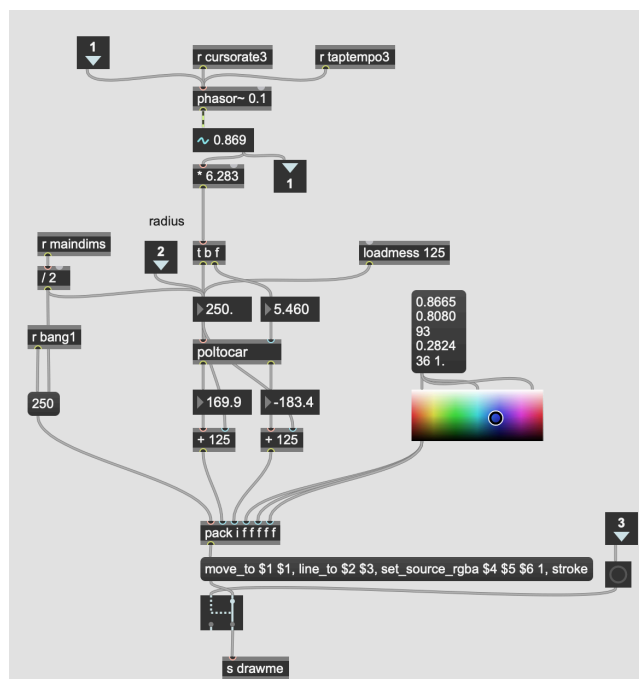


Figure 59 - Subpatcher for cursor 3

There are several unique and adjustable functions in each cursor *subpatcher*. The color is adjustable in each so that they can be differentiated by the musicians. Cursor 2 has a temporal displacement feature (see the *addition* object below *phasor* in Fig. 58). This can be used to offset its rate by a variable number of seconds. Cursors 2 and 3 can be made hidden. The rate of cursor speeds is adjustable by changing the rate of each *phasor* individually using a designated MIDI control knob. As shown in the example in Fig. 55, the main rate is being sent from MIDI control to the first cursor directly and to the other two cursors with multiplications and divisions. I use an *expression* object to multiply the rate of the main cursor by a given fraction for cursors 2 and 3.

The note input is routed through the “p dot” *subpatcher*, shown in Fig. 59. Here, the MIDI note from the keyboard is routed into the *notein* object. Only the pitch index is used in this patch, but MIDI velocity (e.g. volume index) can be used in later developments. The first *coll* object in the sequence stores the note so that it can continually appear on the patch. The note is drawn by when a MIDI note is hit, triggering an “ellipse,” a circular dot, to be drawn onto the score. The pitch is translated from MIDI pitch values of the keyboard (20 - 108) to distance from the center of the circle to the circumference using a *scale* object. On the right side of the patch, there is a preliminary set-up for adding color to the note-dots based on their register. Currently, there is a feature that changes the color of the note-dot depending on the register. The

lower the register, the closer to *violet* end of the color spectrum and *darker* the note-dot is, and the higher the register, the closer to *red* end of the color spectrum and *lighter* it is. One potential future use is to color code each pitch class in a different color, so that pitch information can be visualized with more specificity. For example, one can apply one of the existing color schemes developed by composers for each of the twelve notes, such as Alexander Scriabin's color scheme used in building *clavier à lumières* (1910).

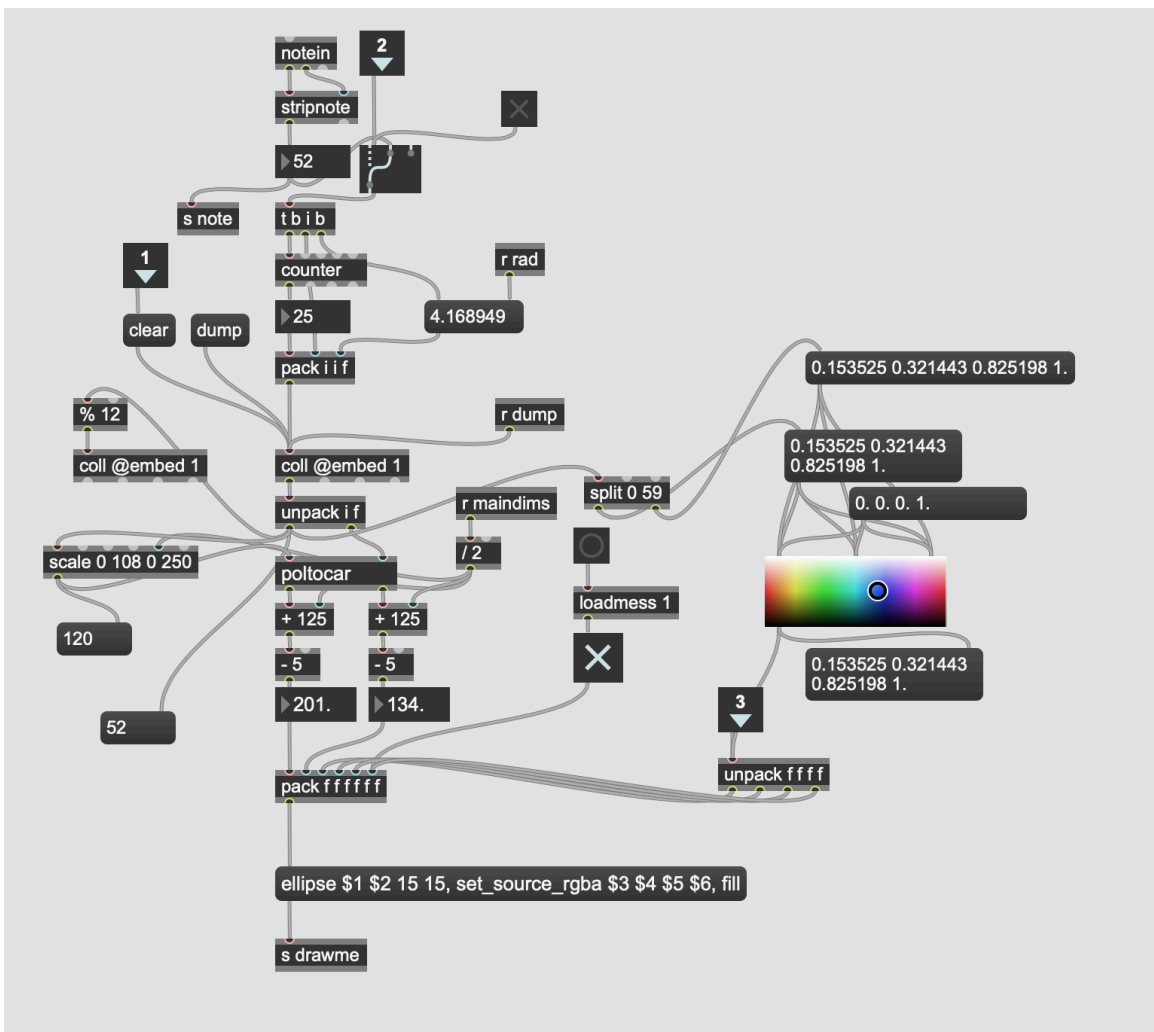


Figure 60 - *Subpatcher* for translating MIDI notes into *dots* on the circular score

Creative Experiments

I've experimented with the patch with a group of improvising musicians: Isaac Otto Hayes on bass clarinet, Steven Lewis on drums, James Ilgenfritz on bass, and myself on piano. We looked at the score together on one screen and recorded three iterations with a different pattern for each. One of the patterns we improvised with is shown in Fig. 61.³⁴

There are several ways in which the patch could be employed musically. In the session, the patch was used primarily as a device to supplement free improvisation. We used the main cursor as the starting reference point and over time began to incorporate the other cursors. When the cursor hit the dot, we would play a note. The note was different for each of us. For the first two

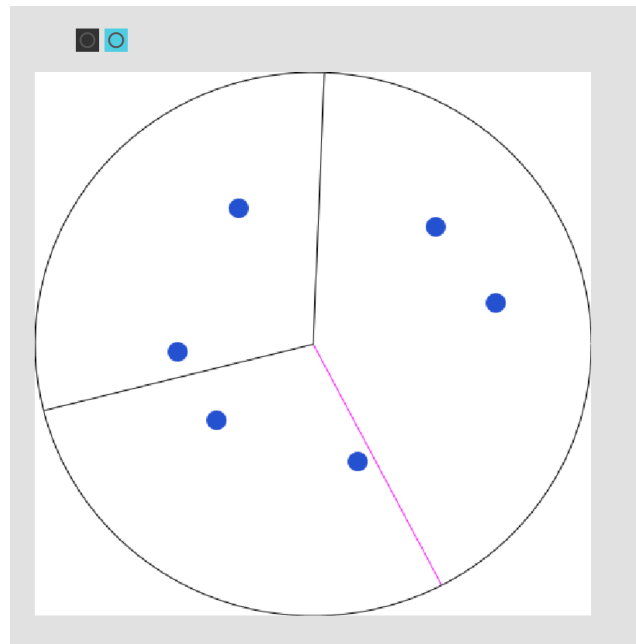


Figure 61 - Pattern in the circular module of the real-time notation tool

improvisations, we all chose freely which cursor we followed, having the two options of either choosing one as our primary cursor, or negotiating between two or all three at the

³⁴ Recording from this session can be accessed using the following link: https://drive.google.com/drive/folders/1mSYGUt7z9PvBg1mgplhTmUYIHYYup_6f?usp=share_link.

same time. We had the freedom of playing notes in between the dots. We didn't have to play every single dot in the cursor's path; it was more effective when we chose certain dots as "our personal" time points among the pattern, for example two out of five dots per cycle. We assigned pitch or sonic register to each dot with consideration of their relative position to each other, and to the space between the center and circumference of the circle. In the process of performing, we largely relied on listening to each other and at times locked into the same pitches and melodic structures. The realm of pitch was thus largely allocated to listening and improvisation, and not to the patch itself. The resultant interpretation was very open. The main aspects of pitch visualization that communicated well were the more obvious differences in distance: close to the center, mid-way, and towards the circumference, for example.

During the improvisation, I set the pattern using a MIDI keyboard into the circular module at the start, and set the main tempo for all cursors. The relationships between the cursors were $1t : 1/3t : 1/8t$. Over the course of the improvisation, I at times added notes to the patch, or replaced the pattern with a new pattern. I also experimented with changing the main tempo at certain points. Ultimately, I was hoping that the score would inspire the performers to experiment with retrospective temporal connections as the main improvisational goal in order to create a kind of alive, organic looping structure that engaged in nested rhythms, polyrhythms, and hypometric rhythmic alignments.

Models for Software-based Notation

The primary model for developing the notational tool is the catalog of *animated score*-based compositions created by the composer Ryan Ross Smith. Smith describes the modality of animated scores: “an animated score contains one or more notations that feature real-time dynamic characteristics, and while these characteristics vary considerably in their appearance, functionality and intentions, a score is only considered to be an animated score if movement is an essential quality.” (Smith 2016:8) My technology and Smith’s scores contain parallel elements, and lead to possible future applications that can be explored. His composition titled *Study 40.2* (2014) is a particularly relevant model.³⁵ It uses an animated circular notational scheme created with a software-based medium. The piece is designed to be performed by an ensemble of eighty performers from a projected video score that is pre-composed, similar to the way one would perform a fully notated composition, but with a completely unique notational vocabulary and animated components.

On a level of rhythmic representation, the patch I developed and Smith’s score both work with a similar visual vocabulary. The time-flow in Smith’s composition is represented circularly in continual, animated, clockwise motion. Individual note onset points are designated by a cursor that passes across a given note. There are several

³⁵ *Study 40.2* was accessed through http://ryanrosssmith.com/study40_2.html.

cursors of different lengths, each moving at a different speed. The relationship between the tempi is not exactly clear. The tempo is dynamic; the cursors' speeds transform as the composition progresses. In comparison, the use of cursors is similar in my tool. They designate onset points and create a multitude of time-flow markers at different tempi with which the performers can engage. While in *Study 40.2* each player is only looking at one note-event per cycle, in my tool, the performers can engage with all three simultaneously. They have the choice of playing them or omitting them. While in Smith's score the cursors are also used for pitch alterations of that one note-event, in my patch they are used for re-iterations of the note-event in multiple time-flow rates.

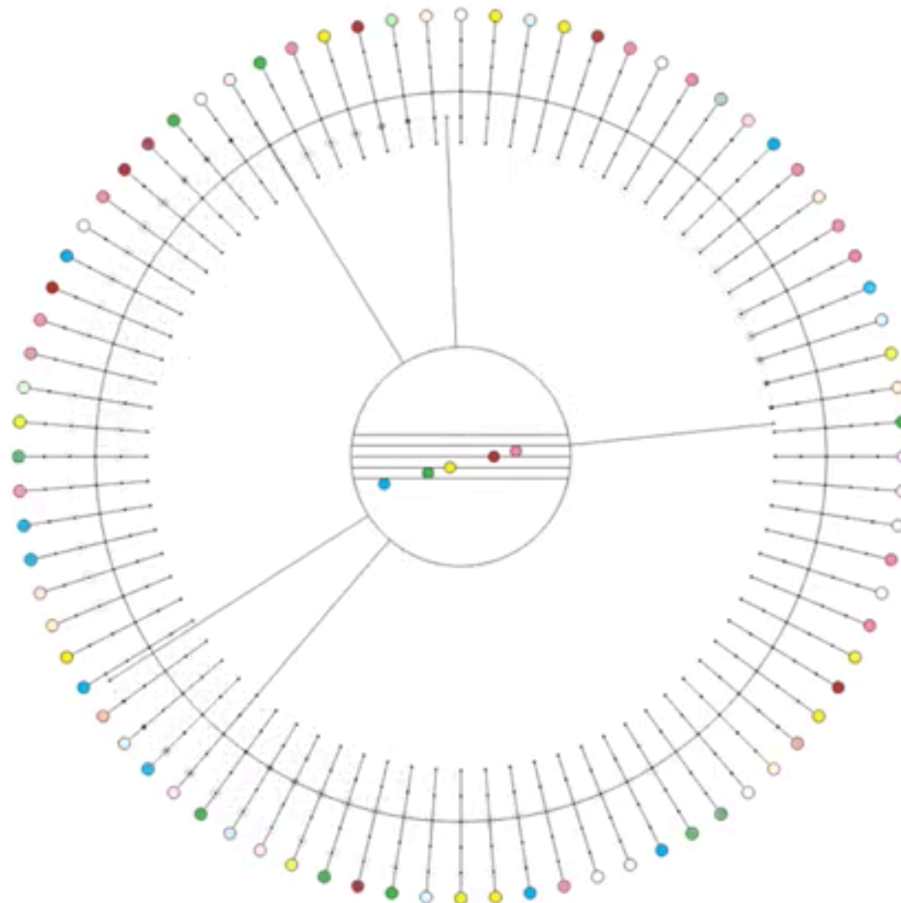


Figure 62 - Still from Ryan Ross Smith's *Study 40.2* (2014)

The combination of staff notation with specific pitches and a circular notation for rhythmic event used in *Study 40.2* is another effective pathway of incorporating pitch and harmony in a more sight-readable friendly way into the framework of the patch. I was inspired by Smith to incorporate staff notation next to the circular scheme. In order to visualize pitch information, I used an existing linear transcription tool in MaxMSP called the *bach.transcribe* object.³⁶ The *bach.transcribe* object is one of a larger network of objects that deal with notation and composition. I use it to visualize and record MIDI notes in real time and separate them by register into three distinct modules, one for saxophone(s), one for piano, and one for bass. The transcription is controllable and editable in real-time, similarly to the circular module, using a combination of MIDI

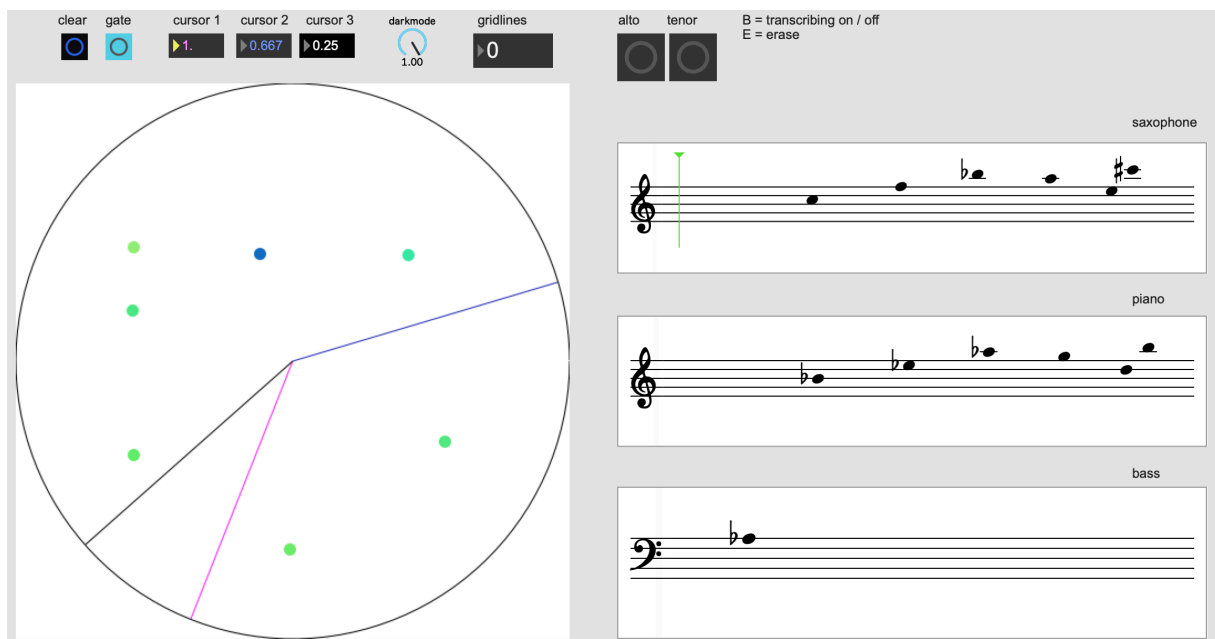


Figure 63 - Image of the MaxMSP tool showing the way it is seen by performers

³⁶ *Bach* is a package of MaxMSP objects for “computer-aided composition” developed by Andrea Agostini and Daniel Ghisi. For more information, see <https://www.bachproject.net>.

controls and computer keyboard controls. The rhythmic information is stripped so that the circular module can be used as the primary source for rhythmic information. The pitch-to-color feature, however, is not readily programmable using this framework, and in effect cannot fully achieve the pitch-to-color correspondence used by Smith.

There are several key differences between Smith's notational framework and the framework I developed. These differences may relate to the distinction between composing for classically trained musicians where the notation has the function of providing each successive note or gesture from beginning to the end, and composing for improvisers where the notation can exist in the background of what is being played in real time. Firstly, the contents of Smith's scores are highly dynamic and many elements within them change over time. For example, a blue "dot" on the circumference of the circle in *Study 40.2* at time-stamp 4:30 becomes yellow at time-stamp 7:00. He is playing with the symbolic relationships set up in the patch, often changing arrangements, and morphing the landscape of the patch over time in subtle ways. Many of these dynamic elements differ from my tool. There is no automated system that's dynamic besides the consistent circular movement of the cursors. The reason is that any automation would have to be either pre-composed — taking away from the improvisational ethos of the patch — or have an adaptive relationship to an aspect of

the music.³⁷ The dynamism that's there is created by the human input. This includes note input, tempo control, and structural edits (i.e. clearing the screen and setting up polytemporal relationships between the cursors). The non-human animation is the continual, automated movement of the cursors. The fact that the score itself is improvisational, and therefore created in real-time, is a unique factor distinguishing it from other existing animated scores.

The underlying compositional processes used in constructing *Study 40.2*, specifically the polytemporal or polyrhythmic processes, are largely hidden from the performers. A performer cannot discern from the visual information the actual periodicities Smith is working with. They approach the score on a moment to moment basis. In my patch, I try to visualize the compositional processes within the score more plainly. One aspect of that is that the elements are not continually changing, so that the performer can understand the compositional processes: the relationship of rates, the note-to-register relationships, and time-points (e.g the durations). The dynamic nature of Smith's score presents challenges to the facilitation of *entrainment* to a referent structure. The performer can't entrain into a structure if the structure changes too rapidly or in non-predictable ways. The circular score should reflect in some ways the

³⁷ Adaptive relationship in the context of music technology refers to the interlinkage of one variable from a given live source (i.e. audio signal, or MIDI input) with another variable within the technology (i.e. effects volume level), wherein if one changes the other changes too.

characteristics of the attentive rhythm of the performers for the pattern to function successfully as a ghost structure.

Another model that has inspired the notational tool is Lavanya Kukkemane's software for visualizing rhythmic phrases of the tabla (2020). Her patch also visualizes rhythms in a circular scheme and in a clockwise direction. It uses an audio input as the main source for receiving information that is then used to draw lines. The thickness and length of each line corresponds to the volume. The patch is animated, and once a line appears, it fades away gradually, leaving a visual trace. While Kukkemane's patch is built around an audio input and does not contain pitch information, it presents relevant potential future applications to the tool I developed, such as the gradual fading of notes, and the representation of volume with a gradient of thickness. These lie beyond the scope of this dissertation. Nevertheless, the modality of visualizing a circular pattern from the imminent past and the ability to perform improvisationally are qualities that are shared in the circular notation framework in both traditional score-based (e.g. transcriptions of *Future Perfect* and *Raga Yaman*) and software-based modalities.

Relationship to Ghost Structures

The notational tool I've developed is designed to provide an underlying rhythmic and melodic structure for musicians to use as a referent for improvisation. There are many ways this tool exemplifies the elements of ghost structures explored in this dissertation. The arrangement of dots represents temporal anchors for the group to

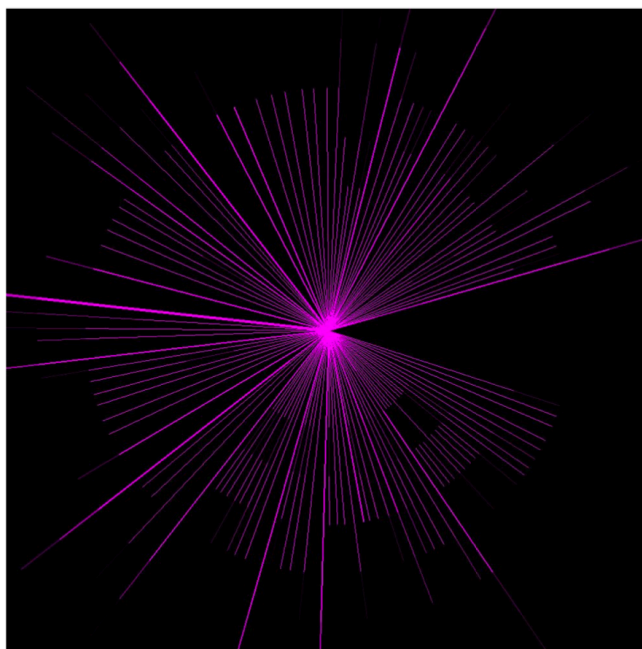


Figure 64 - A still image of circular visualization in Kukkemane's software (2020)

use as a common reference. They provide a temporal architecture for how the musicians inhabit the musical space without the actual pattern being audible, mimicking how a referent rhythmic structure may appear in the mind of an improviser. The improviser does not have to play each note, but is free to reference the structure by aligning with it or playing around it, thus being encouraged to create improvisatory, variational, and otherwise indirectly related musical structures. Since all of the musicians see this, there is lesser need for the musical structure to be stated by any one musician. Much of the allusions to it can be made indirectly. The musical structure itself can be input in silence using MIDI control so that there can be almost no trace of it sonically. Regarding the visual-notational aesthetic of the patch, the emphasis on rhythm and temporality in the

score coupled with the non-emphasis on pitch and harmony is supported by my assertion in this project that ghost structures are temporal schemes and temporal architectures.

The visual vocabulary of the tool has cyclic, liminal, elastic, and indeterminate elements. Purposefully, the notes can be visualized without any grid. The performer has to imagine the time values between each note. By doing so and negotiating them with other performers, the performer operates in a liminal space between what is notated and what is being played. The presence of multiple cursors is designed to create the sense of liminality between multiple tempi. The purpose is to guide the performer towards operating on multiple temporal levels simultaneously. This simultaneity serves to heighten the phenomenological aspect of liminality in ritual musical practices. The cyclicity of the cursor and the circularity of what represents the “meter” suggests a continual return to the pattern itself. The option to return or to depart is up to the performer, but the visual aesthetic emphasizes return over linear development. The notated pattern doesn’t prescribe a fixed interpretation. What is actually played is different. The pitch is chosen by the performers and musical material is played around the dots. How the pattern translates into sound can be continually revisited and re-interpreted, similarly to revisiting a memory of sound and melody.

The cyclicity of the pattern suggests entrainment to the structure, so that it can become internalized by the performer, and facilitate generative musical processes that

develop beyond the pattern and simultaneously in relationship to it. More details on ghost structures are in Chapter 2. The tool still needs further development to include polyrhythmicality and rhythmic elasticity more fully. In its current form, elastic time-flow or micro-temporal deviations are not suggested, since the cursors move at constant tempi. These elements can, however, coexist with the patch in what is improvised. In further developments, I'd like to experiment with alteration of the cursor rate speed to incorporate irregularities, and with addition of elastic grids.

While the current patch has a great deal of non-fixity, future developments I intend to explore might show that fixity is actually a helpful factor in creating and visualizing a ghost structure in real time. Similarly, the way non-fixity is approached can be more in line with the conceptual entailments of ghost structures. It's more important that the visual symbols presented in the patch and the performance guidelines allow for improvisation rather than reflect the liminal and elusive aesthetics of ghost structures, since the elastic, liminal, and indeterminate elements are present most strongly in the mind and body of the performer. The visualization/notation is mainly a tool for suggesting those kinds of processes, and allowing those elements to exist in conjunction with it.

Having concluded the discussions on notational strategies, ghost structures, analyses of works exhibiting properties of ghost structures, and technology implementations designed to combine the aforementioned elements, I turn now in

Chapter 5 to discussing the original creative works resulting from the ideas presented in this dissertation writing.

CHAPTER 5: CREATIVE WORK

Discussing the performance of works in the capstone concert is the primary focus of this chapter. Additionally, I discuss the rehearsal and experimentation phases leading up to the concert. In analyzing the concert, I use transcription of recordings and the analysis of formal and especially rhythmic aspects in a fashion similar to Chapter 3. This enables me to connect the notational tools developed in previous chapters around the music and concepts of other musicians and test them in the context of largely improvised, original works. Through the transcribed examples, I demonstrate how the concept of ghost structures, and the related themes of elasticity, cyclicity, polytemporality, liminality, and non-western approaches to temporality become explored in the creative work.

The primary aims are to show how referential improvised material can be organized at multiple different temporal scales, how elasticity and cyclicity can intermingle on the levels of rhythm, contour, tempo, and larger levels of structural organization, and how multiple rhythmic vocabularies from non-western musical practices can integrate within free improvisation. In analyzing all these processes, I sought to find the conditions, conceptual tools (i.e. a priori ensemble toolkit of ideas and techniques), and temporal schemes that allow them to happen. As with the previous

analyses, I looked for central motifs and themes and traced the kinds of improvisational and variational relations that happened around them.

To organize this chapter, I divide the creative work into three main areas: notation, technology, and improvisational practices. The notation experiments involved the innovative use of circular notation on a traditional score (i.e. paper), and the use of w.c.p. staff notation with augmentations (i.e. to represent modular, non-linear structures) in creating new compositions. These notational experiments draw on research in Chapter 1. Circular notation was also a part of the technology. In effect, there is a crossover between the notational experiments and the technological aspect of the project. The technology, described in more detail in Chapter 4, was comprised of a real-time notation software in MaxMSP that was used to create new compositions within performance. This tool, which is the first of its kind to have sight-readable notation created in real-time from improvised material and performed in the instance of the performance, was used in the capstone concert.

Both the notation and technology experiments drew on the concept of ghost structures. The works I created using score-based notation (i.e. not software-based) facilitated an open and non-prescriptive engagement with cyclical rhythmic-melodic motifs in ways that could allow for engagement with non-western approaches towards musical time, and for liminal spaces between the composed and improvised material. The improvisational practices can be further divided into: a) the application of temporal

concepts from the research, including the idea of relating to ghost structures from the past as well as those emergent from the improvisation, and b) the engagement with intercultural and non-western rhythmic-melodic vocabularies in the context of free improvisation.

The creative work was presented in the form of a capstone concert titled *Ghost Melodies*, which took place in June 2022 in a concert hall at the University of California, Irvine. The concert featured an ensemble of musicians who are steeped in both improvisational practices and w.c.p. notation-based musics (i.e. western classical music, jazz). The ensemble included: bassist James Ilgenfritz, drummer Atticus Reynolds, guitarist Prawit Siriwat, saxophonist Matthew Nelson, saxophonist Isaac Otto Hayes, bassist Julian Lampert, and myself on piano and the real-time notation tool. There were ten original works that spanned a total of approximately 120 mins, and each featured a particular subset of the ensemble. In effect, there were works for solo, trio, quartet, and quintet. The works in the concert integrated improvisation, composition, and technology. Traditional scores precomposed material on paper and the MaxMSP real-time notation tool were used as subtexts for creating new compositions collectively from scratch and in real-time.

Notation Experiments

There are many processes and techniques in non-western musical practices that rely on cyclic structures. For example, in both West African drumming, and in improvisation in North Indian classical music, there are musical textures in which materials are constructed in complex ways around their relationship to the underlying rhythmic cycles. Without the presence of cycles, and specifically the way they are performed and conceptualized by the performers, the specific musical vocabulary for variation and improvisation would be difficult to integrate. In moving towards the context of the capstone concert, the exploration of the elastic cyclic organization of improvised material to serve as a subtext for collective improvisation is motivated by its supportive quality to non-western vocabularies of rhythms and melodies that are based in relating to cyclic structures.

In discussing the role of notation in the creative work, I will focus on the cyclic framework and the surrounding conceptual and improvisational processes. I will first walk through the role of composition in the preparation of the concert at large, which involves the learning process of engaging with the concepts behind the notation, and then analyze the works in circular notation in the capstone concert.

The preparation for the concert consisted of: a) rehearsing a number of original compositions that were used to create a common ground and share the concepts explored through the research component of the dissertation, and b) experimenting

with the MaxMSP real-time notation tool. The majority of these original compositions were actually not used in the concert itself, but rather served as learning tools. Since they were removed from the concert, they functioned as ghost structures for creating our collective improvisational vocabulary that materialized in the performance. The preparation also involved sharing several albums for listening that encapsulated some of the non-western musical vocabularies that were relevant to the concert. As a result, elements from all the materials we learned could re-emerge in altered forms organically through improvisation. The compositions we rehearsed also served the role of sharing some of the non-western musical vocabularies, such as Bulgarian traditional rhythmic-melodic patterns, and specific polyrhythms. The outcome was a kind of common mental map of fragments of rhythms, temporal-improvisational processes, and melodic-modal vocabularies, not unlike the concept of *avant-textes*. The rehearsal processes involved primarily the trio ensemble of Reynolds, Ilgenfritz, and me.

In the beginning I introduced a collection of five etudes that were designed to engage us with the abstract and conceptual aspects of the circular notation, and to internalize these processes in a way that can be referenced in improvisation. These were not performed in the concert, but served as an introduction of the notational vocabulary. In these etudes, the circle itself represents a mode of behavior towards organizing improvised material into cycles (i.e. containment and self-referentiality), as well as a certain time-scale relation between circle size and rhythmic density (e.g. larger circles

translate to slower temporality or lower density
of rhythmic material).

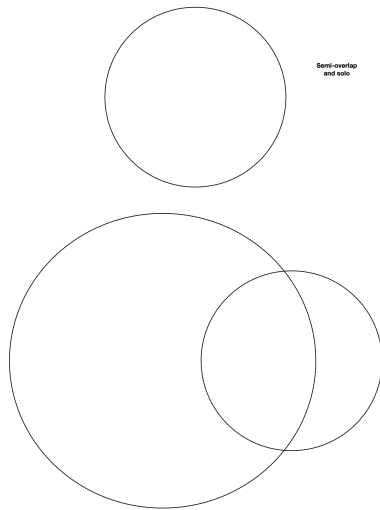


Figure 65a - Etude no. 2
(2022)

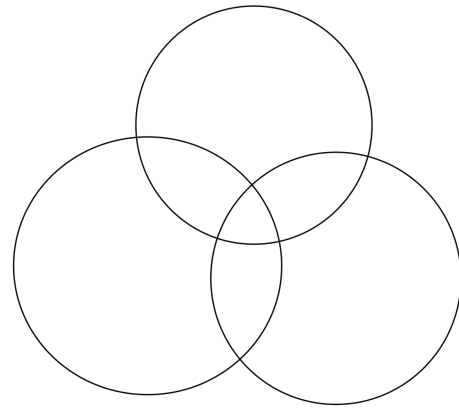


Figure 65b - Etude no. 3 (2022)

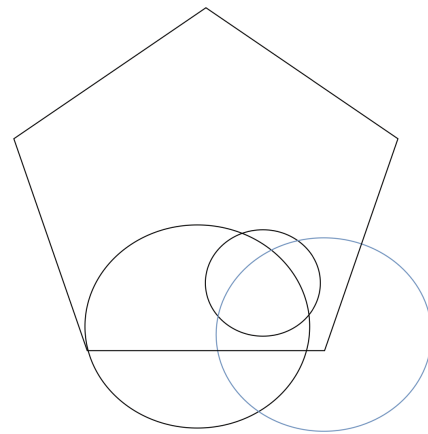


Figure 65c - Etude no. 4 (2022)

In improvising with these scores, each of us associates with one of the circles and use the way they are distributed in space and scaled to reflect two main variables: our temporal inter-relatedness vs. autonomy and the scale of time or tempo in which we are improvising in. The bigger the circle, the less densely we play and the more slowly we feel time. When circles overlap, this creates an opportunity for locking into rhythmic unisons while improvising, and relating the material we are creating more closely.

Polygons were used to represent more rhythmically defined transformation of the circle. They signify a more “metric” texture; a reference to specific meters. The number that the polygon represents is integrated loosely into the musical materials improvised (e.g. pentagon represents the number 5, which can represent a 5-beat meter or a phrase composed of five notes). In the final, fifth movement, the scale differences are at their most pronounced. These scale differences produced polytemporal relationships between the three of us in such a way that whoever associates with a larger circle plays with a greater amount of space in between each sound, and whoever associates with a smaller circle plays with a higher density between each sound in relation to the other musician(s). Thus, the integration of circles of varying sizes and multiple different polygons straddles the two textures of improvising at different rhythmic densities, engaging in loosely polyrhythmic relationships.

Overall, these scores helped establish an awareness of temporal synchronicity on one hand, and facilitate improvising in polyrhythmic relationships while keeping the musical-compositional materials fully open on the other. They expand upon the idea of the circle as a *free* meter; a looping canvas to be filled improvisationally and dialectically, and also of the space surrounding the circle as a kind of environment within which the composition lives, and in which other processes can happen.

There were several other scored compositions that we rehearsed that were also not performed the concert. These included several works composed with circular

notation, hybrid circular and staff notation, and standard w.c.p. staff notation (see the Appendix section for full scores). For example, Figure 66 shows one such composition that we had worked on during rehearsals.

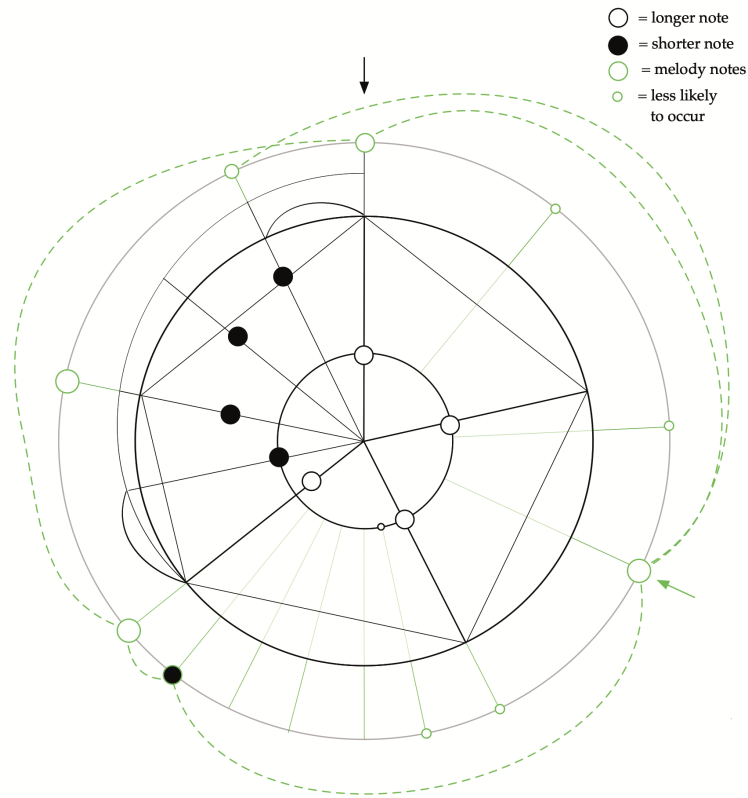


Figure 66 - Experimental score *Are You in Love?* with circular scheme (2022)

The score presents an experimental, creative application of the circular notation used previously in Chapters 1 and 2. The circle represents a specific musical cycle composed of two monophonic lines. The core rhythmic cycle is located within the circle and represents a bass line, while the notes and dotted lines at the periphery show the upper, melodic line, which is also differentiated by green color. Each dot distributed in

and around the circle represents a note. The duration (i.e. rhythmic value) of each note corresponds exactly to the specific distance around the circle in clockwise motion. In effect, the whole pattern can be counted and performed exactly as if it were written in staff-based notation. The size differentiation of dots-notes represents the likelihood of each note's occurrence. For example, smaller dots are less likely to be played when the pattern is looped.

The polygon within the circle represents a primary subdivision of the cycle, similarly to what is implied within a meter, but not in fully isochronous durations. There are additional lines between the center and the perimeter in green and black. These show all possible placements of notes when the cycle is improvised upon. Purposefully, the cycle is not divided fully by an isochronous grid, so that some degree of rhythmic openness and indeterminacy can be preserved. Lastly, the dotted lines encircling the outermost perimeter represent likely patterns of movements from note to note. They are there to trigger a more linear movement that's slightly independent of the lower cycle.

Rhythmically, the score experiments with two unusual elements which are otherwise difficult to notate in w.c.p. notation. (1) The circle represents time-flow. When it is completely even with no anomalies, it means that the time-flow should be steady. This piece uses deviations to the inner circle's time-flow in the form of: a) smaller half circles around individual segments and b) a spiral-like departure above the inner circle

at the end of the cycle. The former (a) indicates slight drag or fermata around a single note. The latter (b) indicates a gradual drag or diminuendo across the whole five note segment.

(2) The other unusual element is the metric division of the cycle. There are two different pulse referents in the cycle in the inner circle. The first, longer pattern of three open-head notes encompasses three measures of $6/8$, or $18/8$ altogether. Because these measures are divided in subtle ways (i.e. in half), the feeling of $6/8$ meter is not clearly audible. The other, shorter pattern of five ascending notes encompasses five units of $2/8$, or $10/8$ altogether. The notational scheme has a unique advantage in making such compound groupings more customizable by the composer, for example to create the feeling of two pulse referents moving back and forth explored here.

Lastly, in performing this score, Reynolds and I repeated the pattern continually over a longer period of time (i.e. 5 minutes) with variations. I played the inner circle with left hand and the periphery with the right hand. Reynolds used lower-pitched drums for the inner circle, and cymbals for the outer circle; both in variable ways. We treated the score like a skeleton structure around which other material was built. We explored alternative ways of subdividing the cyclic space improvisationally in addition to what was written. We also explored some of the variational possibilities indicated by the note-size differentiation and the visualization of the reference grid.

Ultimately, the score became an exercise in internalizing and embodying this non-

isochronous, relatively short cyclic pattern. One purpose it could serve is for that specific cycle and its underlying temporal features to be conjured up in improvisation in building a larger texture. The primary advantage and use of the circular notation in the creative domain seemed to be in facilitating internalization and embodiment of the notated material with its temporal specificities, rather than in representing a full, stand-alone composition. In that sense it is a unique vehicle for musical learning, but it also is limited in its compositional potentialities.

Notation in the Capstone Concert

In the following section I will discuss the application of the circular notation to compositions in the capstone concert. There are two works which were composed with the circular notation as the primary framework: *Constellation in Db* (2022) for piano, acoustic bass, and electric guitar, and *Constellation in Eb* (2022) for piano.

Constellation in Db is a score-based composition notated with circular notation.³⁸ Its performance featured bassist Julian Lampert, guitarist Prawit Siriwat, and myself. The circular score instigates the process of collective restructuring of a core rhythmic pattern and gradual departure into a new rhythmic-melodic structure that emerges out of improvisation. The performance can be divided chronologically into these three processes: 1) establishment of the core pattern and a resonant texture on pedal Db,

³⁸ Video of *Constellation in Db*: <https://youtu.be/iHo9MfdVPBQ>

2) collective restructuring in reference to the core pattern, and 3) an emergent rhythmic-melodic structure.

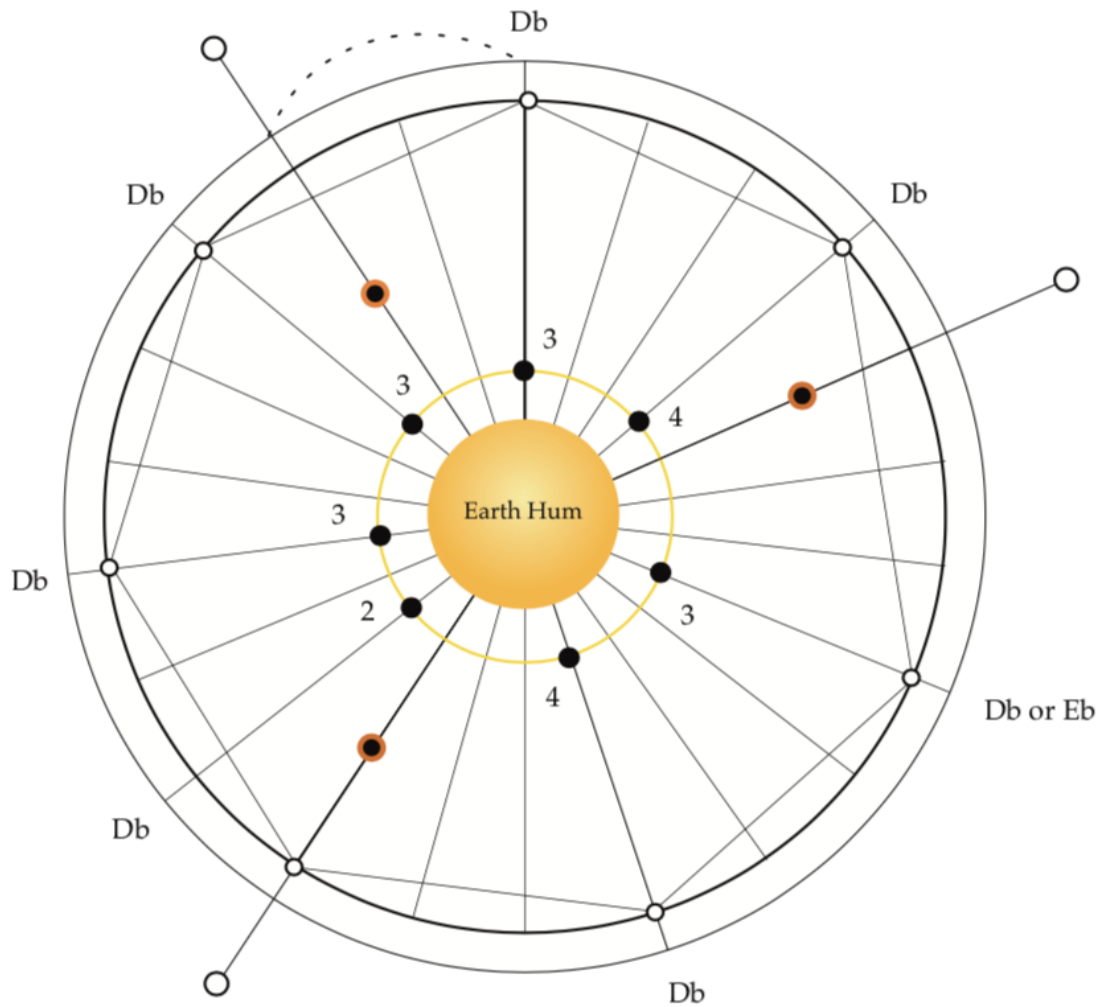


Figure 67 - Score for *Constellation in Db* (2022)

The primary *ghost structure* in this piece is a cyclic rhythmic pattern in 22/8 meter. It's based around the intermingling of several shorter metric groupings: a 7/8 rhythmic pattern — a reference to ta-ta-tan grouping of the *chahar pareh* poetic rhythm, a

3/8 pulse, and interjections of 4/8 pulses. The cycle contains a tension between three cycles of 7/8 which result in a 21/8 cycle and 22/8. The tension is intentional; it serves to elicit a departure from the cycle's initially fixed meter, and move into an elastic meter via either falling into cycles of the 7/8 periodicity, cycles of the 3/8 periodicity, or the occasional extended 8/8 periodicity. And it moves in between them. Ultimately the group is led outside of the 22/8 meter into a wholly new metric grouping created improvisationally.

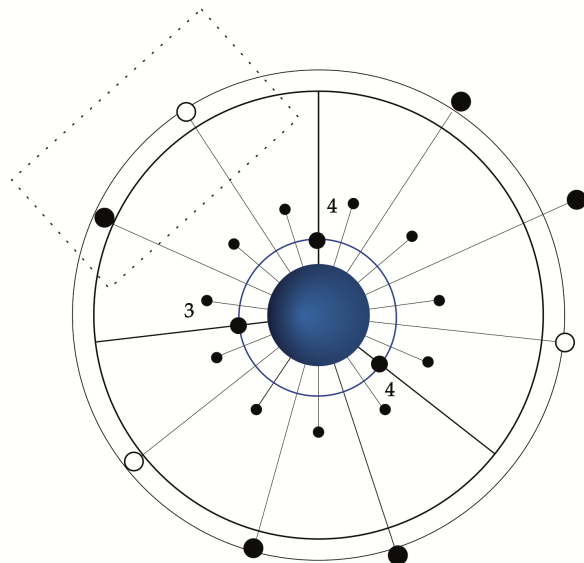
In the score there are two main rhythmic layers: a lower layer notated closest to the center on a yellow line, which is played at a low frequency Db and functions as the primary referent for bass and left hand of the piano, and an upper layer colored in black and orange together with three points beyond the circumference of the largest circle, which are played at a higher transposition of Db, and is used as a referent primarily for the right hand of the piano and guitar. The upper layer is based around an elastic 7/8 meter and the lower layer is a sequence of 3/8 and 4/8 pulses with one 2/8 pulse.

Some of the improvisational relations to the score involved inserting our own polyrhythms in the upper layer against the lower layer, and letting the lower layer converse with these additions and adjust over time. It is as if there was a scaffolding (upper layer) and a foundation (lower layer). As the scaffolding moves, the foundation can also move, but with more resistance, and at a slower pace. These polyrhythms were

elastic. For example, one of us could establish a periodicity in 6 beats that would begin repeating. Over time, we would add or subtract beats freely, adding 7 beat or 5 beat pulses. These techniques were expressed across several moments in the performance, but some of the fluency was compromised by limited rehearsal time given the novelty of this notation.

Additionally, we used two structurally important rhythmic devices to help communicate between each other: 1) repetition of the same periodicity three times that lands at the downbeat of the 22-beat cycle is meant to reinforce the core structure (similarly to *tihai* in North Indian classical music) and signal where the starting point of the cycle is, and 2) repetition of a new or altered pattern at least four times or more to signal that the new pattern is becoming a new referential structure.

Another work that used the circular notation in a paper score was *Constellation in Eb* (2022). This piece was designed for a solo piano performance. The circle itself is less prescriptive than in *Constellation in Db*. The score involves the superimposition of the “melodic cycle” in staff-notation onto the “dots” in the circular notation. One bar in the staff-notation translates to one cycle in the circular notation. There are two layers in the circular notation: the “dots” around the perimeter of the circle, and the “dots” near the center. The latter refers to a pattern in the lower register played by the left hand, and the former refers to the melody in the higher register played by the right hand.



Melodic cycle



Figure 68 - Score for *Constellation in Eb* (2022)

In both *Constellation* works, the score itself is a remnant distilled from multiple improvisations created in the past. Generally speaking, most compositions created through improvisation can be described in this way; as remnants or traces. However, in using the circular framework, I tried to attend to that relationship more closely through notation: (1) by specifically creating open space for the mutable aspects of how this cyclic motif would emerge and change between multiple past improvisations, and

(2) by distilling a singular iteration of the cyclic motif that has common elements from past improvisations.³⁹

This piece was performed as a solo and for that reason I have focused on exactly what kind of notated information (and lack thereof) is most generative in leading towards improvisation. I found this to be a balancing act of specificity and openness, as are many of the transcriptions in this dissertation. On the level of specificity, it was important that the score creates a technical challenge and that it contains a shard of the identity of what was at the *center* of past improvisations. In effect, it is rhythmically specific enough to encapsulate this *center*, and involves some degree of complexity that needs to be deciphered. I found specific complexity to be conducive to becoming engaged with the score as a performer.

At the same time, there are intentionally chosen *open* elements. There is no pitch information in the circular notation, but there is a subtle representation of contour. As a result, one can imagine the melody modulating and moving in various ways while the cycle's rhythmic flow continues. The dots on the perimeter are either open or closed, which indicates relative shorter and longer durations and corresponds to the note-heads in the staff-notation below. There is no meter, but the circle is divided into eleven equidistant parts. All of these features influence the improvisational relation to the

³⁹ Iteration in this case refers to a type of variation. The slight difference between using the terms variation and iteration in this case is that variation implies a version that is secondary to an "original," while iteration can be used to describe one of multiple "originals", each being the primary version.

structure in such a way that the open elements tend to be interpreted in more flexible ways, and these flexibilities carry the other elements with them.

Both of the *Constellation* works had an effect of producing cyclic textures that facilitated extended engagement with the composed pattern. That was different from my past experiences with reading cycles written in w.c.p. notation. In that format, the cycle can be too immediately understood in terms of how it translates to music, which can lead to shorter window of engagement until the phrase becomes overtly repetitive. Reading the circular score, one can trace the circle continually, and also see the architecture of the pattern and any symmetries and asymmetries within it that are otherwise not visible in the linear format in staff-based notation. Seeing these connections creates additional aspects of the cycle to be explored, for example adding nesting polyrhythmic pulses against the cycle. I find that seeing the shape of the full score as a single visual unit is a unique experience. The whole is less reliant on symbolism than w.c.p. notation, and corresponds more closely with the actual physical choreography of playing the musical cycle.

The resultant improvisation shared similarities with a *gat* section in North Indian *raga* performance. There was an ebb and flow between departing into improvisation and returning to the cycle multiple times. There were rhythmic unisons set up improvisationally. Much of the improvised material was organized into cycles, even if they moved beyond the metric boundaries of the scores, which suggested a successful

internalization of a cyclic approach to temporality. There were also linear elements via creating sequences of faster moving and repeating motivic cells using the harmonic mode and its extensions. The scores facilitated the incorporation into each composition the rhythmic and melodic vocabularies from the related non-western practices.

Improvisational Practices

In the following section, I discuss the improvisational practices and their development from the earlier collaboration into the capstone concert.

Reynolds, Ilgenfritz, and I began working together as a trio in telematic sessions as a part of an improvisation seminar in the spring of 2021 at UC Irvine.⁴⁰ Ilgenfritz and I were in different parts of upstate New York and Reynolds was in Los Angeles, CA. We all had remote set-ups in our homes, which consisted of a laptop, a telematic software program called *SonoBus*, audio interface, mics or direct input connections, and instruments. Sarah Weaver describes telematic collaboration as follows: “assisted by technology, but ultimately achieved through human vibratory connection, telematics presents a liminal space for collaboration that can propel music into uncharted depths afforded by the expanded potentials of joint location” (Weaver, 2009: 6). The particular emphasis on connection in this highly translocalized and technological experience

⁴⁰ The term telematic refers to the use of telecommunication technologies, most significantly the internet, to connect performers in two or more different locations. See *Telematic Music: Six Perspectives* (2009) for more information on telematic improvisation.

paired with having the psychological comfort of us all being and listening in a *home* space allowed for a unique and often enriching balance of autonomy, a kind of musical freedom, and synchronicity. The traditional tools of synchronicity (i.e. common pulse, groove) were present to some extent, but had to become temporally more forgiving and *wider*, while our relationship to rhythm and time on a sound-to-sound level became more autonomous. In these sessions, the vessel of the telematic connection worked in favor of the elastic and liminal aspects of relating to underlying rhythmic referents discussed within this dissertation.

There were several factors that contributed to this favorable conjunction: a) the temporal displacement between each of our audio signal feeds created by latency and b) the underlying pulse created by the interval between hearing a sound and responding to it that emerged in our responding to one another. The latency of the audio signal was different between the three locations. The result was a displacement between what, for example, I was playing and what Reynolds and Ilgenfritz were hearing and vice versa. This displacement was set at around an interval in the general range of 50-250 milliseconds (ms), depending on the quality of our connection. At the same time there was a pulse to that latency. If we heard each sound 200 ms later, that 200 ms would become a temporal interval we entrained to.

Because of this latency we had to improvise in a unique way, and in the process we developed several key tools for improvising synchronously. For example, it was

difficult to lock into grooves and pulse referents in a traditional sense so the baseline for our temporality could be described as *free time* (i.e. no clear reference to pulse, playing “out of time”) or *independent time* (i.e. each individual musician playing in their own sense of pulse or time independently of one another). Often, *independent time* was happening more predominantly than *free time*. We would be autonomously moving in our individual temporal zones that had elements of pulse and references to groove, instead of playing in a completely temporally “free” way, and over time exploring and establishing alignments with each other. Through becoming comfortable in this modality, it was easier later on to move fluidly between *free time* and *measured time* (i.e. isochronous pulse).

Sometimes we would establish gestural or sonic pairings that became one of the anchors for our synchronicity amidst the fundamental displacement in the telematic framework.⁴¹ For example, in one of the recordings from these sessions we established a loose pairing between the high single note in the piano with Reynolds’ rim stick playing.⁴² Whenever Reynolds would play a rim shot I would play a certain pitch, and once that was established, I would move the pitch and rhythm around and his rim

⁴¹ The term “synchronicity” is used in two distinct ways in this chapter. In this case, it refers to performing and *feeling* time collectively in a similar way. For example, *feeling* the same pulse referent. It also implies the idea of playing with a sense of simultaneous togetherness. The other term, “synchrony” or “synchronous” refers to “happening at the same time,” and is generally used in conjunction with referring more specifically to ghost structures.

⁴² Audio excerpt from recording is accessible here: https://drive.google.com/file/d/1q5yeMlb13Cig9uqAN6WzsPFFvmB1uWrV/view?usp=share_link

playing would become more varied and embedded into larger textures that he was playing. These kinds of passing, flexible *unisons* would come and go, sometimes arising very quickly and becoming abstract and indirect right away, but would often become embedded into the music as hidden pillars that would continue existing throughout the piece. In this context the relationship to these *unisons* were almost always rhythmically elastic — a feature that was also present in our in-person playing. Neither of us would be intending to lock in at an exactly repeating duration of time, but rather to continually dance around a fleeting reference point, and to freely extend and compress the duration, to incorporate sub-units within it (i.e. embedding into the interval it spans), and make larger rhythmic gestures of multiple units. Such alignments (cognitive, collective, synchronous), and the common language of establishing them and moving away from them, played an important role when we started playing in person. In the same way, the fluidity of moving between *free* and *measured feeling* of time, and the comfort of operating in between those was also crucial in the concert. Both of these tools were built into our vocabulary.

Elastic Cyclicity in Free Improvisation

In the following section, I analyze the rhythmic concepts in a piece in the capstone concert titled *Trio no. 1* (2022) featuring the trio of Ilgenfritz, Reynolds, and

me.⁴³ The MaxMSP tool for real-time notation was also used. This piece was an improvisation that begins with a prolonged collective exploration of an emergent, elastic, cyclic pattern built in relationship to a pattern inserted into the MaxMSP score. It is concluded with a bass improvisation from 4:48 until the end at 6:12 that responds to the collectively constructed material in the middle. In this analysis, I will focus on my playing as an example of how the concepts manifested, in particular the concept of elastic cyclicity in improvisation in relation to *ghost structures*. This analysis demonstrates the concept of cyclicity and elasticity in themes such as meter, engagement in multiple, different timescales, and iterative structures. The analysis shows that there are multiple temporal levels at which cyclicity occurs, and how within these there are distinct ways in which elasticity (i.e. variation around a reference subject, value, or duration; fluidity and changeability) is expressed.

In the background of the improvisation, there is a MaxMSP patch score that is set at a very slow tempo, approximately 30-40 seconds for a single revolution. The presence of the patch with the slow periodicity may have instigated a cyclic approach to organizing the improvised material at a long temporal envelope. In effect, more rhythmically dense material became embedded independently of the rhythms suggested by the patch, because at the slow tempo these are difficult to discern as clearly defined rhythmic values. At the same time, they — the notes in the patch —

⁴³ Video for *Trio no. 1*: <https://youtu.be/Dhezd4atToU>

functioned as rhythmic *anchors*: time-points that were used for collective alignment and temporal synchrony. In the experience of performing this piece, the specific rhythms in the patch were largely in the background of our focus. Our foreground focus was instead on collective improvisation and listening.

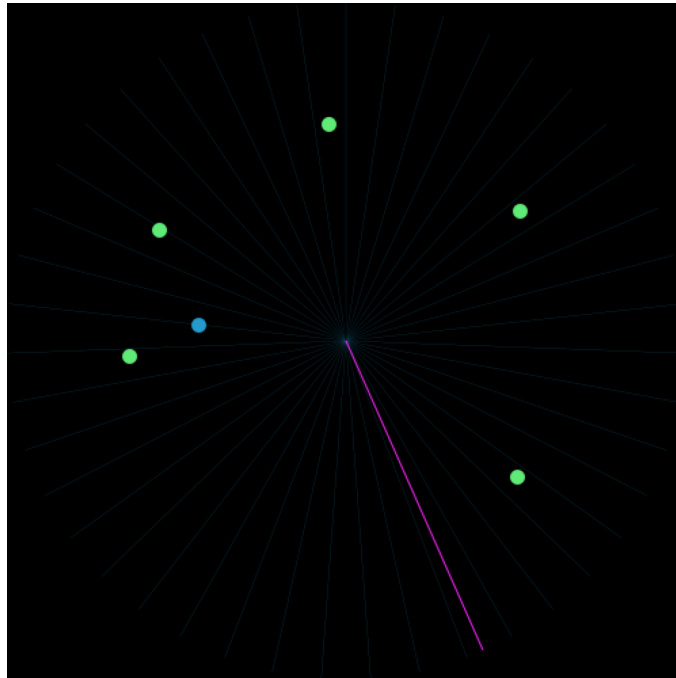


Figure 69 - A re-created version of the pattern in MaxMSP patch in *Trio no. 1* (2022)

There are three levels at which elasticity and cyclicity were manifested in my playing. One is the cyclicity on the macro-structural level, or the *upper scaffolding*; the generally cyclic approach to development of the improvised material. It is an exo-structural cyclicity where the repetition occurs at the beginning and end of the material while the middle content is fully elastic and can be more linear.⁴⁴ The second

⁴⁴ Exo-structural cyclicity refers to the consistent repetition of material that is located at the external boundaries of a give musical phrase or cycle; the beginning and end points.

level is within the content of what is being improvised — a meso-level — which contains rhythmic units, phrases, emergent meters, and melodic patterns. In this piece, the cyclicity there is manifested through references to two distinct temporal structures: isochronous pulse matrices and meters. The third level at which elasticity and cyclicity appears is the micro-structure: the relationship to time and pulse, for example, the cyclicity and elasticity in the structure of each distinct note or sound event. This is manifested through the temporal envelope around each note.⁴⁵ In the following sections, I elaborate on the three levels with examples from the recorded performance of *Trio no. 1* and detailed descriptions.

Level 1 cyclicity — at the macro-structural level — is expressed musically in the piano playing through the return to the (I) primary points of origin (i.e. the very first notes played), (II) secondary points within the linear development that become structurally important (i.e. accents, mid-level counterpoint, emergent cantus firmus), and (III) ternary points that function as temporary anchors in developmental sections and which become overwritten. This was a conscious decision to memorize certain notes within an improvisation, to loosely associate a priority level to each, and to internalize the periodicities between them as they are repeated. This level of cyclicity does not translate to repetition of exact temporal durations (e.g. a 4 bar loop). It is rather a kind of horizontally fluctuating cyclicity that can be described as a general decision

⁴⁵ The terms macro, meso, and micro in relation to rhythmic organization are borrowed from Robert Snyder's discussion of memory and musical rhythm (2001).

to return to points of origin and to seek intermittent points within the improvised material to return to.

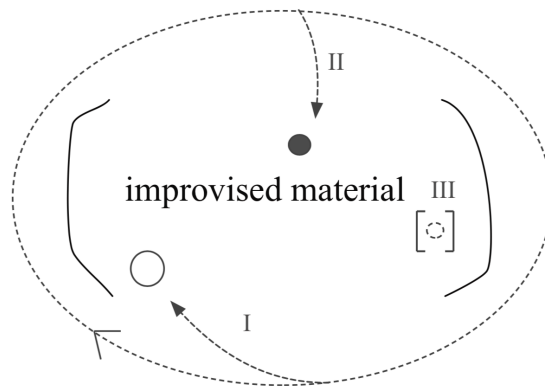


Figure 70 - Visualization of level 1 cyclicality

Fig. 70 shows a visualization representation of macro-structural cyclicality. The notes represent primary, secondary, and ternary points in an early part of *Trio 1*.

“Improvised material” is a stand-in for the other musical material being played.

Level 2 encompasses phrase-to-phrase content of what is being improvised — a meso-level. It contains rhythmic units, phrases, emergent meters, and melodic patterns. The cyclicality there is manifested through references to two distinct temporal structures: isochronous pulse matrices and meters. In the following section, I discuss examples of Level 2.

In my playing in the first section of the improvisation, there are two main isochronous pulse referents: the 3/8 pulse and the 2/8 pulse. The 3/8 pulse is the primary and most frequent pulse referent and the 2/8 is a secondary pulse referent. Often, the movement from one to the other happens diachronically — as a stream of 3/8 and 2/8 values — rather than synchronously — as a polyrhythm — though both are

present at times.⁴⁶ Using these two referents diachronically allows me to engage in an elasticity between the two matrices (i.e. an elasticity in grid-based duration). Sometimes what sounds like temporal elasticity is a movement from one pulse grid to the other, and sometimes what sounds like an allusion to the second pulse grid is actually temporal elasticity (i.e. a free extension of pulse) or liminality between the two grids, such as Hodayun Sakhi's liminal rhythmic patterns in *Raga Yaman*. This occurs more frequently as the improvisation becomes more dense and conversational.

Another level of elastic cyclicity at the meso-level is manifested through references to multiple metric groupings. In the passage in the piano at 0:16, I am referencing two main metric groupings: 5/8 as the primary meter and 2/4 as the secondary meter.⁴⁷



Figure 71 - Transcription of the piano at 0:16 - 0:30 abstracted into rhythms and contour only

⁴⁶ A third pulse referent that's more subtly audible is the slower grouping of 3/4 that runs underneath and explains the duration of some of the metric groupings.

⁴⁷ The terms primary and secondary meter refer to the two main metric groupings.

In the transcription in Fig. 71, melodic contour is represented loosely by vertical placement of the diagonal note-head on the staff, while exact pitches are not represented. The choice of meters was based on the principle of not splitting any of the rhythmic values that are played by bar lines, and listening for recurrent rhythmic-melodic groupings that seem to be played as units. The notes in blue are the fundamental, root notes in the harmonic construction in this section: F2. They function as the prime points in the macro-structural cyclicity discussed earlier. Since this piece was improvised, the meters in the transcription don't reflect a precomposed or conscious rhythmic structure.

The way I conceptualized those groupings was as short, module-like phrases that each resulted in a metric unit. One can see that the same rhythmic groupings are used recurrently with similar contours. For example, the 5/8 grouping is generally short-long, or 2/8 + 3/8, and has a high - low melodic contour. The 2/4 is generally grouped as shorter-shorter-long, or 1/8 + 1/8 + 2/8, and has a *higher - lower - higher* contour. While improvising, I am conceptualizing these rhythmic-contoural groupings rather than metric durations.⁴⁸ There are other meters that happen: 1/4 and 3/4. Because they are less frequent, they can be compartmentalized as a ternary bundle of "other than."

One way cyclicity is manifested is through the recurrence and consistency of the 5/8 and 2/4 metric grouping. In particular, the 2/4 grouping at the end of

⁴⁸ Rhythmic-contoural groupings refer to units of time and relative, but not specified pitch.



Figure 72 - Transcription of the piano at 0:30 - 0:43

each system (in the box notation) is a structurally important point of recurrence. The elasticity is in the variation in the sequencing of these groupings. For example, in the first system there are two 5/8 bars, in the second system there are three, and in the last system there are none. At the same time, the recurrence and melodic consistency of the 2/4 grouping allows me to analyze each system as a whole that is being reconfigured. In the following two systems, the 3/8 meter is introduced and replaces the 5/8 as the primary metric unit. The shuffling of the meters and their rhythmic content becomes more varied as the material becomes more freely improvisational, and new patterns to keep track of as cyclic materials emerge. The elastic cyclicity of the fundamental F2 is shown here. The exact placement keeps changing, but there is a regularity to the interval at which they occur: 10/4, 10/4, 7/4, 7.5/4, 7.5/4, 7/4. The notes in yellow represent G3, and they are another, ternary point of cyclic recurrence in the *upper scaffolding* that emerges in this section and functions in a similar way as the F2, but at a higher and more variable periodicity.

The transcription in Fig. 73 shows the subsequent section with pitches filled in. The 3/8 metric unit continues to be prevalent, and the 2/4 grouping remains structurally important. In addition, I visualized a secondary point in the *upper scaffolding* in green (E3). We can see that, like the F2 and G3, it is continually recurrent, but at a variable periodicity. The sequence of the E3 durations is: 4/4, 6/4, 3/8, 3/8, 3/8, 5/8, 4/8, 3/8, 3/8, 6/8. Its periodicity is clearly grid-based and it functions both in the scaffolding layer and at the meso-level. The rhythmic values reflect the underlying three metric groupings: 5/8, 2/4, and 3/8. And, at the same time, its durations vary continuously. The blue note (F2) periodicities become more variable in this segment, relating more closely to what is happening musically in the upper tones: 7/4, 2/4, 8.5/4, 5/4, 2.5/4, 2.5/4.



Figure 73 - Transcription of the piano at 0:43 - 0:59

The elasticity and cyclicity at the meso-level can also be observed in the confluence of rhythm and melody. For example, the 2/4 phrase outlined in the box in Fig. 73 has a consistent rhythmic profile, but its melodic content is elastic. In the first three instances above, the pitch sequences are different in each one and the contour changes from *higher - lower - higher* to *lower - higher - lower*. At the same time, there are cyclical and repetitive aspects. There is a consistent set of five pitches used in all four instances. The pairing of the first and second boxed phrase has similarities to the pairing of the third and fourth boxed phrase. In both the first and third iteration, the second note is E3 and the other two notes are variable. The second and the fourth iterations are identical to each other; a small, passing call and response structure.

In analyzing the pitch content, it becomes more visible that there is a mid-register iterative rhythmic texture happening that can be characterized as a play with elastic patterns and variable recurrence, and a separate higher-register texture that is more strongly oriented around pitch and melody and is less pattern based. Within the latter layer, there are contrapuntal melodic lines that emerge and come back in elastic ways through this larger section of the improvisation. Notes highlighted in purple show the first instance of the melodic line. The melody functions as a middle-ground counterpoint, while the larger, level 1 cyclicity operates at the background, and the short metric-groupings create the foreground material.⁴⁹

⁴⁹ While this research focuses on temporal dimensions of the ghost structure concept, there are salient parallels with Schenkerian analysis that are relevant but which lie beyond its scope.

The third level at which elasticity and cyclicity appears is the micro-structure: the relationship to time and pulse, that is, the cyclicity and elasticity in the structure of each distinct note or sound event. This is manifested through the temporal envelope around each note. On this level, the idea of cyclicity is expressed through consistent isochrony of the lowest density pulse referent (e.g. 1/16-note pulse). Elasticity is expressed through divergences (i.e. compression and elongation) of the lowest density pulse referent. We can analyze micro-structural temporality in two general ways: as a temporal duration (millisecond) or as a rhythmic unit. In *Trio no. 1*, often the temporal elasticity and the rhythmic elasticity are extensions of one another.

On example of Level 3 elasticity is an oscillation between grid-based elasticity and temporal elasticity. This can be heard at 2:21. At first, the alternation between the 2/4 and 3/8 grids established a grid-based compression and stretching. When single notes are played with no subdivision and no other pulse referent, the movement between 2/4 and 3/8 can mimic the effect of *accelerando* and *ritardando*, because there is no other arbiter of time other than each individual note itself. Later, other, non-grid-based or grid-elusive rhythmic groupings emerge. They can be seen as an extension

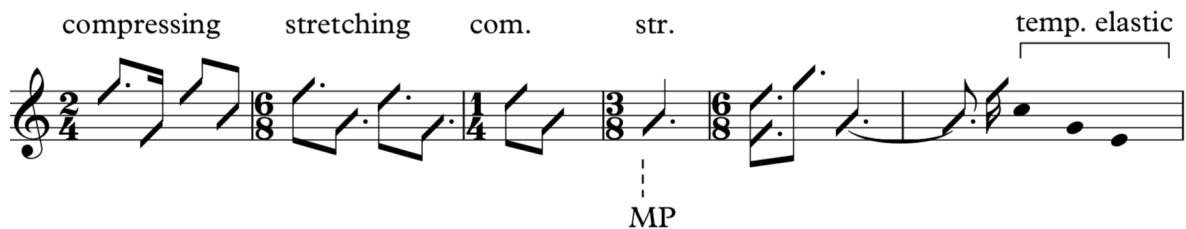


Figure 74 - Transcription of the piano at 2:21

of the same elastic process towards more gestural and temporally elastic phrases, or rhythmic referents outside of the established grids.

This temporal-to-rhythmic fluidity becomes embedded into our collective approach to rhythmic flow as an ensemble. We are all simultaneously moving through alterations of grid-based and non-grid-based pulse referents. For me, this process is very much connected to the alteration of pulse, rather than to the rhythmic values themselves. I think about time speeding up and slowing down from segment to segment. I think about the moving through the primary grids — 2/8 and 3/8 — and their transpositions — 2/4, 3/4, etc. — diachronically as different speeds of motion. I think about the other near transpositions — triplet grid and its transpositions — and the quintuplet grid. The temporal elasticity often emerges in this diachronic alteration of grids, free from their exact durational relationships.

On a temporal level, elasticity in this piece is present most significantly as a foundational concept for approaching the temporal envelope around each note, rather than overt extensions or compressions of time-flow surrounding each note. Berliner describes a similar concept in playing *behind the beat* or *ahead of the beat* in jazz (Berliner 1994: 151). The envelope around each note is wider than a strictly measured isochronous duration, and the performer can create multiple *feelings of time* by choosing where in that envelope to play the note. In free improvisation, however, such practice doesn't function the same way; the pulse referent itself is completely redefinable and

can become very elastic or non-existent. Therefore, playing *behind the beat* can equate to an actual temporal extension of a note's duration. This particular modality relates more strongly to expressive *rubato* in European classical music performance practice (see Dodson 2011 on expressive timing in the performance of Chopin), and also to the elasticities in Bulgarian folk music (Goldberg 2019), both of which are not in relationship to a synchronous pulse framework, but rather treat each rhythm as a diachronous value.⁵⁰ Similarly, T.M. Krishna discusses the concept of *laya* in Karnatik music performance as a flexible temporal interval that constitutes a related concept to that of *tempo* in western musical systems. He writes that, like in nature, the passage of time "is not experienced by a measurable number, but by a general sense of time." (Krishna 2013: 62) Regularity is possible, but it is not the product of measurement. Collective engagement with pulse as an elastic unit is an important factor in being able to engage with other kinds of flexibilities that are more rhythmic as exemplified in all three layers (i.e. macro-structural, meso-rhythmic, micro-rhythmic), as well as idiomatically specific musical vocabularies, which are discussed in more detail later in this chapter.

The purpose of analyzing the cyclicalities and elasticities on these three levels is to show the dynamics and techniques of relating to emergent *ghost structures* in

⁵⁰ These examples are not intended to represent definitive approaches to micro-timing in each larger musical practice. They relate to specific examples that are reflective of specific performers first and foremost, and secondly correspond with larger trends that are nevertheless not systematized.

improvisation and the way these dynamics can be expressed in formal terms. Metric-contoural groupings that arise on the meso-level become passing *ghost structures* that are repeated and altered diachronically. Larger sequences of such groupings, such as those at 0:16 (Fig. 71), are revisited in altered and misremembered forms. Underneath this texture, distinct frequencies such as the low F2 cycle elastically at slower polyrhythmic periodicities independently of the metric groupings. These make up the larger structural cycles within which the material becomes embedded. As the texture expands with more improvised material, much of what constitutes the *ghost structures* becomes these distinct, structurally important frequencies, such F2, E3, G3, or G#4, and their loosely felt sense of periodicity. Such texture mimics the temporality of wind chimes or of church bells, wherein each tone is sounded repeatedly, but at a different periodicity. The *ghostness* is in the improviser's remembering and misremembering of those tones underneath larger, linear, and more dense developmental sections.

The resultant effect of this particular texture in *Trio no. 1* is the sensation of time falling back on itself. The texture presented an embodied application of the kind of polytemporal cyclicity that Carlo Costa performs with around a collection of recurring pitches at specific registers at the piano. The temporal practices were the organizational modality and the pitches were the referent structure.

Intercultural Improvisation

Duvaj rhythm

In the subsequent, largely improvisational piece, *Trio no. 2*, there are melodies and rhythms that reference a popular folkloric Moravian and Slovak dance rhythm, *duvaj*. In the following section, I will trace the transformations around this rhythm to discuss some of the formal aspects of how intercultural elements became integrated into the context of free improvisation. This piece was created in conjunction with the real-time notation tool. However, the improvisation was centered around interplay and what was happening musically, rather than around the contents of the tool.

The *duvaj* rhythm has unique features: it is micro-rhythmic and could be interpreted in multiple ways. The simplest representation is in 2/4, shown in Fig. 75a. A closer interpretation of the micro-rhythmic aspects can lead to a 7/8 representation in Fig. 75b. The way I have internalized this rhythm is as a liminal space between the 2/4 and 7/8 groupings. I use the 7/8 grouping more frequently as the primary referent, rather than the 2/4 grouping. This is also likely due to relating to Reynolds' metric patterns that are based around 7 beat cycles. In compromising between the two schemes, other notational possibilities are generated (see Fig. 75c).



Figure 75a - *Duvaj* rhythm



Figure 75b - *Duvaj* rhythm

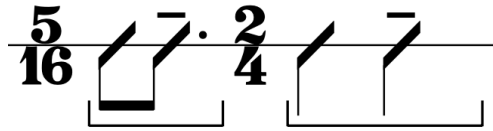


Figure 75c - *Duvaj* rhythm

In *duvaj* performance, there is a difference in temporal flow between the first grouping and the second grouping. In part this comes from the fact that the rhythm is related to a bowing technique on string instruments (i.e. violins) where the two pairs of rhythmic values correspond to two bows, each moving at a different speed. The first grouping (i.e. short - long) is slightly rushed, while the other grouping (i.e. long - long) is slightly extended. This can lead to interpretations where 3/16 (or 3/8) are used in one of the values in the second groupings, as opposed to 2/16 (or 2/8). Consequently, the first grouping functions more strongly as a singular unit, while the second grouping is more strongly dissected into two units (Vysloužil 1997: 172). All these elements are factors for temporal and metric *play* in applying this rhythm into improvisation. Other possible interpretations include the incorporation of a triplets in various ways.

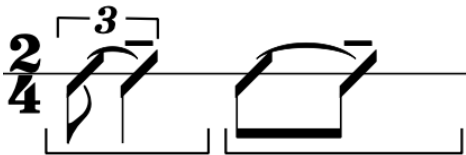


Figure 75d - *Duvaj* rhythm

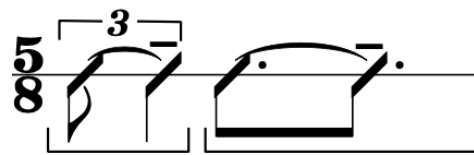


Figure 75e - *Duvaj* rhythm

Transposed into a free improvisational space in which we are engaging with grid references and polyrhythmic underlying structures, this rhythm becomes manifested in several variations, not quite like its original form. In the following passage at time-mark 3:07, the *duvaj* reference is forming in dialogue with the rhythms played by Reynolds.

The image displays a musical transcription of piano in *Trio no. 2* at 3:07. It consists of two staves. The top staff is a boxed-in section with a 7/16 time signature and a '8va' label above a dashed line. The bottom staff is a longer passage starting at [3:07] in 8/8 time, then switching to 7/16, 2/8, and 3/8. It features '8va' labels and a 'shorter' annotation. Blue stems and green accents highlight specific rhythmic elements.

Figure 76 - Transcription of the piano in *Trio no. 2* at 3:07

Two important variation processes in this section are: the switching back-and-forth between the 1-2 grouping and the 2-1 grouping in the first segment of the 7/16 phrase, and the switching between the longer 2- 2 and 1-3 groupings of the second segment of 7/16. In some ways, this elastic play makes transparent the process of establishing a common rhythmic ground between Reynolds' rhythmic *ghost structure* (i.e. 2 - 2 + 1 - 2 phrasing of 7/16) and the *duvaj* rhythm (i.e. 1 - 2 + 2 - 2).

These processes can be described in general terms as segmentation and structural re-shuffling. They relate to, for example, the way Tyshawn Sorey creates continual variation in *Awakening* in the tom patterns. Once a pattern is established, its constituent parts can be segmented off and re-ordered. The resulting texture is a changing sequence in which repetition is generally diachronic, and a pattern does not have to appear as a fixed whole in order for it to be recognized as a particular *ghost structure*, while alligning with a highest density pulse referent.⁵¹

Stronger references to Slovak and Moravian melodies occur consequently at time-mark 3:23 in Figure 77. In this section, the 7/16 meter no longer appears as a fixed whole, but is rather segmented off in various ways. Other groupings are used as well, in particular 5/16 (short - long) and 2/8 (short - short). The original 7/16 pattern is segmented into the short - long, which is the first part of the *duvaj* rhythm, and short - short, which is the second part of the *duvaj* rhythm. It functions as a *ghost structure* diachronically, as opposed to synchronously.⁵² Its component elements are referenced as fragments, not as a whole. Each of these two main segments are improvised modularly, sequenced in various ways and repeated in variable amounts. In particular, this is expressed through the additional repetition of the short - short grouping. The short -

⁵¹ Highest density pulse referent is a term used by Boyle to describe a fast, underlying isochronous pulse that aligns with the majority of what is played, even if what is played is polyrhythmic. The concept is similar to the least common denominator in mathematics.

⁵² The improviser is relating to the *duvaj* as a motif, creating numerous variations and combining it with other phrases. It does not cycle underneath what is being played synchronously, but rather exists as a focal point in the creative process diachronically.

short grouping is transformed into sequences of 1 - 6 repeated short values.

Furthermore, the micro-rhythmical aspects of *duvaj* are expressed through shortening and extending certain values in the sequence. Arrows pointing forward refer to shortening or rushing. Arrows point backwards refer to extending or dragging. Other micro-rhythmical moments are labeled as “m.r.”

The figure displays five staves of musical notation in treble clef, illustrating micro-rhythmical aspects. The notation includes various time signatures: 3/16, 5/16, 7/16, 2/8, 7/8, 5/16, 7/8, 9/16, and 5/16. Annotations include:

- Staff 1:** A dotted line labeled "open" spans the first two measures. A box highlights the first two measures. A blue slash is labeled "tonic".
- Staff 2:** A dotted line labeled "open" spans the first four measures. A blue slash is labeled "(tonic)".
- Staff 3:** A dotted line labeled "m.r." spans the last two measures. A blue slash is labeled "m.r.". An arrow points forward above the last measure.
- Staff 4:** A dotted line labeled "embedding" spans the first three measures. An arrow points backward above the first measure and an arrow points forward above the second measure.
- Staff 5:** A dotted line labeled "m.r." spans the first three measures. A blue slash is labeled "m.r.". A dotted line labeled "mini coda" spans the last two measures.

Figure 77 - Transcription of the piano *Trio no. 2* at 3:23

Aksak Rhythms

Alternative ways of conceptualizing these values show the rhythmic connections to other traditional musical practices. The sequences can be represented as streams of 2-beat and 3-beat values, which make them similar to Balkan *aksak* rhythms.⁵³ The phrases in the transcription above (Fig. 77) feature single 3-beat values (or longer at times) with variable chains of 2-beat values. Fig. 78 shows an alternative, modular representation of the same process. In this representation, boxes indicate repetition. The 2-beat value (i.e. eighth-note) is repeated, and then the whole phrase is repeated. The numbers 1, 2, 4 (3, 5, 6) indicate most likely numbers of repetition, followed by less likely numbers of repetition. The 2-beat value is most often repeated once, twice, or four times, and less likely repeated three, five, or six times. Musically, the 3-beat phrase is often used as conclusion. In representing the rhythmic process this way, I try to distill some aspects of the thought process in generating a texture such as in Figure 77.

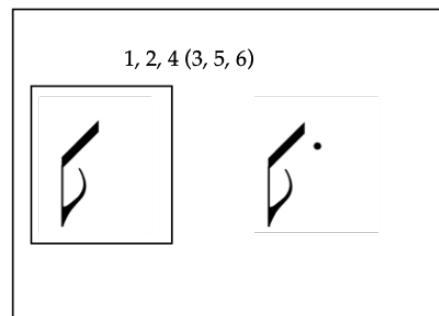


Figure 78 - Modular representation of rhythmic texture in the piano in *Trio no. 2* at 3:23

⁵³ For more on *aksak* rhythms, see Nice Fracile (2003).

Later on, at 4:25, another passing *ghost structure* emerges in rhythmic unison in the lower register and high register of the piano. The structure is composed of two groups of 5/16 followed by two groups of 2/8, or *long - short - short - long - short - short - short - short*. It reflects a process of improvisational re-shuffling that unfolded between 3:23 and 4:25 in dialogue among ensemble members. The pattern maintains some elements of *duvaj*, but the overall metric duration (i.e. exo-structural duration) is extended and the short - long groupings are played more variably.

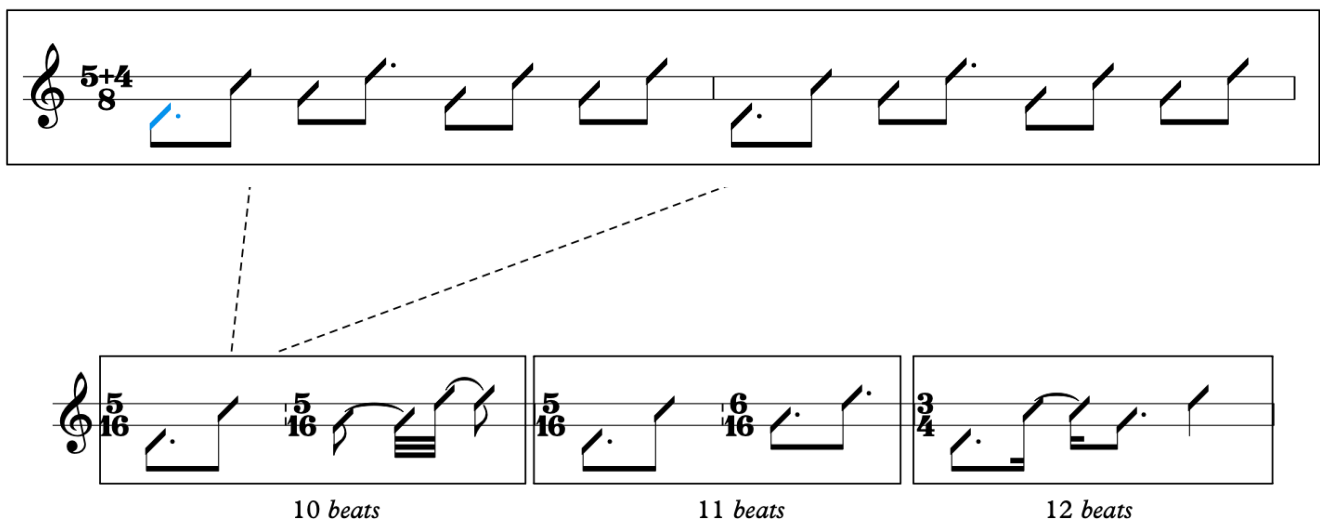


Figure 79 - Transcription of a rhythmic pattern in the piano at 4:25

The structure, shown in Fig. 79 is composed of two rhythmically identical phrases in 9/8 or $[5 + 4]/8$. The harmonic root or pedal tone is represented in blue. The 5/16 grouping is often played elastically. The modules in boxes show several possible variations that occur. In particular, liminality between 5/16 and 6/16 is felt. At the same

time, the 2/8 groupings are rhythmically stable. The resultant pattern is a kind of doubled, modular re-interpretation of the *duvaj* rhythm from the form in Fig. 80 (reference to Figure 75c). Each of the two groupings (i.e. 5/16 and 2/4) is played twice: 2x [short - long] + 2x [long - long]. Additionally, the first grouping's division of short - long is often reversed. The second grouping is played at double speed, and repeated twice, or could be interpreted as a faster subdivision of two long units. It straddles the features of *aksak* rhythm and the *duvaj* rhythm. The components of *duvaj* are re-shuffled into a sequence not unlike compound *aksak* rhythms.

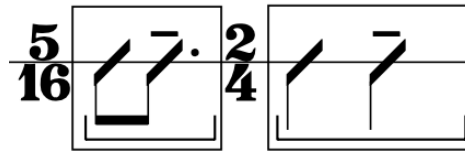


Figure 80 - Re-interpretation of the *duvaj* rhythm

As with the variations on the *duvaj* rhythm at 2:23, this ghost structure in Fig. 79 is not played in the same way repeatedly, but rather becomes embedded into a stream of improvised material within which it surfaces in segments. Between 4:25 and 6:12, the sequence is modified at an exo-structural as well as endo-structural level.⁵⁴ At 6:12 until 7:13, it comes back as an ostinato in the left hand and creates a background for Ilgenfritz's solo.

⁵⁴ Exo-structure refers to the internal content of a musical phrase or cycle.

Many of these patterns are motifs which emerged from the improvisation. In this section, I tried to represent their transformations. These transformations show that motifs and themes created within improvisation tend to integrate together. Some of these integrations have cultural dimensions. Patterns from *Moravian* and *Slovak* folk rhythms are integrated into patterns that connect to Balkan traditional vocabularies.⁵⁵ The initial motif in the 2 - 3 min section is itself a trace of the *duvaj* rhythm from the past. The specific shape it took in the improvisation was unique to that instance. Consequently, it became a recurring point of return and variable reiteration, and a building block for constructing larger structures. In the way that it transmuted into these larger structures has aspects of a ghost structure. There was no single definition, but the same fragment became animated through different contour, rhythmic and metric shapes throughout minutes 2-8.

Rhythmic Exchanges in the Ensemble

In Fig. 81, I notated what appeared to be the central rhythmic patterns and their variable elements in all three instruments — piano, drums, and bass — together with the times that these were present during this larger section of the performance. Box notation indicates the contents are repeated. Dotted boxes indicate places of higher

⁵⁵ Later in research I found that the *duvaj* rhythm is also in the *aksak* class of rhythms, even though this is not widely discussed in Czech Republic, and is connected to the lineage of *aksak* rhythms in the Balkans.

variability within the patterns. Arrows indicate that the two connected modules are inter-changeable or that one can be supplanted into the other. While other values and phrases are played by the ensemble, these modules indicate the primary working materials that are most consistently recurrent.

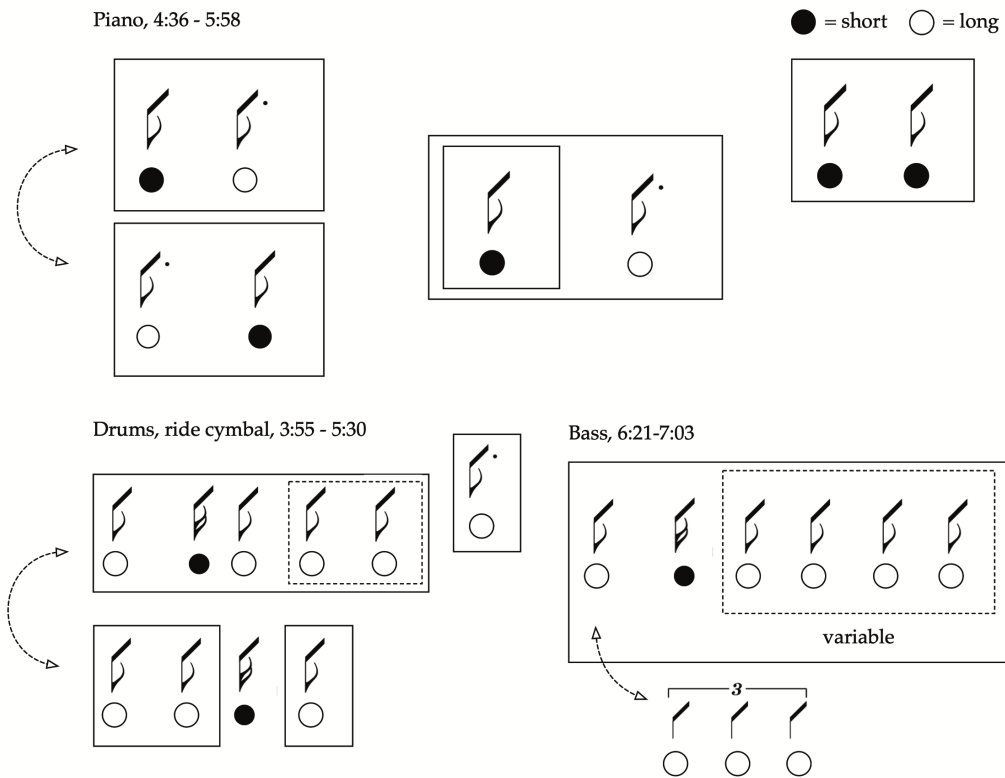


Figure 81 - Motivic rhythmic materials in piano, drums, and bass in *Trio no. 2*

The processes in Figure 81, and the previously discussed transformation of the *duvaj* motif show fundamental variational and iterative techniques that can be traced to various musical practices that deal with variation on cyclic rhythmic referent patterns, including the analyses in Chapters 2 and 3, such as Monk's *Evidence*, Taborn's *All True Night*, or Tyshawn Sorey's *Awakening*. The primary factor that makes these techniques

connected to the Moravian-Slovak and Balkan traditional rhythmic languages is the absence of fixed metric groupings, and of synchronous, temporally fixed ghost structures, such as a 4/4 meter, or of other isochronous and exo-structurally fixed periodicities.⁵⁶ The elasticity of what constitutes the meter, the fluidity of moving diachronically between 2-beat and 3-beat pulse referents, and the elasticity of tempo on the level of units and in pulse overall are all factors that allow for this dialogue to emerge.

Real-time Technology

While attention was given to describing the contents and effects of the real-time notation tool in the previous sections, its role was most explicitly utilized in a subsequent piece, *Quartet* (2022) in the capstone concert.⁵⁷

Quartet was a real-time composition created primarily in relationship to the MaxMSP patch and was centered around the exploration of that relationship. The performance features Isaac Otto Hayes on alto saxophone in addition to Atticus Reynolds, James Ilgenfritz, and myself. The form could be divided into four parts: (1) first circular referent structure in the MaxMSP tool between 0:00 - 5:20, (2) temporal manipulation using the MaxMSP tool between 5:20 - 7:20, (3) a revisiting of the first

⁵⁶ Exo-structure refers to the outer boundaries of a given musical grouping or a cycle. When fixed, the time-span from the starting point to the end point of a cycle is unchanging.

⁵⁷ Video of *Quartet*: <https://youtu.be/rXYOr7CwdPQ>

circular referent structure between 7:20 - 9:08, and (4) second circular referent structure and juxtaposition of staff-based notation between 9:08 -12:54. As in the previous pieces, my role was dual in performing and in creating notation, and making alterations in the MaxMSP patch in real-time. The ensemble related simultaneously both to the score and to the collective improvisation itself.

The application of the MaxMSP patch can be organized into two categories: composition and temporal processes. On a compositional level, the patch was used to create in real-time multiple different *ghost structures* in the circular score. This resulted in several distinct sections across the piece, as opposed to a primarily singular, mono-thematic movement. The framework specifically allowed for re-creation and re-formulation of the improvisational referent. It was also used to notate in real-time harmonic (i.e. pitch collections) and melodic materials into the staff-based score module in the patch. There were moments where these were sight-read by the performers simultaneously, and other moments where they were more abstractly incorporated into the improvisational texture.

On the level of temporal processes in a general sense, the piece featured a cyclic approach to structure with linear development, similarly to its effect in *Trio no. 1* and *2*. More specifically, however, the patch was also used to create significant temporal manipulations of the ensemble's engagement with the score. This included increase and decrease of tempo in real-time, temporal reversal, and near-stasis.

Lastly, there were also unique aesthetic and visual structures created within the patch that related more strongly to the framework itself. These included the dense textures of dots organized in a circular pattern and the change of background color between white and black. These influenced the emergence of specific improvisational relations as well as musical textures that corresponded to the patch's additional role as a graphic score.

Establishing the Referent Structure

The first referent structure was built in the circular module of the patch. The tempo was set at a slow rate, at approximately 15 seconds per revolution. The pattern was built gradually; at first only one or two dots appeared. By the fourth minute, the pattern was fully filled in. Fig. 82 shows a version of the first pattern in development. Between 0:00 and 4:40, the pattern is on a white background, at 4:40 the background gradually changes to black, and from 4:40 until the end it is fully black.

Synchrony

Much of our relations to the *ghost structure* were synchronous. We had used the pattern as a temporal scheme with which we either aligned with or played against. The pitches were fully supplanted by the musicians in real-time. Because of that, listening to one another was very important. At the same time, the score visualized aspects of pitch

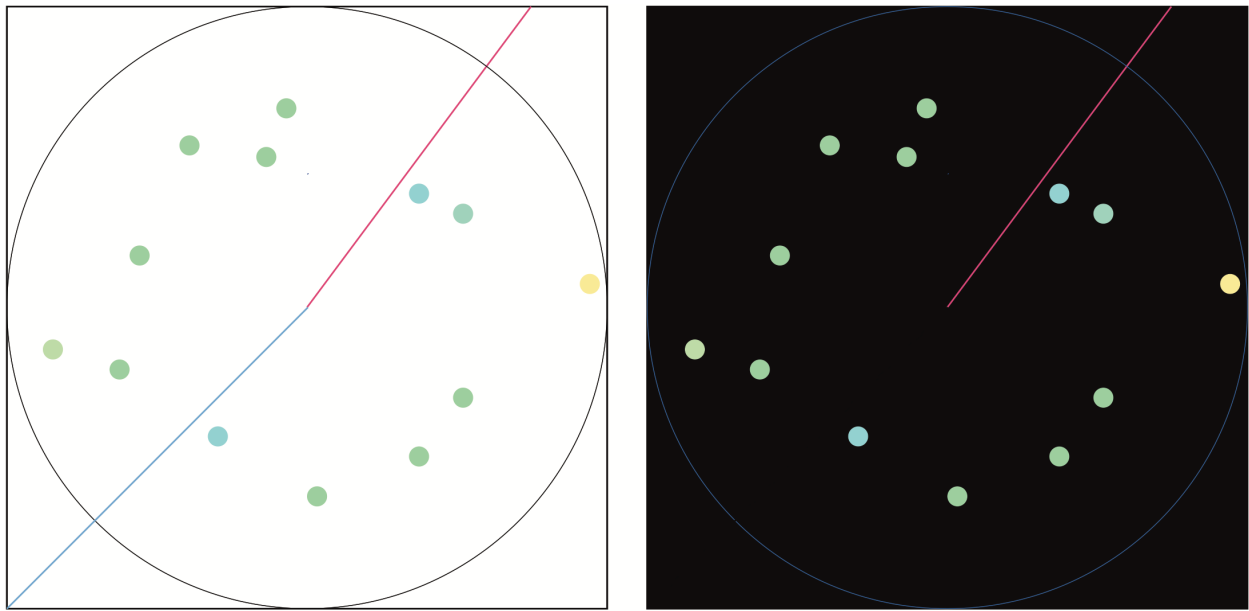


Figure 82 - A re-created version of the pattern in MaxMSP patch in *Quartet*

contour.⁵⁸ Those contours were referenced more strongly in sight-reading segments with perceivable visual contrast. Structurally, the amount of space in the score allowed for a spacious and sparse texture in which a larger dynamic spectrum between very quiet and very loud could be explored. There was a strong element of *play* in how we chose which notes to play and which to omit. Since we didn't know who would choose to play a note in the score and who would omit it, playing the score became a guessing game, and resulted in a range of *orchestrational* permutations within the quartet, from solo to ensemble unison, for each successive note. Additionally, the envelope and attack of each note was indeterminate, therefore some notes were played staccato and others

⁵⁸ Pitch contour is represented by the distance of the note from the center of the circle, and by a color spectrum from dark purple at the center, to blue and green in the mid-point, and to light yellow and red at the circumference.

were sustained.⁵⁹ Overall, the score prompted us to develop a strong sense of collective synchrony on many levels beyond the temporal level, in particular in dynamics, attacks, contour, and amounts of space. Because it provided a very defined sense of timing and rhythm of the referent pattern, we were able to focus more on these other dimensions. Some of the cognitive processing that would otherwise be used to formulate and synchronize temporal structures collectively in a free improvised context was offloaded to the patch.⁶⁰

Independence

There were also elements of independence in our relation to the *ghost structure*. These included temporally independent rhythmic materials played by Reynolds, expansive timbral vocabulary in Ilgenfritz's playing, and referential improvisation around the *ghost structure* in Otto's playing. As was the case in *Trio no.1 & 2*, Reynolds had perhaps the most independent and abstract way of relating to the score. This is likely because drums traditionally provide the role of the *time keeper*, and *rhythm divider*, which clashes with the temporally prescriptive nature of the patch. His playing included various sustained circular movements on rims and membranes that mimicked

⁵⁹ Ilgenfritz used an especially wide array of timbres and kinds of attack in his playing of each note. Some of these were: bow glissandi, bow ricochet, short bowed harmonics, and double stops.

⁶⁰ More specifically, one could posit that what is offloaded are some of the mnemonic processes that normally happen within improvisation.

the visual aspect of the score in a more general sense, rather than the temporal scheme itself. At other points, Reynolds would play countering referents, such as a long sequence of steady pulses on the cymbal at 2:45 - 3:15, that did not relate to the patch and that re-contextualized the sparse and non-isochronous rhythms in the patch in relationship to these regular pulses. Other independent materials included a pulse-based drum set pattern that was clearly temporally independent of the patch at 4:00 - 5:23. These materials provide more rhythmically defined referents for the rest of the ensemble to play with, which often is a helpful element in creating a more *musical* and *organic* relationship to the score.

Improvisation

The relation to the circular referent structure became more improvisational over time.⁶¹ This shift is in part lead by the ensemble and in part triggered by a visual cue in the patch. Between 3:55 and 4:39, the background is changed from white to black.⁶² White background represents a direct and close relation between the musician(s) and the circular *ghost structure*. Black background represents a more abstract, autonomous and improvisational relationship between the musician(s) and the circular *ghost structure*. This was one of the sub-textual *behaviors* for interpreting the MaxMSP patch

⁶¹ In this case, “improvisational” is used to imply indirectness, elaboration, and autonomy, as opposed to the more general notion of “creating in real-time.”

⁶² The change is triggered and controlled manually in real-time by a MIDI control knob on the electric keyboard.

that was pre-determined before the concert. At 3:55 the background color is changed to gray, which suggests a liminal state between a direct and improvisational relation to the *ghost structure*. Later at 4:39 the background is shifted fully to black and remains as such until the end of the piece.

As the initial shift occurs, the ensemble starts relating to the *ghost structure* similarly as how they might to a jazz standard or how Craig Taborn's trio relates to the composed material in *All True Night* (see Chapter 2) during a solo or an improvisational section.⁶³ The score becomes a temporal scheme that is elaborated upon with, for example, faster sequences, and signified upon through alignments and variations. The effect can be described as a widening of the field of what can become a ghost structure. It is not only the score, but it is also the materials improvised by each musician. In effect, improvised motifs are exchanged from one to another and our playing becomes more conversational. We negotiate both the visual modality (i.e. the score) and the aural modality (i.e. improvised materials) in a more integrated way. The score is the background and the improvised materials are at the foreground of our music-making.

Temporality

The middle section of the piece features real-time temporal processing in the MaxMSP patch, which has effects on how the ensemble embodies the passage of time.

⁶³ This section lasts approximately from 3:30 to 5:20.

The temporal processing involved are: temporal reversal at 5:20; back-and-forth slow motion at 5:29-5:45; near static slow motion at 5:45; and moving slowly in reversal until 7:10-20. At 5:20 the cursor tempo in the patch is reversed to a very slow backwards tempo. As a result, each note is significantly prolonged. The resultant texture is sustained, sparse, and includes sonic signifiers of *reversal*. Otto plays breathy swells with slower attack and slightly faster decay, later switching to multi-phonics.



Figure 83 - Visualization of a reverse attack envelope

Ilgenfritz plays bowed murky, subterranean-like frequencies with a very slow vibrato, and switches to fragile harmonics. Reynolds scrapes the cymbal with a stick to produce a sustained sound while slowly rotating the cymbal. At a certain point, I freeze the cursor around a single dot on the patch and extremely slowly move it forward and backward around it. The rest of the ensemble respond to this by sustaining the single gesture they were playing at the moment, and slowing down the temporality with which they are moving through that gesture-sound to near stillness.

It was particularly interesting to move into the microscopic level of the sounded moment with this technique — a level that is normally not explored at medium and fast

tempos — and for that scale to be exploited to its extreme point. The slowing down of the tempo in the patch leads to a *precipice* of sorts; a term that Rajna Swaminathan discusses in relationship to rhythm and temporality.⁶⁴ A *precipice* is a breaking point; a point which I understand to be a space where precedents fall short and understanding can be rebuilt from scratch. Those kinds of spaces are particularly salient to improvising musicians, because they are forced to abandon what they know, and in the process discover new processes, instrumental techniques, and sonic spaces. Because the patch has an unprecedented relationship between notation and performance, the temporal manipulation at a slow tempo reveals the hidden aesthetics of performing music in reverse and in sub-normal time flow — aesthetics that we know primarily through electronic music and sound processing. Additionally, at 5:45, what is being played and modulated is simultaneously an interpretation of a single dot in the patch. The moment reflects the symbolic relationship between the score and sound, and the real and physical sonic moment in time. The temporal precipice muddles the waters between the symbolic with the physical.

Staff-based notation

Lastly, in the final section of the piece I incorporate the staff-notation module in addition to the circular module in the MaxMSP patch. This results in several notable

⁶⁴ This discussion happened in a seminar taught by Rajna Swaminathan in Fall semester of 2022, titled *Improvisation & Temporality*, at UC Irvine.

processes. At 9:08, there are pitches input into the staff-based notation module from the MIDI keyboard. These are integrated diachronically into the texture created in relation to the circular *ghost structure*. The result is a poly-temporal texture where I'm playing on the piano and inputting the same pitches into the staff-based module in real time, Otto is integrating those pitches into his improvisation while negotiating some of the rhythms in the circular *ghost structure*, and Reynolds and Ilgenfritz are improvising primarily in relationship to the circular *ghost structure*. The two temporal schemes collide; one that is primarily rhythmic and another that is primarily melodic.

The melodic material visualized in the patch orbits around a collection of approximately five pitches. Otto uses this set of pitches as a motif freely in his improvisation, supplanting his own rhythms. At this moment, each MIDI note input from the electric keyboard into the staff-based notation module is also populating the circular score, which is in effect making the circular score increasingly dense.

The resultant texture that Ilgenfritz and Reynolds are playing is likewise becoming more dense and abstract. As the circular *ghost structure* transforms, its function changes from being a temporal scheme to becoming more of a graphic representation of a particular rhythmic space. At the same time, the notes in the staff-based module appear and float away. In such premise, the circular score has a palimpsest-like, cumulative quality — all layers of the past are recorded and embedded — while the staff-based

score is impermanent and in effect holds no memory. The rhythm is recorded, while the melody is erased.

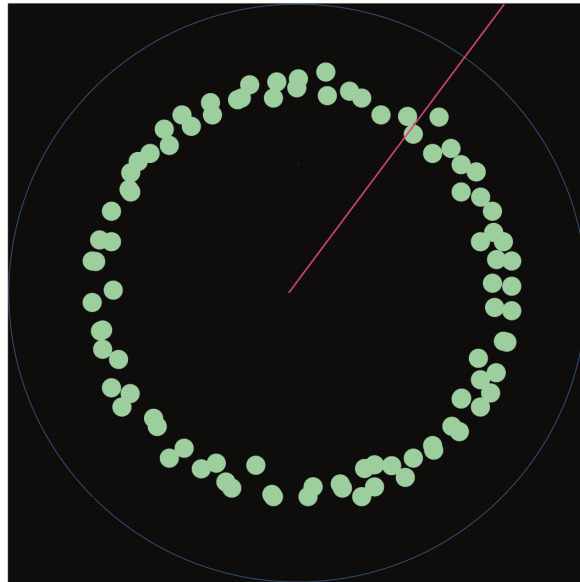


Figure 84 - A re-created version of a pattern in MaxMSP patch in *Quartet*

Later on at 11:53, a different process happens where I input a stream of notes into the patch on the MIDI keyboard only, so they are not sounded in any way, while playing a single note on the piano in an isochronous pulse. Ilgenfritz responds to this by sight-reading the notes as they occur. This moment most closely resembles Morton Subotnick's *ghost-score* concept utilized in several of his electroacoustic works. The source — in this case my playing — is only heard through the interpretation of another source — in this case Ilgenfritz's playing, via the notation as the in-between medium. What was previously referenced in a modular fashion by Otto — as a set of pitches to

improvise with — is now referenced concretely and linearly in the exact sequence with which it is played.

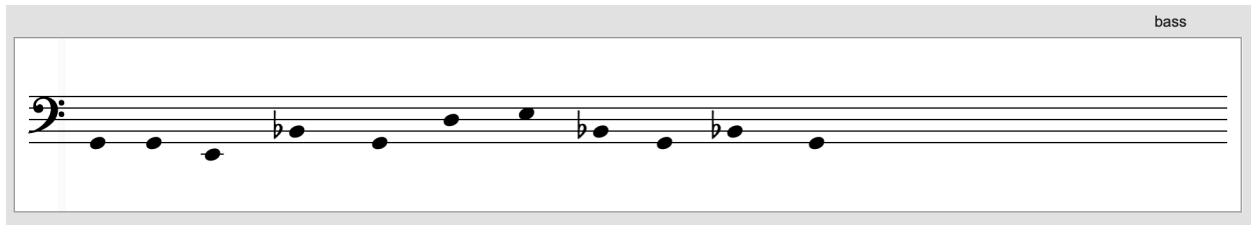


Figure 85 - A re-creation of the staff notation module in the MaxMSP patch at 11:53

In discussing the creative work in this chapter I explored the areas of notation, improvisation, and technology as grounds for the intersection of larger practices surrounding cyclical rhythms, ghost structures, and representation. In the last chapter, I summarize the research presented in this dissertation, and reflect on the creative work and its future applications.

CHAPTER 6: CONCLUSION

Summary

In this dissertation, I present an alternative approach to composing with *meter*, which is to use the core musical pattern as the underlying temporal scheme for dividing a given cycle, in a similar way that a *meter* functions. This implies that a temporal space is divided in potentially non-isochronous sequence of units, in relation to which other material is built. This framework allows for a more accurate representation of micro-rhythmic and temporally elastic aspects of a composers' musical vocabulary or the analyzed musical vocabulary at hand. It also implies that the contour of the pattern (i.e. melody) can function conceptually as the *metric* referent simultaneously with the rhythmic sequence. As a result, this model is applicable to the analysis of music that has micro-rhythmic or temporally elastic features. The model is exemplified in *Raga Yaman* transcription in Interlude section of the dissertation.

Through both analysis of the works of others and my own creative works, I've found that visual grids in both linear and circular schemes can function well for non-hierarchical demarcation of multiple pulse referents (e.g. polyrhythmic matrices). Several of the typical symbolic implications of *meter* w.c.p. notation, such as down-beat and off-beat delineation, primary pulse referent and secondary pulse referent, or primary denominator of a metric grouping (i.e 5/4), which complicate the analysis of

improvised music, are taken out of the equation. Alternative visual tools, such as color differentiation, can be used to notate multiple pulse referents within the same grid.

These concepts are presented in Chapter 1, but many are not fully explored in creative work. In future I hope to explore elements such as polyrhythmic grids and note-size differentiation in representing variability amount in the context of composition more.

In both analysis and composition, a hybrid combination of linear and circular schemes is helpful in representing different layers in the musical material. Across various musical practices, there are rhythmic processes that are more strictly linear, and others that are more strictly cyclic. I've explored the differences between linear and cyclic processes in underlying temporal schemes in the formulation of *synchronous* and *diachronic* relations. *Synchronous* relations are references to an underlying temporal scheme that are superimposed on the underlying scheme, and happen concurrently with them. In effect, their representation suggests circular notational schemes and a *vertical* visualization of the relationship between a ghost structure and a variation (i.e. improvisation). *Diachronic* relations apply to references to underlying temporal schemes that are temporally separated from them. In effect, their representation suggests more linear notational schemes and a *horizontal* or modular visualization of the relationship between a ghost structure and variation (i.e. improvisation). Integration of linear and cyclic schemes in notation seems to work better than solely one or the other. In

particular, the notation of pitch, melody, and harmony is well allocated to linear, staff-based notation.

Western Common Practice Notation

In the analytical portions of this dissertation, I use western common practice notation as the starting point for understanding the transcribed work. It has proven to be useful throughout much of the process. Rather than disposing of the framework altogether, I found that using it with alterations, and in conjunction with alternative systems works well to represent most of the analyzed works. Some helpful alterations of w.c.p. include: the stripping away of stems, re-defining beaming based on phrasing, separation of specific pitch information from rhythmic information (in analysis of fully improvisational works), non-standard uses of meter (i.e. using a specific meter for every individual rhythmic duration), and box notation.

Circular Notation

I found that the circular notational schemes for representing musical cycles are useful for both analytical and compositional purposes. There are several the unique advantages of the framework.

They're valuable in retaining a sense of rhythmic ambiguity in regards to how a given cyclic pattern can be performed. This may be a desired value in certain musical

performance practices, such as *free* improvisation, Moravian & Slovak folk songs, or Afro-diasporic timeline-based musics. In these musics, it's often desirable for the musical material to be notated in an incomplete way, so that its transmission is not fully allocated to the *score* and written notation, but is to be complete by other modalities and sensory mechanisms (e.g. aural transmission, in-person experience). The incompleteness leaves aspects of the rhythmic structure and *feeling* to the performance practice of specific musicians, where rhythmic dimensions can be defined, re-defined, or purposefully left fluid.

They're also valuable in instigating a cyclical approach to temporal flow and temporal organization in performing and improvising with the notated material. This aspect is helpful in designating non-linear approaches to structure in improvised music, such as iteration, stasis, and meditation.

They're valuable in visualizing structural and spatial aspects of cyclic patterns, such as temporal profile, symmetry, asymmetry, and internal repetition.

In the context of composing for improvisation and in real-time notation, circular schemes are useful in designating the temporal scale at which the improvised material is to be repeated. For example, a 30-second cycle in the real-time notation tool leads to cyclicity of improvised material at a larger time-scale, consequently leaving the inner space of the cycle to linear development. A 2-second cycle in the real-time notation tool leads to the development of shorter cycles.

Some critique of the circular framework is also in order. In practice, I found that for most performing musicians with training in western classical music or jazz performance, a linear representation of rhythm was more natural. It was my experience in experimenting with the circular notational modality that the musicians had difficulties in understanding the rhythmic values and as a result, learning each pattern took a longer time than it would in a w.c.p. staff-based notation. On the other hand, prologued engagement with the circular score (for example *Constellation in Db*) had a shared result of feeling more creatively generative and did not preclude from improvising away from the structure while still maintaining recurring visual contact with the score.

There are also compositional issues with the circular framework. In notating a cyclic phrase into a circle, one has to clearly define the duration of the phrase. As a result there is very little room for representing exo-structural elasticity (e.g. the elasticity of a cyclic structure to expand to larger or compress to smaller metric groupings).

Most importantly, as a performer, I found that engaging with the circular notation, especially on paper scores, can lead to a more embodied and elastic experience of performing a notated cyclic structure. The way the structure appears visually corresponds more closely to how I conceptualize of it internally. As such, the score has the feeling of a physical imprint of the music, rather than a notation. The circular framework was often a useful analytical tool, not only for the works of others, but for

my own as well. In wanting to approach the same central motif again from past improvisations in new ways, or notating it in a shape that left an open room for features that seemed to change each time, the circular framework was conducive in starting off new interpretations and leading into improvisation. It also offers future possibilities for exploring its palimpsest-like quality further, and for creating works with multiple circular sections.

Future Applications of Real-time Notation Technology

In this dissertation there are many potential dimensions of the real-time notation software which can be explored in the future. One application, which I imagine would be helpful for other composer-improvisers, is to use it to build and recall an archive of past works, including past improvisation. The composer-improviser can record their musical ideas into the MaxMSP patch and notate them into either the staff module or the circular module, in essence circumventing the traditional notation process. The MaxMSP software allows for real-time capture of MIDI information through the *patrstorage* object, which can be accessed later and played back into the notation. This process entails recording a MIDI input from a MIDI instrument into the software in real time, and storing it in a digital library, which can be accessed through the program. In using the patch in its current form, all information input into the program from the MIDI keyboard during a performance and which appears in the notation can be

recorded. Additionally, other materials which are formatted in MIDI can be input into the program. Once in the program, a function can be added to sort through and insert them into the program. The staff-notation module facilitates this process well. It involves other tools, which can be used to *process* the score, such as transposition and harmonization, and a wealth of objects designed specifically for notation. Outside of *bach*, most MIDI processing tools developed in MaxMSP for real-time manipulation of MIDI input can be used also to process what appears in the notation. To insert archived materials into the circular module in the program, they can be either re-performed in real-time using an archived MIDI recording, or stored within the module's own objects as sets of co-ordinates. Translation between the staff-module and the circular module would require a new framework to be developed to bridge the format differences between the two.

The modality of the software can be particular use to composer-improvisers whose work involves intercultural elements. In its current form, w.c.p. notation does not involve substantially useful elements for notating micro-rhythmicality and temporal elasticity (e.g. time-flow deviations) that is groove-based (i.e. exists within cycles). The tool has the capability to capture micro-rhythmic deviations such as those present in Balkan *aksak* rhythms, and “conduct” them for an ensemble to sight-read using the cursor feature. Furthermore, these micro-rhythmic and otherwise non-isochronous elements can be abstracted beyond their traditional forms. New, rhythmically unique

cycles that lie outside of isochronous grid references can be constructed, and performed relatively synchronously by an ensemble, using the metronomic-like guidance of the cursors. In situations where rehearsal time is limited, or when performers don't have experiences with particular "other" rhythmic frameworks, the metronomic guidance in this tool can function as a shortcut. Ideally, however, the tool is one component in an ensemble's larger practice, in addition to a shared improvisational vocabulary, a body of composed works, and prolonged intercultural research.

In the future, each ensemble can supplant their own representational frameworks onto the visual notation that contrasts the framework I've used. For example, the "dot" color scheme feature can be used to translate to musical elements other than pitch, such as a vocabulary of timbres, or volume. As the sequence of "dots" is sight-read by an ensemble, each "dot" can trigger an onset of a particular timbre, depending on its color. One visual representational technique I've explored is the alteration of the background exposure level (i.e. spectrum between black and white) to signify movement between concrete and abstract relation to what's notated. I felt this technique was very useful in exploring the nuances of relating to ghost structures, and communicated well to the ensemble. I imagine that other techniques for visual abstraction would be effective in the future, especially surrounding the dialogue between hidden musical phenomena and the aesthetics and ontologies of the ghostly, translucent, and unknown. The

dynamic and animated capabilities of the tool make it possible to move between specificity and non-specificity over time in a controlled way.

There are also abstract and intertextual dimensions of relating to the circular score as a visual subtext, which became prevalent in the creative work in this dissertation. Improvisers tended to view the score simultaneously as notation and as a visual referent, at times favoring the latter. Percussionists in particular have tended to translate the score in more abstract ways to their improvisational practices. Others using this tool in the future can take advantage of this feature to a) create more intentionally visual scores by, for example, treating the MIDI input as a *painting* tool, or b) translate other visual subtexts into, for example, the background of the circular score. The score lends itself to experiment with “sonification” of other circular objects in nature, such as constellations or snowflakes. Whereas w.c.p. notation is fully representational, the circular notational framework in both its paper score and software formats has the unique capacity to be simultaneously representational (i.e. contain symbols representing musical information) and material. Real, physical objects can be translated into rhythmic and/or melodic schemes. Similarly, variety of geometrical shapes can be experimented with musically using the tool.

There are also significant overlaps in the tool with the intersections of music and statistics. The notational vocabulary is indebted to Ohriner’s research of Hip Hop rhythmicity, which applied processes from statistics and computational science to

transcription and notation. In essence, using the tool in improvisation to transcribe one's playing arrives at a statistical representation of several types of data from the course of a performance. Specifically, the data consists of the accumulation of individual note attacks in relation to a particular cyclic structure over time. I imagine that in the future, this tool can be used in a joint project with statistics research to further advance the notational scheme itself using the current approaches to data visualization, and to study musical phenomena in free improvisation, such as emergent rhythmic patterns, associations to specific cultural musical practices, or networks of connected themes and variations.

The same, intertextual aspect of the tool in some ways works against the notation of specific rhythmic phrases that could conjure up rhythmic vocabularies from specific traditional musics. There are two main reasons for this. The format of the circular score is very much defined by the tempo that is set, and this makes it technically difficult to notate a full cycle of a rhythm from an improvisation that exactly corresponds to the duration of one permutation of the cursor. In effect, the resulting score often represents a segment of a pattern that's either incomplete or has additional amount of space, which changes the resultant rhythm of the phrase and how it is then performed. When performing the resultant cyclic pattern it's more difficult to establish *groove* as I have hypothesized. And because of that, the result leads to either continual sight-reading, or an independent development of another *grooving* rhythmic pattern, which happened at

several points in the concert. The modality of the later is not necessarily a negative aspect of improvising upon the score, but it is something I imagine could be addressed and improved upon in order to experiment with the full spectrum of intercultural rhythmic vocabularies. The second reason for engaging more deeply with specific cyclic rhythmic patterns is the prescriptive nature of following the cursor. In the future, I imagine that if the cursor itself oscillated between being visible and being invisible, or its tempo was more adaptive to the improvisation, it could work more effectively to facilitate *groove*-based rhythms.

On the other hand, my experience with using the animated circular score in concert suggests that more sparse cycles presented at slow tempos work better in producing more integrated textures with both elements of *groove* and temporal relation to the patch. In slower tempo, the pattern begins to function as underlying scheme of *anchor*-like rhythmic unisons that is superimposed onto faster-moving improvised material, which can be cyclic.

In my own work, I imagine two main future expansions of the technology. One is to address the cyclic framework to make it more useful for notation of specific, cyclic patterns. The initial motivation in creating this tool was to represent materials from improvisation that are somehow motivic or thematic, and for the ensemble to use them as hidden reference structures that are, nevertheless, visualized as closely as possible to

how they emerge in the improvisation. Implementing adaptive tempo feature into the circular score can be one pathway to facilitate this.

Another future expansion is to expand the number of circular notation modules to two, so that multiple, rhythmically independent ghost structures can be visualized simultaneously. This would enable the creation of two polyrhythmically related reference structures that consist of different materials. The separation of the moving cursors into two scores may actually make engaging with polyrhythmic structures more intuitive. This would also facilitate the smoothness of editing what is notated. In the current format, to transition from one notated structure to another, one has to erase the full circular score. When the score is erased, the ensemble's improvisatory flow can be disrupted. While there are advantages to such modalities as disruption and uncertainty, on a musical level, intentionality is commonly reiterated as an essential component of successful improvisational music. When the score undermines this for performers their sense of trust and comfort can be undermined. To have gradual transitions from one structure to another, while being able to see both, could help in continuing the improvisatory flow and also to deepen the expression of the *ghost*-like temporal warps within the framework of the software tool. With two circular modules, there are additional improvisational modalities which open up. For example, the ensemble can engage with two ghost structures simultaneously.

Reflection

To conclude this dissertation, I'd like to reflect on the relationships between the different processes that make up this research. The project has lead me towards a practice in which analysis and transcription of other works across diverse musical practices offer opportunities to apply creative ideas and practices, and in which the resulting discoveries can be used as new analytical tools as well as new modalities for creative work. It made formulating an artistic practice that is based in several, sometimes confusingly contrasting traditions, value systems, and idioms a more tangible and structured process. The intertwining of ethnomusicology and composition, drawing on analytical research from multiple musical practices, using improvisation as a testing ground and a research method, transcription of recordings, development of technology, and the notational experimentation all supported one another. In particular, it showed how intercultural research can have fundamental and timely implications for re-thinking technology, as well as notation. I imagine that some of the notational elements to represent non-linear temporality, as well as musical indeterminacy and incompleteness in specific ways can be used, for example, in creative notation of Moravian and Slovak folk songs, and other traditional folk song vocabularies in Eastern Europe and beyond.

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TERMINOLOGY

Avant-texte - a network of documents that can be traced in order to determine how the identity of a text is constituted and changes over time; the term is applied to jazz practices by Smither (2021) and in his work refers to a modular network of past sources that make up a musician's interpretation of a particular composition, which are in meaningful ways connected to the history of that composition.

Augmentation - recasting a melodic motif or theme in longer, often doubled, note values while maintaining a constant beat and measure (London 2004: 54).

Diachronic relation - ways of improvising or composing with referent structures linearly (i.e. in sequences), where the new and reference materials are temporally separate and not simultaneous (i.e. repeating).

Diminution - the converse of augmentation; recasting a motif or theme in shorter values (London 2004: 54); in Balkan traditional rhythmic practices, augmentation and diminution are used not in strict translation (1:2), but in more relative translation (2b - 2b - 3b = 4b - 4b - 5b).

Endo-structural - the dimension of internal content in a structural unit or whole.

Entrainment - a synchronization of some aspect of our biological activity with regularly recurring events in the environment (London 2004: 4).

Exo-structural - the dimension of boundaries (i.e. beginning and/or ending) in a structural unit or whole.

Free rhythmic space - a musical texture that does not demonstrate any clear or consistent relationship to a metric grouping or an isochronous pulse referent.

Ghost structure - underlying reference structure that function as a foundational temporal scheme against which music is created and organized, but which is — or becomes — hidden, removed, or otherwise obscured.

Grid - underlying scheme dividing a larger or continuous time span; can be imagined (i.e. in music performance) or visualized (i.e. in notation).

Hypermetric - rhythmic groupings that appear at a smaller scale (i.e. shorter duration) than a given meter; for example, a grouping of 2/4 within a 4/4 meter.

Hypometric - rhythmic groupings that appear at larger scale (i.e. longer duration) than a given meter; for example, a grouping of four measures of 4/4 meter.

Iteration - 1) a type of variation; while variation implies a version that is secondary to an “original,” iteration can be used to describe one of multiple “originals”, each being the primary version; to iterate or to re-iterate is to return to the the primary theme of a given section and to explore it in anew; for example, a performance of an improvisational composition is an iteration 2) in discussing musical process, I use iteration loosely to refer to a continual recurrence of a central theme or variable that has some degree of consistency and change.

Iteration bracket - iteration bracket is an alteration of the repetition bracket used in w.c.p notation to represent a repetition together with a specific transformational process; a process of variation or micro-variation around a central musical phrase; similar concept is explored by improviser - researcher Christian Ferlaino in his dissertation (2018).

Jazz - the term “jazz” is used here to relate to the larger historic practice of African American art music that straddles a specific kind of improvisation with modern composition, however, it is a problematic term; others prefer to use the term black classical music to replace “jazz” and black improvised music to discuss the more improvisation-heavy practices that have emerged in parallel.

Macro-level - a level of musical organization that spans longer intervals (i.e. 10 - 30 sec or more) relative to what the overall rhythmic density level is.

Meso-level - a level of musical organization that spans imminent groupings of rhythmic, melodic, or sonic units (e.g. phrases, rhythmic groupings, meters).

Metric space - a musical texture that demonstrates continuous relation to metric groupings.

Micro-level - a level of musical organization that happens at — or within — a single rhythmic, melodic, or sonic unit (i.e. single note).

Micro-variation - continuous iteration and variation of small musical fragments (Carlo Crivelli 1979).

Note - a sound with a clearly defined pitch (e.g. frequency), colloquially used to described sounds played by non-percussive instruments.

Ostinato - a repeating melodic figure.

Polymeter - simultaneous juxtaposition or reference to two or more meters of different durations; for example, a juxtaposition of 4/4 and 5/4 meters.

Polyrhythm - two or more isochronous, continuous pulse referents of different durations; polyrhythms can be sounded, or exist underneath as underlying schemes.

Polytemporality - a very flexible term referring to the engagement or performance of multiple temporalities; in this dissertation, polytemporality is used to discuss more generally the presence of phenomena such as polyrhythm, polymeter, hypometer, hypermeter, or other less rhythmically-defined engagements with materials in more than one point of time simultaneously; it's also used to denote polyrhythmic relationships which are flexible and abstract.

Pulse-based space - a musical texture that demonstrates continuous relation to one or more isochronous pulses.

Pulse matrix - underlying scheme dividing a larger or continuous time span into smaller, generally isochronous units of time; matrix implies — but doesn't necessitate — the presence of more than one subdivision unit in the same scheme (i.e. polyrhythm).

Pulse referent - a continuous stream of generally isochronous units.

..

Referent - a specific and unique underlying formal scheme or guiding image for a given piece, used by the improviser to facilitate the generation and editing of improvised behavior on an intermediate time scale (Pressing, 1987); in this dissertation, it is used to talk about underlying reference schemes (i.e. pulse, meter, or a motif) that are audible or manifest in less abstract ways than ghost structures.

Rotation - shifting the order of rhythmic or melodic motif by beginning it at a different starting point within its structure (i.e. starting the 3-3-2 pattern as 3-2-3); the values within are preserved but their order is shifted; a full reversal of a motif is also a form of rotation.

Scheme - an open-ended term for musical phenomena that result in specific organizational processes.

Sounding - the act of making sound; the act of translating a subtext (i.e. notation, an idea) into musical sound.

Synchronous relation - ways of improvising or composing on top of underlying cyclic structures synchronously with the cyclic structures happening; essentially stacking new or variational material on top of them (i.e. improvising against an ostinato pattern).

Temporal architecture(s) - a spatial image of a musical structure in time, which corresponds to, for example, the way the structure is imagined or embodied by a performer independently of how it's notated.

Upper scaffolding - a structurally important organizational scheme consisting of several anchor points or pillars that is superimposed loosely onto larger sections of improvised material; I use this metaphor to mirror how the improviser may be imagining such organizational process spatially.

APPENDIX A - Links for *Ghost Structures* (2022) Concert

This section provides links to the recordings from the 2022 *Ghost Structures* concert.

Trio no. 1 with James Ilgenfritz and Atticus Reynolds



Trio no. 2 with James Ilgenfritz and Atticus Reynolds



Quartet with James Ilgenfritz, Isaac Otto Hayes, and Atticus Reynolds



Rest State with James Ilgenfritz, Atticus Reynolds, and Prawit Siriwat



Constellation in Db with Julian Lampert and Prawit Siriwat



Quintet with James Ilgenfritz, Matthew Nelson, Atticus Reynolds, and Prawit Siriwat



Constellation in Eb



APPENDIX B - Scores for *Ghost Structures* (2022) Concert

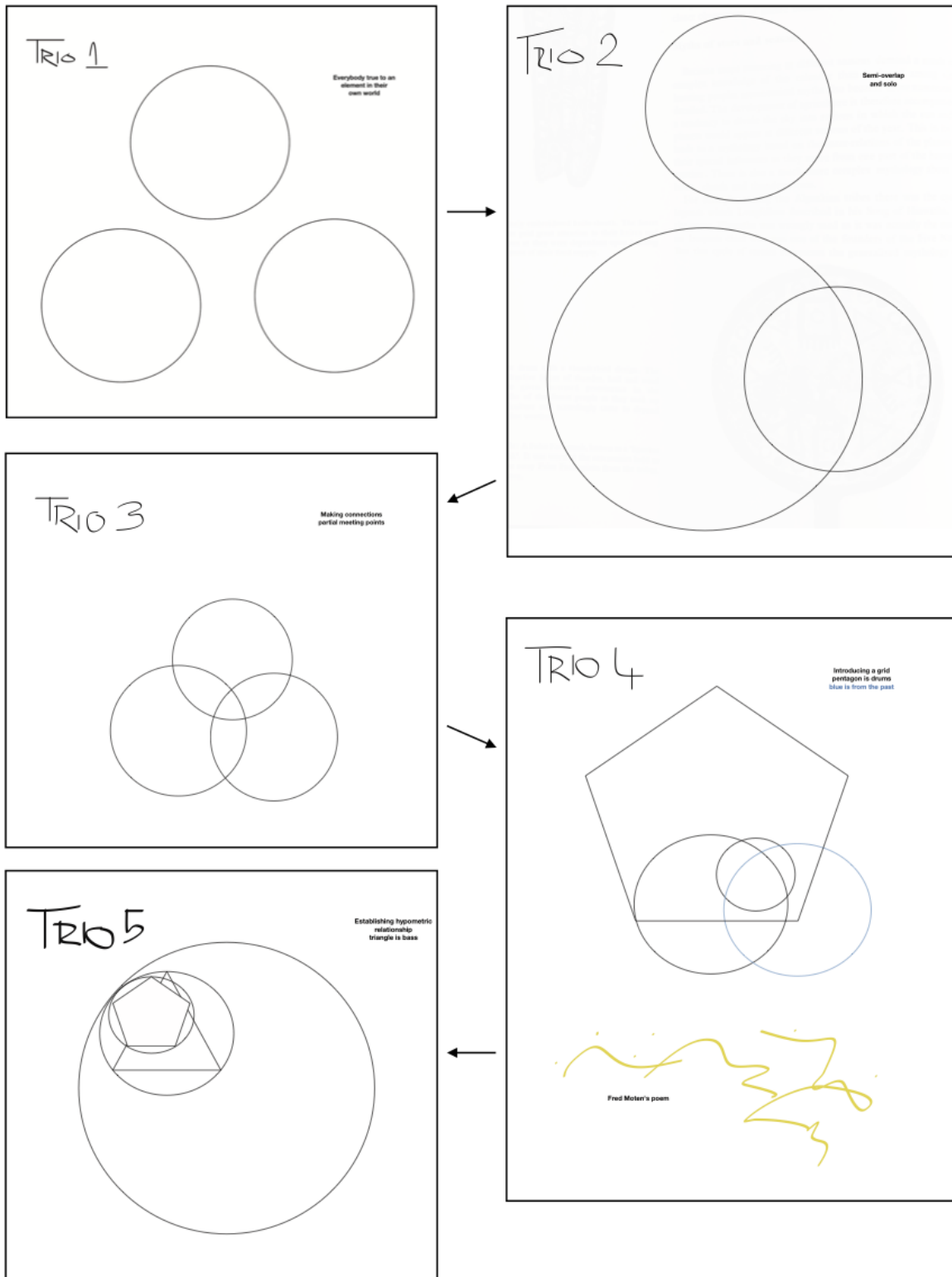
Scores can be accessed using the following link:

https://drive.google.com/drive/folders/1FOy6SkKOqII_RIzybeN_QPxjTWFJiout?usp=share_link

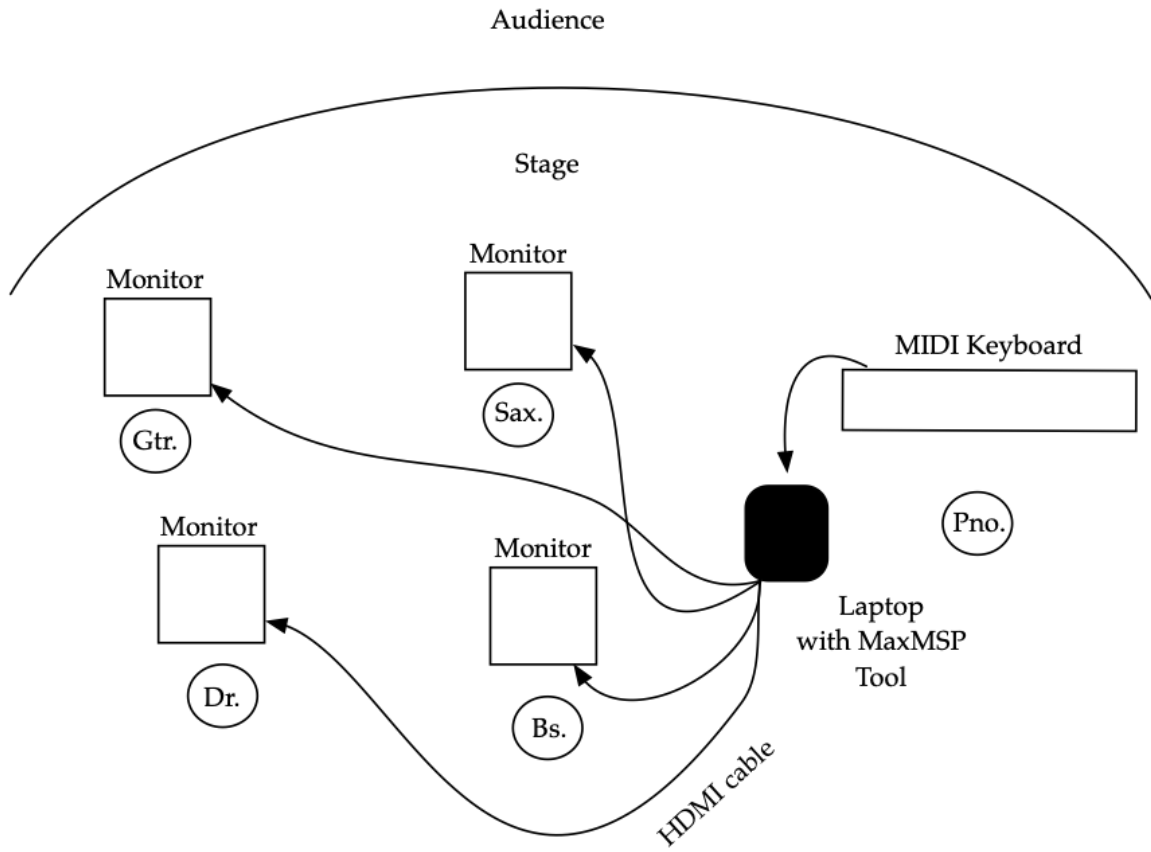
The real-time composition software tool in MaxMSP can be accessed using the following link:

<https://drive.google.com/drive/folders/1E7NklgN4yYuGVYp5jgAnDPGCEDsqf7ig?usp=sharing>

Map of *Etudes 1-5* used in rehearsal

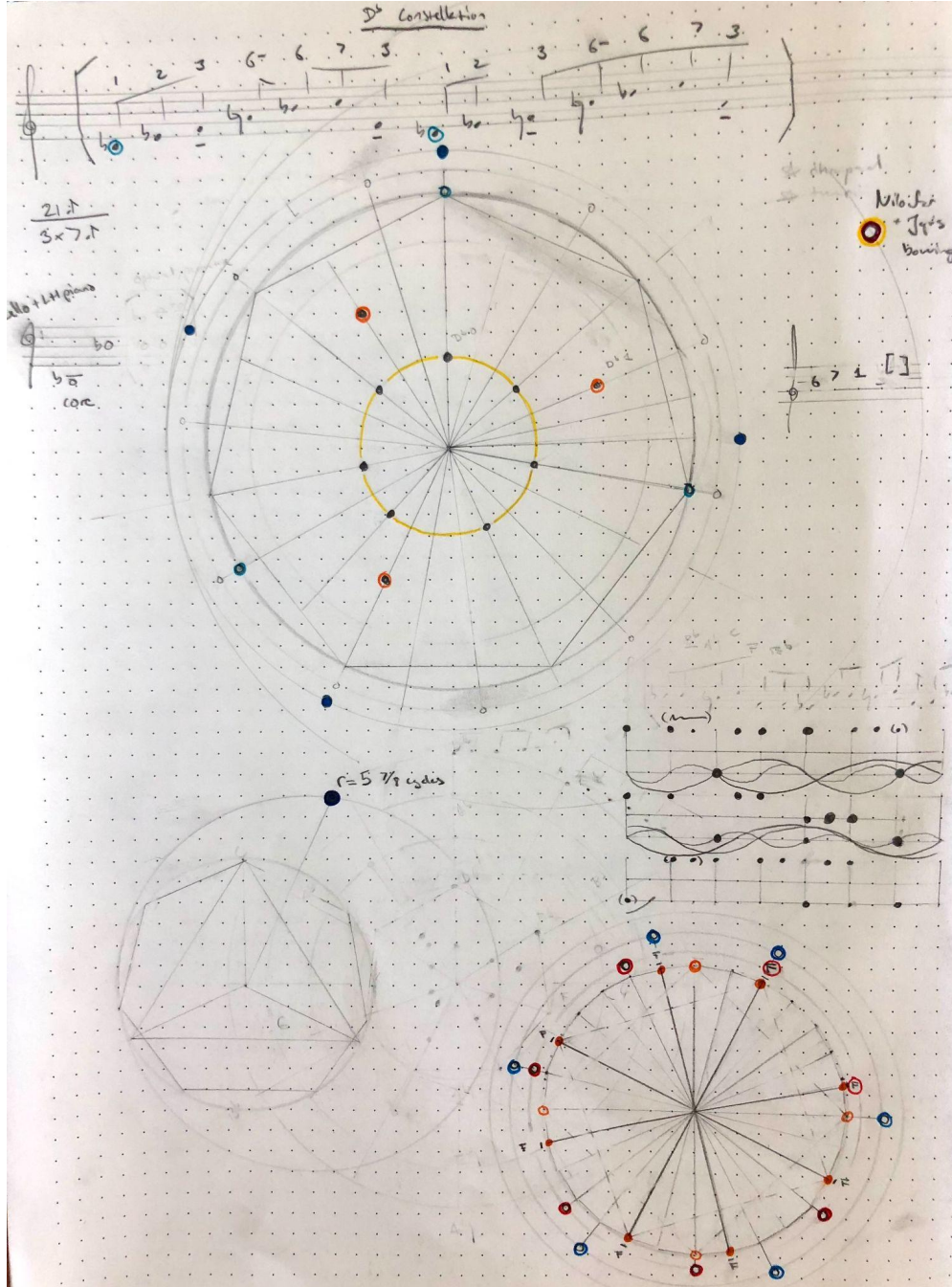


APPENDIX C - Real-time Technology Set-up Diagram for *Ghost Structures* (2022)
Concert



APPENDIX D - Sketches of Circular Notation

Constellation in Db hand-written sketch used in rehearsals



APPENDIX E - Examples of the Short-Long Rhythmic Grouping in Moravian and Slovak Folk Songs

This section provides examples of the short - long rhythmic grouping in Moravian and Slovak folk songs.

Bartok's "Sailor's Song" in *For Children, Vol. 1.* (1909), measures 1-4

Moderato

Stó - jí	Ja - no	při	po - to - ce,	e - ja	hoj!
1. Steht der	Ja - no	an	dem Flus - se,	hei - ja	hoj!
2. Ja - no,	sag, was	ist	ge - sche - hen,	hei - ja	hoj!
3. Hab' ein	Täub - chen	ab - ge -	schos - sen,	hei - ja	hoj!
4. Täub - chen	gurr - te	al - le	Stun - den,	hei - ja	hoj!
5. Ja - no,	nein, das	war	kein Täub - chen,	hei - ja	hoj!
6. Geh' nun,	Ja - no,	in	die Fel - der,	hei - ja	hoj!
7. Dort wirst	du zwei	Hü - gel	se - hen,	hei - ja	hoj!

"Milenec Vrah" in *Moravian Folk Poetry in Song* (Janáček 2013 [1909]: 54), measures 1-3

Andantino ([Redakcia, 1880], Nitrianska)

Ka-de i-dem, ta-de tr-niem, vždy len my - slím, že za - hy-niem;
 ne-bo - jím sa za-hy - nu-tia, len sa bo-jím, že ma chy-tia.

The image shows a musical score for a Slovak folk song. It consists of two staves of music in 2/4 time. The tempo is marked 'Andantino'. The lyrics are in Slovak. The first staff has the lyrics 'Ka-de i-dem, ta-de tr-niem, vždy len my - slím, že za - hy-niem;' and the second staff has 'ne-bo - jím sa za-hy - nu-tia, len sa bo-jím, že ma chy-tia.'

Slovak folk song "23.", from Nitra, (Galko, 1972: 142)

Moderato ([Redakcia, 1880])

ritard.
 Ne-stís-kaj mi, šu-haj, rúč - ku, čo chceš, ja ne - viem,
 tvo-jím sl - zám, tvoj-mu smút-ku ja ne - ro - zu - miem;
 f a tempo
 ne - hne-vaj sa, keď sa sme-jem, žar - ty vy - strá - jam,
 spe - vy, tan - ce že mi - lu - jem a svet ra - da mám.

The image shows a musical score for a Slovak folk song. It consists of three staves of music in 3/4 time. The tempo is marked 'Moderato'. The first staff has a 'p' dynamic marking and a 'ritard.' instruction. The lyrics are in Slovak. The first staff has the lyrics 'Ne-stís-kaj mi, šu-haj, rúč - ku, čo chceš, ja ne - viem, tvo-jím sl - zám, tvoj-mu smút-ku ja ne - ro - zu - miem;'. The second staff has a 'f a tempo' marking and the lyrics 'ne - hne-vaj sa, keď sa sme-jem, žar - ty vy - strá - jam,'. The third staff has the lyrics 'spe - vy, tan - ce že mi - lu - jem a svet ra - da mám.'

Slovak folk song "4.", source undisclosed, (Galko, 1972: 129)

231. KLÁŠTERNÍK

469. Z Mikulčic

Co si myslíš, moja miuá, se mnú u-či - ni - ti? Snaď si myslíš své panenství se mnú za-ta - ji - ti.

The image shows a musical score for a Moravian folk song. It consists of one staff of music in 3/4 time. The tempo is not explicitly marked but the number '469.' is in the left margin. The title '231. KLÁŠTERNÍK' is centered at the top. The source 'Z Mikulčic' is in the right margin. The lyrics are in Czech. The lyrics are 'Co si myslíš, moja miuá, se mnú u-či - ni - ti? Snaď si myslíš své panenství se mnú za-ta - ji - ti.'

Moravian folk song "Klášterník," (Sušil, 1951: 198)