"Situated Sound
and Compositional Circumstance
in My Recent Musical Practices"

Jorge W. Boehringer

A portfolio of compositions and commentary submitted to
the University of Huddersfield in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

January 2019

Abstract

My recent compositional work consists of installed sound environments and pieces for performance by ensembles, soloists, and machines. Throughout my research period I have proposed musical and sonic art works as fields of and for phenomenological inquiry and reflection. From this perspective, my pieces become sites for enacting environmental encounters that unfold around listeners. These circumstances problematize the certainty of subject and object within aural and aesthetic experiences of sound situations. This commentary surveys material and thought processes in my recent compositional work and accompanies a portfolio of works from my research period to comprise my submission for partial fulfilment of the requirements for the degree of Doctor of Philosophy.

In the opening of this text to follow I review and contextualize key technical areas within my material and compositional processes of my portfolio work. Three main areas of research and their outcomes within specific pieces are considered in Chapter 1. First, a permutational and parametric technique for composing patterned musical material is discussed. Following this, I examine and contextualize sculptural approaches to temporality in recent works. Finally, I consider applications of indeterminacy at several structural levels within my recent pieces.

In Chapter 2, I discuss the conceptual development of my research and portfolio work, locating my own strands of inquiry and contributions to thought and practice within contemporary and historical practices in music and the sonic arts. I consider key sources of inspiration from visual art, perceptual psychology, and philosophy. Developing this, I demonstrate how phenomenological activity underlies, has developed within, or assists in my reflection upon the outcomes of my compositional and experimental strategies.

Chapter 3 offers further commentary on each piece within my portfolio submission. I then conclude with Chapter 4 by proposing further developments for my research and future compositional projects.

Table of Contents

List of Figures

Acknowledgements

I am extremely grateful to the University of Huddersfield for granting me a fee waiver for my research period. I would like to thank Bryn Harrison for supervising my degree and for our many insightful conversations along the way.

I would also like to thank Peter Ablinger for his provocations, Alex Harker for his detailed and considered advice, Winfried Ritsch for bringing RHEA to Huddersfield and for all the encouragement. I am endlessly grateful to tracensemble for the leap of faith in performing my work, as well as to Cassandra Miller, Kathy Gray, and Sarah McWatt for subsequent leaping. I would like to specifically thank Stewart Worthy for helping me get things done, and to Alex Heywood for technical assistance at the perfect moments. To my collaborators Pascal Silondi and Jakub Grosz, I bow. I thank the University Library, in particular the Shelving Team, for both intellectual and terrestrial subsistence. Thanks to Braxton Sherouse for the friendship, discussions, and the room. Elias Merino for objectivity. Pierre Alexandre Tremblay for his unpredictable and energetic spirit. Luc Döbereiner for his work and conversations. Monty Adkins for helping me get the boat launched. The Center for Research in New Music (CeReNeM) for many inspiring lectures and discussions as well as all the stimulating concerts and performance opportunities. hcmf// for so many listening experiences formative for the course my thought has taken. Thanks to my family for their continued faith in me, and for bringing me to where I am.

A special thanks to Eleanor Cully, whose patience was (seemingly) not exceeded by my vast capacity for oration and endless expositions of the ideas contained herein, whose encouragement has been without bound, and whose company on many exploratory voyages musical, culinary, and within hiking boots has been simply essential.

Copyright Statement

"Situated Sound and Compositional Circumstance in My Recent Musical Practices"

Unscrew the locks from the doors!

Unscrew the doors themselves from their jambs!

(Whitman, 1969,54)

Introduction

How much of what I hear is composed by my participation in the world?

My compositional work has sought to situate the question above within circumstances of encounter between listeners and the music and sounding environments I have composed. In response to this question my work with sound has taken the form of an investigative and experimental practice in which the circumstances of sound art and music are framed as sites for phenomenological investigation of temporality and memory, perceptions of musical texture, and the formation and recognition of pattern and structure in sound. Investigations into this question and these complementary topics take active and public form in my musical works and sound installations. The conceptual framework and manner of inquiry with which I develop my pieces embodies my reactions to phenomenological philosophy and reflections on recent psychoacoustic research.

The encounters proposed by my recent pieces take place here and now, in our collaboratively constituted environment. In doing so they form part of an intersubjective and invented context of historical and contemporary fine arts practices. This context is *invented* because it begins with us as creative listeners, who construct environments from what we hear. When it is we who are also sounding, a process of systemic feedback is present in which we listen to and react towards an environment we are simultaneously creating. Such recursive feedback is proportional, on another order of magnitude, to that between individual creations and their shared and invented context.

However, from the recursive spirals thus described, the ground of experience has been removed, and existential problems emerge. A pervasive and essential uncertainty develops as we pursue the object of our listening. It has been my recent practice to embrace this uncertainty as part of an active and participatory process of temporal self-definition. We express and define ourselves as we unfold in time along with the world we inhabit and simultaneously constitute.

Having found this to be a productive activity, my recent work attempts to share such experiences with other people, and it is my hope that dialog can provide a foundation for further research activity. This commentary provides starting material for such a dialog by situating my portfolio work in the circumstances in which I practice.

◦ The first chapter, Material Processes, highlights technical inventions and compositional strategies developed as frameworks for my conceptual aims.

◦ The second chapter, Thought Processes, further details these aims, establishing aesthetic and philosophical contexts in which uncertainty becomes a catalyst for experimentation at the conceptual core of my own and other's practices.

◦ The third chapter discusses specific aspects of the works contained in my research portfolio.

◦ The fourth chapter outlines some future developments for my research work.

The epigraph quoted above, from Walt Whitman, suggests a lifting or dissolution of barriers, and a permeability towards our environments. It also suggests an openness and a willingness towards sharing and dialogue, and a refusal of fear. Undertaking research practice in music composition within a university, one enters as a social space that describes another recursive loop of the sort that began this text. Our subjective expressions create the environment we experience at the university, while their collective presence frames and informs what we do. My portfolio and commentary aim to embody specific contributions which have resulted from my research period.

Chapter 1

Material Processes

1.1 Creating Contexts For Phenomenological Listening

My work during this research period has consisted of creating sound environments that problematize how structure is constituted from what is heard. This chapter concerns techniques I have developed in the course of my research and is divided into two sections: the first focuses on determinate material processes, and the second is devoted to the creation of indeterminate situations in my recent works.

The overarching need for working in the ways I discuss stems from the phenomenological realization that awareness of my own perceptual processes arises in response to the presence of uncertainty in sound environments. To this end, composition of ambiguous structures or shifting temporal relationships problematize the establishment of perceptual reference points by which listeners recognize patterns, structure figure/ground relationships, and constitute temporality.

The conceptual development and outcomes of these activities are discussed in Chapter 2.

1.2 Determinate Processes Part A: Diagonal Metamorphism

In this section, I detail a process of composing musical textures by which various streams of musical information are woven together into a single line. I call this diagonal

metamorphism in reference to a geomorphological process by which "rocks …become altered by pressure and heat or by the infiltration of other material, so that the original characteristics have been…replaced by different ones" (Lobec, 1939, p.41).

I came upon this way of working in setting out to write an oboe solo. I sought a way to project a sense of multiple musical trajectories within a single line of sounds. I wanted the sounds to suggest repetition, without repeating exactly. I began to form the idea for the process of diagonal metamorphism in observing a stream close to my house. I realized that the form of the stream was not only the result of the water which rendered it visible. The water, left to itself, would form a puddle. Instead, a stream takes the form it does due to myriad interactive and sometimes conflicting material environmental pressures.

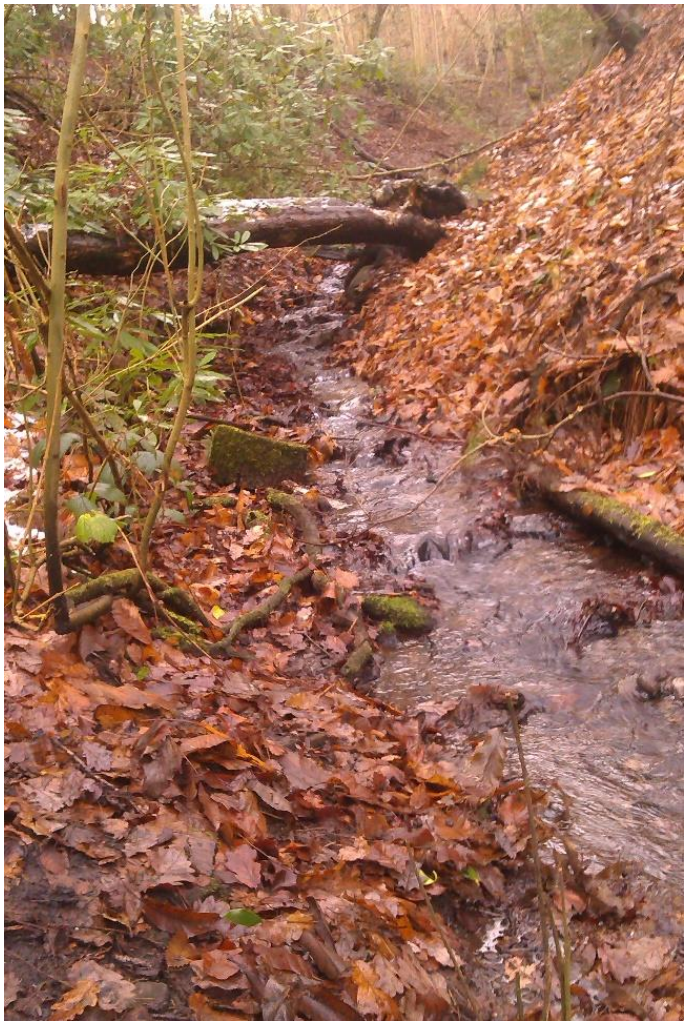


Figure 1: A photograph of a stream in Gledholt Woods, Huddersfield.

I began to think about the stream as information rather than just matter. Although depicted on a map as a unified linear form, this line is the product of forces and processes at a particular time. Thus, the form of the stream, apprehended from one perspective as a line, is a complex manifold when considered from another. Changing perspectives results in both a gain and a loss of information. I realized that by studying a phenomenon from various perspectives, different operative forces could be abstracted from it.

In creating a mapped image of a stream, some structural aspects are combined in order to render the stream in graphic form, while time is frozen. In diagonal metamorphism, I decompose sound trajectories into performance parameters (for example, breath or bow speed, direction of hand or finger movement, frequency of articulation) or acoustical characteristics (frequency, amplitude, envelope, duration). Parameters analysed can then be recomposed according to their individual trajectories, which are subjected to a grid-like temporal treatment, in which time moves forward in discrete steps.

Figure 2: The stream from Figure 1, as seen on topographical map (Ordinance Survey,1948).

In diagonal metamorphism, a ground motive under iteration is progressively sieved through transformative sequences of dynamics, articulations, and register transformations. These processes modify, modulate, interrupt, or obstruct one another, yet the final form is a single stream of linear sound that bears the cumulative traces of all of them. Because the transformative processes have different loop lengths, as the whole collection iterates

permutations between the ground motive and the applied processes occur. This results in the 'diagonal' relationships represented below by sequences of different hue within a larger 14-step 'measure.'

Figure 3: 5 sequences of different length in permutation within a 14-column table. Thicker horizontal black lines separate groups of 5. The sequences are of 13, 7 (as 4+3), 3, 7 (as 3+4) and 5 events within a 14-unit period. These map to the 13, 7, 5, and 3 note iterations within the 14-beat measures out the variations discussed in the coming section (figs. 4-9).

1.2.1 Creating Expectations Through Patterns in Sound

Diagonal metamorphism begins with a sedimentation-like layering of materials and processes. Each new layer sieves previous layers and creates conditions for those that follow. Gradually, information is compressed into the single line that results. This line retains audible traces of the materials and processes by which it was constructed.

Constituent trajectories within these layers are implied or felt, while not being explicitly stated. While a great deal has been altered in this layering process, often enough remains to imply causality or teleology, providing audible cues to listeners, who create structural expectations from them. In Chapter 2, this is discussed as a form of a creative participation enacted in the listening experience. The technique of diagonal metamorphism

provides material for individual phenomenological investigation of experiences of pattern formation in a musical context.

1.2.2 Implementing Diagonal Metamorphism

Diagonal metamorphism begins with a sequence. A sequence of structural information of any sounding parameter, for example, pitch, dynamics, or durations, could be used. In the examples to follow, I construct a model implementation of diagonal metamorphism based on how the guitar part for my piece *In Warmer Seasons* developed. This began with the thirteen-note cycle of pitches shown below. In the example to follow this sequence will be gradually transformed through a series of steps, each of which filters this material in turn. Subsequent transformations will follow the step-rate of this first iterative motive, unless a subsequent motive were to adjust the duration of the steps.[1]

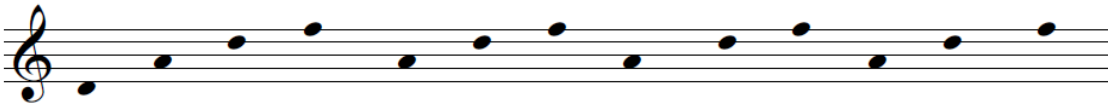


Figure 4: A beginning sequence for enacting diagonal metamorphism. This motive has a specifically d- minor orientation and regularly articulates an arpeggio within a slightly asymmetrical rhythmic cycle.

Mapping this motive onto a grid of 7/4 measures produces a thirteen-bar cycle by which the motive returns to its original position, shown in fig.5.

[1] The rigidity of the step-like behavior of this system, and the possibility of transforming it through the addition of a sequence of durations that alters it, points to a strong relationship between diagonal metamorphism and the technique of transformative temporal grids that I discuss in the next section. These techniques often appear together in my portfolio pieces.

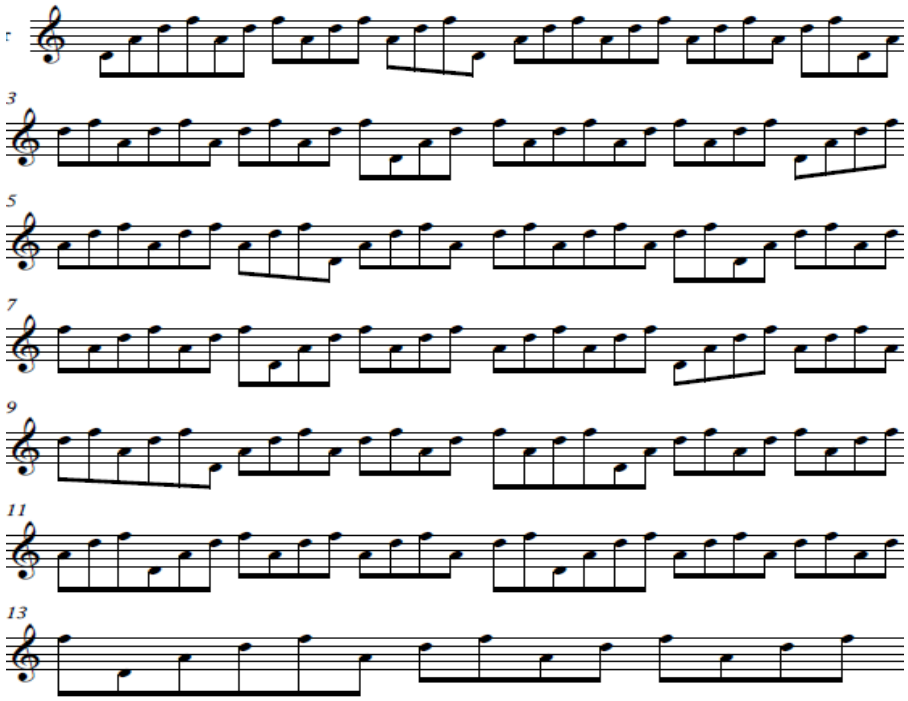


Figure 5: The thirteen bar meta-cycle.

Opting next to apply a sequence of register transformations to this meta-cycle, I composed a sequence of octave displacements that zig-zag across the range of the guitar, from the 4th (highest) octave of the guitar to the 1st (lowest). The octave displacements follow a seven-event sequence, which transforms one pitch per step by the octave given in this sequence, from highest to lowest across the guitar: 4 - 3 - 2 - 1 - 4 - 3 - 2 (repeat). An example of the results of this process is shown in figure 6.

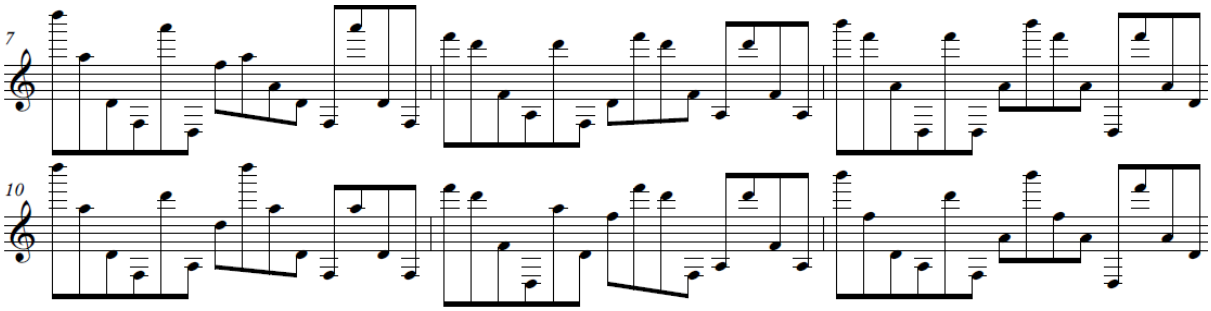


Figure 6: A sequence of register transformations with a period different to that of the initial motive is overlaid.

Following this, an accent is added to every third note:

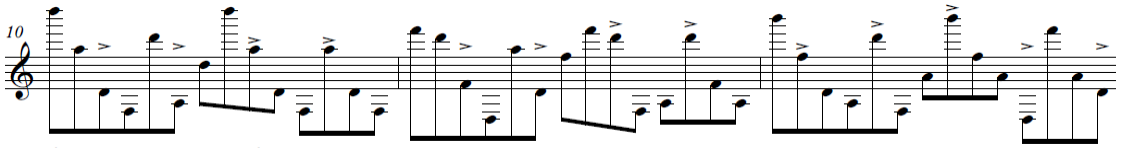


Figure 7: A simple sequence of repeating accents is added.

Next, a pattern of alternating pitch bends first every three, and then four steps, repeating.

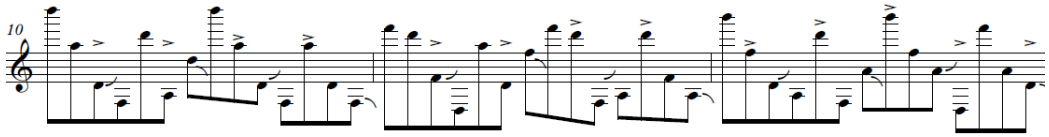


Figure 8: A 7 note cycle of pitches to be bent up or down with the left hand.

A sequence of larger glissandi occurring every 5 steps is applied. This is played with a pitch-shifting footswitch, notated by capital letter T. The notated pitch slides alternately up or downwards to the maximum extent allowed by the pedal.

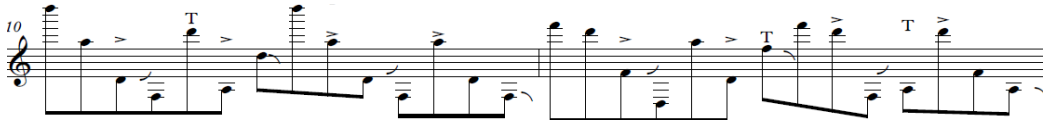


Figure 9: "T"denotes larger glissandi performed to the maximum extent allowed by a pitch shifting footswitch.

Although proceeding by discrete step, diagonal metamorphism allows for the design of rates of change in single parameters within a sound texture. In this example, chromaticism is gradually increased as all the other cycles iterate. The 13-bar meta-motive (see figure 5) repeats thirteen times in the piece. Chromaticism is gradually but regularly introduced throughout this overall duration using a 12-step sequence that permutates against the 13-measure cycle of the 13-note motive, as shown in figure 10. A chromatic accidental is added to one position within the 13-note motive at every repetition of the 13-measure cycle, resulting in the accidental shifting one note backwards with respect to the 13-note motive with each cycle. Over the course of the full 13-measure cycle, each note would be altered in turn. The chromatic alternations are therefore not tied to specific steps, but rather to positions that change relative to the others, within their 12-step iterating cycle.

SEQUENCE OF EVENTS

0	1	2	3	4	5	6	7	8	9	10	11	12
1								+				
2	–							+				
3	–		+					+				
4	–		+			–		+				
5	–		+			–		+				–
6	–		+	+		–		+				–
7	–		+	+		–	–	+	+			–
8	–		+	+		–	–	+	+			–
9	–		+	+		–	–	+	+	+		–
10	–	–	+	+		–	–	+	+	+		–
11	–	–	+	+	+	–	–	+	+	+		–
12	–	–	+	+	+	–	–	+	+	+	–	–

ITERATION

Figure 10: X-axis represents steps 1-12 in the cycle, Y-axis indicates on which iteration of the pattern an alteration is added. A plus symbol (+) indicates movement upward by a half-step, and a minus symbol (-) indicates movement downward by a half-step. One note is left unaltered in the thirteenth and final iteration of the sequence.

The motive (seen in figures 4 and 5 above) begins with a strong sense of harmonic stability, but progressive chromaticism creates a gradual sense of movement away from this and towards a chromatic field that is isotropic, where no note is privileged.

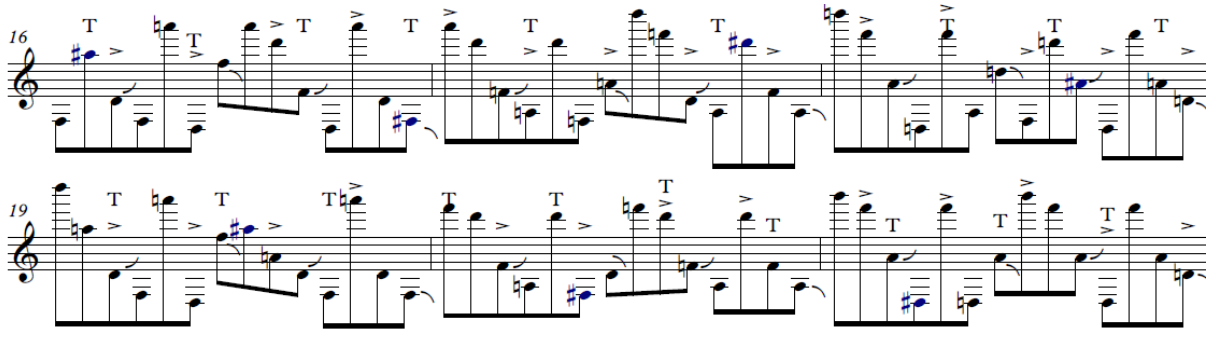


Figure 11. Captions for figs. 11-14 follow.

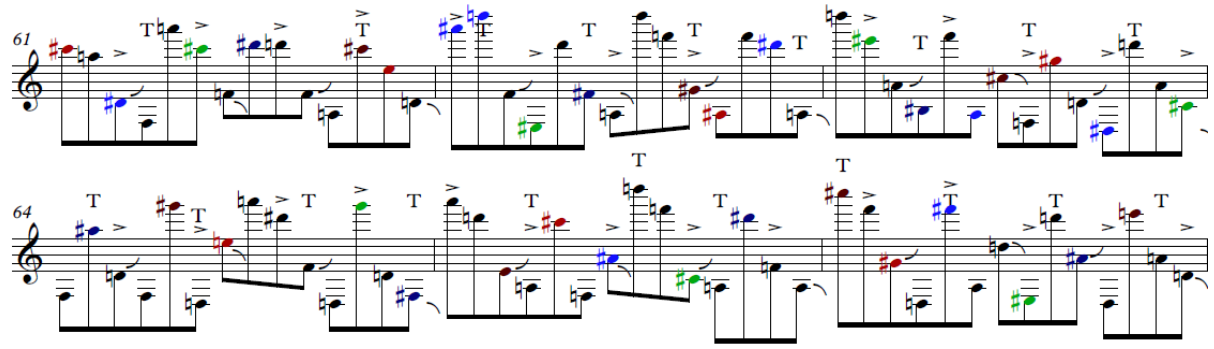


Figure 12. Captions for figs. 11-14 follow.

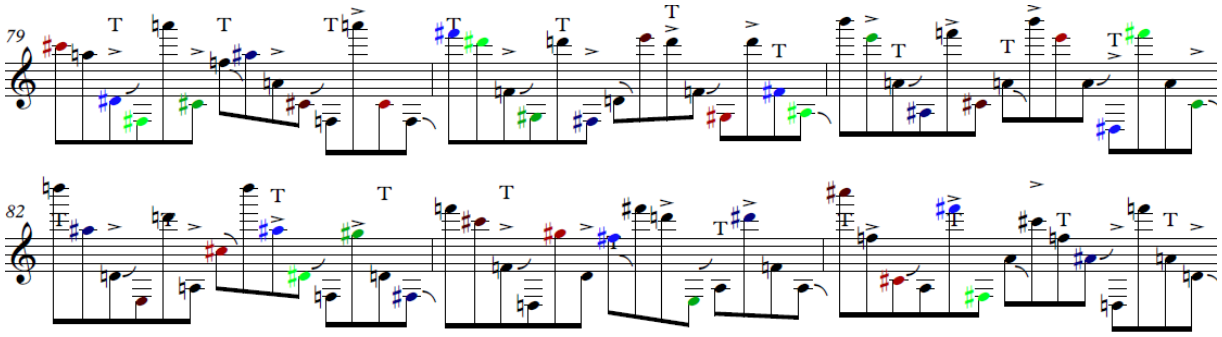


Figure 13. Captions for figs. 11-14 follow.

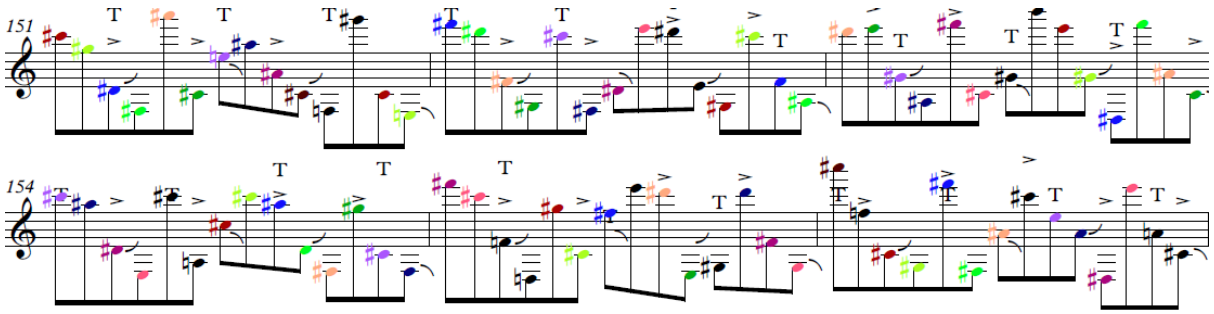


Figure 14. Captions for figs. 11-14 follow.

Figures 11, 12, 13 and 14: The gradual increase in chromaticism over the course of the 13 iterations of the 13-bar motive is evident in these progressive "snapshots." Alterations are always notated by sharps for easy reading.

In the final version of the guitar part, a final layer of process, discussed presently, resulted in considerable transformation of the material seen above. However, this remains a characteristic implementation of the diagonal metamorphism, underlying both the guitar and flute parts in *In Warmer Seasons*, as well as forming the basis of the second movement of *Unnatural Processes*(2015), the first half of *Helical Pastimes* (2016), and present throughout *Unnatural Habitats* (2016).

1.2.3 Influential Approaches from Music Theory And Perceptual Psychology

Diagonal metamorphism allows me to design varying rates of change in musical textures, and to imply the existence of sound structures that are not explicitly stated. There is a strong tension between repetition and variation in the textures produced through diagonal metamorphism, and the degree to which the result is heard as unity or a multiplicity of materials is always in flux. However, presenting fragmented lines and layers of interrupted causal processes does not prevent listeners from rendering perceptual wholes from them. Where this occurs, listeners experience an awareness of lines and implied contrapuntal activity that are not explicitly stated.

Implied polyphony occurs in works for solo instruments in which multiple melodic voices are suggested through the activity of a single line of sound.[2] This is notably the case throughout the cello suites of J.S. Bach, as discussed by scholar Sandy Davis who compares "structural expression" to "perceptual relevance" (Davis, 2006, pp.423-446). Davis' focus is relevant to my work in that I find the most perceptually interesting phenomena occur where a seemingly straightforward presentation can be apprehended in the process of giving way to an unexpected complexity, as occurs, for example, in the middle movement of my piece *Unnatural Process,* for mechanical piano and performer. While Davis underscores the relevance of perception in the apprehension of structure, in my own work I emphasize the phenomenological centrality of perception in structural expression.

Diagonal metamorphism, especially when containing register shifts and in the context of a fast tempo, provides a frame for a perceptual phenomenon related to implied polyphony known as perceptual streaming (Davis, 2011). Perceptual streaming is the perceptual separation of a sequential selection of available sound. (Micheyl, Hunter, Oxenham, 2010). Streams are perceived linear wholes that emerge through the interaction of a combination of material processes and listeners' own processes of perception. In *Helical*

[2] Implied polyphony is "the perception of multiple voices or melodic lines within a monophonic texture" (Temperley, 2001,p.91).

Pastimes, for two mechanical pianos, the relative uniformity of timbre results in streams being segregated according to register and temporal proximity.

Theorist David Huron's criteria for the perception of voice-leading relationships in pseudo-polyphonic lines suggests reasons for the increased likelihood that textures produced by diagonal metamorphism will be heard to contain multiple streams of information (Huron, 2001). Huron provides a perceptual basis for harmonic voice-leading that demonstrates conceptual parallels to the notion of auditory streaming. In pseudo-polyphonic textures[3], perceptual relationships are shown to be activated by lingering perceptual 'tails' that accompany sounding notes, prolonging their harmonic relevance for a listener beyond their sounding envelope. Subsequent research suggests that the onset of a new sound event perceptually 'cuts off the tail' of the event before it, unless events are separated by a great enough distance in frequency, as is the case in register displacement (Temperley, 2001). Thus, events close together in time but far apart in frequency are more likely to form separate perceptual streams and result in a pseudo-polyphonic texture, as is the case in *Helical Pastimes*. However, it is most interesting to consider that it is a listener's individual memory which constitutes this immaterial "tail." Sounds that we apprehend as unified are linked together by memory in our conscious present. Could it also be that we at least partially constitute what our sense of the present moment is through the sounds that we group together? This question, central to my research, is taken up in Chapter 2.

In general, diagonal metamorphism, especially when employed in a manner involving register shifts, tends towards perceptual segregation of different voices by register. As this process steps forward, each voice tends towards a melodic logic within its own register, and therefore is heard as a separate line. This makes it a very useful tool for composing situations in which stream separation is likely to occur as part of the listening experience. In working with diagonal metamorphism, I sought different ways of parametrizing my sound materials in the hopes of provoking the emergence of different types of patterned behaviours. Throughout my search the work of perceptual psychologist

[3] Another name for compound lines or implied polyphony.

Albert Bregman has been extremely helpful for its synthetic basis, and influential in its openness towards thinking outside either conventional musical or psychoacoustical paradigms. Bregman has developed a broad body of qualitative and quantitative research into Auditory Scene Analysis, a robust perceptual model for how listeners give sound meaning (Bregman, 1994). Auditory Scene Analysis focuses on how listeners parse, segment, or integrate sounds into a unified phenomenological world, which he denotes as the auditory scene (Bregman, 1994). Bregman's research provides theoretical and experimental support for most of the key musical discoveries I have made with diagonal metamorphism. An example of this is that similarity of timbre, along with shared articulatory qualities and duration, act together to suggest strong perceptual groupings that can override other present structural cues, such as the grouping by register emphasized above.

I explored this topic in my live electronic work *Unnatural Habitats*, an extension of work begun with pitch, register, and dynamics in an earlier piece, *Unnatural Processes*. By adding further layers of processing in the domain of timbre, I was able to experiment with relationships of proximity, register, and timbre in real time as I prepared the piece, listening for groupings that emerged and making note of the conditions under which they occurred. In a live performance of the piece, the performer reinforces aspects of pattern formation that arise as the music progresses, a performance practice that stems from my research process.

This effect of timbre on perceptual streaming is pronounced in my piece *In Warmer Seasons*. In this piece, wooden percussion parts are linked to individual instrumentalist's phrases, derived by diagonal metamorphism. However, in performance the percussion instruments are heard to segregate from the instrumental parts, forming their own perceptual whole, despite having consistent visual and causal ties to the phrases played by performers. In a later work, *Descent from the High Arches and the Bog Chorus*, this became the subject of the piece. In *Descent* entire textures, rather than sequences of notes, are segregated from one another, resulting in the entire piece having two discrete layers of sound (woodblocks and sine tones).

1.2.4 Related Approaches in The Arts

Working with an approach audibly similar to diagonal metamorphism, composer Laurie Spiegel's *Expanding Universe* (1973) occasions a great deal of implied polyphony and perceptual streaming. In this piece the canonic structure of the phrases combine with factors of proximity, register, repetition, and speed, in biasing the texture towards stream segregation for listeners. Many of Steve Reich's early works, like *Violin Phase*, combine similar ingredients and provoke similar perceptual traceries.

Maryanne Amacher's 1999 *Sound Characters*, an album of electronic music released on the record label Tzadik, achieves its result in related but different ways. Amacher's process involves high speed antiphonal hocketing of tones in different registers and between speakers. Some of the apprehended tones do not exist in the recording but are instead the product of distortion-product otoacoustic emissions (DPOAE), a form of perceptual synthesis (Haworth, 2011). Amacher's patterns unfold not only within the parametric space of her composition but also the space of broadcast, to include the bodies and minds of listeners, whose ears are activated as synthesizers through her application of DPOAE (Kirk, 2010; Cheng, 2000).

In painter Bridget Riley's 1992 work *High Sky 2* a similar process is carried out in schematic and visual form. As this is a visual, rather than a musical work, the tension between notions of repetition and variation is immediately present, and deepens upon closer inspection, during which a viewer's visual system adjusts and responds to Riley's work in a manner not unrelated to how our auditory attention system segregates streams from what we hear. Perceptually, Riley creates an awareness of a consistency of sizes on two simultaneous picture planes. However, this is achieved through an inconsistency in what seems at first to be presented as a ground pattern of regular grid square sizes, producing the perceptual effect of a shimmer or flicker. Riley achieves such perceptual effects through intersecting planes that simultaneously suggest repetition and interruption of one perceived whole with another in a manner evocative of diagonal metamorphism.

Riley's work separates structures into temporary perceptual wholes that produce the aspect of a skewed grid and an impression of motion. Three moving planes of geometric development are sensed to be at work at any one moment of a viewer's experience with *High Sky 2*, a result similar to what I was seeking in my application of discrete and simultaneous time frames in my portfolio work *In Warmer Seasons*. Riley's work provides a conceptual and visual bridge linking notions of perceptual fusion and synthesis, and pattern recognition, to that of distorted grids. This subject is taken up next, in regard to a sculptural approach to time I have adopted in several recent pieces.

1.3 Determinate Processes, Part B: Elastic Frameworks for Temporal Reference

I explore how I experience sound and time through listening and composing. My research considers how sonic perceptual wholes are established and given meaning. This section discusses technical approaches by which I propose temporal frames of reference for listeners in my recent works. As discussed in the examples to follow, the establishment and transformation of proposed temporal frameworks alters the material and perceptual relationships of sounds and listeners residing within them. The course of such transformations offer opportunity for phenomenological reflection. In this section, I comment on three main methods whereby I create the conditions for transformative temporal frames of reference in my recent music:

◦ In *Unnatural Habitats, Helical Pastimes,* and *Unnatural Processes* the remoulding of quantized or metrical frameworks alters relationships between the sounds that reside within them. This forms the main rhythmic activity of the pieces listed above, offering listeners points of reference that are in a state of constant movement, as though residing on a grid that is in the process of being slowly skewed.

◦ Secondly, I use local, rather than global organization of time in several pieces, resulting in the simultaneous existence of multiple metrical frameworks. This is the case in *In Warmer Seasons*, *Magnetic Arch* and *Island in Natural Colours,* in which a degree of autonomy between individual instrumental parts or musical textures is achieved. This offers listeners an experience in which unity and multiplicity are simultaneously present, and different structural developments may be heard depending where listening is focused.

◦ In other works, for example *Descent from the High Arches and the Bog Chorus*, and *Circular Bridge Squirrel Walk,* the subjective experience of time as it is enacted and simultaneously encountered by performers is the focus.

1.3.1 A Temporal Context For Perception of Pattern

The perception of elements like change, repetition, causality, variation, and large-scale form rely on comparisons based in memory. Listeners measure change based on short and long-term schematic models with which a listener compares the progress of a phenomenon to expectations of what is believed to be operating in a sound environment (Bregman, 1994b). Frames of reference are either adopted or imposed. Examples of adopted frames of reference include the adoption of the pulse, or meter, of heard music. Harmonic expectations over sequences of chords represent a learned and culturally-mediated perceptual schema. Individuals also impose frames of reference over events, as for example in reference to a stopwatch, a time signature, or by placing a steady pulse against the events.

In discussing how musical structures are perceived, Albert Bregman refers to more immediate adopted processes as primitive perceptions, versus schema-influenced processes of perception that are reliant on memory and learning (1994b). These first reactions, referred to as primitive by Bregman (1994a), are innate and result in our immediate organization of the sonic world. According to Bregman, they are organized according to a materials-first or "bottom-up" approach (1994a). Schema-based perceptions follow a "top-down," or knowledge-based process. Observed environmental regularities, or abstract notions of regularity, like causality or representation, comprise the knowledge that informs these

schematic processes. Special cases of schema-based sound perception, like language, or a musician's ability to isolate melodies from a contrapuntal texture, form special and complex cases of schema-based sound perception (Dowling, Lung, Herrbold, 1987).

1.3.2 Music as Research into Temporal Phenomenology

In order to study experiences of time, I design processes that materially provoke a question. In linguistic form, the question may be rendered*: do I feel that the sonorities articulate changing tempi, or are they being transformed by a larger alteration of the context we both share?* In exploring this question through my recent music, I have been inspired by notions of time in the writing of philosophers Henri Bergson, William James, Edmund Husserl, and musicologist Jonathan Kramer.

Bergson's argument differentiating spatial from temporal attributes includes the premise that time cannot be conceptualized in terms of "extensions" as space can (Bergson, 2001). While objects in space can be placed end-to-end to form an extended line, and distance measured against such standards, this is not appropriate for describing the experience of time. Rather than "one thing after another[4]," for Bergson time is a field of interpenetrable multiplicity, which constitutes his special usage of the term duration (la durée)[5]. He compares perceptual indivisibility of time to the action of stretching a piece of elastic:

> Let us draw it out gradually in such a way as to bring out of the point a line which will grow progressively longer. Let us fix our attention not on the line as line, but on the action which traces it. Let us consider that this action, in spite of its duration, is indivisible if one supposes that it goes on without stopping; that, if we intercalate a stop in it, we make two actions of it instead of one and that each of these actions will then be the indivisible of which we speak; that it is not the moving act itself which is never indivisible, but the motionless line

[4] This famous phrase is alternately attributed to writer Edna St.Vincent Millay, historian A.J. Toynbee, Henry Ford and others.

[5] Bergson's notion of time and his application of this term developed and changed across his many works.

> it lays down beneath it like a track in space. Let us take our mind off the space subtending the movement and concentrate solely on the movement itself, on the act of tension or extension, in short, on pure mobility. This time we shall have a more exact image of our development in duration (Bergson, 1968, pp.193-194).

Musicologist Jonathan Kramer has undertaken a rigorous study of the perception of time in music (Kramer, 1995). In his book *The Time of Music*, he offers a taxonomy of compositional approaches to musical time and corresponding species of listening by which these are apprehended. Of particular interest are his expositions of moment form and vertical time. As characterized by Kramer and exemplified in works by Karlheinz Stockhausen and Olivier Messiaen, moment form consists of mosaic-like arrangements of self-contained entities that exist on their own time scales, in contrast to works that operate within a single, global time frame (Kramer, 1998). A great deal of my recent work presents stratified textures of autonomous materials (*In Warmer Seasons*, *Island in Natural Colours*). Each textural component operates on its own time scale while the listener negotiates the piece as a whole, in relation to their own temporal frame of reference. While this multiplicity of time frames relates to moment form, Kramer describes a musical circumstance in which structure is not gesturally but "vertically" experienced, and this is more suited to the intention in my recent pieces:

> In music without phrases, without temporal articulation, with tonal consistency, whatever structure is in the music exists between simultaneous layers of sound, not between successive gestures. Thus, I call the time sense invoked by such music "vertical." (Kramer, 1998, 55).

Although most of the music I have composed in my research period is not in Kramer's sense "vertical music," his description applies structurally, while suggesting a means of working with experiences of time that characterize what I referred to above as an interpenetrable multiplicity in Bergson's "duration." But what is the sense of time evoked in this vertical music? As my research has progressed, I have found it beneficial to step back from the categories established by Kramer and consider instead the formulation of the specious present in the writing of philosopher William James.

James' concept of the specious present centres around the idea of a flexible and subjective duration for the present moment. According to James, the present is actually located in the immediate past, in a volume of time referred to as retentional, held in present attention before becoming part of the "obvious past" (James, 1890, 609). The volume of retention forms the duration of the present moment and is a function of attention. James uses musical experience to illustrate this, stating "all the notes of a bar of a song seem to the listener to be contained in the present" (James 1890, 609, quoted in Anderson, 2014,6).

Notably both Henri Bergson, discussed above, and philosopher Edmund Husserl utilize melodic constructions to elucidate models of time. Lengthy discussion of either exceeds the scope of this text, however, in brief, Bergson (2001) states that melodies are synthetically constituted by listeners from successive phrases, and together held as a present unity defined by qualitative experience. Interestingly, he later suggests that listeners may adopt the temporal frame of reference of what they hear. "An indivisible melody," proposes Bergson, entrains a listener's sense of duration to itself as "ego comes in contact with external world at its surface" through which, "our successive sensations, although dissolving into one another, retain something of the mutual externality which belongs to their objective causes" (Bergson, 2001, 125).

In the *Phenomenology of Internal Time-Consciousness* Husserl also harnesses the example of a melody to demonstrate a retentional notion of time in which experiences of sounds are accumulated, in combination with our expectations, to form the "now."[6] Thus, as philosopher Charles Ford points out, Husserl's phenomenological time is not something music resides within, but a state or characteristic of the intersection of music and a listener. "Musical time is *how time is* for music and its listeners" (Ford, 2010).

Composer Agostino Di Scipio, with whom I share an interest in environmentally organized compositions, feedback systems and unstable materials, highlights ideological

[6] See Husserl, E. (1928/1964). Dodd (2005) summarizes and discusses the diagrams with which Husserl illustrates his ideas.

and historical challenges to the view of sound and music as process rather than object (Di Scipio, 2013). According to Di Scipio (2015), ideology embedded within historical approaches to western musical notation contribute to the misrepresentation of sound as an object-like phenomena, rather than a temporal event. While spatial thinking is regularly employed as a metaphor for sonic characteristics in musical notation,[7] this extends throughout the digital domain, where spatial thinking is reinforced by graphical interfaces that employ the same designation to changes in pitch and volume as to movements in stereo or multi-channel space. Such technical approaches encapsulate time as quantized units that are arranged linearly, creating precisely the notion of extension that Bergson believes inappropriate for consideration of time as duration (2001).

It is important to consider the results of notational and technical approaches that privilege a view of time as quantized extension. Has object-oriented thinking as applied to sound processes produced object-like musical structures? If so, do these function any less well for producing music? A less often considered aspect of such debates that has presented itself in my recent practice is the point of view of the perceiving individual, in which the experience of time and space may not be separable. The linguistic entanglement evident in how we describe relations in space and time is likely to reflect their degree of entanglement in our apprehension of them. Since extension of objects through space is an action necessarily performed in time, perhaps time as well as space is always, as Husserl puts it, adumbrated, apprehended from a perspective (Husserl, 2012b).

Spatialized thinking and quantized tools for manipulating sounds are taken on by composers as a means to an end. In my recent works, I have attempted to pull this issue apart by placing or designing sounds within deliberately quantized structures that I further transform. Beginning with a process temporarily considered as an object, for example, a notated pitch for an oboe or a piano, or electronically, as a pitch stamped into position within the grid of an electronic music sequencer in *Unnatural Processes* or *Unnatural Habitats*, I attempt to return an awareness to listeners that these sounds are processes, and further,

[7] Pitch referred to, and notated, in terms of low and high instead of fast and slow, for example.

that they are processes of perception. My compositional approach for doing so, discussed in the sections to follow, relies on raising awareness of listeners' activity when listening, through materially restructuring established the temporal frameworks that sounds and listeners share.

1.3.3 First Steps on Pliable Ground

In the final movement of *Everything is Happening at One Time*, a four-note ascending motive describing an e-minor chord is seated within a linearly slowing tempo (fig.15).

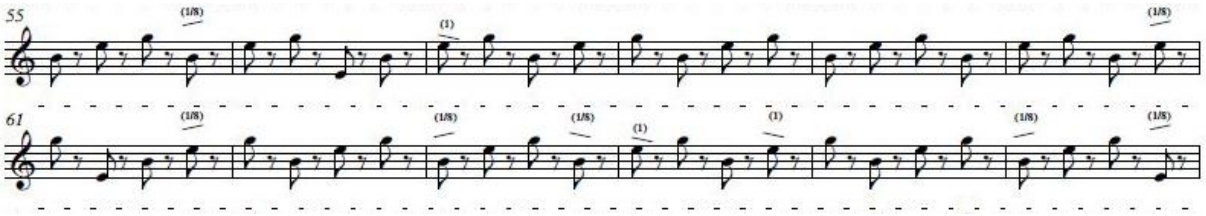


Figure 15: Grid-like notation belies the experience of this constantly decelerating music.

While the notation of *Everything* is very regular, what is heard is a gradual expansion. Notated as a long ritardando and achieved in performance via a gradually slowing visual metronome, the pulse expands to create a form in which little else happens. However, repeated listening suggests that the expansion occurs in different places, and at different speeds, while in fact the expansion is linear, as seen in figure 16.

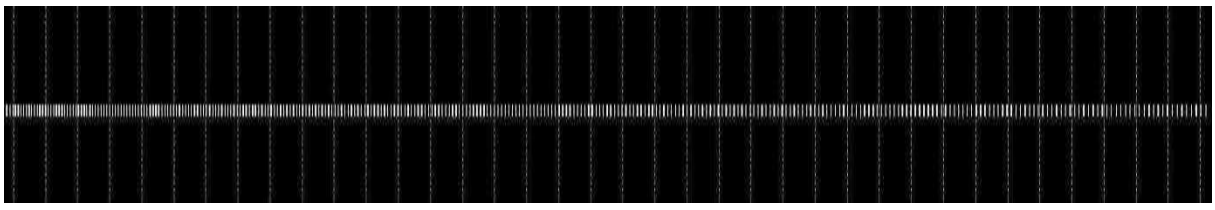


Figure 16: The metronome events, seen above as midi notes, gradually expand.

In the context of the fluctuating time of a listener's experience, irregularities in otherwise unchanging material are heard. While listening to a sine wave, a repeated chord, a metronome, or a ticking clock, active listening suggests change over time. What causes

this change in experience? At times, a largely unchanging context can serve to magnify small imperfections in the material surface of the sound. In other instances, the irregularities are artefacts of perceptual process. These moments provide sonic mirrors in which we listen to ourselves hearing. These circumstances also set the stage for the experiences of uncertainty I seek to frame in my recent work, and recall the questions that began this section, which can now be rephrased in terms of the extent to which pattern formation is a function of pattern recognition.

1.3.4 Skewed Grids

Working musically with the questions as to how context and listening affect experiences of time, I have sought to embody perspectives from philosophy, physics, and conceptual art that might be tested in musical performances or sound environments. As live experiments, these works provide material for phenomenological reflection.

As discussed previously, culturally mediated assumptions as to the nature of sound and time are hard coded into our tools and language, reinforcing spatialized and object-like representations of these phenomena (Di Scipio, 2013). Nevertheless, I have gained considerable insight from repurposing tools grifted from spatialized conceptualizations and created applications that repurpose grids and metronomes.

Grids provide a self-referential frame based on multiple dimensions. In a two-dimensional grid, the x-axis is measured based on the regularity of the y-axis, and vice versa. An element placed in proximity to the grid can be compared against the rigid internal structure of the grid. Precisely because of this rigidity, grids provide excellent grounds for measurement and consideration of change. They can also be transformative tools. The shifting sound relationships in *Unnatural Processes, Helical Pastimes,* and *Unnatural Habitats* were arrived at by establishing a pattern of material within a grid framework, and then transforming the grid, and the material along with it.

In these works, temporal relationships between sounds result from transformation of a higher structural level than that on which the sounds themselves are produced. A visual analogy can help to picture how this works: imagine a lemon on which two points are drawn with a pen. Allowed to rot, the points draw closer together on the surface of the lemon. The reverse occurs when a figure is drawn on a balloon that is then inflated: the figure grows in such a way that each point moves away from every other. It is not the figures, but the space in which they reside, their context, that is transformed.

Such a transformation is applied unsynchronized to all three parts of *In Warmer Seasons.* In this piece, each part begins at a slow tempo, the grid compresses around the notation, speeding the material up, and then relaxes somewhat, expanding elastically. As was the case with the last movement of *Everything Happens in One Time,* most of the rhythmic activity happens due to this transformation, rather than in rhythmic subdivision of beats. As such, when this technique is employed, rhythmic notation involves a small range of temporal values. As seen in the guitar part of *In Warmer Seasons* (fig.17) or the final movement of *Everything*, single durational note values are predominant throughout.

Nevertheless, under transformations of its temporal framework, straightforward repetitive notation experientially undergoes great changes. In search of larger rhythmic contexts for what is heard, listeners are constantly redirected to the surface of the sound as the mind grasps at fragments in an attempt to establish order in what is always already slipping away.

1.3.5 Skewed Grids in the Context of Instrumental Composition

In the final version of the guitar part of *In Warmer Seasons*, the linear transformations of material discussed at the beginning of this chapter are verticalized into repeated blocks of sound. This verticalization is accomplished by bracketing brief sequences of tones that outline a harmonic identity, and rendering this as a chord, rather than a line. In this guitar

part, each of these is expressed as an ostinato group, the duration of which lasts for as long as the harmony would have been prolonged in the previous, unverticalized context. This is similar to the process that provides the ground for the second of the two halves of the binary form of *Helical Pastimes*, discussed subsequently.

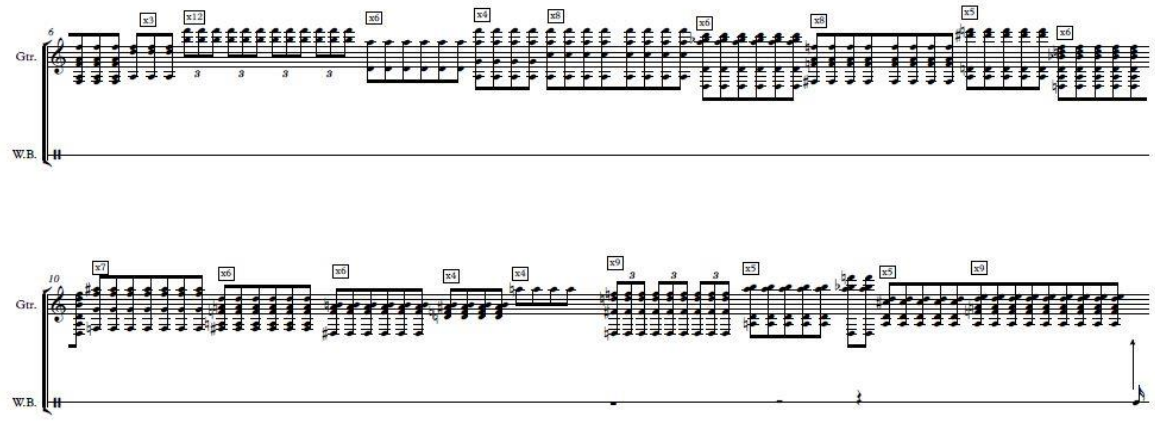


Figure 17: An excerpt from the guitar part for *In Warmer Seasons*. The layers of processes of permutation discussed previously are now rendered as simultaneities.

Figure 18 shows the three click tracks from in *In Warmer Seasons*. Each mark on the three tracks below represents a metronome beat, rendering visible the independent, yet similar movement of tempo within the work. Given that the notation in figure 17 retains similar note values throughout, it is clear that the change in pulse comes from the metrical ground within which the notation is situated.

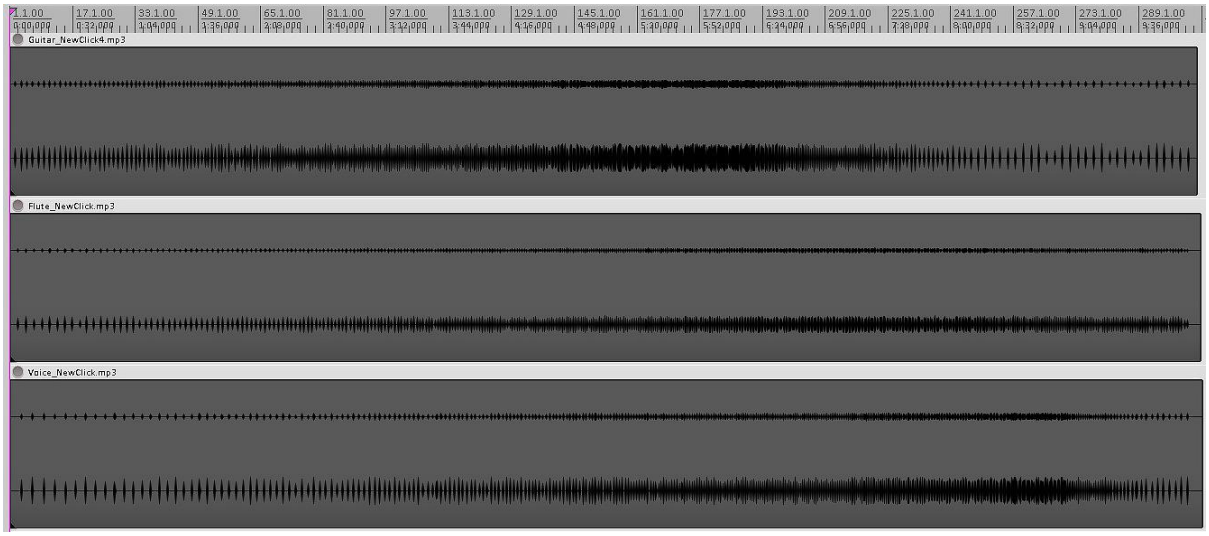


Figure 18: Click tracks are shown to gradually speed up and slow down for each of the three instrumentalists for *In Warmer Seasons.*

Helical Pastimes for two mechanical pianos provided the context for an explicit meeting of diagonal metamorphism and verticalization within a context of shifting time frames. The first half of the piece consists of an unfolding of diagonal metamorphism that gradually increases in chromaticism towards a more symmetrical pitch space in the centre of the piece. At measure 151, this development reverses itself, and symmetry is broken as chromatic field gives way to a harmonic orientation. However, beginning at this midpoint of the work, the pitch material is verticalized, sounded in a simultaneous rather than linear manner.

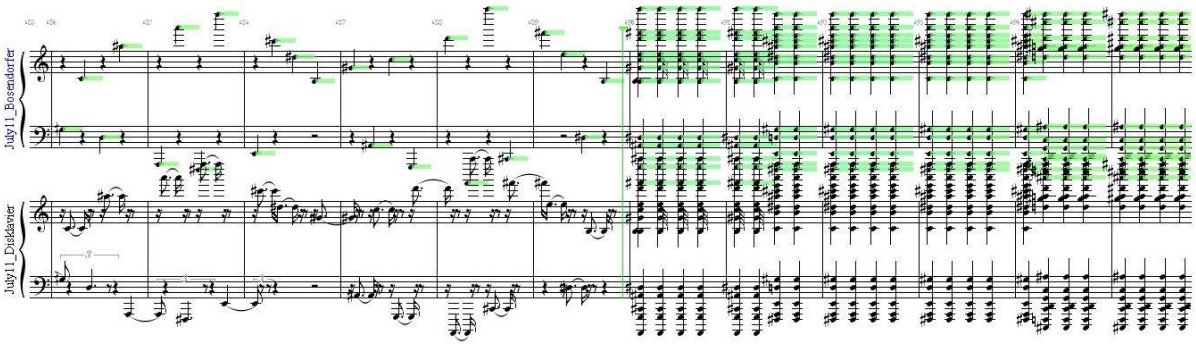


Figure 19: Notation derived from the midi information that drives the two pianos.

In Fig. 19, the midi data that drives the two pianos is visually rendered as musical notation showing the transition from horizontalized sequences of sonorities to their verticalized presentation at the centre of the work. Note that in this representation duration appears regular. In Fig. 20 actual differences in duration are revealed, as is the "mirroring" that takes place at this central moment of the piece.

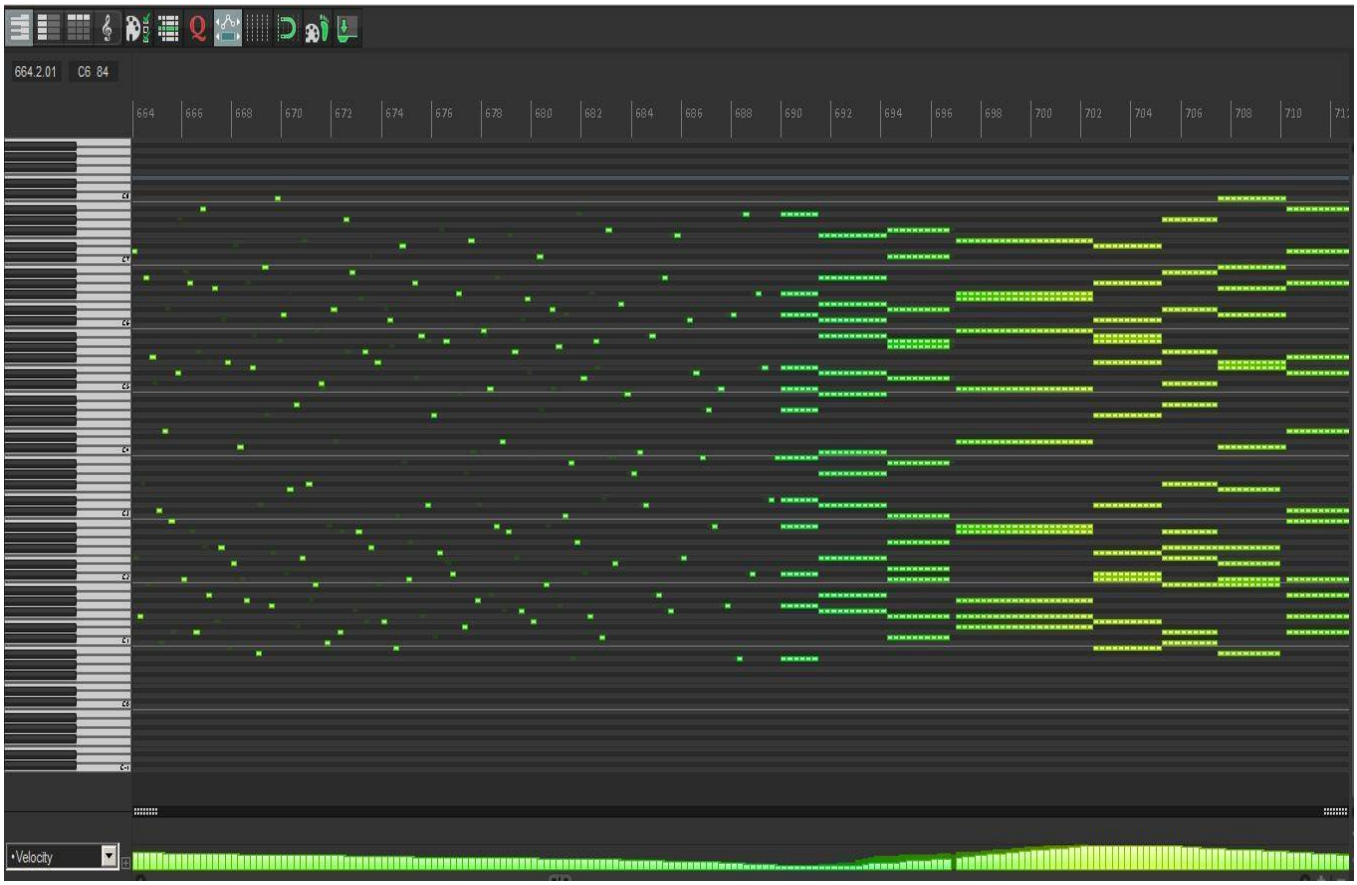
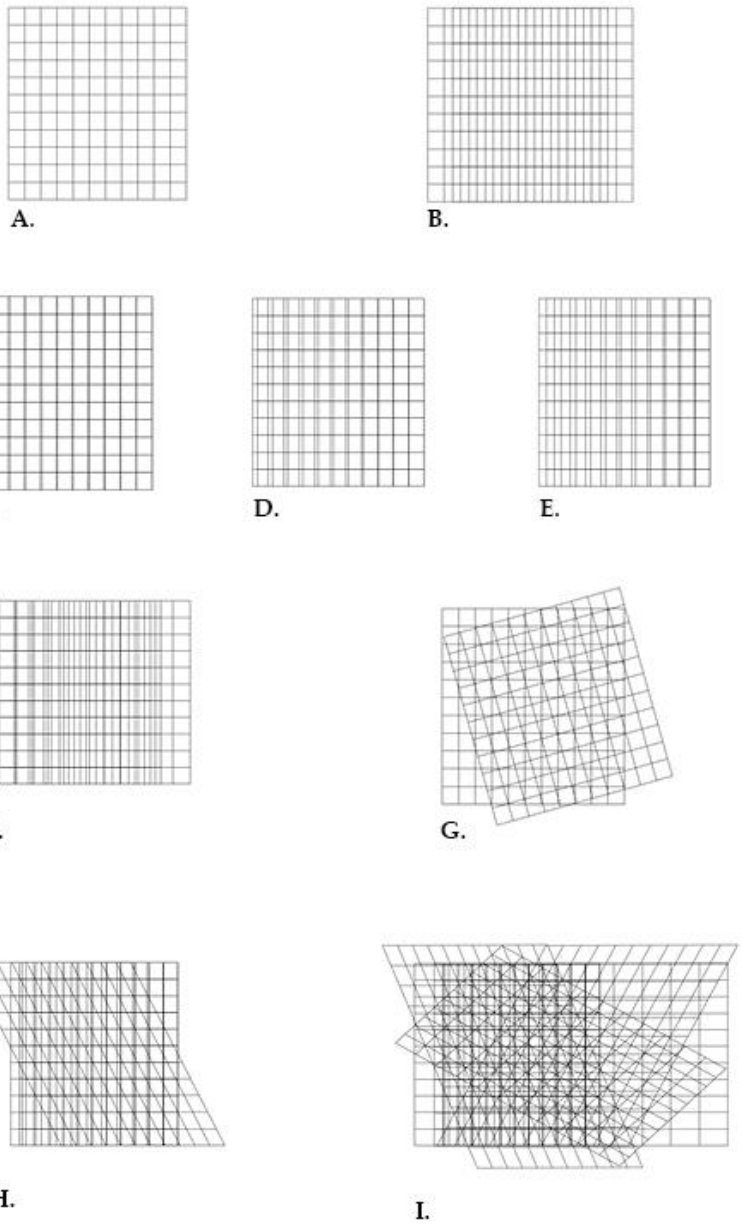


Figure 20: A visualization of the raw midi data driving the two pianos.

1.3.6 On and Off the Grid in the Electronic Domain

The grid is a ubiquitous construction in the realm of digital music. Time is quantized by default in many production platforms and the grids that appear onscreen often represent the resolution of the quantization being applied. Sequencers, in particular, are usually designed to function according to a stepwise progression of time. Sequencers allow for the establishment of a sequence of control values to be sent to a device that produces, triggers, or transforms sound. I began to imagine how temporal transformations would unfold if the sequencer's steps were not regular but rather, could themselves be composed of progressive rhythmic values. Thus, rather than rhythmic change coming from the subdivisions of sounds in relation to one another, it would be directed by its immediate context, in terms of an expansion or contraction of the space around the sound. These transformations can be imagined as grids that are skewed or distorted, or as superimpositions of multiple grid frameworks.

Figure 21 (below): A sequence of transformations involving distortions and superimposition of grid structures in order to examine the combinatorial results in terms of their visual rhythm. **A.** Orthogonal grid. **B.** Two orthogonal grids superimposed, the second superimposed 50% into the second square of the first. **C. – E.** Two superimposed grids, one orthogonal as in A, above, and the second linearly compressed by increasing amounts. **F.** Two superimposed grids, one orthogonal as in A, above, the second compressed logarithmically over the first. **G.** Two superimposed grids, one orthogonal as in A, above, the second rotated in relation to it. **H.** Three superimposed grids, one orthogonal as in A, above, the second compressed logarithmically over the first, and the third skewed. **I.** Free transformation of planes.



The grid studies pictured previously are inspired by a compilation of grid structures called Grid Index (Nicolai, 2009), assembled by sound artist Carsten Nicolai. Nicolai, under his stage name Alva Noto, conceives musical time in terms of "grid-size rather than tempo"(Darton-Moore, 2018). It is fascinating to imagine the complexity of the superimposed grid frameworks in the images above mapped into the time domain of music. I began to experiment with this possibility through the spatial interface of an electronic music sequencer.

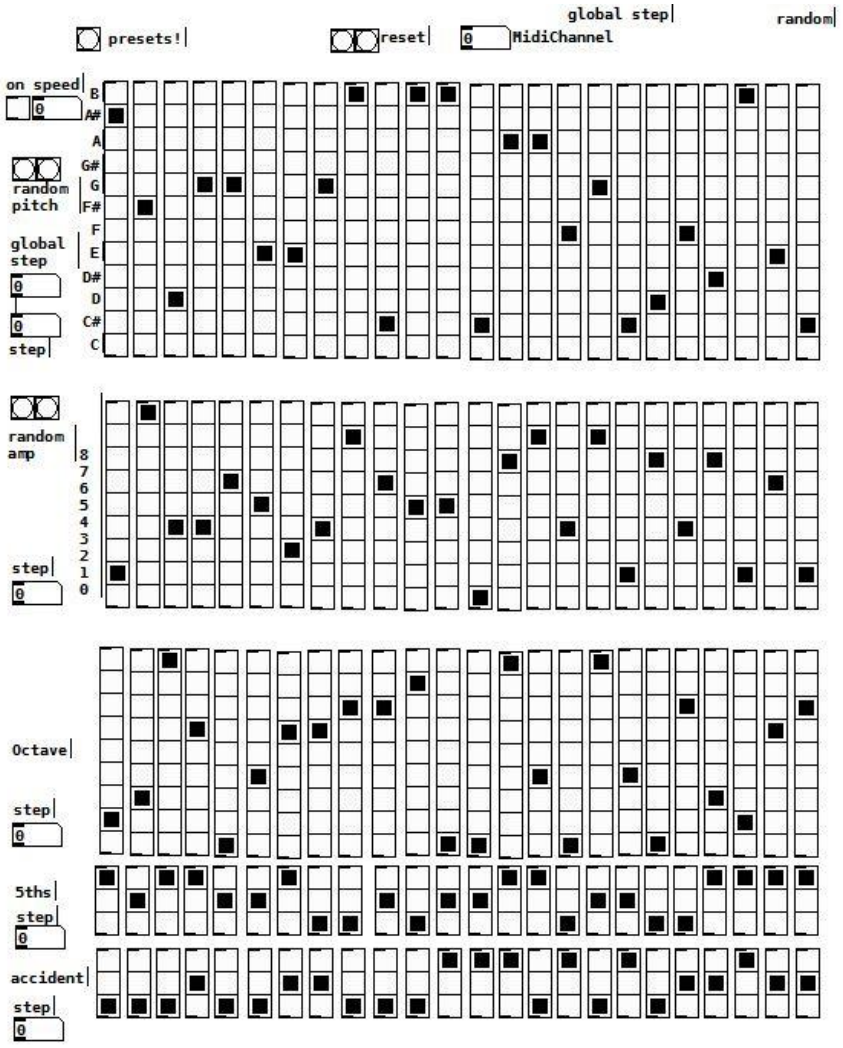


Figure 22: The control interface for the sequencer that I designed and used in *Unnatural Processes* and *Unnatural Habitats.* Though the interface appears grid-like the functionality of flexibly altering step sizes and loop lengths was a design priority.

To experiment with this directly, I began designing digital sequencers in Pure Data (Pd) to control synthesizers. As in most sequencers, the device I developed allows for quantization of time steps and sound parameters. On the left side of fig.22 and moving

downward, there are blocks of transformative processes that have to do with pitch and amplitude (pitch, volume, register, and accidentals), each of which can have its own period of repetition. These processes are sequential, superimposed on one another in manner of diagonal metamorphism. Time runs along the x-axis and precedes by discrete steps. Each step results in the output of a pair of midi numbers, one for pitch and the other for volume. What is different about my sequencer is that not only can each of these cycles of parameters have their own periods, but the length of each subsequent time step may be changed. I can establish and modify changing rates of change, for experimental listening or in live performance. Furthermore, any of these factors may be randomized. These sequencers make it possible to establish and transform temporal grids while listening to the results in the moment the change was made.

The first of my sequencer-based performance systems was developed in 2015, for a workshop in which composers Peter Ablinger and Winfried Ritsch brought Ritch's RHEA robot piano system to the University of Huddersfield. This project provided the first opportunity to use the sequencer I was developing outside of the studio, and also my first experience in controlling a live acoustic instrument with a computer. Originally, this tool produced only two numbers at a time, representing pitch and volume. However, the variable rates of change of each stage within the sequencer, controllable according to any logic whatsoever (to include chance) gave this tool a great deal of versatility. The elasticity offered by the system can be heard in the second movement of *Unnatural Processes* in which multiples of a single motive are transformed in real time by changing grid size (number of steps in a phrase) and time step size (pulse). I performed all three movements of *Unnatural Processes* live by interfacing my computer keyboard across a network to RHEA, who then played the piano keyboard with an array of servo motors stimulated by microcontrollers. The performance follows a scored part and requires the performer to initiate, fine tune, and react to results of robotic processes set in motion.

Peter Ablinger's interest in the nature and perception of musical time (2006, 2011), encouraged me in this project. His use of metrical and temporal plasticity in pieces such as *Augmented Study* for 7 violins, and *22 Kanons Fur Peter Lackner*, both from 2012, exemplify his

solutions to working with transformable temporal frameworks. The straightforward appearance of the notation, grid-like in aspect, belies underlying alterations in temporal reference points that result in abundant variety. Finding these works to result in similar experiences to those I had in mind when developing *Unnatural Processes*, I set about searching for other composers working with quantized temporal frameworks that yield smoothly curved experiences of time.

In pieces like *Madrigale* (1979), and *Concerto (*1975), Aldo Clementi reveals a very personal approach to designing with musical time. Gianluigi Mattietti points out that the *Concerto* not only slows, but that the texture simultaneously thickens as the piece progresses (2011). For the listener, both of these pieces thicken in terms of memory as iterations accumulate. In combination with the slow deceleration in some of Clementi's works, a progressive physicality is sensed as the pieces come into being over time.

Morton Feldman employed grids both as notational devices, and as compositional tools. However, the qualitative experience of listening to Feldman's music, especially his later work discussed here, contrasts with the quantization implied by its grid-like notational image.[8] Time in these works loses objectivity and becomes something felt by individual listeners, like a thick, humid quality in the air. A first glance at *Crippled Symmetry* (1983), for example, lends the impression that the notation is straightforward. However the regularly spaced appearance of the notes on the page belies a wealth of experiences for an active listener in response to this music. One such experience is the shimmer that seems to arise from the surface of the sound. The shimmer occurs when two or more timbre-pitch aggregates, often two or more different instruments, elide. The shimmer is not located in the score, but rather in the coincidence of particular musical moments, when it is noticed and attended to by an individual listener.

[8] In early works like the *Intersections (1951-1953)*, Feldman used graph paper, however, I focus here instead on works that *appear* grid-like, while neither functioning or sounding grid-like. It is also the case that *Vertical Thoughts 1-5* (1963) and *Last Pieces* (1959) employ notation that is anything but grid-like in appearance.

Although this experience seems highly subjective, I encounter it most often in pieces like the aforementioned *Crippled Symmetry* in which Feldman establishes individual temporal frameworks that exist simultaneously in the same piece. This suggests that a material basis for the shimmer resides within the uncertainty that accompanies these ambiguous time constructions. In other words, Feldman's ambiguity creates the conditions by which a listener constitutes the shimmer. Musicologist Tom Hall (2007) proposes that the grid-like notation in Feldman's later work has a meaning beyond its appearance, citing works like *Triadic Memories* (1981), and *For Samuel Beckett* (1987). In these works, the grid-like appearance of Feldman's notation reinforces the presence of a time standard for individual performers, a temporal referential frame which a performer must adopt to play their part. However, composing a coincidence of independent grids offset from one another destabilizes a listener's temporal frame of reference and perceptually liberates the whole from a metric standard. This is very close to the ideal I hold for my own recent works in which multiple temporal grids or simultaneous time frames are employed.

1.3.7 Not Static

Descent From the High Arches and the Bog Chorus (2016) is a quartet for four temple blocks and sine waves. The title refers to *The Descent of Man* by Charles Darwin (1981), the wood-like "singing" of frogs around ponds in northern California, people who sing in toilets, and the *High Arches*: an appendicized improvisational work. A Pure Data patch acts as both score and instrument. The quartet gathers in a semi-circle around a single computer that simultaneously provides the players with performance information and generates the synthesis that accompanies them.

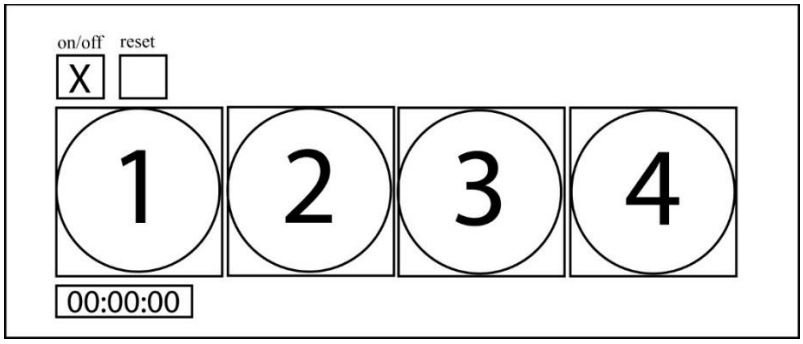


Figure 23: A schematic of the interface as would be viewed by performers in *Descent from the High Arches and the Bog Chorus.*

In *Descent*, simultaneous stasis and movement is embodied in the process and experience of performance. Each of the four performers plays a temple block. Each of these parts is linked to a sine wave. The sine waves trace up and downward pitch trajectories for the duration of the work. At the same time, blocks are struck at continuously changing rates, which articulate, in proportionally scaled down form, the activities of the sine waves that each performer's part is tied to. The frequencies of the sine waves, and therefore the tempi of the performer's articulations, articulate the form of the piece, and are shown below.

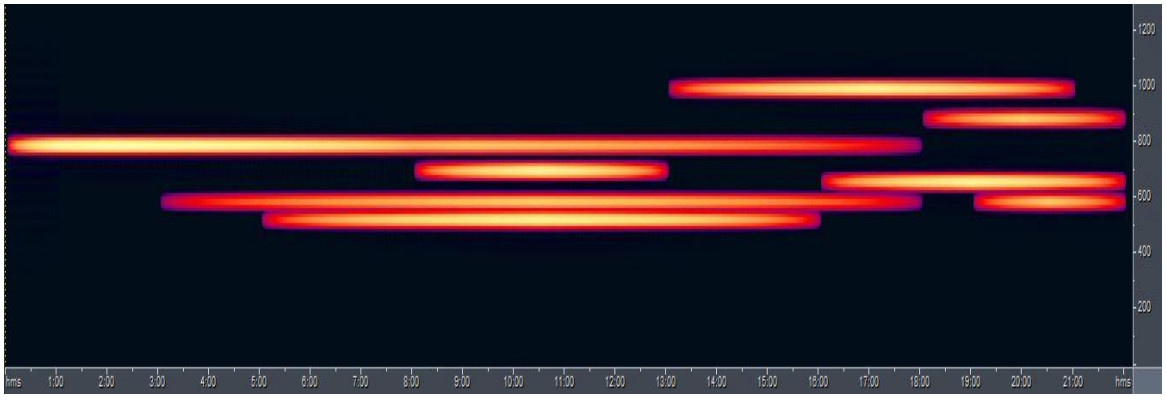


Figure 24: Spectrograph of sine waves from *Descent from the High Arches and the Bog Chorus.*

The piece develops two aspects of *In Warmer Seasons*. The first aspect is the formation of perceptual wholes in disagreement with the physical mechanics of sound production. The second concerns the use of shifting tempi and the effect of this on qualitative temporal experience. As is the situation with *In Warmer Seasons*, where each performer plays along to a click-track in a constant state of change, in *Descent,* the performers utilize a constantly shifting visual metronome (fig.23), and cannot predict the

exact duration between events. Instead, they find themselves increasingly glued to the present in its moment of becoming.

Composer Jennie Gottschalk (2016) discusses simultaneous movement and stasis with respect to the well-known *waterfall illusion*.[9] Gottschalk makes reference to a "veiled grid" against which perceptual processes play out (Gottschalk, 2016, pp.137-139). Gottschalk compares the simultaneous sense of stasis and motion in composer Bryn Harrison's 2009 work *Surface Forms (repeating)* to the painting practice of James Hugonin, whom Harrison acknowledges to be an influence. In Hugonin's work, a grid forms the ground for emergent experience between his work and the viewer in which:

> It becomes possible for random movement to evolve and occur within the rectangle. It is the reflected light pulsating from adjacent colours that creates an indeterminate and unpredictable colour field emanating light. Nothing dominates (Hugonin, in Harrison, 2007, p.84).

That the use of space-like, quantized standards of measurement, like grids, can be manipulated compositionally such that they function to frame the qualitative and constantly fluctuating shimmer of experience is a key insight from my research period. It is precisely this quality that makes reference systems, be they metronomes, grids, or bodies, fascinating for me in my recent work. In viewing the grid-like work of Agnes Martin, who has stated that "the value of the art is in the observer" (Martin, in Morris, Bell, and Martin, 2015, 31) or the mirrored cubes of Robert Morris (that reflect and include the spectator as participant in the work), the entire ambient life of the space one shares with these works is offered back to the audience for participatory perception. Listening to my recent works is a chance to experience time through them, and, through their re-sculpted temporal frameworks, what they offer back is a field of possible points of reference by which to experience listening and reflection.

[9] A good discussion of this illusion can be found in "Waterfall Illusion" Macpherson and Baysan, 2017 from the Illusions Index published by the Centre for Perceptual Experience at the University of Glasgow (Macpherson and Baysan, 2017).

1.4 Indeterminate Processes

The techniques discussed in the previous two sections result in largely deterministic musical processes in that running the same operation with the same input material results in the same material output. However, what makes these processes interesting for me in terms of my research work is that, perceptually speaking, they are indeterminate. Thus, indeterminacy drives the phenomenological inquiry that I have been discussing throughout this commentary. However, in contrast to the previous two sections, the present focuses on how I create situations of indeterminacy within my recent music. Here, I focus on the use of chance processes and unstable materials, beginning by discussing how chance is applied to the large-scale formal structure of some recent pieces, before moving inwards towards three specific species of chance that I apply to generate or transform sounds.

1.4.1 Environments and Chance: Large-Scale Form

Whether composed to be presented linearly in a concert setting or instead, to be installed in an exhibition context, I view the interaction between a listener and sound to be an environmental encounter. In my recent work, I consider large-scale form to be environmental in nature. Thus, ideas from complexity and systems theories have been very influential to the consideration of form in my recent pieces.

Based on notions of environments that either lack a central organizing force or develop such a force from their own internal interactions, I have prioritized autonomy in the composition and arrangement of my musical textures. By autonomy, I refer to sound textures designed independently from one another, with their own internal processes, causal relationships, and sonic identity. These are juxtaposed together in montage-like arrangements in time, yielding unforeseen interactions and listening situations. In this way I sought to build or allow form to assemble itself, from material interactions. Some methods undertaken in different portfolio pieces, and their results, are discussed below.

Film director David Lynch has stated "contrast makes things happen" (Lynch, in Chion, 2006, p.5), and in my recent works, contrast provides a motivating formal catalyst. However, it is also an experimental catalyst, asking the question: "what does contrast provoke?" Thus, in my montage-like assembly of contrasting textures in recent works like *Island in Natural Colours*, *In Warmer Seasons,* and *Abiogenesis Begins on the Road to Nowhere* experimental discovery of unforeseen outcomes from material interactions has been a compositional priority.

In *Abiogenesis*[10], a multi-media work, the juxtaposition involved visual and kinaesthetic senses in addition to audio. Artists Jakub Grosz, Pascal Silondi and I created an immersive projection and virtual reality environment. The visual materials provided control values, altering the production and spatialization of the electronic sound textures and behaviours I composed, while also reacting to the behaviour of the sound environment. In *Island in Natural Colours*, a fixed media sound environment, synthesizers based on those I created for *Abiogenesis* are juxtaposed with field recordings and spoken texts. Each texture has a strong internal identity, in terms of both sound and temporal behaviour. The collective arrangement of these sound textures is based on the structure and behaviour of the textures themselves, rather than being composed to suit an imagined teleology for the whole. Here the notion mentioned previously, of environments as individual entities in a space collectively defined through material interactions, is advanced for the purpose of observation and testing. In this fashion, the form of the work becomes contingent with the interactions of visitors and the internal behaviour of the system itself.

Form composed of juxtapositions of independent elements recalls Max Ernst's collage work, or Comte de Lautréamont's celebrated description of a young boy as "beautiful as the chance meeting on a dissecting table of a sewing machine and an umbrella" (Lautréamont, 1994, p.193). The component structures involved in Lautéamont's image: umbrella, sewing-machine, and dissecting table, possess high degrees of autonomy. Their manner of interaction is significant: a "chance meeting," yet within the analytical context of

[10] This work is included as an appendix to my portfolio.

a dissecting table. Framed so by Lautréamont, a new form emerges from the juxtaposition of these autonomous entities. Behind the foreboding image of dissection, Lautréamont encodes a challenge to the reader: what would an analysis of this synthesis reveal? Despite the independence of the parts, the image's formal unity only speaks as a whole.

My trio piece *In Warmer Seasons* presents itself as a monad, a dyad, or multiplicity of autonomous entities, depending on the perspective of a listener. This piece is structured in a manner that bears a strong resemblance to a description by architects Mark Wigley and Philip Johnson about a work by their colleague Bernard Tschumi: [11]

> The basic principal of the project is the superimposition of three autonomous ordering systems…. Independently, each system begins as an idealized structure, a traditional mechanism of order. But when superimposed they sometimes produce distortion (through interference), sometimes reinforcement, and sometimes indifference. The result is a series of ambiguous intersections between systems, a domain of complex events, a domain of play, in which the status …[of] traditional composition is challenged. Ideals of purity, perfection, and order become sources of impurity, imperfection and disorder. Each system is distorted by the conflict with other systems but is also distorted within itself (Johnson, Wigley, Museum of Modern Art, 1988, 92).

The three performers of *In Warmer Seasons* are asked to perform notated material against individually and constantly shifting reference tempi delivered via click tracks over headphones. The performers struggle to accomplish a task that has a limit of precision at infinity and must determine an appropriate strategy for this. The performance results from a mediation between the written material and the performers' individual and collective interpretations as to how they will approach the situation. Each well-rehearsed performance will be similar but will result in different details of superimposition, a serendipitous coincidence of textures following their own trajectories. The large-scale form of *In Warmer*

[11] The project referred to here is a design for a public park development in the Parc de La Villette, Paris, France which Tschumi worked on from 1982-1985 and was awarded first prize in international competition.

Seasons is collage, but in the sense of some of Hans Arp's paper collage's it is "ordered, like nature, according to the laws of chance" (Arp, 1948,40).

I have also taken inspiration for indeterminate material processes in sound from the field of geomorphology. In the formation of landscapes, minerals aggregate or melt together, break apart, dissolve, decompose, invade, interrupt, or intrude on one another, form clouds of independent particles, or crystallize under pressure. In my music, material relationships concern degrees of fusion or resistance between sound textures. Fusion of textures is synthetic with a new sound emerging from the components, while resistance to fusion results in multiple sound trajectories occupying a shared space. The notion of environment as collections of largely autonomous entities in process is relevant to geological environments, the environments we encounter in daily life, and the environments I compose in my recent works. Furthermore, consideration of the form of a work in environmental terms suggests the perceptual mode by which it is apprehended. I leave the outcome of interactive meetings between sounds and textures open in order to explore this.

Clearly, sound installations involve different modes of attention and listening than works composed for concert performance. Installation works encourage a visitor to approach them in a manner closer to how they approach other environments. This contrasts the special environmental situation of concert music which comes with its own frame of expectations and assumptions as to how time and works can unfold. Rather than be presented with a designed situation in which most questions have been accounted for, I, as an audience member, want to be presented with unpredictable and even surprising circumstances.

Installation works offer the possibility, for the moment, of greater freedom of design as to how the context of presentation is situated. In fact, a traditional concert hall presentation could be described as a special case of a sound installation. In some of my recent works, abandoning the need for visitors to arrive before sound begins and stay until the end before leaving has allowed me to design events that can be both composed and experienced in environmental terms.

Islands and *Abiogenesis*, discussed above, are both installation environments. However, the concerns addressed above are also relevant in consideration of my recent concert performance works. With *Magnetic Arch* (2017), I explore interactions between related textures whose superimposition results from independent decisions made by performers. *Magnetic Arch* is a piece for any number of string players. Each plays a part that is similarly structured, while completely diverging from one another in specific details of tuning and duration of events. Initial decisions being taken, each part then describes an "arch" based on the instructions in the score. The overall form of the music is therefore a sum, or better a Bergsonian "interpenetration" of these superimposed arches.

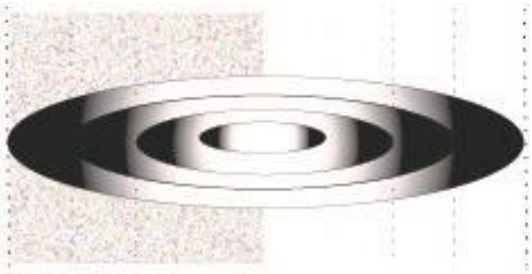


Figure 25: A mnemonic device from Magnetic Arch.

I have applied chance juxtapositions in the large-scale temporal structure of several recent works in order to askew spatialized formal shapes in favour of a process-based dynamicism. Describing the overall form of a work requires stepping outside of the continuity that the piece exists in and applying symbolic language to it. In doing so, people often apply spatial metaphors, describing the work in terms of shape (as, for example, in the case of an "arch"). However, if the shape is different each time the piece is enacted, the experience cannot be reduced to a description advanced beforehand. Chance-derived approaches to form thus create conditions for experiencing encounters between material processes, at least for devoted listeners, as suggested by Hans Arp:

> The artist must let the work create itself directly….My reliefs and sculptures fit naturally into nature. On closer examination however, they reveal that they were formed by human hand, and so I have named certain of them: "Stone formed by human hand." I further developed the collage by arranging the pieces automatically, without will. I called this

process “according to the law of chance.” The “law of chance,” …embraces all laws and is unfathomable like the first cause from which all life arises, can only be experienced through complete devotion (Arp, 1948,70).

1.4.2 Creating Indeterminacy in My Compositional Material

I use chance within material processes in three related ways. The first takes the form of variables that are filled with random values as is the case in *Unnatural Processes* and *Unnatural Habitats*. Another is my use of unstable processes or materials that produce complex or uncontrollable results as exemplified in *Circular Bridge Squirrel Walk* and *Magnetic Arch.* The third species of chance process I use maps the structure, flow of information, or data from one system onto another.[12] The arbitrary nature of the act of mapping information from one system onto a separate musical system can result in a suspension of musical logic or causal relations between sounds, while retaining traces from the sourced materials. The result of this type of process can be heard in *Island in Natural Colours* and *In Warmer Seasons.*

There is difficulty in separating these three species of chance from one another, or in defining chance objectively. Tautology is found in nearly every attempt at definition. Philosopher Antony Eagle refers to circular definitions of chance and randomness as the Commonplace Thesis where "something is random if and only if it happens by chance" (Eagle, 2018,1). In practice, randomness is usually defined in strongly anthropocentric terms, as that which exceeds human capability for prediction (Haarh, 1998). While this definition might serve to fulfil immediate tasks such as generating unpredictable streams of numbers, it does not guarantee that results are free of pattern or structure. My use of a particular species of chance for a specific musical application addresses the need I have identified in each musical situation.

[12] By system I refer to any group of interconnected processes forming a whole. This is at the heart of the definition of systems as adopted by the developers of system theory as “a set of elements in interaction” (Bertalanffy, 2015 19, 83).

I often use algorithms for randomization when faced with a structure which I want to render progressively more or progressively less well defined. This occurs in the opening of *Unnatural Habitats,* in which progressive peeling away of layers of randomized variables reveals a well-established rhythmic and harmonic substrate. I also use randomization procedures for variation. When, for example, the five synthesizers in *Island in Natural Colours* move from one defining fundamental to another, they all move from the same starting to the same ending frequency. However, the exact steps they take, and the time it takes to make them, follows a random walk, lending variety to what might be a repetitive interpolation.

Instability, on the other hand, functions to offer a direct and physical experience of chance as a mediator between a performer's activities and the behaviour of the sound production system involved. This is the case in *Magnetic Arch*, for example. By contrast, in *Circular Bridge Squirrel Walk* material instability provides a situation in which to make discoveries.

The final species of chance used in my recent work involves mapping information or structures from one system to another. Specific mapping methodologies vary widely in different pieces, and examples are detailed in the sections to follow. In general, while offering degrees of unpredictability, mapping also invites semantic and conceptual engagement between mapped systems, as new results often bear traces (causal, material, or even metaphorical) of the parent signals.

Specific applications of each of these categories of applied chance in my recent works are discussed in the sections to follow.

1.4.3 Indeterminacy in My Compositional Material: Randomness

In working with random number generators, the situation must be composed such that the desired range of variability is in the intended places. After considering what generating mechanism will be used, and what operative definition of randomness is to be adopted, I then compose a trajectory for the random distribution for the texture under consideration. For example, in the opening of *Helical Pastimes*, a complex knot of sound trajectories slowly gives way to a single thread. This occurs by a simple reduction, discrete but gradual, in the number of random decisions being taken as regards the sound produced. Later in the same piece, the tempi of the six synchronized sequencers are varied by increasingly wider amounts, to the point at which they eventually drift apart. This is achieved by gradually increasing the threshold of possible values for tempo at its upper limit.

When people think of randomness, they often think of processes such as flipping a coin, or rolling dice. The founders of the science of probability began with speculations along similar lines.[13] Such processes generate unpredictable results within a specific range of values. Sometimes however, the way the system is set up may render predictions possible in the long run, which can be useful for composing convergences or tendencies into randomized situations. To use dice as an example: the result of each roll is unpredictable in the short term because each roll exists independently of every other, resulting in the expectation that over many rolls each number 1-6 occurs 1/6th of the time.[14] However, if multiple dice are rolled and their sums are taken, the results can be predicted to a greater degree of certitude in the long run because there are more ways of achieving some values than others.[15] Thus, rolls of dice are both predictable and unpredictable.

---

[13] Gerolamo Cardano wrote a book about games of chance in 1564 (published 1663), Cardano's theories are summarized in Bellhouse (2005). In 1654 Pierre de Fermat and Blaise Pascal developed a correspondence concerning how to divide the stakes of winnings when a game is interrupted prematurely (Aldrich, 2012).

[14] This is called the law of large numbers for fair dice.

[15] Increased predictability is given by summing the results of rolling two dice. With two dice, there are six ways of generating a result of the value of 7 (by rolling (6,1), (5,2), or (4,3) and their inversions)

Compositionally, such situational dynamics can be desired randomized trajectories in a given texture. To return to the opening of *Unnatural Habitats,* random processes influence frequency, wave shape, amount of modulation, centre frequency of modulating wave, and centre frequency of filters for each of the six individual polyphonic synthesizers. This is achieved through input to each parameter of scaled random variables, from fields of possibility representing a composed trajectory over time. However, at the opening of the piece, the random number generators are refreshed with each new decision, without history, as if each moment existed without reference to any other. Based on my intention of opening with a symmetrical field, in which any future possibility is equally probable, I establish no trajectory for the sounds or processes opening the piece. Left in this state, they would continue to produce new combinations of randomized behaviours. I break this symmetry as the music progresses by inputting converging values to these random number generators. Thus they adopt an overall direction, converging to unity over time. In this way I can compose a gradual aggregation or dissipation over time by slowly scaling values, narrowing or widening the pool of possibilities available. The results will be different, but similar, for each performance.

The sequencer which drives the synthesizers in *Unnatural Habitats* was first prototyped for the piano playing robot in my piece *Unnatural Processes*. In the first movement of this piece, random values control specific amplitudes with which individual piano keys are repeatedly re-articulated. This was arrived at through imagining the surface of a pond that becomes gradually more agitated by falling drops. Watching a pond as a storm gathers, the first raindrops are seen to result in calmly spreading waves on the pond's surface, with the waves echoing back from the sides of the pond as it provides feedback, in the manner of resonance. Should the magnitude and frequency of the falling drops increase past a critical threshold, the pond, based on its size and the surface tension of water, would

---

but only one way of generating a 2 or 12 (through rolling a (1,1) or (6,6), respectively). Thus, with two summed dice the overall result of 7 has a greater probability of arising than any other. This differs from the uniform distribution found with a single dice where each roll offers a 1/6 chance of coming up with any number 1-6.

transition to a more agitated state. In my piece, the feedback mechanism is the physical resistance of the sound production mechanism of the piano combined with bandwidth limitations of data processed by the computer that controls the robot piano player.

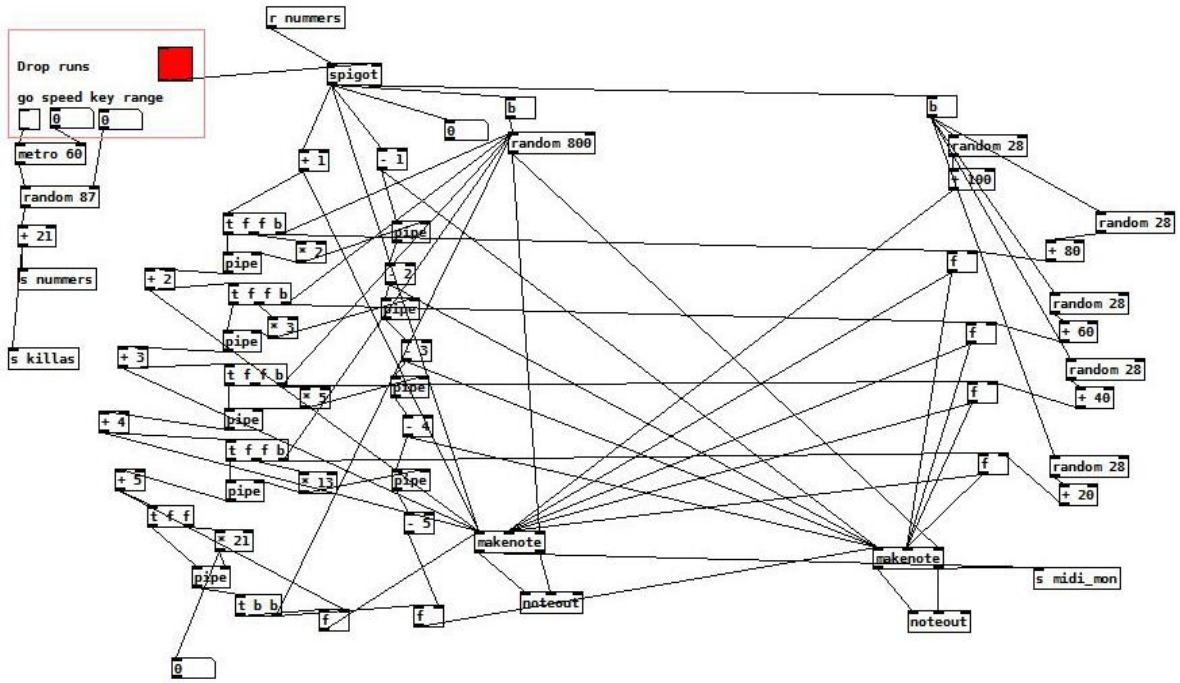


Figure 26: "The Drip" a part of an early version of the software for performing *Unnatural Processes*. The Drip uses random number generators to determine pitch, duration, and amplitude of output midi notes from set fields of possibility.

1.4.4 Indeterminacy in My Compositional Material: Instability

In recent pieces, I have refined methods of working with unstable systems, a central aspect of my ongoing practice. Working with instability, whether in process or material, encourages a prioritization of experimental inquiry over the perfection of design ideals.

In *Magnetic Arch*, highly amplified performers use a technique of exaggerated but very light ponticello bowing. For the most part this produces a broadband noise. Occasionally, however, harmonics reinforce themselves in the production of a sustained tone. Such tones arise out of a complex relationship between the environmental conditions

of the room and resonant body of the string instruments, along with variables such as bow speed, pressure, and position. While it is possible for performers to provoke the harmonics, such activity is antithetical to the piece, and a performance where no harmonics emerge could still be a successful performance. Performers are, however, instructed to attempt to maintain these fragile harmonics if they arise. They collapse easily when the bow direction is changed or where any significant change in sound production occurs, and so performers maintain them by attempting to hold their bodies, instrument and bow in a stable and consistent position, while continuing to play. Micro adjustments of bow angle and position are allowed, but what is most important is that the mind remains stable.

The situation is intensified by the presence of an electronic system that augments the relationship between performer, instrument, and performance space. This system compresses and amplifies the performance to a point at which the signal is distorted, at a volume just below feedback. This has the effect of magnifying instabilities and increasing the likelihood that harmonics will be reinforced. Such magnification brings into focus the paradoxical situation around how sound is produced in the piece. Performers exist suspended between stability and instability, concentrating on the cusp of each changing moment.

In *Magnetic Arch*, instability is located beneath the fingers of a string player, and tightly wound around their relationship to their instrument and the sounding environment. Here instability is mediated by the performer, but also mediates the work of the performer. This tensely concentrated situation of a performer within a network of interacting processes results in emergent sounds, and takes inspiration from brainwave-driven pieces developed from 1965 to 1977 in the United States. *Music for Solo Performer* (1965) by Alvin Lucier, *In Tune* (1966-74) by Richard Teitelbaum, and David Rosenboom's *On Being Invisible* (1976-77) highlight technical and philosophical issues regarding the nature of performer, instrument, and environment when approached as a networked system. In each of these pieces, an attempt is made to locate the interface between the performer and the sound production system at a pre-linguistic level. In these works, the composers used biofeedback sensors to measure brain activity to which the instruments respond, requiring performers to

concentrate or introspect in specific ways in response to the emerging sound situation. In *Magnetic Arch*, performers create a sound which feels to be not entirely in their control, however as the piece progresses performers come to feel that the issue of control is very subtle and mere changes in attitude are enough to enact changes in the sound produced. Actively apprehending the sound on an intimate scale as it comes into being, performers become both active listeners and creative participants in their unfolding experience.

David Rosenboom's work philosophically parallels my own interest in "the spontaneous evolution of musical forms" (Rosenboom, 2012). His work with bio- and neurofeedback began in the same period as Lucier and Teitelbaum's and continues into the present, focusing on the emergent nature of musical form, and on the "various states of awareness and consciousness associated with musical performance"(Rosenboom, 1990, pp.48-66). This ethos is represented in his solo performance work *On Being Invisible*, described as "the use of improvisation as a form of self-experimentation"(Doyle, 2003).

In *On Being Invisible*, Rosenboom performs a variety of instruments while his brainwaves are analysed by software which compares his brainwave data with the musical activity in the room to create an evolving algorithm resulting in correlative musical material (Vales and Thurtle, 2005). In a manner similar to how I would describe *Magnetic Arch*, Rosenboom describes this as "a self-organizing, dynamical system, rather than a fixed musical composition" (Rosenboom, 2000). In Rosenboom's work as in my own, unstable systems offer an experience of structural emergence from complex interactions:

> It is an essential characteristic of all parts of this piece that the performer constantly rides a borderline between being, on the one hand, an initiator of action and, on the other, submerging him/herself in processes larger than him/herself. This requires that the performer become adept at manipulating his/her state of consciousness [and] application of wilful actions…(Rosenboom, 1984 pg.8)

Feedback both supports and constrains the performance system of *Magnetic Arch*, and *Circular Bridge Squirrel Walk*. In *Squirrel*, the sounding production system is a feedback

loop in which the viola strings are activated by both bow and transducer. The signal that excites the transducer is the signal of the performed viola itself. The sound produced in the piece is an improvisational regulation of feedback by the performer, in the manner of Agostino di Scipio's piece *Modes of Interference n.2* (2006) for saxophone and live electronics (Bittencourt, 2014). Although work with unstable materials and systems ostensibly represents a small amount of my research portfolio, it is important throughout my practice. Working with unstable materials, and specifically electronic feedback, has instructed me in maintaining a balance between doing and observing. The attitude discussed as necessary for performing *Magnetic Arch* is congruent with the best approach to all my pieces: a position both active and aware, attuned to the present in all its becoming. This is the attitude by which *In Warmer Seasons* should be approached, as well as *Descent from the High Arches and the Bog Chorus.*

1.4.5 Indeterminacy in My Compositional Material: Mapping

Mapping the structure, processes, or data from one system onto another is a complex use of chance that appears in my recent work. This species of chance often includes other determinate or indeterminate systems within it, and can be used in appropriating linguistic material, or other carriers of meaning. Employing what artist George Brecht refers to as "irrelevant processes" (Brecht, 1966) produces unpredictable results, but also unforeseen associations, as demonstrated in the examples to follow. Such associations result from sound that has gained or lost context, while retaining evocative structural nuances of its former pre-mapped self. An eerie uncertainty pervades inter-mapped textures, in that perceived relationships turn out to be based on irrational grounds. The results are particularly interesting when they involve systemic or semantic feedback loops, or offer diverse possibilities for application, as is frequently found in the work of artist Marcel Duchamp.

Duchamp illustrates the principal of mapping in a 1914 note documenting a chance process that was later re-applied as a measurement standard in subsequent works. [16]

The Idea of the Fabrication

from a height of one meter on to a horizontal plane

twisting as it pleases and creates

a new image of the unit of

length --

-- 3 examples obtained more or less

similar conditions

:considered in their relation to one another

they are an approximate reconstitution of

the unit of length

The 3 standard stoppages are

the meter diminished (Duchamp, 1997, 603).

Duchamp's new meter exists in not one but three forms, destabilizing notions of objectivity. Nevertheless, this work appears pictorially within several works, [17] and was applied (if Duchamp's notes are to be trusted) as a measurement standard in the creation of works including *The Bride Stripped Bare By Her Bachelors, Even (The Large Glass).* [18] In *3*

[16] Fabrication of *3 Standard Stoppages* is itself a process providing a good example of a deliberate use of instability.
[17] The stoppages are pictured in *Network of Stoppages* (1914), and later along the lower left edge of *Tu'm* (1918).
[18] Originally fabricated 1915-1923.

Standard Stoppages, Duchamp has transposed the result of a simple action to a new context, giving it a new use that it would not otherwise have. The note above functions as a kind of score, similar to those made later for Fluxus "Events" (Friedman, Smith, and Sawchyn, 2002). Mappings are complex, different in each application, and result in unpredictable disruptions of patterns of thought and structure.

Mapping of data from one system to another has also become a standard technique within interactive arts practice. In *Abiogenesis Begins with A Single Step on the Road to Nowhere,* an audio-visual installation and performance by LIBAT,[19] mapping principals were employed to create a large-scale feedback loop sensitive to the movements and activities of the audience. Data from audience movements tracked by computer vision and sound analysis provided real time modulation affecting the multi-channel audio-visual projections we composed. Within the environment, some participants wore virtual-reality headsets. Interacting on local dimensions of the environment, they unknowingly provided control information that altered the behaviour of synthesized sound and position of the projectors in the global environment. This created an immersive experience for an audience whose movements were in part determining the behaviour of the environment they were themselves part of.

Phase vocoding, present in *Island in Natural Colours* and other recent works, extends the notion of collage in a manner most literal. In this process, two signals are mixed together into one, by mapping information from one onto the other. In phase vocoding, a signal is analysed to find spectral peaks in its frequency envelope. Data from a second signal is then fit to the spectral-amplitude envelope of the first. The process can also be run in reverse where an envelope from one signal is stamped onto another signal, in the manner of a cookie cutter. In *Island*, I used this form of phase vocoding, adopting Pure Data inventor and *Convolution Brothers* member Miller Puckette's technique of the 'timbre stamp.'[20]

---

[19] See appendix for more information. I invited LIBAT to the 2017 Electric Spring Festival at the University of Huddersfield. A week-long workshop co-directed by artists Pascal Silondi, Jakub Grosz, and myself, concluded with the installation and performances discussed herein.
[20] See Fig.27.

The timbre stamp bears a symbolic relationship with some of my recent techniques for working with acoustic instruments. For example, diagonal metamorphism, discussed at the beginning of this chapter, superimposes lines of parametric information to create a new synthetic whole. The mixing together of two sounds in phase vocoding struck me as a means to achieve a similar process, but with greater immediacy and on a more intimate scale of sound.

While the mapping between the sounds in phase vocoding procedures can be unpredictable, the relationship need not be conceptually arbitrary. In *Cartesian Birds*[21] and *Island in Natural Colours* I vocode material conceptually chosen for its potential to provoke sound-text relationships. In *Cartesian Birds,* readings from works by philosopher René Descartes include his first book, the *Musicae Compendium*, (a text on music theory that I only had access to in Latin), the *Discourse on the Method,* and *Meditations on First Philosophy*. These texts, dealing with subjects such as human nature (and animal nature), the existence or nonexistence of God, and, music theory, seemed to be the most appropriate material for a talking digital bird entity to share with visitors.

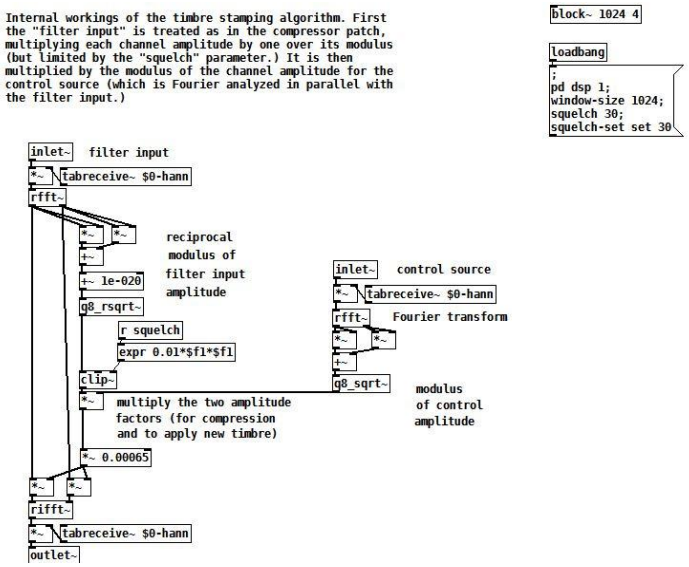


Figure 27: Miller Puckette's Timbre Stamp implementation (Pure Data, 2018).

Vocoded with synthesized birdsong at stochastically determined times, *Cartesian Birds* are visualized onscreen in the body and shifting background of a fractal generated,

[21] See appendix, and Fig.28.

birdlike oscilloscope seen below in fig.28. While vocoded materials are related conceptually, the dynamics of their sonic mapping is arbitrary, and the resulting artefacts provide multi-layered material for the piece.

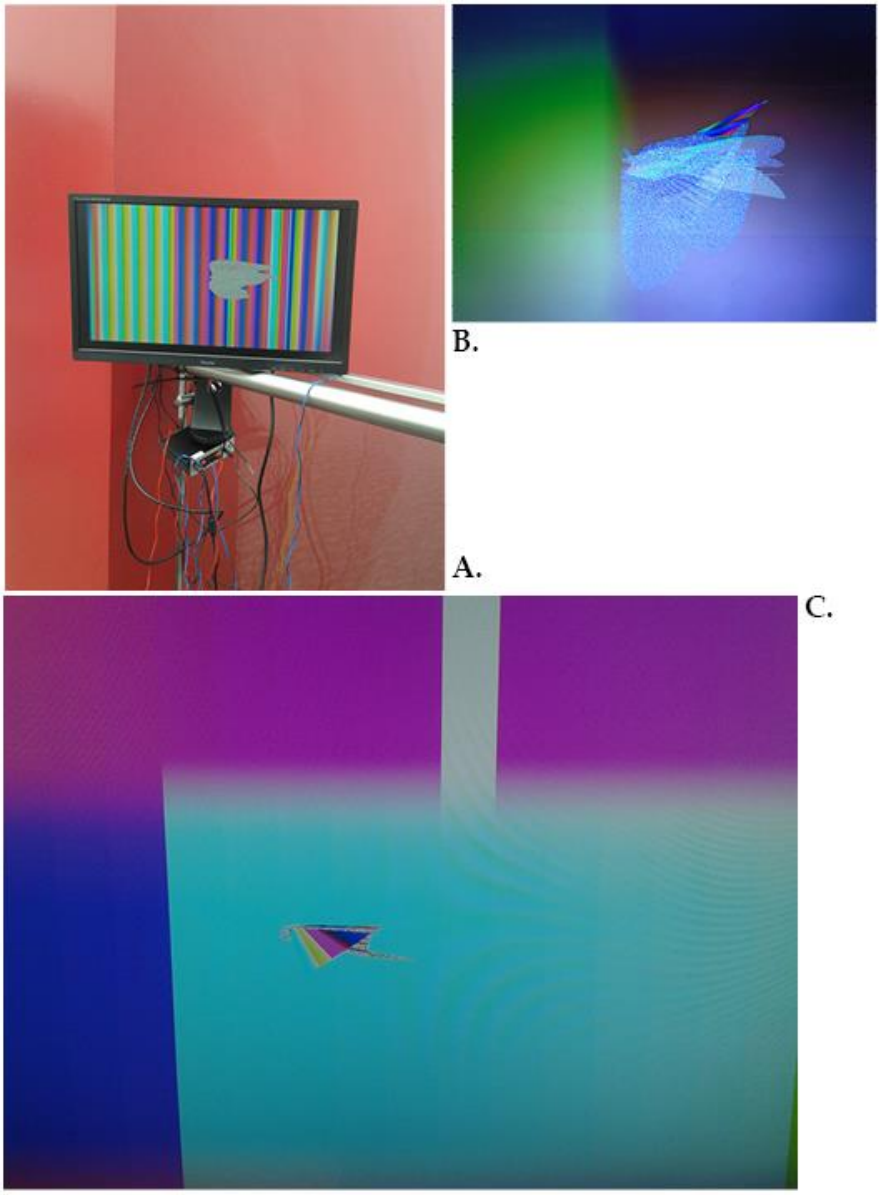


Figure 28: Installation view (**A**) and two screen captures (**B** and **C**) from *Cartesian Birds.*

In *Island in Natural Colours,* and *Unnatural Processes*, other mappings take the form of a relation between sound and a process intended to model herd, flock, and swarm behaviours. In these works, I make use of researcher Craig Reynolds' BOIDS algorithm (Reynolds,1987) to determine patterns of articulation and for spatialization of sounds. Using BOIDS, semi-independent agents can be tuned to interact with each other and their environment to varying degrees, using a large number of parameters as shown in the control panel below (Reynolds, 1987, 2001).

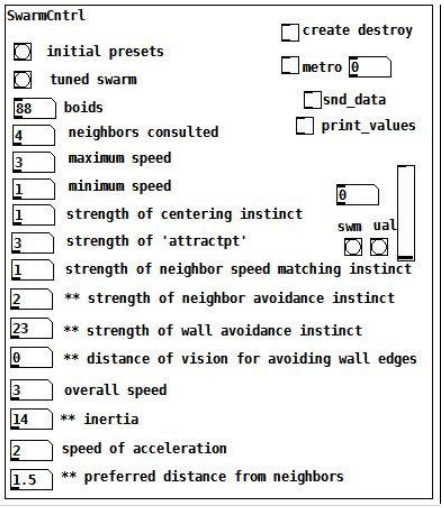


Figure 29: A control panel for Pure Data's BOIDS object.

Figure 30: A swarm of BOIDS around a moving centre point (the open circle in the upper left of image). Each dot was assigned to a single piano key.

In *Unnatural Processes*, I applied BOIDS to patterns of articulation by assigning one boid to each of the eighty-eight piano keys. The movements of each boid across a three-dimensional coordinate plane is then extracted numerically and rescaled as data for controlling the amplitude and the rate with which it's specifically assigned key is played. This represents a case of a deterministic mapping of a flocking algorithm across a piano keyboard, resulting in indeterminate behaviour of each sounding key. The performer triggers the key into action, but its specific rhythmic behaviour and volume contour will differ from one performance to the next.

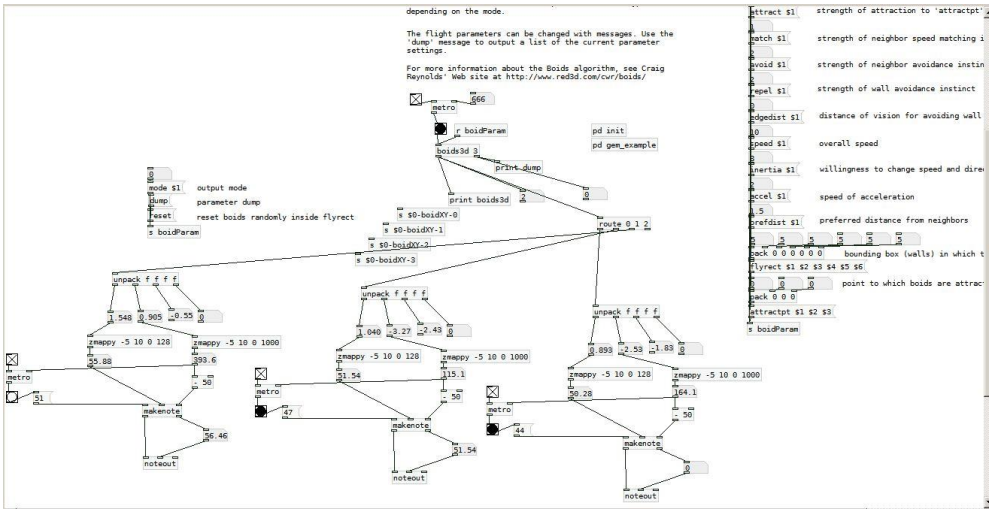


Figure 31: Extracting BOIDS data to control amplitude. In this example, only three boids are being remapped.

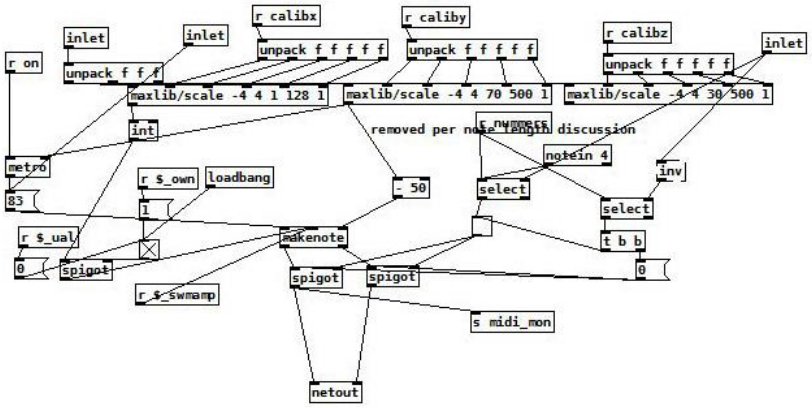


Figure 32: Remapping of data from x, y, and z axes that allows the design of amplitude and duration of a piano key (midi note 83, which is F6) with BOIDs.

In *Island in Natural Colours* and *Waterfall Effect*[22] I have used BOIDS to influence density and patterns of articulation within sound synthesis processes, while simultaneously articulating aspects of sound spatialization. In these electronic works, the BOIDS swarm not only helped me to work with masses of agents in an indeterminate sound production process, but likewise to apply this same logic to their transmission into the space shared with listeners. An explanation of how the BOIDS were linked to the synthetic systems for these pieces is included in the commentary text accompanying *Island in Natural Colours.*

Mapping also occurs in some of my acoustic pieces from my research period. The flute part of *In Warmer Seasons* consists of melodic fragments separated by irregular durations of silence. These silences are 'holes' in the fabric of the piece, and these holes provided me with a compositional problem. I wanted to keep the note values similar throughout the part, because the performer in this work must respond to a click track which is in a constant state of subtle change. However, I also wanted these "holes" to have contours that did not sound regular or metric, and the results I first arrived at lacked the character of the natural interruptions or punctures in the texture that I sought.

This problem was solved by superimposing a Hubble Space Telescope image over the notation.[23] Lowering the opacity of the telescope image to fifty percent allowed me to read notes through white spaces left by stars. After experimenting with several images I found a satisfactory distribution. A dense galactic cluster resulted in a great deal of notes being preserved, and an irregular rhythm was created from what was visible though the 'holes' in the image.

[22] This piece appears as an appendix.
[23] A tip of the hat to John Cage who, in *Atlas Eclipticalis* (1961), mapped star-chart images from Czech astronomer Antonin Becvar's 1958 book *Atlas Eclipticalis 1950.0* to musical staves to produce notation.

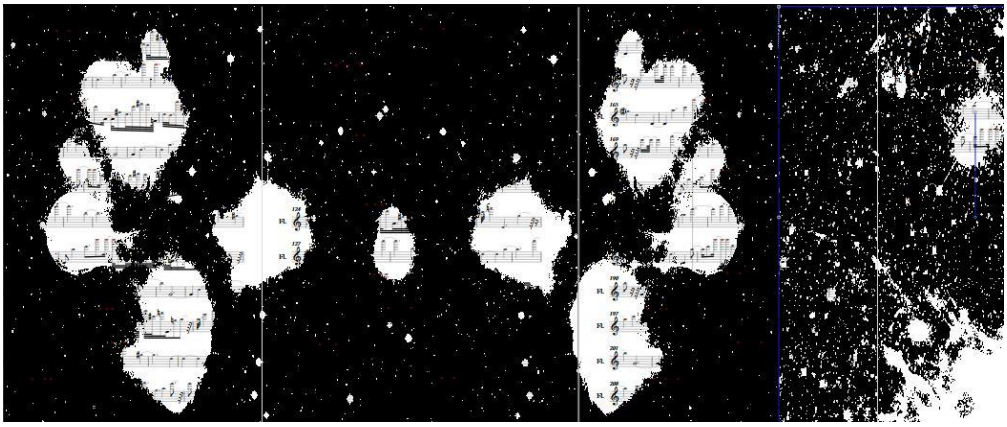


Figure 33: Galactic clusters in high contrast function as notational filters for the flute part of *In Warmer Seasons.*

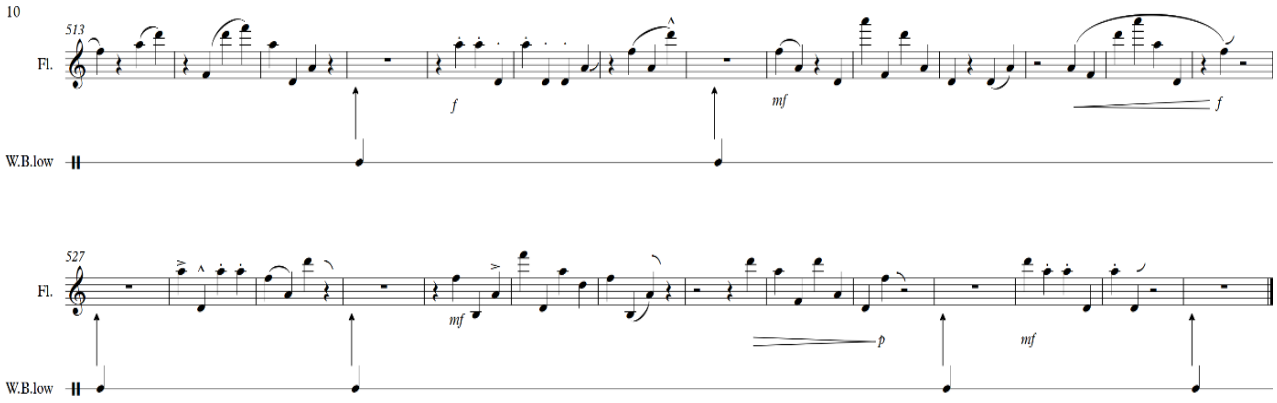


Figure 34: The end of the flute part from *In Warmer Seasons*.

1.5 We Are Involved in Our Material Processes

> The medium is as unimportant as I myself. Essential is only the forming. I take any material whatsoever if the picture demands it (Schwitters, 1921, 68-69).

The preceding discussion highlighted some of the techniques in my recent practice, and the following discusses my conceptual concerns and motivations. At root these aspects are impossible to separate. Together, and with an added catalysing ingredient, they constitute my works, which exist at an intersection between material process and ideas. The catalysing ingredient is us, ourselves as perceiving individuals, who bring our energy and freedom to our experience of the work. In closing with these two short statements by artist

Kurt Schwitters, I emphasize that while technique and material are necessary to the embodiment of our works, it is within us that the music happens.

> Merz stands for the freedom of all fetters. Merz also means tolerance towards any artistically motivated limitation. Every artist must be allowed to mould a picture out of nothing but blotting paper….(Schwitters, 1920, vol.5 p.77)

Chapter 2

Thought Processes

2.1 Asking Questions Through Material and Process

Metaphorically, the compositional circumstances of my recent musical practices resonate in the manner of a stretched string. They are anchored on one side by the subject of the previous chapter: investigations into materials and processes that I use to frame sounding situations. On the other side of the string, and in the manner of a finger, a moveable node is formed in relation to the first. This second node in my research takes the form of an inquiry into how experiences are constituted through listening. To vibrate a string, both nodes are required, and from the moment a sound is produced wood, finger, and string become increasingly entangled, inseparable. Similarly, entangled and inseparable layers of inquiry catalyse, materialize, and enable critical reflection regarding my new sounding situations.

In the present chapter, I discuss influences from phenomenology and perceptual psychology in my recent work and contextualize my music and sound art in terms of the practices of artists who explore similar intersections in their own work.

Defining the Key Themes

My recent work has emerged around a consideration of how we experience changes in musical time and texture and constitute our experiences from attention to these changes. I begin this chapter by providing conceptual background for my personal approach to composition as a form of phenomenological inquiry. I discuss the motivational role of uncertainty in my practice and establish some of the key terms for the discussion of my work: texture, framing, scale, and figure/ground relationships.

Following this, I discuss the conceptual centrality of the notion of encounter in my work, by which I acknowledge that sounds are situated through the subjective agency of listeners who constitute my pieces via their own processes of aesthetic engagement. Consideration of the compositional circumstances of such a perspective has yielded questions of a phenomenological nature, such as how we apprehend structure, and how intentionality is framed within artworks. Sonic exploration of these has led to the specific musical practices that are enacted or reflected in my portfolio pieces, discussed in Chapter 3.

2.1.1 The Subject or the Object

"The work," said artist Allan Kaprow, is "a form of investigation…and testing of reality…. a kind of ontological tool" (Kostelanetz, 1970, 104). When we listen to or look at things, especially works of art, we actively engage and participate in them, and we do this in relation to our own frames of reference. However, our experiences also result in an adaptation of our frames of reference. For example, in determining it is too dark, we light a candle. Our experience is now altered in any number of ways, not least that our ability to see detail close beside us is enhanced and our ability to see distant light is diminished. While we cannot often interact with artworks to the same degree of freedom with which we approach a dark room, our encounters with artworks are experimental, and it is we who do the testing referred to above.[24] When we interact with artworks, we are both subjects and objects of our experiences.

I have sought to posit the listener in the role of both subject and object in my recent work through the adoption of a reflective, reflexive, and participatory aesthetic. By rendering structures that are permeable to facets of their environments, and that are in some respects deliberately ambiguous, their form and structure lend themselves towards

[24] Artist Marcel Duchamp's innovative design for the 1938 International Exposition of Surrealism in Paris, in which visitors used torches to navigate, offers an illuminating precedent to some of the specifically interactive installation works of recent years (Hopkins, 2014). The installations I undertake with Libat, such as the collaborative work *Abiogenesis Begins With A Single Step on the Road to Nowhere*, (appendicized) aims to offer visitors greater freedom of mobility and behavior than they would have without the installation.

perceptual completion by listeners. Framed as such, my music and sound environments can create circumstances for phenomenological reflection, especially when interpretations differ as to the nature of the situation at hand.

A related, if seemingly opposed, situation is present when a listener is considered to possess permeable frames of reference, that can be modified by the stimuli they apprehend, entraining to the sounding situation surrounding them, with or without conscious will. Musicians seem to have attempted to 'entrain' listeners with induced emotional content since the advent of musical practice. More elusive if not more nefarious than this is the manner in which we are responsive and permeable to environmental sounds on deep levels of biological structure. Simply put, our neurological, respiratory, endocrine, and circulatory systems all have ways of falling into phase with what we hear (Clayton, Sager, and Will, 2005). This is apparently not a rare occurrence and may even be a "domain general mechanism and likely universal process in music perception and production" (Stevens and Byron, 2016). We seem to be especially good at entraining aspects of musical temporality. This has even been shown to take place cross-culturally, in contexts where music's function and temporal structures are vastly different (Drake and Bertrand, 2001), suggesting that some of the 'universals' sought by pioneers in the field of ethnomusicology (Lerdahl and Jackendoff, 1983) might be found in this area.

By contrast, my research and the perspectives presented in this text celebrate difference rather than seek universality. However, it is important to note the ease with which affect and effect, and subject and object, can switch positions in phenomenological inquiry, and that this is one of its advantages. It is such that artwork can create conditions for investigation, and that I can present my portfolio of pieces as embodied, materially constructed questions.

Rather than ask questions in explicit language, my practice is to frame an entrance to a field of inquiry that can be returned to and materially reconsidered. John Cage states "..my choices consist in choosing what questions to ask."(Cage and White, 1978, 2). In interpreting my works, it is not only me, but also the audience who must choose which

questions to ask. My project recognizes a basic uncertainty at the root of our existence as individuals and examines responses to that. The questions that inspired the technical developments that form the subject of Chapter 1 are ancillary questions to this. These questions consider the nature of subject and object in my recent work in three ways: firstly, they concern the objective ontology of material, in light of the perceptual entanglement between pattern recognition and the degree to which the recognizer forms the pattern they apprehend. Secondly, they problematize the degree to which time can be considered a subjective phenomenon, and finally, they engage issues raised by the use of chance in a context of artistic intentionality.

My recent compositions destabilize expectation by framing ambiguity on several structural levels of my music. Ambiguity is suggested in the goalless movement within sonic figure/ground as heard in *Fans of Beethoven*. Relations of scale suggestive of immersion while redirecting the listener to the sounding surface are present in many pieces, notably in *High Arches and Bog Chorus* and *Magnetic Arch*. Ambiguity confounds objective notions of time in *Helical Pastimes*, and *In Warmer Seasons*. In *Unnatural Habitats'* and *Island in Natural Colours* suggestions of pattern present incomplete or deceptive structures.

The discussion to follow explains how, in my recent work, points of view and frames of reference are suggested through the careful composition of relationships of scale between a visitor and an ambiguous situation of sound and time.

2.1.2 Texture and Tactility

According to artist Robert Irwin "Art is a non-thing. It's about feelings" (Irwin, in Feinstein, 1997). Irwin goes on to explain that what he means by feeling is part of an act of seeing. In referring to seeing as a feeling, he subtly alters the colloquial usage of the word from its emotional connotation, to its tactile sense as a verb, to feel. Irwin is suggesting that to see is to touch with the eye, and he applies a strong tactile sense to sculpting the behaviour of light in his work. Tactility lends itself even more readily to application in

sound, where membranes in our ears sense tiny fluctuations in pressure to stimulate the sensation of sound in our minds. When I speak of the behaviour of aggregates of sound in my music, I refer to them as textures. Touch cannot be separated from the time in which it is experienced, and tactility is an apt term to describe bodies of shared timbre, rhythmic structure and/or spatial or amplitude trajectory that are apprehended as perceptual wholes. My usage of the term texture adds to, rather than departs from its traditional usage in Western musicology, where it provides a qualitative measure of the internal complexity of trajectories within composed sound masses.

In discussing sound in music, sematic descriptors are often used,[25] emphasizing relationships of sounds reminiscent of language. Tactile descriptors instead emphasize sounds as immediately apprehended, as felt processes. My usage of the term texture in no way conflicts, but rather enriches previous musicological usages. By considering the tactile quality of sounds, experience of their physicality can be better discussed.

2.1.3 Scale and Figure/Ground Relationships

The notion of scale is a recurring theme in my recent work. In the third movement of *Everything is Happening at One Time,*[26] a repeated pitch motive rests on a constantly expanding temporal ground. By the end of the movement, the same sequence of pitches bears different internal relationships between its parts than at the beginning. As the piece slows, listeners simultaneously experience an expansion of the material and a sense of greater focus on the details of the individual sounds. This represents a simple case of a change in relationship of the sound structure to the scale of the listener.

Scaling always involves relations between things, a determination of how a person situates themselves in relation to a phenomenon, or within an environment. Scale functions as a perspectival lens that relates the order of magnitude a phenomenon exists at, to one's

[25] 'Phrases' for example.
[26] An early work from my research period that appears in an appendix.

own frame of reference. In *Meta-Hodos*, composer James Tenney emphasizes the importance of scale for the apprehension of continuity in musical structures.[27] Furthermore, in considering scale "in the sense a draftsman or map-maker might use the word" (Tenney, 1988, pp.18-19) composers can establish conditions, framing relevant structural regions in the work for listeners to direct their attention. For example, recognition of a returning or transformed theme in a sonata or variation form requires a combination of memory and structural listening, both focused towards the appropriate scale of sonic resolution. As Tenney points out in *Meta-Hodos*, perceptual attention shifts relative to scale. The elastic frames of temporal reference mentioned above are one way I experiment with this in recent works like *Unnatural Processes* and *In Warmer Seasons*.

Another way in which I compose relationships of scale between sound textures and listeners is through manipulation of the density of textures. In *Fans of Beethoven* the listener is presented with what seems to be a wall of noise. Upon a longer duration of listening, detailed variations can be heard. Listening into this texture by focusing attention on different parts of the frequency spectrum on different time scales reveals that rather than white noise, there are several component vibrations happening. If these sounds are recognized representationally (recordings of voices in this case), this represents a further shift in scale, from an immersive to an intimate, and finally towards an imaginary texture.

The transformations of scale discussed above in *Fans of Beethoven*, affect which sound elements claim the foreground of attention in a texture, and what becomes background. In gestalt psychology figure/ground relationships are a perceptual organization of material into a subject that is attended to, and an environmental context in which it resides (Rubin, 1915). In sound, factors such as similarity, continuity, repetition, and volume influence perception of figure/ground. Shifts in textural foreground and background can be compositionally

[27] Note Tenney also uses the term scale to apply to a range of values that describe a particular sounding parameter. This corresponds to standard musical reference to "scales of pitch." Tenney distinguishes this parametric scale, a "rank ordering of relative magnitudes of some attribute…." (Tenney, 1988, 92), from the temporal scale by which musical structures of different orders of magnitude are described.

framed through careful cross-fade and attenuation of these factors, especially when attention is directed elsewhere. These techniques are regularly applied in *Island in Natural Colours*.

While scale in my music is a function of volume, density, and duration, changing figure/ground relationships in the attentional foreground of my compositions are motivated by contrast in timbre, pitch register, volume, spatial position, and temporal envelope of sounds. Albert Bregman, the psychologist mentioned in Chapter 1 for his insightful research into sequential auditory stream perception, also discusses the vertical integration of sounds, into what I refer to as textures. Bregman's research in this area concerns the factors that facilitate or create resistance of sounds to fusion. In general, Bregman's laboratory research parallels the results of my own practice-based musical research. Vertical integration into textures occurs when sounds of complementary timbre share simultaneous and similarly shaped temporal envelopes, and occupy parallel or related spatial trajectories (Bregman, 1994a, 1994b). Likewise, Bregman points out (1994) that unsynchronized temporal envelopes create resistance to textural fusion even in sound fields of similar timbre. Consistent with my own findings, this functions to provide the subtle factor of detachment between the whole and the temporally autonomous textures within *Island in Natural Colours* and *In Warmer Seasons*.

A great deal of my structural thinking centres around composing the movement of sound phenomena across different orders of magnitude in relation to a listener. Paying attention to activity on different orders of magnitude requires that a listener adjust their sense of scale to apprehend what they hear at an appropriate resolution. By framing the activity of textures at different orders of magnitude I aim for an approach to listening that is similar to how we perceptually encounter environments in our daily lives, in which textures across different scales fluctuate, combine or separate into foreground or background, and we must adjust our frames of reference accordingly.

A great deal of the textural behaviour just described is a function of attention and how we apply it. After all, in our daily lives we regularly ignore or overlook elements within environments we encounter. However, awareness of one's own process of

perception often occurs when one's perspective must be adjusted to deal with a phenomenon of a different order of magnitude than what was previously given attention. In *Fans of Beethoven*, or *Island in Natural Colours*, changes in the scale of the predominant sounding activity render such shifts in attention likely. Conversely, their absence frames a perceptual continuity, and can facilitate the prolongations of a phenomenal moment in the experience of a work, as illustrated by my sound and video piece *Suspended Upper Bank*,[28] in which neither timbre nor volume changes significantly over the development of the piece.

2.2 Towards a Recursive Aesthetic of Experience

In a conversation in 1978 at Crown Point Press, interviewer Robin White queried composer John Cage about whether the changes that occur in the experience of an artwork over time "invalidate" the artwork, to which Cage responded "…the experience of looking can itself be used aesthetically in situations that don't set out to be art in the first place" (Cage and White, 1978, 3). Paraphrasing a statement from philosopher Henry David Thoreau,[29] Cage continued, asserting that by the act of directing one's attention to something, we transform it into an object of aesthetic consideration: "…art is everywhere, it's only seeing which stops now and then" (Cage and White, 1978, 3). Cage then stated that the responsibility for aesthetic experience is located within the will of the observer: "…music is continuous- only listening is intermittent" (Cage and White, 1978, 3).

In this short exchange, Cage proposes a re-location of the conceptual focus of artwork, moving away from a material-based, object-oriented view of art, music, and environment, and towards acknowledgement of the role of individual, subjective agents in the creation of their own process of aesthetic experience. This highlights a conceptual recursive loop at the centre of artistic, or at least aesthetic, experience: we create the art we

[28] appendicized.
[29] "…we begin to discover where we are, and that nature is one and continuous everywhere" (Thoreau, 1961, 299).

experience by the way in which we engage with the fluctuating field of possibility that makes up the environments that we are a part of.

In my recent practice I have taken the perspective suggested in the previous statements literally, creating pieces that allow for phenomenological testing of these ideas. My recent work unfolds around the experience of individuals, including myself, who encounter it. In the next section, further recursive loops are shown to be present in the creative practices of the artists with whom I contextualize my own work, as well as fundamental to phenomenological inquiry.

2.2.1 Generative Loops

In *Godel Escher Bach: An Eternal Golden Braid*, cognitive scientist Douglas Hofstadter presents the notion of strange loops, recursive networks connecting structures on different orders of magnitude. Strange loops are self-referential, yet, unlike mirrors that merely display an inverted image of what is in front of them, strange loops simultaneously create and inhabit multiple levels within the seemingly hierarchical structures that characterize their paradoxical presence. Processes that determine their own form, which in turn is the form of themselves as processes, are portrayed by artist M.C. Escher's well-known lithograph *Drawing Hands* (1948) and exemplified in the audio illusion known as the Shepard tone.[30]

A key feature of strange loops is that they suggest the presence of downward causality, a situation in which what had been perceived to be an effect turns out to be the cause of the circumstances in question. Hofstadter demonstrates the presence of downward causality in the structure of computer programs, formal logic, and in systems in the process

[30] The Shepard Tone, named for psychologist Roger Shepard, is a tone constructed of an internally crossfading harmonic sequence that suggests the sensation of continuous movement upward or downward in frequency, while in fact cycling through the same harmonic materials in sequence. This can be compared to the visual illusion of a Barbershop Pole, or the Penrose staircase.

of becoming self-aware (Hofstadter, 1979).[31] This notion presents itself in various guises throughout this chapter, as it has throughout my research work. Its has already been visited in Cage's formulation of the activity of a subject who creatively constitutes the environment they experience.

In my recent work, I have deliberately courted ambiguous readings of material relationships in order to draw forth the interpretive participation of listeners. This is intended to delve beyond the initial experience of the material I present, to result in an interpretation of listeners' own listening and interpretation. In other words, by suggesting the presence of pattern in an immediately perceivable structure, an invitation to engage in an interpretative process is begun. By composing loops and linkages within different hierarchical levels of the sound, I aim to invite listeners to a potential encounter with self-referentiality in which they become both subject and object of their listening experience. The uncertainty as to the intentionality of patterns in *Helical Pastimes* or *Unnatural Habitats*, the ambiguous encounter with the scale of sounds presented by *Fans of Beethoven, Island in Natural Colours*, or *Unnatural Processes*, and the differed pulse of *Descent from the High Arches and the Bog Chorus* or *In Warmer Seasons* are calling cards of such musical invitations.

2.2.2 Hermeneutic Spirals

The cycle suggested above is not vicious. Rather, as stated previously, it is generative. As Hofstadter discusses in terms of strange loops, creating an impredicative link between orders of magnitude of structure within perception can lead to both ambiguous causality and new states of awareness.[32] Hermeneutics, the study of interpretation, offers a conceptualisation of the situation I have been describing. Friedrich Schleiermacher was an

[31]Unlike the fallacy of circular reasoning, a tautology in which premises support a proposition that supports the premises, the multi-dimensional causality implied by strange loops makes them a necessary condition of the phenomena they support, rather than a poorly formed argument.
[32] An impredicative link is a logical notion in which a subject is its own predicate.

18th Century philosopher who described a theory of hermeneutics that functions in both a top-down and bottom-up fashion. In this formulation, understanding a text consists of understanding the parts it contains; yet the understanding of each part of text is established by its relation to the whole (Foster, 2017).[33]

This cycle has become known through the work of philosopher Martin Heidegger as a hermeneutic circle. This loop presents the ontological circumstances of the situation of uncertainty within a self-conscious Being:

> The "circle" in understanding belongs to the structure of meaning, and the latter phenomenon is rooted in the existential constitution of *Dasein*—that is, in the understanding which interprets. An entity for which, as Being-in-the-world, its Being is itself an issue, has, ontologically, a circular structure (Heidegger, 1962, 195).

In *The Origin of the Work of Art* (1960), Heidegger constructs the argument that while all art has a material body, it at least partially transcends this to become an experience that is best described using phenomenological language (Heidegger, 2008).[34]

Heidegger presents many hermeneutic circles expanding like concentric rings or a spiral around the notions of art, the materiality of art objects, and artists (Heidegger, 2008). In my practice I have taken a related approach through my consideration of the recursive loops that erupt between a maker of sound who is also a listener, proposing that the epistemology of his circumstance itself forms a loop. However, rather than a circle, a better metaphor for this interpretative action is spiral in form, especially in that the hermeneutic activity of interest in my work is temporal in form, as is the sound itself.

---

[33] In fact, to the whole context of the text, a notion developed by Jacques Derrida and extended by others to include the entire corpus of the writer, and the history of the language and culture in which they resided, and other global factors. A succinct discussion of this is found in the endnotes of the *Origin of Geometry: An Introduction* (Derrida, Husserl, and Leavey, 1989).

[34] Notably, Heidegger also developed his concept of a hermeneutic circle as the basis for a view of a reality in which the whole is constructed of the parts of each of our everyday lives.

In the case that the experience of the work is its form, as I have been suggesting here, phenomenological descriptions of experiences of artworks are central to the ontology of the works themselves. This locates at least part of the work in the embodied experience of the intersubjective unfolding of the work during its presentation. The trajectory of such an unfolding depends on the aesthetic frame of reference of participating audience members, as mentioned earlier in terms of John Cage's remarks.

Furthermore, the extension of these perspectives from a personally creative towards an intersubjectively creative field, provides a sense of social value for public presentation of music and artworks.[35] The notion that we use the presentation venues of artistic engagement to observe our own conscious intentions, permeates every piece from my research period and gives their public presentation research value for me.[36]

2.2.3 Listening As Touching

In consideration of the foregoing discussions of interpretation and recursive loops, it is important to point out that these concerns apply to myself, as the first audience member, and often the performer of my work. In moments that a listener becomes aware of themselves listening, and furthermore aware that some of what they hear is their own thought, a strange loop manifests itself: an awareness whose awareness includes awareness of itself. This resonates with philosopher Maurice Merleau-Ponty's location of the creative act within consciousness. "It sees itself seeing; touches itself touching; it is visible and sensitive to itself" (Merleau-Ponty , 1993, 124). It is this notion that I explore through tactile, physical listening in pieces like *Magnetic Arch*.

---

[35] The notion of intersubjectivity in phenomenology was established by Edmund Husserl in *Cartesian Meditations* (Husserl, 1999), published 1929. Since its publication the term has been widely used in the social sciences and in psychoanalytic practice, and its meaning has diversified. My own usage simply denotes a field where it is possible to share interpretations of experience.

[36] *Intention* is used here in Edmund Husserl's sense of the term, as the object of consciousness. See Husserl (2012a, 2012b).

Magnetic Arch is named in part for its structure, which frames the careful but contingent actions performed within it. However, the piece is not about structure. Instead, it is about the enactment of the sounding situation and its simultaneous encounter. The piece occurs in first-person experience, and most thoroughly for the performer who both enacts and encounters the sounds. The sound produced in this piece magnifies rather than conceals artefacts, and for the performer there is very little mediation between the touch of the bow to the string and the sound produced, a circumstance of immediate feedback.[37] Through this enactment and simultaneous encounter, I explore the possibility of this hearing of touch. The question is, do intersubjective listening experiences of this piece tend towards univocity or multiplicity? The answer depends on the level of active listening that listeners choose to apply, as this determines the depth of their participation.

2.3 Artistic and Phenomenological Practices

Merleau-Ponty investigated the nature of aesthetic inquiry as a productive artistic practice. In the *Phenomenology of Perception*, Merleau-Ponty reacts against philosophies of positivism by pointing out that our lives are lived subjectively, and that the data accumulated by quantitative research cannot assist us in expressing the qualities that make up our lived reality (Merleau-Ponty, 1962). *Cezanne's Doubt* was published in 1945, the same year as *Phenomenology of Perception*, and expands Merleau-Ponty's critique of positivism within the sphere of artistic practice. In this essay, Merleau-Ponty suggests parallels between aspects of his own philosophical methodology and painter Paul Cezanne's artistic practices (Merleau-Ponty, 1993). Cezanne's phrase "the landscape thinks itself in me, and I am its consciousness," (Merleau-Ponty, 1993, 77) is taken up as a representation of the relational position of subject and object in Merleau-Ponty's "intuitive science" of perception.

[37] The seeming disembodiment of the sound through amplification and broadcast functions in this case to enhance the quality of magnification, rather than distract from this experience.

The various forms of perceptual inquiry throughout my recent work centre around the situation of an autonomous, conscious individual in an environment. Merleau-Ponty's understanding of Cezanne's remark suggests a scale-less interdependency of consciousness between landscape and human inhabitant. Landscapes are structures on higher orders of magnitude in terms of both size (space) and duration (time) than the human subject (Cezanne). Through the invocation of a recursive loop between individual and environment, these are flattened: Cezanne depends upon the landscape for a spatial address, while the landscape is made to rely on the figure for an awareness of its own existence. The role of the individual in the landscape becomes a creative role, an activating agent. Merleau-Ponty's exegesis points directly to a central question of mine: where, and in what situations does this objective sharing of subjectivity arise, and how does it unfold temporally? Merleau-Ponty presents Cezanne's practice as a case of active, embodied phenomenological investigation of a being in an environment, which is the starting point for my own phenomenological practice, as embodied in my sonic investigations.

Examining Cezanne's conceptual and material working methods, Merleau-Ponty sketches how artistic investigation can function as a methodology for a phenomenology of perception. "Conception cannot precede execution" says Merleau-Ponty (1993, 69), while pointing out that Cezanne looks in order to paint, and then paints in order to see. Composer Peter Ablinger concurs, writing that Cezanne "did not paint what he saw, he painted seeing" (Ablinger, 2014, 2). Ablinger reflects that as Cezanne problematized his relationship to his world of experience through painting, certain limiting factors for his project came to the fore. Facets of Cezanne's project that appear unfinished at first suggest impossibility, and, as Ablinger points out "…the further [he] went, the more he became conscious that his project would fail, that in the strictest sense it was unreachable" (Ablinger, 2014, 2).

Cezanne's project is unreachable because the task of painting a rendered image of one's own process of perception reaches a temporal limit on immediate attention. The experience of this is not dissimilar to what is set forth for performers of *Descent from the High Arches and the Bog Chorus* or *In Warmer Seasons,* in which gradually changing click tracks make the possibility of accurate subdivision impossible. However, I believe that Cezanne

found a solution to communicate the fluctuating and ephemeral fixity of visual experience, and he did so in deliberately cultivating ambiguity in areas of his work.

To remove uncertainty from the image, and thereby "finish," would be to produce a *nature morte*: a framed representation proposing a static object. Instead, Cezanne's use of carefully tuned ambiguity invites perceptual engagement through a participatory encounter with the work. What are read correctly as traces of process in his paintings (and my recent sound work) are reminders that these are events, not objects, and also invitations for engagement. Such works are open rather than closed systems. The interactive solution proposed by Cezanne in the unfinished appearance of his works suggests his own process of constituting his world, while subtly activating viewers to complete it with their own. It is in this sense that our intentions share a common field, and along with Merleau-Ponty give primacy to perception.

2.3.1 Perceptual Synthesis and Zen

Perceptual synthesis is the process by which a sense of phenomenal wholeness is assembled through the awareness of a perceiver, from material fragments, relational cues, or incomplete processes (Arnheim, 1987). Gestalt principals found to facilitate grouping through perceptual synthesis in visual phenomena (proximity, similarity, and common fate) operate similarly in sound perception. This is demonstrated in audio illusions, in which listeners perceptually segregate groupings of sounds in opposition to causality (Deutsch, 2013). In my piece *Helical Pastimes*, the motivic material is never explicitly stated, and is always presented in a process of transformation, yet a strong sense of specific identity is suggested. Rather than being literally present, a sense of presence is constituted by the listener. Diagonal metamorphism, the technique used to achieve this, frames a field for perceptual synthesis by applying separately patterned sequences to chosen sound parameters, as discussed in Chapter 1. In doing so independently of one another a tense whole emerges from the incomplete or contradictory trajectories within it.

Diagonal metamorphism appears in many portfolio works, such as *Everything is Happening at One Time* and *Unnatural Habitats*. It is highlighted here because it engenders the perception of lines of musical material that are not notated or programmed, but rather are artefacts of perception. In *Unnatural Habitats* high-speed melodic lines are heard through a shimmering field of pulses that continuously change aspect. The overall effect of these sequences comes not from the synthesizer or even the physical filtering effects of a performance space on what is broadcast, but rather emerge from a listener's interaction with the sound, and in their linkage of the sounds together in memory. Dependent on memory and a listener for its existence, this field of pulses calls to memory works by painters Georges Seurat and Bridget Riley.

Georges Seurat developed a technique of applying colour that relies on optical mixture, a form of perceptual synthesis. In his work dots of unmixed colour are applied in order to be mixed by the eye and in the mind of the observer. Peter Ablinger, discussed earlier in reference to Cezanne, emphasizes the importance of the experience of time in apprehending Seurat's work: "given the phenomena of the duration of a light impression on the retina…synthesis is the unavoidable result" (Ablinger, 2014, 7). Seurat's colour field is dependent on an intimate, inner perceptual event on the part of the viewer. This is interactive art, in the same sense that I describe my own work as interactive. The objective materiality of the piece itself is constituted in a viewer's perception. Simultaneously, the situation of the piece creates circumstances for an encounter between an individual and their perception, and this ("seeing") becomes the subject of the piece.

Bridget Riley's art relies on the participation of the responsive eyes and minds of her audience to create the dance that shimmers across the surface of her work. Riley's early works, like *Shift* (1963) seem to physically move before a viewer. This phenomenal movement is intersubjectively verifiable yet cannot be quantifiably measured. The beat frequencies heard in many of my pieces such as *Suspended Upper Bank*, create an audible shimmer. These are emergent phenomena, contingent with the intersection between the works and perceiving mind-bodies. Such works reassert that the subject of the work lies in the experience of them, rather than in the inert material of which they are made.

Riley (2015) discusses Seurat's influence on her own work, pointing out that in Seurat's drawings, a sense of uncertainty suspends the attention of viewers (Riley, 2015). In *Landscape with Houses* (1881-83), something seems to hover just out of sight. A viewer remains engaged with the image, their attention held by Seurat's framing of the experience of uncertainty, a situation I have described working towards in my own work.

> What is this mysterious presence which recurs so insistently?…the heart of this mystery, it seems to me, lies more in its employment of our powers of perception….by confronting us with an experience just beyond our visual grasp, with something unfathomable, the imperceptible…Seurat asks "What is it we are looking at? (Riley, 2015, 55)

Riley discusses this question in terms of a recursive loop in which she imagines Seurat answering his own question: "…by holding up a sort of mirror.. what we see is ourselves looking"(Riley, 2015, 61).

Riley's paintings provide me with a similarly temporal mirror, in that I feel my relationship with them unfolding in time as I remain looking at them. In Chapter 1 I refer to sonic mirrors in which listeners are faced with unchanging sound structures in time yet hear change. In such instances the apprehended changes are often reflective of changes in one's own consciousness, and it may become unclear whether it is the listener who changes, or some facet of the environment. In my portfolio works I do not use static material or processes, but very subtly changing material calls forth similar experiences of uncertainty, a gazing pool for listeners to observe processes of temporal constitution. As with Riley's works, the question "what moves?" is posed. This recalls an ancient Zen *koan*:

> Two monks were arguing about a flag. One said: "The flag is moving."
>
> The other said: "The wind is moving."
>
> The sixth patriarch happened to be passing by.
>
> He told them:
>
> "Not the wind, not the flag; mind is moving" (Reps and Senzaki, 1994, pp.208-209).

2.3.2 Form and Practice

The works discussed so far highlight perceptual engagement on the part of the visitor to complete or activate the work. Taking this as my compositional strategy necessitates framing practices within how the works are enacted. This means that in certain cases the performers for the works adopt specific attitudes or practices for performance, while in others the audience is deputized, becoming themselves performers who enact the work in their own experiences. While in most of my works this process is one of subtle inference, *Magnetic Arch, Descent from the High Arches and the Bog Chorus, Unnatural Processes,* and *Circular Bridge Squirrel Walk* call for specific practices to be adopted in performing or rehearsing the pieces. In the score of *Helical Pastimes* this is stated explicitly, while in the other works this is inferred from the process of working through the piece.[38]

> A useful practice is to sit with eyes closed, or nearly closed, for twenty to thirty minutes a day, redirecting one's attention to sounds as they are heard, while suspending discursive operations and internal dialogue. (Boehringer, *Unnatural Processes)*

In these works, the aim of the practice involved is a listening-based reflexivity enacted through sound production. As discussed previously with respect to the experience of time for performers in *Descent,* and texture in *Magnetic Arch,* performers become vertices at which meet an intentionality to produce sound with the immediate results of this production. In *Magnetic Arch* and *Circular Bridge Squirrel Walk* the current state of the sound affects what can become. Perceptually speaking, the sound produced is immersive yet repels perception as much as it entices closer listening. In *Squirrel*, the practice exists primarily for the performer, and the audience listens to the result of a performer's improvisational 'circular walk' around their instrument, interfaced by the system provided by the piece.

[38] The score of *Magnetic Arch* suggests attitudes of mind and body to be worked with for successful performance, and *Descent* offers suggestions in the score for what performers might discover in working with the piece.

In *Island in Natural Colours* the scale of the sounds is environmental. The piece utilizes a very wide dynamic range and a large diversity of types of sound textures are developed in the environment defined by the 24 loudspeakers in their dome-like configuration. Just as *Island* inverts the normal trajectory of a visitor to an island (here my *Island* moves around the visitors, rather than the visitors walking around it), the situation of practice is inverted. Presented as a sound environment, listeners encounter the work at any time within the flowing continuity of the sounds. A visitor begins making sense of what they hear from this point. In *Island* I have composed sound trajectories that evoke outdoors environments in everyday life though their behaviour, though usually not through the vocabulary of the sounds themselves. In other words, the sounds are often totally synthesized, non-representational sounds, yet they may be found to behave like, for example, wind, rain, or birds. The act of being in an environment like *Island* is an act of relation, out of which the temporal form of the work emerges. Through their interaction, visitors to *Island* provide the creative consciousness in this landscape.

Through specific performance practices, or by creating sound environments such that visitors "perform" the environment, I embody phenomenological intentions within the process by which my works are enacted. In this I am preceded by artist Robert Irwin, mentioned earlier. Irwin shares my strategy of using art for phenomenological experiment and exploration. Irwin has dedicated his artistic practice to the experimental development of phenomenological principals within his works, which he explicitly describes as a question-driven process (Weschler, L, 2008). Embodying key methodologies familiar to the disciplines of practice-based and practice-led research, Irwin's works are not only outcomes of research, but also live experiments in perception and cognition that an audience enacts through their engagement. The experiences people have with Irwin's pieces is central to the works themselves, inseparable from the objects he makes to create these experiences. Irwin, speaking of his painting of the late 1960s said "One of the things about those paintings is that they have no existence beyond your participation" (Irwin, in Weschler, 2008, 79).

In works spanning his career, Irwin addresses his work "in response" (Weschler, L, 2008, pp.169-170) to the scale and texture of environments and visitors to them. An increasing awareness of the importance of scale in how works are apprehended is formally evidenced throughout his development. Beginning with large abstract paintings, Irwin gradually moved through the creation of installations to arrive at architecture, creating spaces intended to facilitate the performance of the questions Irwin is interested in exploring. In *Notes Toward a Model,* a text Irwin composed for his 1977 Whitney museum solo exhibition, Irwin discusses his process of continuous questioning. Beginning by questioning the art object "as meaning and then even as focus" before he "slowly dismantled the act of painting to consider the possibility that nothing ever really transcends its immediate environment,"(Irwin, 1977, 139) he analysed the context in which his works were presented until the presentation and the piece became unified. Critic and historian Lucy Lippard describes her experience of Irwin's work in a 1967 article *The Silent Art*:

> The surface [of Irwin's painting] slips away into the surrounding space, and they stress the atmospheric…rather than the traditional properties of the rectangular support…. he insists on a directly "hypnotic involvement" between painting and viewer. By reintroducing energy and illusionism and by de-emphasizing picture support, he deliberately breaks the rules of the formalist academy…. since the viewer's optical experience is finally one of amorphous light-energy (Lippard, 1967, pp.59-60).

In this description Lippard articulates the aim of my environmental sound works, like *Island*, discussed above, or the appendicized *Waterfall Effect*. As Irwin asks in several of his pieces: where is the edge? Where is the boundary between visitor and environment? Are intention and structure within my work, the listener, or me?

In *Fans of Beethoven* and *Waterfall Effect*, broadband noise functions reflectively in rooms, simultaneously encouraging and masking resonance. Noise is scale-less, and functions both to immerse and to encourage concentrated focus. Noise has no edge, is uncountable, and though it has density, it presents itself as quality rather than quantity. It is symmetrical and suggestive of both undeniable presence and absence of structure.

Phenomenological consideration of noise begs the question "where is the edge of a sound?". Irwin asked a similar question in undertaking a gradual but radical material and phenomenological reduction within what was originally a painterly practice:

> I had come to a point where I was investigating the idea of painting a painting without a mark…then suddenly I realized for the first time: there was the frame….now that is a highly stylized learned logic, but not the sum total of how we see the world, because aesthetics is not limited to the frame. So, I tried to paint a painting that didn't begin and end at the edge. I moved from the quantitative realm to the qualitative realm – that is, from images and meanings to the whole process of seeing and perception itself. I went through this whole reductive process, which was mis-identified as minimalism…this reduction was essentially a break from the past essentially taking all that content and all that meaning down to point zero in order to ask that question again -ok, how can it be otherwise? (Irwin, in Feinstein, 1997)

Previously I stated that the value of presenting my work in public lies within the intersubjectivity of experience that is opened up by this, and the possibility of dialogue. For me, this is one of the main points of making artistic research within a social centre, like a university. In presenting works for people, I am interested and available, like Irwin, 'in response.' I see my work as being an interactive experience, even when the material itself does not contain a mechanically interactive system. It is to this end that I focus, like Irwin, on scale, texture, time and aspects that affect the formation of perceptual wholes, like foreground and background relationships in the context for presentation of my work. Also like Irwin, my work is frequently mis-identified as minimalism. This is the subject of the next section.

2.3.3 Experience as Form

This chapter began with a discussion of the notion, as expressed by John Cage and Henry David Thoreau, that form, if not exactly in the ear or eye of the beholder, is certainly in their mind. In recent works, I have attempted to interject uncertainty into many areas of musical experience, in order to draw a listener into a subtle interactive relationship with my

work. Such relationships often involve questions of scale in terms of how a listener relates to a sound work, in spatial and temporal terms. As such, I do not seek to establish an ontology that suggests objectivity in my recent works, rather I am interested in pluralistic interpretation and experiences of them.

Works that have elemental forms, use simple materials, or result from material processes, suggest a relationship to musical or visual minimalism. This is also the case in pieces that have few perceivable parts, or in music of pulse-based material or sustained continua. My work makes frequent use of all of these tendencies. However, although I have a lot of respect for the minimalists, the aim of my work seems to be diametrically opposed to at least some of the stated aims of their own.[39]

While the recent *Ashgate Research Companion to Minimalism and Post-Minimalism* (Potter and Gann, 2013) contains an introduction that suggests perception to be of notable concern for some minimalist musicians, it does not seem to be a subject of active discussion, at least not to the degree that this is the case in the visual arts. In fact, the notion that perception is of central importance for musical minimalists is not borne out by the texts in the anthology, with the word 'perception' only occurring thirty-nine times out of a one hundred sixty-six page text. The discussion of perception in the introduction is brief and focused on "metamusic," said to occur primarily in the music of Steve Reich, and characterized by "unintended acoustic details that arose (or were perceived) as a side-effect of strictly carried-out processes" (Potter and Gann,28,2013).[40] However, as a performing percussionist well versed in orchestration, as well as the exploratory tendencies of the New York art scene he was part of, it is unlikely that the interesting perceptual qualities in Reich's early works were mere artefacts. Such a characterization rather reflects the musicological

[39] The qualifications in this sentence stem from the fact that the writing of sculptor and media artist Robert Morris. Morris, most notably, broke ranks with statements made by Donald Judd and Richard Serra in several theoretical texts in which his own, more phenomenologically-oriented views are developed (Morris, 1970). However, this supports my point that there is more pluralism than unity within what is often grouped as minimalism.

[40] The use of past-tense is also noteworthy: would such phenomena fail to present themselves in repeat performances?

discomfort in dealing with phenomena that are clearly present in the music but not notated in the score.

By contrast, in my own practice the types of phenomena the authors characterise as side effects are absolutely central to the experience I aim to create. In fact, the ambiguity as to whether they are intentional or not functions to provide points of entry to my works, and while it is not possible to predict at what exact moment or in what location a phenomenon may be apprehended, it is clear to composers working with such materials that the desired phenomena will emerge. The work of Alvin Lucier, or Maryanne Amacher, to be discussed later, illustrates this. Not knowing exactly where an experience will arise does not invalidate the work but instead, it characterizes experimental practice.

While there seems to be a reticence among musicians to discuss perception,[41] such discussion is more common in the visual arts. Nevertheless, statements by the visual artists referred to as minimalists put forth arguments for an objective literalism as the motivating factor for a great deal of their work. "I try to reduce illusion in my work," said sculptor Carl Andre (Andre, in Inaba, 1999, 38). Andre, along with sculptor Donald Judd advanced a highly materialist, object-based ontology of form (Judd, 1965), at least in terms of how they sought to have their work interpreted.[42]

Writer and critic Bruce Glaser highlights this demarcation in a 1964 conversation with artists Donald Judd and Frank Stella. Glaser states that in contrast to approaches that use "an unfinished quality by which one can participate in…the process of painting the picture…Judd…denies all that"(Glaser, 1966, 5). Earlier, I highlighted the notion of the seemingly unfinished as an invitation. In works of my own like *Unnatural Processes,* diagonal metamorphism is employed to suggest the presence of melodic material not actually present, but in many if not most of my portfolio works, the music is organized in

[41] This is especially the case when the discussion regards qualitative rather than quantitative aspects of perception.
[42] Robert Morris is a notable exception to this, experimenting with issues around perception and phenomenology is his work and text.

forms suggesting it continues or could continue 'beyond the frame.' This is most obviously the case in my portfolio installation works, which begin and end outside of a visitor's experience (or, arguably, depending on when they enter and leave).

In his essay *Art and Objecthood* (1967) critic Michael Fried famously criticized the sculptors now generally known as Minimalists for creating work that, in complete divergence from the statements they were making at the time (in their conversation with Glaser cited above, for example), characterized "a plea for new genre of theatre" (Fried, 1967,3).[43] In an example of particularly questionable word choice, Fried even referred to this as evidence of the "degeneration" of art (Fried,1967, 8).[44] In fact, what Fried terms "theatrical" is the sense of invitation to participatory phenomenological engagement that these works offer, and this is precisely the point they share with my own recent work. Furthermore, while I agree with Fried's assessment that the most interesting aspects of the contemporary sculpture being produced at the time of his writing were those evocative of phenomenological framings of perception, I am less convinced by his characterisation of this as theatre. Nevertheless, if minimalist visual artists and their critics wish to disregard the viewer in the construction of their works, and if most minimalist musicians would prefer not to discuss perception, then I clearly must locate myself in some other grouping. In the meantime, my primary interest is to move in the sound domain, as Irwin has in the visual, "from images and meanings to the whole process of seeing and perception itself" (Irwin, in Feinstein, 1997). In other words, from the things-in-themselves towards the entire circumstance of the situation-in-response.

2.4 Unbounded

In my recent projects, large-scale form is the structural aspect that I have attended to the least. There are several reasons for this. One reason is that early in my research period, I

[43] A genre of theatre that was perhaps already emerging in post-Dada, Fluxus performances and the Theatre of Mixed Means (Kostelanetz, 1970).
[44] In the school of art criticism arising in the wake of critic Clement Greenberg, theatricality was seen to be extremely detrimental to the progress of art.

committed to working in favour of materials-first or bottom-up organizational logic as much as possible. This meant form in my recent music usually arose out of processes that articulated their own shapes in time (as in, for example *Helical Pastimes* and *Suspended Upper Bank*).[45] I avoided establishing formal shapes and then filling them with material. Aiming instead for music that opens up infinitely around each passing moment, I adopted a process-based structuring in many of my portfolio works. I imagined these material processes sharing information with their temporal environments and calling on memory in the formation of structure and form in the experience of listeners.

Rather than the 'open works' discussed by Umberto Eco in his eponymous essay (1989), my recent work functions more as "Open Systems" (De Salvo, Burton, Godfrey, Groys, 2005), in which even a bounded structure may remain open by sharing information with its environment.[46] As works of art and music, an open system may "present itself from the outset as a fragment of a potentially infinite progression that, while it certainly can be understood, grasped, and even continued at will, cannot be completely realized"(De Salvo et al, 2005, 57). In works that have no beginning or end, or are suggestive of infinity, the listener must relinquish any need to ascertain an overall formal shape for the object of their experience, and instead plunge into the temporal flow of the work. The openness offered by shaking off the tyranny of "bookends" has allowed me to make installations that I conceive of as musical compositions, to compose music suggestive of spatial relationships, suggest infinite sequences without completing them, or create variations in the manner of simulacra, without an original motive. In this I have been inspired by the work of composers La Monte Young, Éliane Radigue, and Bryn Harrison.

La Monte Young and Marian Zazeela inhabit the border between music and sonic installation in their Dream House installations and with the collaborative ensemble work of

[45] This is discussed in detail in Chapter 1.
[46] This idea is also present as a key component of cybernetics, systems theory, and Artificial Intelligence.

the Theatre of Eternal Music.[47] Both of these contexts present sonic experiences framed as continuous presentations of sound and light, without beginning or end, and performed at volumes loud enough that one listens tactilely. Although these works appear highly deterministic in their form, they are highly indeterminate in phenomenological terms. In these works, a sound continuum presents itself, at least at first, in a largely unified fashion. No movements are announced and there seem to be no component parts in time or any formal tension or resolution brought about by dynamic change. Discursive analytical thought finds little to grasp in the paradox presented by work simultaneously still and moving. My admiration for this quality is stated in the closing section of Chapter 1 and is evidenced in *Fans of Beethoven, Island in Natural Colours,* and *Descent from the High Arches and the Bog Chorus*, though my portfolio does not contain any continua of the explicit sort Young creates.[48]

Critic and historian Barbara Rose has described the *Theatre of Eternal Music* as "a single, continuous experience interrupted by intervals during which is it not being performed" (Rose, 1965, 5). This approach is similar to the attitude I adopt for the ongoing development of my solo performance project *Core of the Coalman*, under which name most of the ideas formalized in my portfolio works were first sketched and performance-tested. Similar to *Theatre of Eternal Music* performances, these concerts emphasize physicality of sound and dispense with many of the aspects of traditional concert presentation, like proscenium staging and seating, which distract from the phenomenological framing of experience central to my practice. By far the greatest similarity between my own recent work and the tone continuum created in Theatre of Eternal Music performances, is the paradox between material suggestive of stasis while being full of variety at another structural level. Is it the music that is changing or are the listeners themselves changing? One senses a constant process of becoming within the eternally suspended sound, an expanding of the continuous or specious present.

---

[47] The Theatre of Eternal Music, consisted of Young, Marian Zazeela, John Cale, Terry Riley, Tony Conrad, Terry Jennings, Jon Hassell, Angus MacLise, Alex Dea, Billy Name, Dennis Johnson and others.

[48] However, the appendicized *Waterfall Effect, Suspended Upper Bank,* and *High Arches* present examples of work that shares in aspects of this.

While the opening of the present moment is potentially infinite, these works also present a fictive infinity on the level of large-scale form, in that they begin before listeners arrive and continue until after they all leave, as is the case with all of my recent sound installations. From the frame of reference of a listener, a sense of scale is suggested that locates them inside of the sound continuum: a paradoxical experience at once immersive and also concentrated, heightened by the physicality of the sound relations.

2.4.1 Alluvial and Meteorological Form

The experience of form in the music of Éliane Radigue is akin to the experience of the weather. Something lasts for a while, then changes. It seems that it must have its own logic, yet gently destabilizes expectation. Although it is possible to say, after settling into a piece, how it might unfold, the details are of great subtlety and the small and gradual gestures that result in constant foreground and background movement within her textures are such that the situation defies predictability.

The location of this unpredictability on a scale of duration subordinate to that of the large-scale form of the works leads me to believe that it is on these shorter time scales, rather than on the scale of form, where Radigue applies most of her compositional attention. As is the intention in all of my portfolio works, the unfolding of the present moment is what is composed. This unfolding, in Radigue's electronic and her recent music for instrumentalists, occurs through small gestures whose trajectories are sometimes aggregated into clouds of activity. These are sound textures in composed processes of transformation, and the form of the work arises from activity on this structural level rather than the other way around (Radigue, 2009). Such an intention corresponds to my own.

In *Koume* (1993), the final part of *Trilogie de la Mort*, small but constant fluctuations across nearly every parameter of the sound send ripples through what might at first be primarily apprehended as a fused continuum. What is first heard as a single perceptual

whole becomes, upon longer listening, a multiplicity: individual systems of event-trajectories that make up a larger form. Although form may be an important aspect of her overall compositional plan, consideration of her recent work with instrumentalists such as Rhodri Davies or Ryoko Akama evidences the importance of specific practices and mental attitudes from which performers enact the piece. This suggests that her electronic works could be likewise enacted in the moment of performance, with form of subordinate concern.

Radigue's compositional practice is a performance of itself in the world. In watching her work (Wright, 2007), or watching performers work with the practices she has transmitted to them in order to perform the pieces, sound and actions seem to ooze outward from the cybernetic bodies of Radigue with her synthesizer, or from the performers and their instruments. Most of her work, as most of my recent work, is of extended duration, and my experiences with it lead me to believe that we share an intention in that the pieces take the shape given to them by listeners' attention, form as the shape of a listening experience. The shape of a work is constituted in listeners' memories, arising through extending moments, thickening specious presents. Like a river delta or an alluvial fan the work gradually spreads out, creating its own landscape. As it moves it leaves behind aspects of itself in memory, and like a river delta colours the water at the meeting of river and sea, our apprehension of new material is strongly coloured by what Radigue has already established for us.

In Richard Glover and Bryn Harrison's aptly named *Overcoming Form*, Glover refers to this paradoxical sense of immersive intimacy in the music of Radigue as "form as scale", and his listening experience as moving through a period of "performative listening" to eventually reach a point at which he begins to "comprehend or actually experience the entire scope of the whole work" (Glover and Harrison, 2013, pp.17-21). This strikes me as particularly apt in the sense that Glover is adopting a performative position as a listener, in response to Radigue's performative position in her music. His use of the notion of scale to relate the abstract idea of form to the body of a listener is in agreement with the application of the term I gave earlier in this chapter, and can be expanded to include Radigue's more

recent work in which her personal practices are shared with performers in a manner not dissimilar from my own approach to *Magnetic Arch.*

In Radigue's recent pieces, like *OCCAM HEXA IV* (2016), the surface of the sound, as heard, is the form of the piece. The process-based form of the work is encountered by listeners and, like Robert Irwin's visual artwork, Radigue's music does not exist apart from the experience of it. Radigue confirms this:

> It's like looking at the surface of a river… There's an iridescence …, but it's never completely the same…There you can make your own soundscape. Among the responses I have had which I find particularly true for these kinds of sounds,…, it is that they act as a mental mirror. They reflect the mood you are in at the time. If you are ready to open yourself up to them, to listen truly, and devote yourself to listening, they really have a fascinating, magnetic power. I know this to be true also, otherwise I never would have done it (Radigue, in Institut fur Medienarchaologie, 2009).

Glover notes similar approaches in the music of James Tenney, highlighting later works like *In a Large Open Space* (1994) to demonstrate a precedent for art in which the aesthetic concerns have to do with the production of insight through subjective experience. Through constantly shifting detail and the low overall volume level of the sound presented, an immersive, but focused relationship to listeners is developed. Performers, firstly, are listeners. Scale is considered in framing sound that expands around visitors, as if from beneath their feet.

> Can a word such as 'form' apply to a piece such as this, with its continuity over duration entirely fixed, without development of any description? …Form as experiences, or form of experiences, in which there is no universal form, but rather one that cherishes the individual's own listening performance ultimately satisfies Tenney's outlook on his own creative project: sound for the sake of perceptual insight (Glover and Harrison, 2013, pp.38-39).

2.4.2 Fixed Media and Variable Experience

> Third Rule:
> State problems and solve them
> in terms of time rather than of space. (Deleuze,1988,31)

As discussed in Chapter 1, it is difficult to contextualize the aesthetic inquiry driving my work without reference to spatial metaphors. I have found the work of composer Bryn Harrison inspiring for his ability to ground an experimental phenomenological investigation of time and memory within fixed notated music. While the musical sounds are fixed, a listener's experience of them is not. Harrison's interest lies not only in time itself, but in our apprehension of it. In a recent documentary video with the Bozzini Quartet, he states:

> …the music repeats in various ways, and gradually slows down, but also the levels of repetition increase, so the idea is to draw the listener gradually into the fabric of the music over time (Harrison, in CeReNeM, 2016).

Harrison invites listeners into the musical fabric of his textures with processes that encourage shifts in perceptual focus and frames of reference: transformations of tempo and levels of repetition.

The impossibility of hearing all of the repetition present in Harrison's *Repetitions in Extended Time*, even when listening with the score in hand, suggests an intention similar to my use of uncertainty in my recent pieces. Excluding subtle variations, in this work everything is repeating, and over relatively short periods. Repetition is clearly perceivable visually in the timeless dimension of the scored notation, however, in the temporal flux of the sounding music, ambiguous instrumental exchanges, registral shifts, and rhythmic variations render the situation uncertain. Harrison frames our attention spans with sounds, rather than a passive apprehension of sounds through our attention to them.

Harrison discusses cyclical form in his dissertation *Cyclical Structures and the Organization of Time* (Harrison, 2007). I have also explored cyclical, and more often pseudo-cyclical forms, helical, and nested forms in several of my portfolio works. Elements at the end of a piece deliberately and misleadingly suggest circularity in the sense of a return to a process in play at the beginning. They suggest that it might even be possible, for example, to loop the work as a whole, in the manner of Joyce's *Finnegan's Wake* (Joyce, 1992). A comparison of the beginnings and endings of my works *In Warmer Seasons, Unnatural Processes*, *Circular Bridge Squirrel Walk* or *Helical Pastimes*, reveals that while some elements are similar or poised to be repeated, other elements absolutely deny repetition. Time in my music has direction, but my compositional intention is to reframe and redirect how we feel its passing.

Although structured within different contexts and with different materials, I share Harrison's interests in the subjective perspective of a listener towards their own state of attention, who moves with or in response to the piece, constructing a sense of time within the mobility of their attention and memories.

2.5 A Recursive Equilibrium

My recent practice is outward looking yet recursive, expanding from myself as an individual into an environment in which I am a receptive and creative participant. Rather than design contained forms, my recent work proposes situations for phenomenological reflection through the framing of ambiguous perceptual circumstances. Listeners are presented with structures in their processes of becoming, intended to provoke an awareness of their own process of constitution of their environments. This chapter relates the thought processes in my work to long-standing practices within music, visual art, and philosophy, and demonstrates the means by which I have first extended, then embodied these within my research.

Chapter 3

Notes On My Portfolio Works

3.1 Notes on the Contents of My Portfolio

In each of the sections to follow, I introduce a single piece of work from my portfolio. As my portfolio comprises sound installations, electronic music, music for mechanical instruments, and music for instrumental performance, several contrasting media are engaged in how the works are presented. The conceptual focus of each of these works calls for a different manner of presentation, and I address this in each case.

3.1.1 Notation in My Recent Work

Notation in my recent work functions as one of many technologies for bringing about the circumstances for a piece, and the situations that occur within it. Scores are not only instructions for performed actions, but in pieces like *Descent from the High Arches and the Bog Chorus*, are part of the instruments themselves. Therefore, notation may take several forms in my portfolio works, suited to particular needs for a specific piece. In general, my notation dispenses with any aspect that need not be specifically constrained or determined in performing the piece in question. I have generally sought the simplest solution along notational lines, in consideration of what seems most efficacious and comprehensible for performers.

I do not view notation as the location of my work, nor as a vessel in which my pieces are located, nor do I see it as an ideal form for a work. Instead, my scores are a technology amongst others that I use, taking many forms and roles. In my portfolio work, scores often function in linguistic exchange, but they also provide frames of reference to performers in terms of, for example, temporal standards of reference in a piece. Additionally, they function to frame or provide information, to provoke, to create constraint, resistance, or

permission, or to provide material for performer interaction. My scores are inseparable from my works, but, like the instruments involved, they are part of the body of the piece, not the piece itself.

3.1.2 Composition And Phenomenology

My works are not ideal entities only approximated in performance, but rather they are what is heard when it is heard. These are composed processes set in composed circumstances, generally designed to differ from one enactment to another. Divergences between experiences of the same work on different occasions arise from interactions between the materials of the work and their environment, situations between processes and materials within the work, and out of the encounter between individual audience members with the sounds and the piece. Through this, my intention is to underscore the fact that listeners change, such that each time a musical process is encountered it is new. While all music, in this sense, is new with each hearing, during my research period this novelty has increasingly become the object of the work. To this end, these compositions create conditions for listeners to encounter their own constitution of experience, by providing active contextual frames through sound-events experienced in time.

The experience of the sounds in time, rather than the sounds as idea, ideal, or discourse, is essential to my project. In committing to an overtly phenomenological field of inquiry in this project I have had to embrace the fragility of indeterminate and complex processes and face the decentring of the position of the score as the primary container and location of value for my work.

As can be seen in the works that follow, my recent pieces are flexibly embodied sets of circumstances enacted through performance and encountered by both listeners and musicians. Pieces are located in the experience of the situation: an encounter between sounds and listener in a shared environment. My primary interest is in the dynamics of how

such situations unfold, and what sort of environments they create. I therefore write music to hear it, and the experience of it while it is happening is primary.

3.1.3 Personal and Performance Practice

I am often the performer, or at least the first performer of many of my works. Music is the main tool in my research. Through composing, and also performing, I establish situations, sites of phenomenological engagement and reflection within the world. My practice persists through building on insights and embodied knowledge gained from this activity. Thus, performance has an important place in my practice, both in the past and present.

Despite this, I do not view the work included in this portfolio as work for myself to perform exclusively, nor do I see this as work specific to a composer-performer. In fact, during my research period I have continued to develop my repertoire for "self-as-solo-performer" through my project *Core of the Coalman*.[49] I have also regularly participated in public and private improvisations, alone or with other musicians. While these activities share many conceptual concerns and even practical approaches with the compositions presented in my portfolio, overall, they reflect a related, but different approach.

My research into situated sounds and a consideration of music as the establishment of circumstances and environments for phenomenological reflection has been a primarily compositional investigation. Installation works like *Island in Natural Colours* and *Fans of Beethoven* serve to place the listener in a situation of performing, in the sense that where listeners direct their attention will contribute to the experience of the structure they apprehend. When environments are thereby 'performed', hierarchies between listener, composer, and performer are significantly flattened. Pieces like *Unnatural Habitats* and *Circular Bridge Squirrel Walk* place performers in a position of shared compositional decision making as to what to foreground in a performance. Furthermore, openness to

[49] See multiplesystemsofevents.wordpress.com

environmental interactions and aspects of chance evidences the important permeability that characterizes *Magnetic Arch.* In my recent work the meaning of the terms composer and performer are therefore somewhat flexible. Both indicate roles in which I or a performer create the conditions for, or enact the unfolding of, a more or less prescribed situation within a set of composed circumstances.

All of these factors point to a fundamental curiosity that is an active part of my practice. Through these works I have been able to gain some insight into how perceived situations are interpreted structurally, how meaning is constituted through encounters, and how I as a composer of these circumstances can, through my practice, deepen my sense of wonder at the emergence of phenomena and pattern in the world.

3.2 Unnatural Processes: for Computer-Controlled Robot Piano (RHEA) and Human Performer (2015)

Unnatural Processes is a 22-minute piece for live performer, and RHEA, Winfried Ritsch's piano playing robot.[50] The piece is in three movements performed without pause and subtitled:

A. *reflections move in both directions*
B. *border state's rights*
C. *the flock momentarily assumes an aspect of the head of Dmitri Shostakovich before departing into the distance*.

[50] http://algo.mur.at/projects/autoklavierspieler

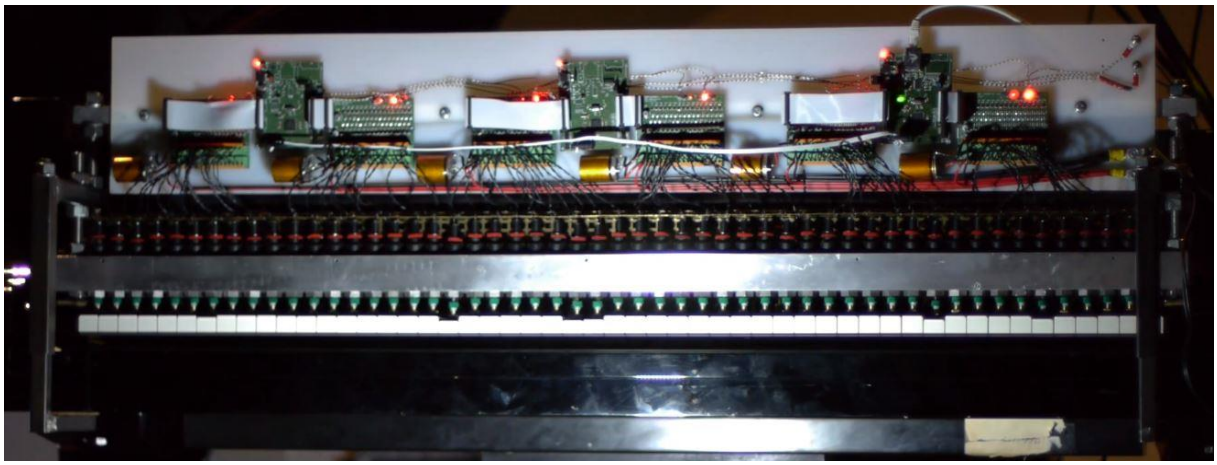


Figure 35: Winfried Ritsch's RHEA, a Vortsetzer, or piano-playing robot.

3.2.1 Structure and Compositional Considerations

A performer interfaces RHEA across a network, with a computer running Pure Data. In each of the three movements, musical materials aggregate, interact, or decompose. In each of the three movements musical time is structured differently, and each uses different technology to bridge a performer's activities on a computer keyboard with RHEA's servo motors on a piano keyboard.

The work repeatedly creates the expectation that it will continue to progress in a linear manner, but frustrates this with textures that gradually increase in ambiguity, undermining certainty as to structure or orientation. At such points materials and processes in the work may then dissolve, or simply vanish, to be followed by introduction of another thread. In the case of the final movement, this thread offers a return to the world outside of the piece.

The title for this work refers to a 1990 paper by Nobel prize winning chemist and philosopher Ilya Prigogine called *Time, Dynamics and Chaos: Integrating Poincare's 'Non-Integrable Systems'* (Prigogine, 1990). Prigogine's discussion of the nature of time and concepts of order in systems that have many similar parts inspired me to look more deeply into his writing. An earlier volume, co-authored by Belgian philosopher Isabelle Stengers,

offered a counterintuitive image of entropic systems that can increase in order and even self-organize into hierarchical structures, in what they refer to as systems "far from equilibrium" (Prigogine and Stengers, 1984). I was particularly keen to consider what it would mean musically to be far from equilibrium, and to test the notion that transitions between energy levels might lead to order from disorder.

3.2.2 Keyboard Interfaces and Quantized Fields of Material

The combination of RHEA and the piano provided an extremely fortuitous pairing for my experiments and the performed work that developed. RHEA allows for the independent performance of each of a piano's keys at rates and dynamics limited by the condition and structure of the piano on which the RHEA robot is mounted. The very fast, but mechanically limited servo motors, hardware, and network with which RHEA performs provide other physical limitations. Outperforming the leading commercial mechanical pianos in terms of number of keys playable at a given time, and maximum and minimum velocities with which each key may be played (Steinway & Sons, 2018), RHEA nevertheless shares with a standard piano and human performer some inherent resistances and limitations which assisted me in focusing my approach to realizing this piece.

A key aspect of working with a piano is the keyboard interface itself, which provides both constraint and access. It is a trace of a performer's interaction with this interface that is eventually diffused through the soundboard and out into the room. Thus, gesture is distanced, delayed, or differed by the interface on the way to the production of sound. Electronic musical instrument interface designers often eschew keyboards in favour of interfaces that purport to offer greater gestural control, along with performance surfaces more appropriate to temperaments other than 12-TET.[51] However, with digital instruments the distance between performer and sound production mechanism, combined with the

[51] Ironically, the piano keyboard offers a literally digital interface, being played with the fingers as well as exhibiting quantization of the playing surface to 12 discrete steps.

palpable latency that accompanies all digital computation,[52] function to differ the production of sound from the moment of its initiation. This lends performance on digital instruments an uncanny sense of suspended reality. The opportunity to combine a computer's ability to run multiple simultaneous processes with the acoustical dynamics of a piano seemed a unique opportunity to address these fields of resistance compositionally and through performance.

The equally tempered octaves of the piano proved to be another inspiring limitation in focusing my conceptual approach. In contrast to the sound design possibilities offered by the sculpturally plastic situation of electronic music broadcast over many loudspeakers, the piano offers a specific gamut of timbre articulated by a given chromatic array. This suited my desire to create a context: a ground within which processes could play out, and conditions in which they could be listened to.

3.2.3 Considerations Specific to Each Movement

In the first movement, *reflections move in both directions*, I imagined the piano keyboard as the surface of a pond. In other words, I considered it as bent back on itself, forming a circle with the top and bottom notes touching and the surface forming a plane, as if viewed in polar projection. I created a simple algorithm called *Flicker*, in which each individual note triggers a continuous yet irregularly pulsing tremollo. This activity is cumulative and builds for five minutes during this movement, eventually losing the linearity suggested at the music's start, and becoming quite dense, before the material of the second movement washes over it in a wave. Prior to the initiation of second movement, the action of each key is independent of the others, an individual.

[52] Latency in a digital system is the processing time between a command and its execution, which often creates a perceivable delay that can be problematic in musical applications.

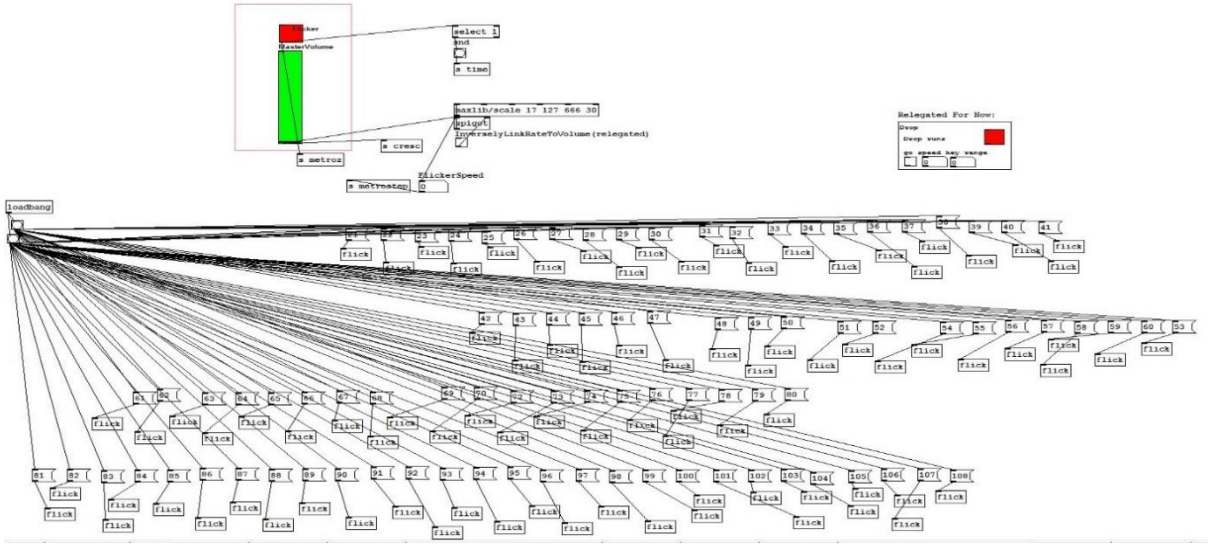


Figure 36: Inside the patch for *reflections move in both directions*. Each piano key is assigned its own individual program, [flick], that determines its pulse rate and volume.

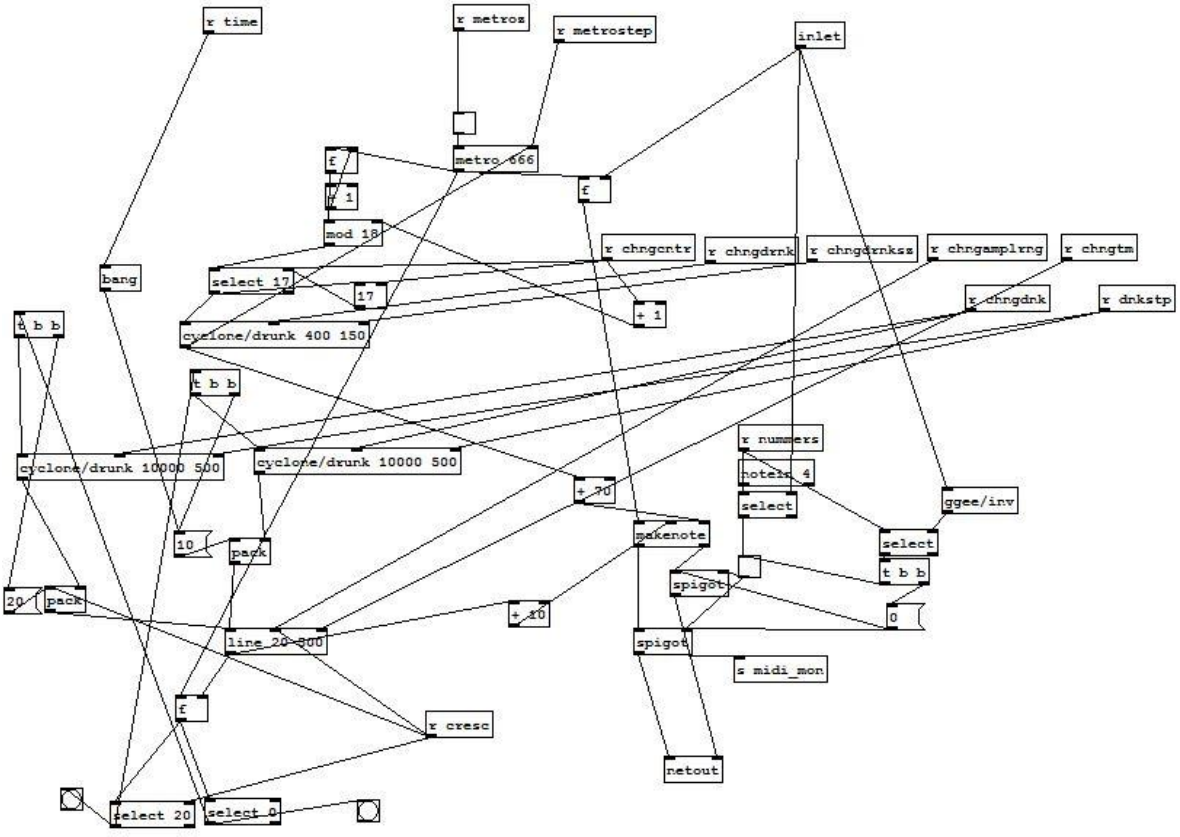


Figure 37: Within each of the [flick] objects values for timing, and on and off controls are input. An unstable metronome (periodically reset internally) begins a 'drunkard's walk', a random interpolation between two given points. These determine the volume trajectory, and the frequency with which the key is struck.

During *reflections move in both directions*, time is established for the performer, who brings each new key pulsating to life with a click on an appropriate part of an onscreen keyboard. The score allows for flexibility within one-minute windows of time, with durations suggested by spatial notation but mediated by a performer's interpretive decisions. The score instructs the performer to play by listening for emergent relationships in the aggregating texture, beginning new events in a manner that encourages patterns they hear emerging, while remaining within the limitation of the bracketed timeframes.

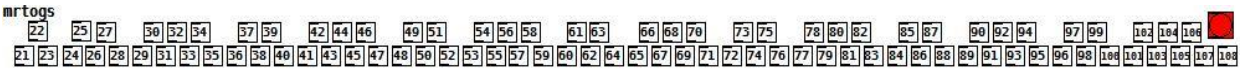


Figure 38: "mrtogs," the onscreen keyboard by which musicians play RHEA

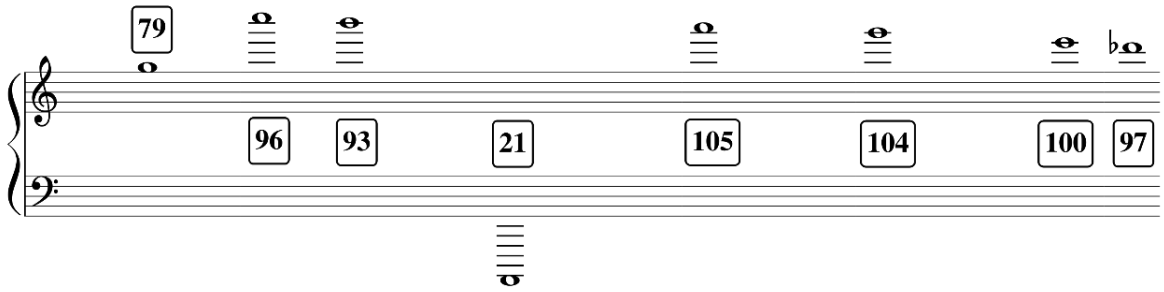
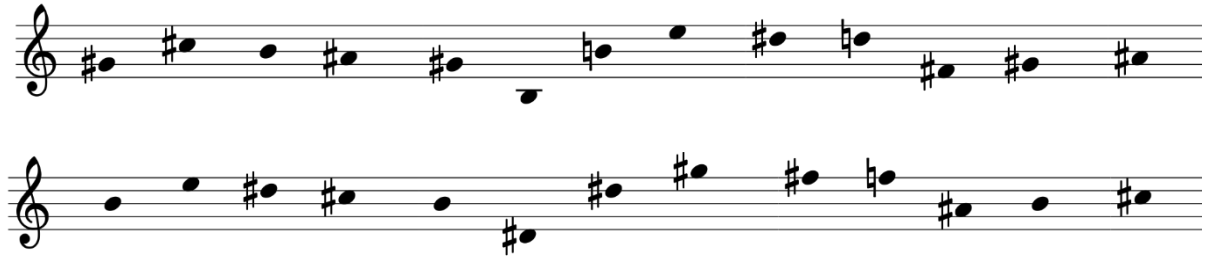


Figure 39: An example of the notation for the first movement of *Unnatural Processes.*

Work on the second movement, *border state's rights*, began with an unintentional misreading of a melodic fragment from fugue number 12, in G# Minor from Dmitri Shostakovich's 24 Preludes and Fugues for Piano (1955).

A.



B.

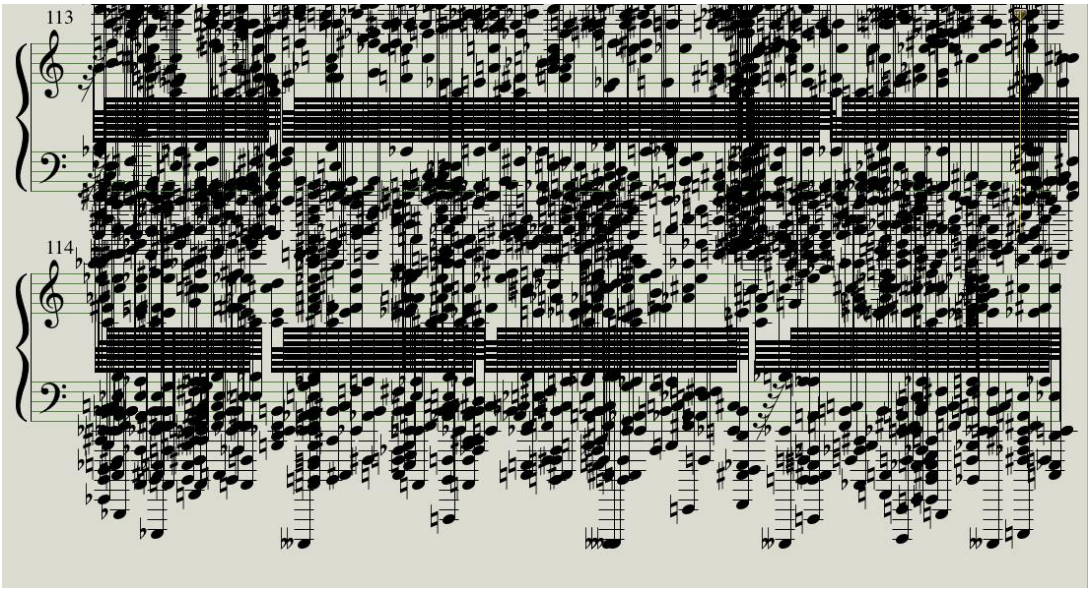
Figure 40: A. Pitches in the order they appear in the original motive by Shostakovich, and **B.** My "transposition," on which *Border States Rights* is built.

Since RHEA was playing the piano, rather than a human, I was able to transform the melody through an application of diagonal metamorphism, as discussed in Chapter 1, in ways that transcend the abilities of a human performer and inspired by works of Conlon Nancarrow. The role of the human performer in this movement is somewhat like that of a conductor, holding back and at times urging the processes forward. This role is expanded and enhanced in *Unnatural Habitats*, a computer and performer outgrowth of *Unnatural Processes.*

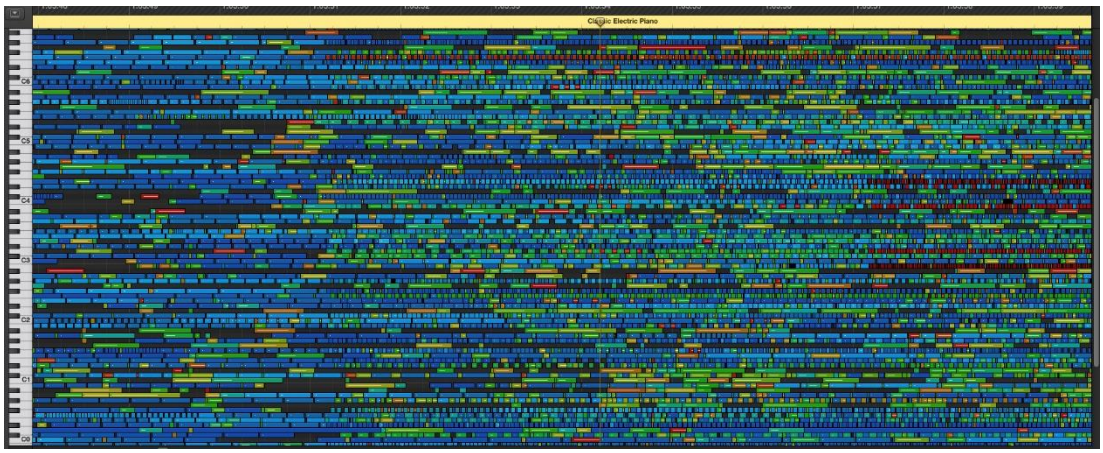
The progressive process of diagonal metamorphosis allows for degrees of obstruction of the melodic motive that is driving it. In *border state's rights,* I progressively change the pattern of transformation applied to the underlying repeated motive, clarifying or obscuring it by degree over time, adding a kind of cyclic development to the framing devices used in the piece.

To this end, I designed a bank of six sequencers, discussed in Chapter 1, with which I could implement linear behaviours over groups of notes. Patterns of transformation of register, dynamics, and degree of chromaticism all interact with the initial melodic line, at periods independent from it. This takes place on each of the six sequences individually, each at their own rate. This allowed me to suggest frames of reference to listeners that are gradually transformed or obscured. As the subtitle suggests, I sought a border-state between perceptually apprehensible forms.

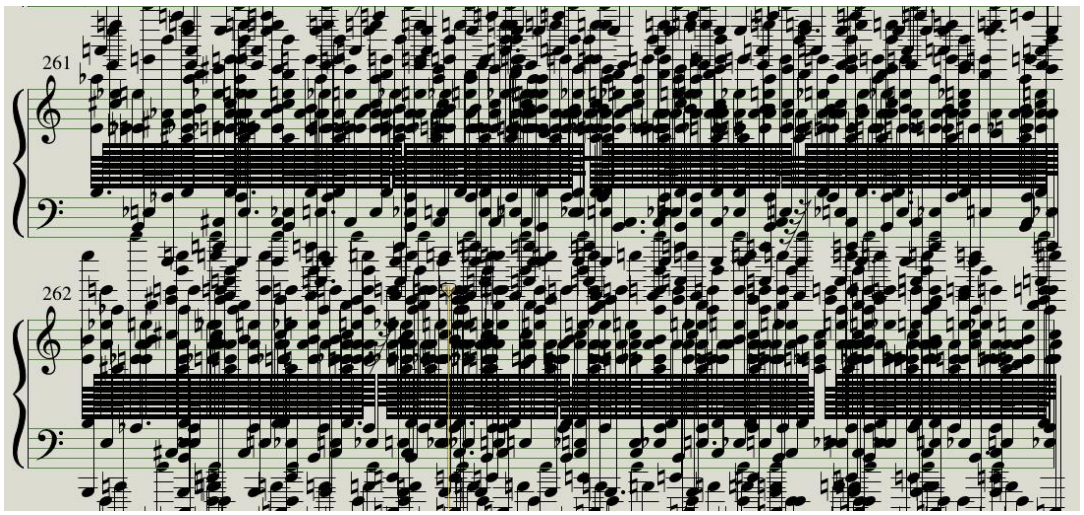
A1.



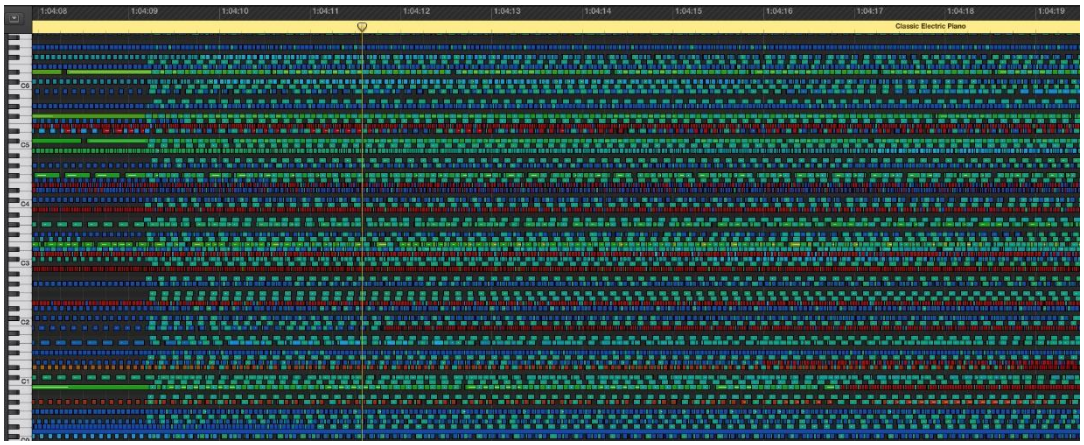
A2.



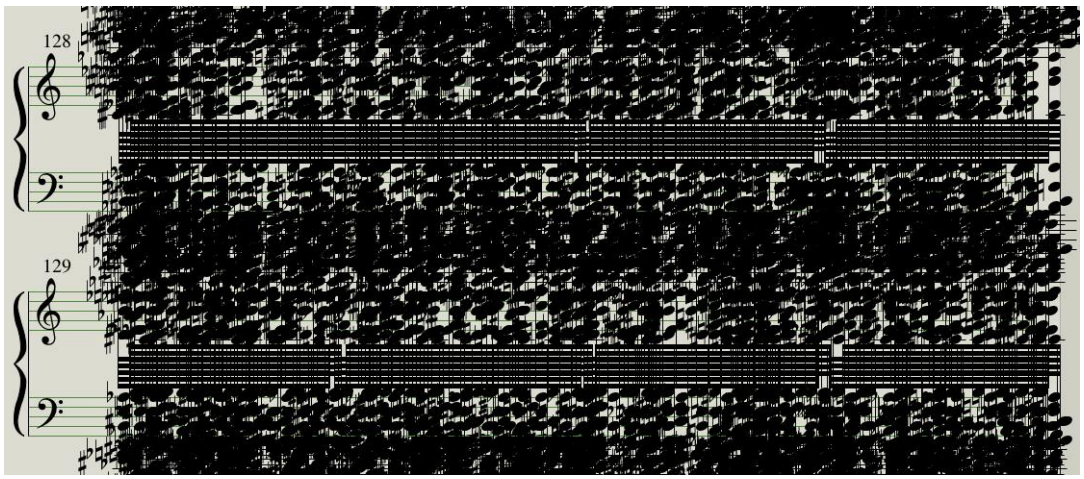
B1.



B2.



C1.



C2.

Figure 41 A(1,2), B(1,2), C(1,2): *Border States Rights* builds to an incredible density, demonstrated here in both raw midi data visualized in a DAW, and in notation generated from this. The density is such that both become unreadable. The results are cumulative moving from A to C.

In *border state's rights*, there is no global time frame that a performer must adhere to. Rather, local time frames in which each action should last between three and twelve seconds as determined by the performer hold throughout the movement. Time becomes a treaty compromising large-scale formal concerns with the need for local responsivity in creating the conditions for listening to the emergence of pattern.

For the last movement, *the flock momentarily assumes an aspect of the head of Dmitri Shostakovich before departing into the distance*, durations are free but proportional indications are provided to the performer through spatial notation. Additionally, although the movement seems to progress in a similar manner to the first movement, a subtle change has occurred. In this movement, keys do not behave as individuals, but rather each responds to those around it, in the manner of a flock. This is discussed at the end of Chapter 1 with reference to the BOIDS algorithm.

In *Unnatural Processes*, each of the three movements create and then frustrate linear expectations. The use of an approach more common to digital synthesis than acoustic piano playing, and the use of an acoustic piano for "broadcast" rather than an array of loudspeakers, both limited and enabled the possibilities for creative action in this piece. I found these limitations beneficial in that my working process focused on patterns of sounds within a unified field of timbre, rather than on sound design or more commonly encountered performer-centred concerns.

3.3 In Warmer Seasons:
for soprano, flute, and guitar
(2015)

When I began working on *In Warmer Seasons*, my intention was to use the diagonal metamorphism technique that I had developed previously for *Everything is Happening At One Time* (an oboe solo) to determine a trajectory of expansion and variation for the ensemble as a whole. I was especially interested in two outcomes of the use of this technique and wanted to develop these in an ensemble work. The first was a notable tendency for diagonal metamorphism to create conditions facilitating perceptual stream segregation. This is discussed in Chapter 1.

The second outcome of my early work with diagonal metamorphism that I wanted to explore further was the sense of uncertainty created through the ambiguous suggestion of a motive never explicitly stated. Such simulacra, variations without originals, found their way into each of the parts in the work. In each case the results were, in their own way, interesting and fruitful enough to stimulate research in related and divergent directions in the pieces I wrote following this one. In writing *In Warmer Seasons*, several ideas I had been working with came together, and following it several new ideas diverged from it, making this a central work in the early part of my research period. Following this piece, my research focus shifted from material concerns about what was happening in terms of material processes towards a more direct emphasis on phenomenological concerns.

My original conception of the work as an ensemble-oriented, largely monophonic exposition of diagonal metamorphism underwent a complete redirection as I worked on the piece. I realized that nearly every aspect of the piece I was writing demanded to be considered at once singularly and autonomously, and only secondarily in relation to the rest of the material in the work, or the ensemble. My initial impulse is a project that remains to be realized in future work.

The materials first, or bottom-up approach I adopted in this piece worked due to certain shared, yet unsynchronized structures in the architecture of each of the three parts. In terms of tempo, each accelerates in the second half of the piece, and then slows down. They do not start and end at the same tempo, nor do they climax together, but rather they miss each other, drifting past like ships in the fog. However, they do each 'heat up' and then 'cool down' in terms of tempi.[53] Perceptually, this leads listeners to a strong feeling of common ensemble movement, despite the lack of absolutely synchronized chronologies.

There are also harmonic relationships between the three parts that make up the ensemble. The flute and guitar parts mirror one another in that the guitar begins with a strong sense of tonal gravity, before very gradually moving towards a symmetrical

[53] One of the ensemble members described feeling like "a hot mess" at this point of the piece.

chromatic field in which twelve equal tempered tones are given equal importance as the piece progresses. The flute follows the exact opposite trajectory, beginning in a highly chromatic and symmetrical harmonic state and gradually moving towards a more asymmetrical orientation. The voice meanwhile maintains the same harmonic orientation throughout, drawing on similar melodic gestures that expand and contract in light of changing temporal frameworks, and with some gestural variations.

3.3.1 Form

Around the time I wrote this piece a great deal of my structural thinking was focused on notions of autonomous sound-producing centres and how individual listeners apprehend these. I began to consider environments as collections of independent or semi-autonomous individual entities in a shared space. This idea has influenced all of my portfolio work, at least to some extent.

Form in this piece presents a kind of paradox in that the piece presents a unified body, yet simultaneously a multiplicity of possibilities exist for coincidence between the parts, as they pursue their individual trajectories. These approaches work together in the manner of a montage of independent materials in a shared frame, situations occurring created by the circumstances of the piece.

3.3.2 No Standard

I composed each of the three parts simultaneously, yet separately. The three musicians play parts that occupy distinct process-trajectories developing at their own individual rates. Despite a shared eight-minute duration, there is no clock-time, meter, conductor, or other ensemble-wide time standard used in the piece.[54] Instead, players follow their own variable time standards as delivered by a click track. The click track each player receives is specific to their part, and they all indicate their own rates, yet they follow similar

[54] However, the parts begin at same moment.

trajectories. The three parts may be performed as solo works, separate from the ensemble version.

3.3.3 Expected and Unexpected Results

Each musician also plays a small wooden percussion instrument. Performers outline the beginnings or endings of short phrases with wooden signals, but the end result across the ensemble is a texture of multiplicity resembling disordered metronomes. Thus, by highlighting both relationship and divergence between parts, the wooden instruments serve to illustrate a point central to this piece: the presence of simultaneously perceived yet contrasting time frames. In addition, though tied absolutely to the instrumental and vocal parts of each player, the repetitive wooden articulations result in an interesting and unforeseen sonic gestalt. The activities of the wooden percussion instruments fused to form a textural cloud that seems to float independently of the rest of the sounding material. Thus, the wooden articulations create a sounding map of the progress of individual tempi in the piece, but one rendered as a separate and very uniform precept. The strength of this unexpected perceptual grouping by timbre was such that it led me to explore this notion of a collapse of many elements into a perceptual monad in several pieces following this one.

3.3.4 Quantization and The Impossible

There is an impossibility at the root of the task to be undertaken by each musician in this piece. The parts contain subdivisions, yet the tempo is changing from one moment to the next, such that no three subsequent metronome beats will delineate the same two time intervals on either side of a central beat. Thus, the performers cannot subdivide the rhythmic material with a finite degree of accuracy. The issue is one of an appropriate threshold of attention to apply in order to attain rhythmic accuracy, an acceptable standard of quantization for the performance of the piece. Yet the point is in no way to induce the performers to fail, but rather to encourage them to throw themselves into the music and its moving current of time, playing forward into the material while calibrating their progress to

the clicks received. It is a bit like swimming into breaking waves at the seafront. The point is freedom rather than failure.

This highlights a preference in my recent work for continuity of experience, surprise, and discovery, over the desire for a perfected formal design. What might at first seem similar to an obstacle course undertaken against a clock, in which one moves forward despite error, is rather a situation of falling, in which performers fall forward into the continuously contracting and then expanding moment. This is an approach I have since developed in other works in my portfolio, such as *Descent from the High Arches and the Bog Chorus*, and *Magnetic Arch*.

The ecology of this work is composed in both a bottom-up and top-down manner, and addresses both material interaction and formal design. Meaning arises out of situations between sound textures, whose context is created through the circumstances of the piece. As Lucretius points out, we make meaning out of what is given in a situation. Rather than becoming frustrated over the lack of a standard, let us celebrate our response to the present: "Nothing in the body is made in order that we may use it. What happens to exist is the cause of its use" (Lucretius, 1951, 156).

3.4 Unnatural Habitats: for performer and real-time computer music system (2016)

Unnatural Habitats is a piece of real-time electronic music for computer and performer. This piece represents my first resolved development in an effort to use the live electronic performance tools created for *Unnatural Processes* in a broader environment and for further exploration. In contrast to the earlier work, in *Unnatural Habitats* I adopt an approach to sound design focusing on creating tension between aspects of timbre that fuse, and aspects that resist one another. Since my individual lines are canonic repetitions of a

melodic motive,[55] the individual independence of the lines presented is in a constant state of tension with their collective identity as a fused whole.

While active listening is a performative consideration for *Unnatural Processes*, it is central to a performance of *Unnatural Habitats.* Through this practice, the phenomenological aims of *Unnatural Habitats* come closer to the central aims of all of my recent work. The performer is called upon to adopt a specific attitude of both receptivity and action in order to perform the piece correctly. The score advises performers to practice not only the music, but also concentration.

Unnatural Habitats is the first work from my research period in which the performer acts to focus the sound according to their own personal experience of what they hear. Instructions provide circumstances as to what to listen for (emergent patterns that arise from combinations of performed material, along with room resonances), but the foregrounded aspects of the sounding texture are in the hands of a specific performer and their interpretive approach. This work continues in pieces like *Magnetic Arch* and *Circular Bridge Squirrel Walk.*

3.5 Helical Pastimes: duet for player pianos (2016)

Helical Pastimes was written in response to an invitation from a festival in the USA in which two mechanical piano systems were present.[56] It is just over 25 minutes in length and involves no performer, but rather two SPIRO-equipped pianos,[57] controlled by synchronized midi files. In comparison to Winfried Ritsch's RHEA system, used in *Unnatural Processes*,

[55] Derived from the second movement of *Unnatural Processes.*
[56] http://www.pianoswithoutorgans.com
[57] Spiro is detailed at http://www.steinway.com/spirio

these devices are mechanically limited in terms of the number of notes that can be played at one time, and the upper and lower velocity values that they can be played with. My approach in this work is thus both similar and divergent from my earlier work for mechanical piano.

As with *Unnatural Processes*, in *Helical Pastimes* I create a context to examine aural attention and perception of musical structure. However, in contrast to the immersive, Dionysian presence of the earlier work, *Pastimes* instead suggests coldness and control. From the beginning, a sense of order is established, yet as the piece progresses this reveals itself to be deceptive. The piece is long, and cyclic material continuously unfolds or unravels without a clear thematic statement, in the manner of a Baudrillardian simulacra (Baudrillard, 1994). Mirroring and circularity are present in the piece, as well as a simultaneous sense of forward motion and stasis. Like waves on the surface of a river, the movement is continuous but the form remains consistent.

The manner in which the piece is presented in concert and how it is presented in the live video recording I designed are similar but different. The orientation of the pianos for live performance is seen below. This design is intended to emphasize the circular motion of the melodic activities across the keys. This also emphasizes the fact that the listeners and the sounds are in a shared situation together, an encounter, which, should the audience be allowed to move about freely, creates a performance that is also an installation. From no vantage point, save above, would the audience apprehend both piano keyboards simultaneously, but by moving around them circularly, they could construct a sense of the similarly circular movement across the keys of both keyboards.

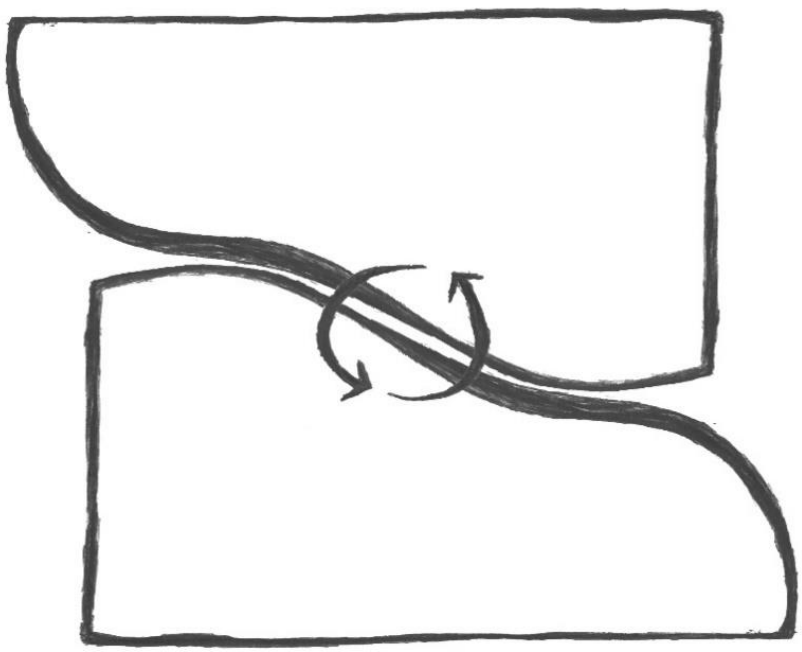


Figure 42: This drawing from the *Helical Pastimes* score indicates the preferred position of the two pianos and also suggests the circular motion that occurs between the two keyboards at several points in the piece. The audience may locate themselves anywhere around the pianos, sit or stand, and change positions as they wish.

Conceptualizing a way to capture this piece as a recording presented a special challenge. Video helps to convey that this is not a recording of several overdubbed piano parts, but rather a "situation" between two pianos. I felt that a full view of both keyboards was needed onscreen to spotlight the visible circularity, hocketing, and other patterned activity between the two pianos, despite the fact that this is precisely what is counter-indicated in an optimum live presentation. However, many options I experimented with resulted in compromises that either did not leave the full keyboards visible or did not preserve the equality of the two pianos. The compromise that solved the problem, obvious from the onset of the video, is that one of the pianos is presented upside down. As a result, this video offers a vantage point on the action of the piece that cannot be seen in any live performance, at least not until someone stages it with one piano suspended inverse above another one.

Figure 43: A captured video frame from just before the piece begins, showing the orientation of the pianos in the video recording.

Helical Pastimes is the most thoroughly deterministic piece in my portfolio. The relative uniformity of timbre that could be achieved with these pianos suggested the perfect medium to test diagonal metamorphism. Here this is applied to a determination of the large-scale form of the piece. This best illustrated by the gradual increase in chromatic alterations from the opening pitch material, progressing to the midpoint of the piece. At this point, what was just heard is then verticalized and performed in retrograde (with some modifications) to end the movement. I also subjected the underlying temporal grid to periodic expansions and contractions. The temporal curves are sometimes in unison between the two pianos, but more often diverge, rising and falling at different rates, to different extents, and eventually contrasting one another, to resemble a landscape shorn in divergent directions by underlying forces.

These temporal fluctuations have a noticeable perceptual affect in that streaming, as discussed in Chapter 1, is greatly enhanced as the tempo increases and then diminished as it falls again. This was expected, as fast tempi are known to enhance the likelihood of experiencing this perceptual effect, especially when the material is presented in different registers as it is here (Bregman, 1994). In this case, the listener is presented with sequences of material that seem to separate into treble and bass voices, from the two melodic lines

incessantly travelling up and down. The continuous speeding up and slowing down, while making it rather difficult to remain focused on the piece, has the benefit of framing the fact that these segregated streams emerge from the texture again and again as the tempo changes. The repeated changes foreground how similar material is experienced differently in different temporal contexts.

The swelling and constriction of the temporal grid on which this material is situated causes longitudinal waves of temporal acceleration and retardation to run through the material. Combined with the smaller transverse waves of up and down frequency activity across the piano this is again suggestive of fracture in the most active sections, and a sense of stretching of texture in the gradually slowing sections. The rhythmic contour of the piece as visible in the midi data of the piece looks like a view of an area of landscape subjected to seismic activity, in which the land has been alternately stretched and folded in response to energy currents beneath it.

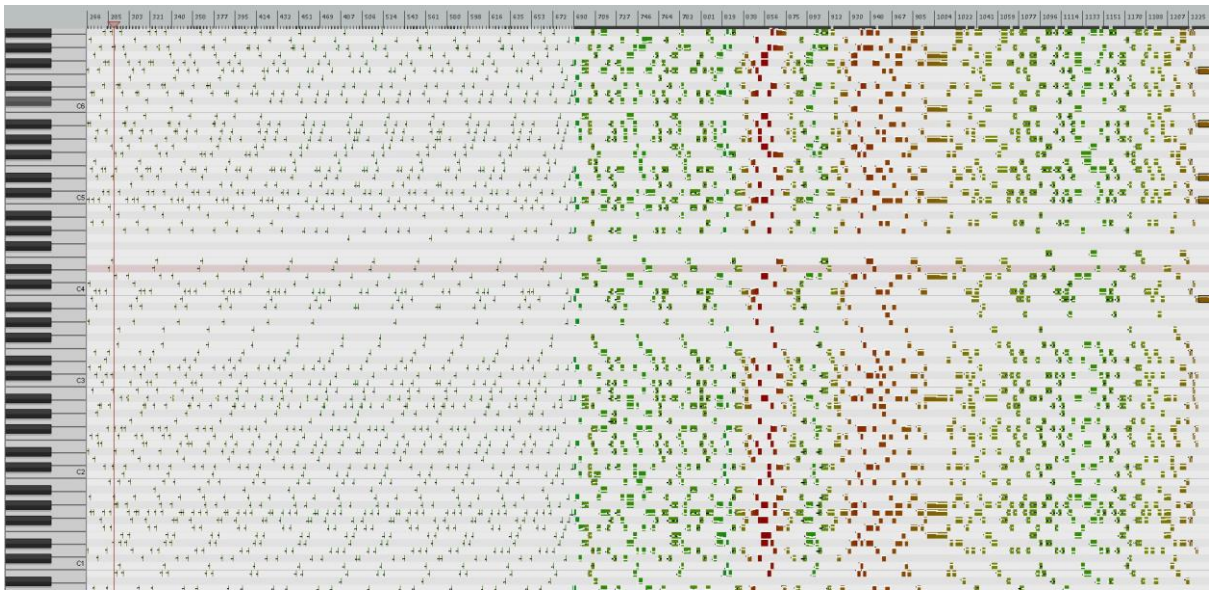


Figure 44: Midi data from the Piano 1 part of *Helical Pastimes* visualized.

Figure 45: San Andreas Fault in the Carrizo Plain, California (Ikluft, 2007).

In *Helical Pastimes* the elastic treatment of musical time frames coupled to the use of diagonal metamorphism creates material that is already in transformation at the moment it is heard. The piece creates the conditions for listening to sound structures that are being modified by the same processes that are simultaneously creating them. These processes themselves are the subject, and the notes are the material, through which they are audibly embodied. Following the development of this piece, my treatment of both musical material and temporal frameworks has become more free, guided by an interest in how the overall experience of the work develops for a listener. As such, later pieces set aside any formal need to visit every possibility within a permutation of material, and in general do not focus on mechanical aspects of material processes.

3.6 Descent from the High Arches and the Bog Chorus: a quartet for wood and waves (2016)

Descent from the High Arches and the Bog Chorus is a twenty-one minute piece for four musicians playing one woodblock or temple block each, and loudspeakers. Seating follows

the approximate arrangement for a traditional string quartet. All performers respond to a single score, which is a piece of software run on a computer with a display visible to all players. The software is a Pure Data (Pd) patch that both synthesizes electronic sound used in the performance, and simultaneously cues the actions of performers. Thus, a piece of software functions both as the part from which the performers play, and simultaneously synthesizes some of what is heard.

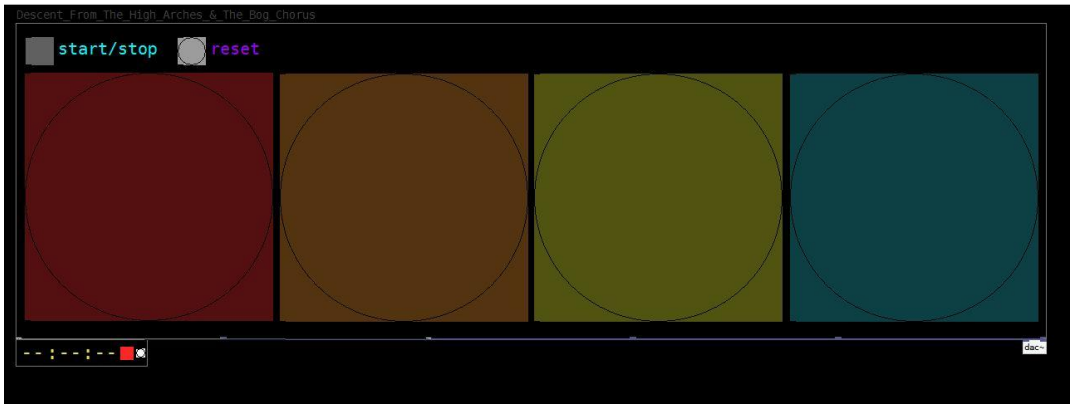


Figure 46: *High Arches Bog Chorus* performance interface.

For the duration of the piece, performers produce a steady stream of pulses from their instruments, as cued by visual metronomes that appear in the form of flashing coloured circles in fig.46. The metronomes follow continuous curves of acceleration or deceleration. Each is matched by a tone that varies proportionally with the flashing indicator. These tones are broadcast from the loudspeakers. Since the woodblock players strike their woodblocks every time their light flashes, their parts are each fundamentally tied to one of the four broadcast sine waves. Each of the woodblock parts is simply a proportionally slower copy of the synthesized tones.

In practice, and as is the case with *In Warmer Seasons*, performers are encouraged to think of the metronomes as calibration devices, anticipating the tempo's trajectory at each moment. An effect of this for those performing can be that of surfing between moments. Each subsequent pulse is separated by only slightly greater or less time than it was from its immediate predecessor, so there are no abrupt changes of speed. The exact speed with which one is asked to play is neither predictable nor perfectly definable, and so, strictly

speaking, the task is impossible if rhythmic perfection is what is sought. However, as in the earlier work, perfection is not the goal, and the solution is simply to play, watch, and listen, rather than count. The frustration built into this situation serves to highlight the fact that the goal is not rhythmic perfection.

Instead, the goal is to engage with the immediate present through performance. The strategy for doing so is to establish and then immediately dissolve a series of nested referential frames, and this is enacted in performance of the piece. The presence of time is demarcated by a cloud of differently pitched reference points, articulated by the metronome-like attacks of the instruments. These shift in ways that keep attention focused on the space between them. As in some of the work of my former teacher Pauline Oliveros, this piece is something of a meditation, an activity to be undertaken and experienced. In dealing with the circumstances created through performing the piece, performers and listeners can engage with unfolding sense of the present moment, further creating the conditions for awareness of their own sense of awareness.

For performers, locating and applying an appropriate degree of precision and focus to the task at hand is part of the practice needed to perform the piece. A question each performer must individually negotiate is: *what is the appropriate level of detail with which to respond to this anti-metronome?* As a question of quantization, this question frames a basic principal of interaction by which we engage phenomena in the world (and especially when dealing with digital technology).[58] What level of detail results in the best response?

Meanwhile, for audience members, the piece frames exploration of another perceptual phenomenon, developed from working on my trio piece *In Warmer Seasons*. In *Descent*, perceptual grouping by timbre is highlighted by the fact that although each sine tone is structurally welded to the pulse played by a particular quartet member, the sine

[58] Quantization is the process by which a smooth and continuous signal is constrained around a discrete set of values. This occurs when smooth analog sound-pressure waves are recorded as discrete digital signals in our computers, for example. Within all applications of digital technology, an appropriate amount of quantization is applied to information in a particular situation in order to achieve the desired field of meaning, or quality, termed resolution.

tones are heard as a group. The wooden instruments, heard as a collective cloud of sound, oppose their own construction. This result extends observations of a similar phenomenon in *In Warmer Seasons*, and in *Descent*, testing this in a focused way was a priority. In *Island in Natural Colours*, this effect is applied in yet another way in which varied attack envelopes of synthesized tones are used to create percussive clicks that move about the room with different degrees of sharpness.

3.7 Magnetic Arch:
for any number of string players
with amplified acoustic instruments and electronics
(2017)

Magnetic Arch is a piece for any number of string players in any tuning. Each individual player's part constitutes a performance of the piece. An ensemble performance is therefore an aggregation of many individual performances. A performance lasts any multiple of 4 minutes of 2 or greater (e.g. 8, 12, 16). Performances may be devised in which performers begin at different times, and individual parts may follow their own durations. Performances overlap, occur sequentially, or may be separated in time.

In each individual performance, the selected time frame is first divided into two halves, and subsequently into four quarters. This yields a total of eight segments of equal duration, all performed in sequence without pause. Each segment consists of bowing a single open string, beginning on the lowest string for segment one, moving to the highest for segment four. The highest string is repeated for segment five, at which point the process is performed in reverse finishing on the lowest string in segment eight. For the first four segments, a distortion system is engaged. At the beginning of the fifth sequence, the exact middle of the piece, the distortion system is abruptly disengaged, and the second half is performed amplified but otherwise without electronic processing.

The manner by which performers play their instruments remains consistent throughout the piece regardless of whether the distortion system is engaged or not. Performers steadily and consistently bow open stings with light to medium pressure in positions very close to, on, or just across the bridge. The angle of the bow may be varied slowly and gradually, always attempting to avoid abrupt changes in the sound produced.

Much of the time a complex noise band will be produced, but occasionally and unpredictably a harmonic will reinforce itself and emerge from the noise band. When this occurs, performers attempt to sustain this state for as long as possible. Performers spend the piece actively attending to the momentary emergence of sound at the meeting of bow and string, and with a strong bodily awareness of balanced movement.

The score of the work consists of instructions and a simple graphic, which may be used as a mental mnemonic device. Musicians should perform the work without score, rendering the instructions into a practice though rehearsal.

Performance of this work, as with *Descent from the High Arches and the Bog Chorus*, acutely frames a sensation of awareness of passing moments. Additionally, a sense of magnification of minute sonic detail becomes audible. As these are coupled to very slight changes in body orientation, bow speed or angle, and mental attitude, the performer enters a kind of feedback loop with themselves. This experience can be extremely hypnotic, disturbing, or pleasurable, and I have found it to be each of these in a single performance. Performers are continuously reminded that their sense of time passing is but one of many possible frames of reference, a point made by each glance at the stopwatch that governs the abrupt movement of string to string throughout the piece.

3.8 Fans of Beethoven: environmental sound situation

Fans of Beethoven calls for two full range and preferably large speakers to be placed on the stage or in the performance area of a venue usually used for concerts. The venue should be lit and seating provided as would be the case for a performance to take place. A stereo track, 27 minutes long, is played in a continuous loop commencing before the first visitor arrives and concluding after the last leaves. The loudspeakers should be adjusted to a volume at which the sound fills the space, provokes the resonances of the room and can be felt physically. The sound should be quite full, and suggestive of a great deal of presence, but not to the point of pain.

The sound material in the work consists of audience applause, incidental and environmental sound from concert venues, and various performances of a specific chord taken from live recordings of recent performances of Beethoven's Seventh Symphony. The mood of this piece was partially suggested by passionate online debates regarding which movement of this symphony is the 'best'. Thematic and material subtexts of the piece weave material paths from sonic transcendence to absurdity and pathos. These subtexts will be discussed briefly below. However, any narrative or subtext in the work is secondary to the temporal unfolding of the sound in a visitor's experience.

Without a point of reference, a visitor enters the space at any point in the audio track. Their experience begins then, and they will construct a sense of what they are hearing based on this. Sonically, there are three main textures of which the piece is made. The first is a dense broadband noise, the second an extended chord forming a continuum, and the third consists of muffled and diffuse sounds suggestive both of catering work and orchestral rehearsal. All of these function in ways that suggest meaningful completion by a listener.

The dense broadband noise presents an immersive relationship of scale to a listener, and a sense of temporal stasis. However, closer listening will reveal a great deal of detail

and even teleology within the cloud. I have composed some of the trajectories that can be heard in this noise wash, but others are the result of relationships emerging from combinations of micro-variations in the harmonic materials of the broadband noise. Artefacts in the recordings and the pattern-structuring functions of a listener's own mind complete the picture. As in the case when listening to a waterfall, a great deal of what is heard is actually one's own structuring mechanism grasping for order in a continuously changing situation.

Moving inward from the immersive broadband noise, the next texture, that of an extended chordal continuum, suggests penetrability. This texture abruptly begins, and then glacially fades to nothing. Tiny changes in tuning and accent within the continuum of sound are emphasized. This approach invites internal modes of listening, in the manner of the beating intervals often used by Morton Feldman and Giacinto Scelsi, however, this chord also redirects the listener back to its surface. It is not penetrable, despite its luxurious invitation. Redirected to the surface of the sound, the paradoxical simultaneous presence of perceived stasis and movement provide a tracery framing the ceaseless now.

The third main texture in the work enters while the chord continues. This is a mixture of undirected independent instrumental sounds, constructed from recordings that included orchestral pre-concert warm-ups and the sounds of workers clearing away catering following a performance. Vocoded with the sounds of rain, this texture takes on a sombre tone, rich and dark. The muffled voices and irregularly looped instrument sounds suggest small melodic motives, accompanied by a difficult to define sense of labour. These sounds seem to struggle and interfere with one another, and there is no centre of focus, apart from the suggestion that a listener is eavesdropping on sounds of work being done by others, unintentional and not intended to be heard.

In all three of these textures there are a great deal of elements for a listener to work with in terms of constituting meaningful structure and perhaps memory-based representational associations from what is heard. A great deal of material presented in this piece lends itself to associative chains of meaning should listeners apprehend or construct

ideas around the source of the sounds. The noise texture, for example, is based on audience applause vocoded with the sound of ventilating fans to create a wash of sound that suggests vague pitch trajectories and a river-like quality. Therefore, a listener who picks up representational cues in these sounds may find their associations oscillating between images of moving water and a concert hall!

Furthermore, the violence of the applause and cheering suggests the maddening and frightening effect of being immersed in a crowd and moved along against one's will in the current of a human torrent. Voices in this texture are vocoded with variants of the chord that will soon enter, creating a subtle trajectory towards this new texture. This creates an alien quality in which voices first seem to scream or cry out, then sing, with a tone more like metallic string instruments or organ pipes than voices.

The suggestivity of these sounds, in combination with the staging of this piece, creates a narrative frame present in this work that is not explicit in other portfolio works. While for me this involves themes of mortality, artistic intentions, individuals and societies, the madness of fandom, the pursuit of fame, the alluvial spreading forth of material in nature at river deltas and glacial moraines, the somewhat violent mechanical wind produced by ventilating fans, beauty, communication, and Beethoven's Seventh, I do not expect the audience to specifically share in these. The dense and ambiguous nature of the sound textures are composed to present structures that are foregrounded only to collapse back inside themselves leaving the listener uncertain as to whether the sounds were intentionally placed there by the composer or their own minds. For me, this somewhat mirrors the experience of attempting to understand the minds of others, even those with whom we are closest. Yet to this situation is added the possibility for schema-based narratives to evolve, and possibly for fans of Beethoven, even some of a historicist nature. Although a fixed media work in terms of the broadcast audio, it remains an open system when situated with listeners in the circumstances called for in the score.

3.9 Circular Bridge Squirrel Walk

solo for viola and electronic feedback system

(2017)

Circular Bridge Squirrel Walk is a frame for activity; a composed context for performance that results in partially unforeseen musical material whose continued existence is mediated by a performer. As the 'circular walk' in the title suggests, it explores similar territory on the body of the viola from two different vantage points, returning to a place reminiscent of where it began.

In a circular hike, the difference between a hike and a utilitarian, everyday walk is emphasized. Circulars have no destination apart from the marvellous. Since they end in a similar place to where they begin, they function to frame phenomena encountered along the way, and the walker is free to linger whenever something interesting is encountered.[59] The walker on a circular knows where they are going and how far along they are, and so can attend to the abundant circumstances of their situation. *Circular Bridge Squirrel Walk* mediates material instability in musical performance with a performer's improvised reactions to the situation as it arises. The performer may proceed at their own rate, lingering over any sound that they find interesting, exploring its characteristics and developing it through their interaction. The only regulation is that they generally move forward through the score.

The piece is performed with an audio transducer in the left hand and a bow in the right. The audio transducer, a speaker coil without a speaker cone attached, forms part of a feedback circuit that it is driven by an amplified form of its own output signal. The piece begins with the performer bowing the low string of the viola while exciting the high string with the transducer.[60] At the start of the piece, the performer may make a few broad

[59] It is interesting to consider this perspective to the contemporary practice of sound walking, particularly of the sort found in Hildegard Westerkamp's work.

[60] Strings may be retuned according to performer choice for this piece. In the recording low to high C-G-C-G was used, to encourage as much harmonic reinforcement as possible.

gestures with the bow to set the transducer in motion, after which it generally sustains itself with its own feedback, mediated by the performer lifting and reapplying bow and/or transducer to the strings. The system is very sensitive to pressure and a great many harmonics will be found and activated through different combinations of bow and transducer techniques, developed through practice by the performer.

Figure 47: An 'audio exciter', signal to vibration transducer.

At the opening of the work, the transducer begins on or behind the nut of the viola, where the strings meet the resistance at the end of the fingerboard, and angle into the tuning box. During the first half of the piece both the transducer and bow are gradually moved from the nut to the bridge, adding the second highest string upon reaching the 2nd harmonic, as shown in the score. The speed and distance covered by both bow and transducer are in the hands of the performer, and this continues to be the case throughout the piece.

Significantly, this score has no time in it. It is referred to as a map and depicts the landscape of the viola. What a performer is to do is notated relative to each point, but how long this should take is not specified. There are no specific details for sound design given, rather the piece is itself a frame for focusing on sound production as it happens.

Circular Bridge Squirrel Walk is an exploration of transduction and feedback in a performance context. The signal is mixed into itself, coming about through amplification of its own process of becoming. At times the activity of the bow seems to contradict what is heard. The sound is subtle and unpredictable at the beginning of the piece, and usually very dense, piercing, and full in the second half. All the while harmonic resonances attuned to

the scordatura of the viola are excited. The performer highlights particular points of interest. These factors function to build form and structure into the activity of performing and that of listening, creating a shared musical situation between audience and performer.

It is of particular interest to me that structures emerge in this piece through signals that interrupt one another or reinforce one another indirectly, as feedback. As discussed earlier in light of phase vocoding, the interruption by a signal with itself provides a particularly intimate and physical extension of the idea of diagonal metamorphism, the technique that begins Chapter 1. However, in contrast to diagonal metamorphism, this piece results in a real time modulation of sounds brought about by interaction within their own harmonic and articulatory aspects, which are then compressed into a unified result.

3.10 Island in Natural Colours: environmental sound situation (2017)

3.10.1 Conceptual Motivation

Island in Natural Colours is a fixed media sound environment composed for a three-ring array of twenty-four loudspeakers. The total audio running time is four hours and twenty minutes, although it is presumed that in most cases visitors will only experience a portion of the available material.

A drawing based on a modified view of Marcel Duchamp's *Oculist Witnesses* (1920) serves as a model for the overall composition of broadcast-trajectories throughout the piece. In *Oculist Witnesses*, Duchamp appropriates figures from an optician's chart and presents them in a skewed view, as if they had a particular perspective in which they were situated. A pun in the French title (*Temoins Oculists*) serves in English translation as 'eye witnesses', and, with Duchamp's *The Bride Stripped Bare by Her Bachelors, Even* (1915-23) as its object,

implies voyeurism (Schwarz, 1997). These witnesses are peeping at the bride, who is not entirely visible. However, in Duchamp's work, "the Bride" is the piece itself, and since it is translucent, it too is stripped, leaving us, as audience members, the voyeurs.

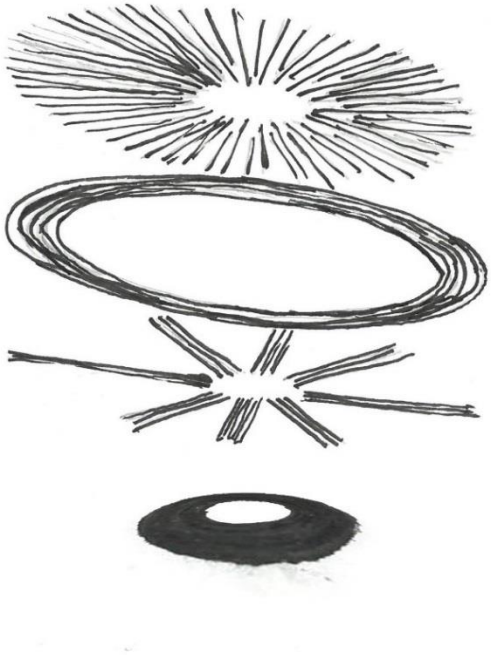


Figure 48: In the diagram, the position of the listener (the dark oblong ellipse at the bottom of the drawing) is shown in relation to the three rings of eight speakers each. In the drawing, the rings become less directional and more diffuse as our eyes follow them upwards. This mirrors the spatialization in *Island* in which ambisonic materials are presented from the top of the speaker array downwards, while more point-sourced directional sound is initiated from the bottom ring of eight, and secondarily, the bottom two rings of speakers.

In *Island,* listeners are not explicitly eavesdroppers (sonic voyeurs), however, upon entering into my sound environment already in progress, it is my hope that they become eavesdroppers upon their own ear-mind pattern formation system. To reflect the activity of active listeners back to themselves, listeners must be first conceptualized as active participants in the phenomena they apprehend. Surrounding listeners with sound that presents ambiguous figure/ground relationships and never settles into a fixed spatial orientation leads towards a perceptual completion of this situation.

The island metaphor is suggestive of a manner of visitation. As visitor to an island moves about, exploring its contour. However, in the case of *Island*, it is the piece that swings, surges, flutters, and washes around visitors. While visitors are free to move about the installation space, the area defined by the speakers is fairly constrained. For most of the piece, several mostly independent layers of sound activity exist simultaneously. By their presence and attention, visitors add further layers to the activity within the environment of *Island*. Who or what, then, is the *Island* referred to in the title?

3.10.2 Sound Design: Synthesis

The sound materials in *Island in Natural Colours* consist of synthesized and sampled sounds. The synthesized sounds were created using my own approach to additive synthesis, along with an implementation of the BOIDS algorithm for spatialization of sounds. This creates swarming, pulsating textures, along with the glacially-paced undulation of sound masses that are heard throughout the piece. The images below detail first the internal workings of the synthesis system, and then step through the BOIDS mapping onto the 24-speaker array for which the piece was composed.

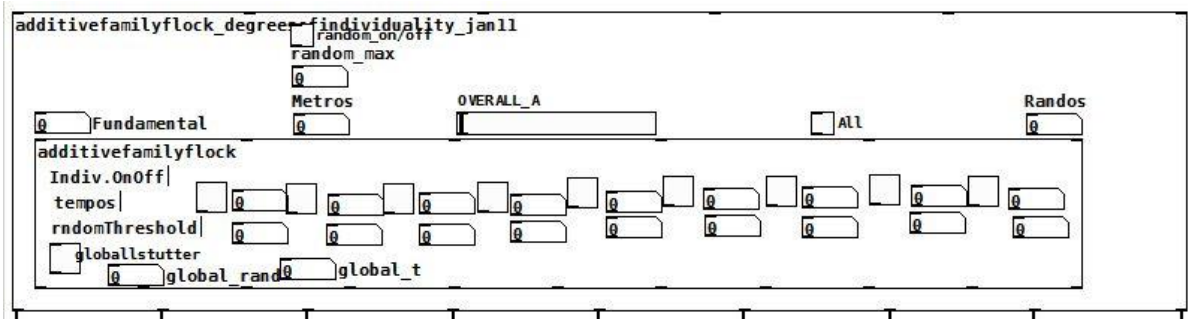


Figure 49: The "Additive Family" synthesizer creates tones made from nine component harmonic partials (the line of nine square toggles turns each of the these on and off individually). The frequency of each of these, and the rate at which they are played can be individually controlled (the number boxes next to each square toggle) or set globally (with the "fundamental" number box).

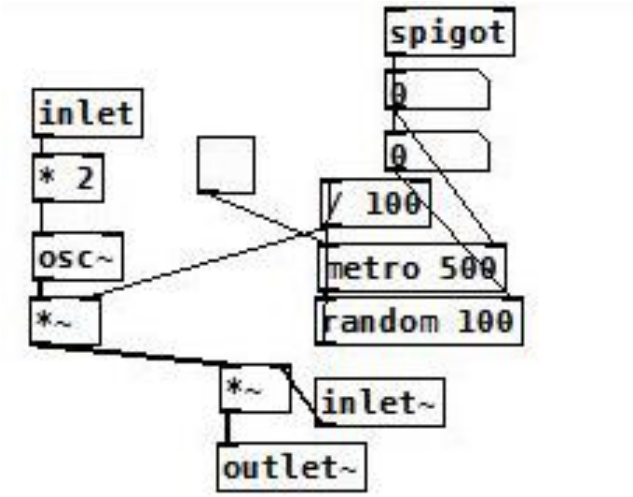


Figure 50: Inside the Additive Family synthesizer, nine modules like the one above create sounds. A single partial (the first overtone in this case, as designated by the *2 multiplier) is synthesized on the left side, while the right determines when and how often it is articulated.

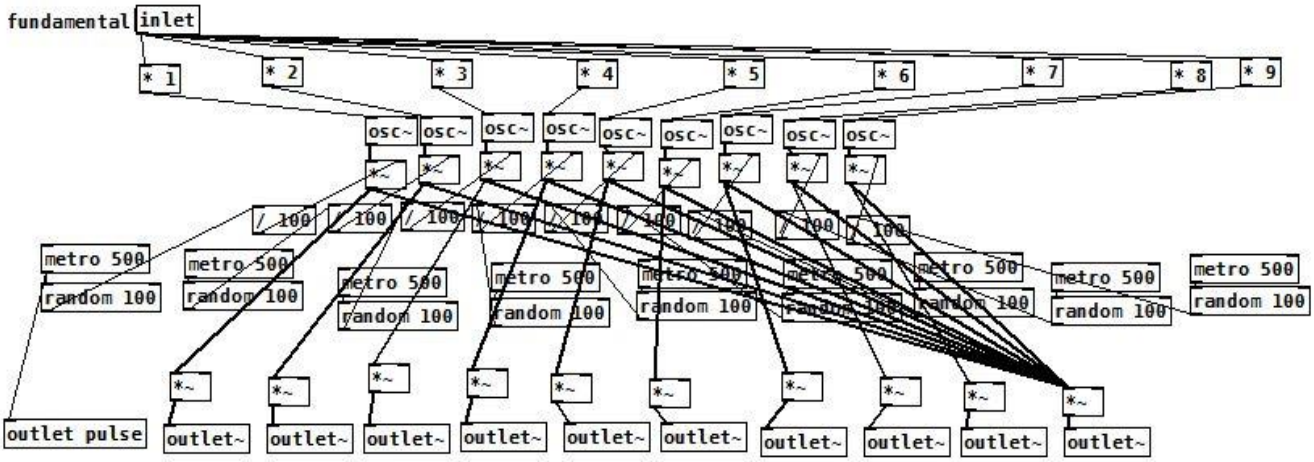


Figure 51: All nine partials can be seen to be multiples of the module shown in the previous figure.

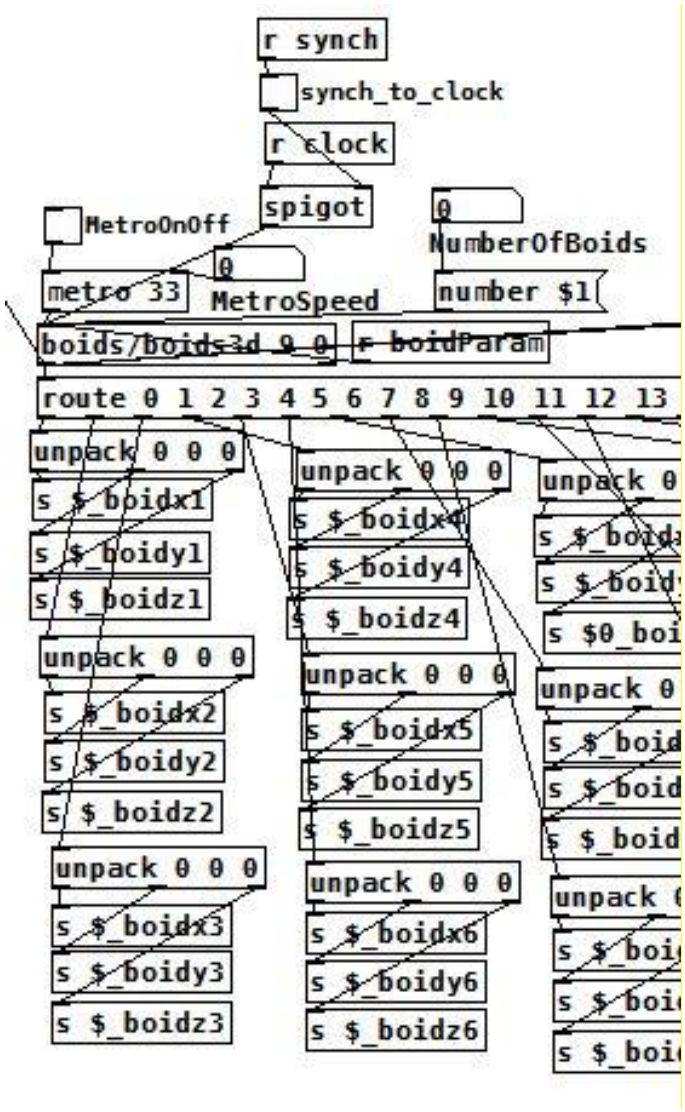


Figure 52: A swarm of BOIDs that defines a virtual three-dimensional space composed for the piece are polled for their x, y, and z positions with each tick of a clock.

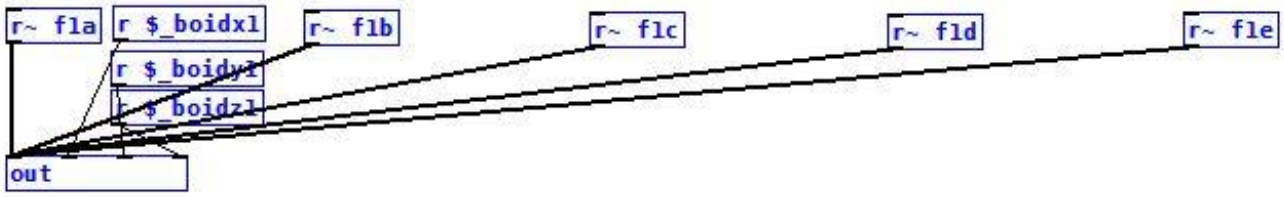


Figure 53: These values are combined with the sound data from the Additive Family synthesizers shown above and sent to speakers for output.

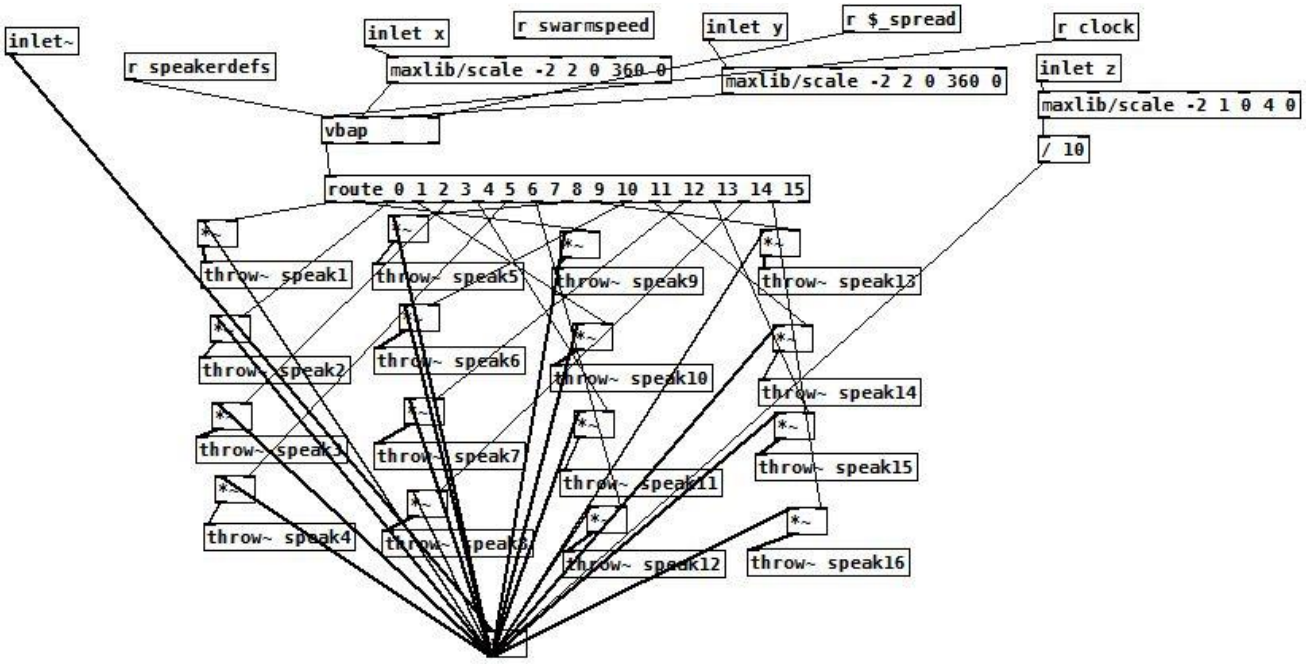


Figure 54: The spatialization is handled by first scaling the values to the appropriate range needed for the speaker array. Then, a Vector Based Amplitude Panning (VBAP) module is used to design a more or less diffuse or point-sourced image of the sound over some part of the speaker array, by sending values to each speaker, as shown. Moving sound is created by interpolating between a present and subsequent state of the sound's trajectory (as represented by x, y, and z coordinates).

3.10.3 Sound Design: Sampling

The piece makes use of sampled material collaged from readings from the 1898 edition of the journal *Birds and All Nature in Natural Colours* (1898). At times, these recordings are vocoded with synthesized bird song of my own design,[61] or convolved with recordings of water environments from around the world. The results represent environments from coasts crossing both oceans as well as arctic, rainforest, and river environments. These are at times presented without processing, and at other times used to modulate the readings from *Birds and All Nature.*

[61] See the appendicized *Cartesian Birds* for a focused example of this bird song synthesis.

The work follows in the footsteps of composers exploring sound in space and how it is perceived, from Charles Ives to Maryanne Amacher. The piece takes its title from contrasting popular conceptions of nature from 1898. On the one hand, the 1898 edition of the journal discussed above presents an idyllic view of nature as a harmonious and balanced paradise over which humans rule as kind stewards. On the other hand, the highly publicized ordeal of Alfred Dreyfus on Devil's Island, where he was imprisoned in 1898 after being falsely accused of treason against the French state, provides a contrasting view of nature.

Imagining the hut in which Dreyfus was confined, often in restraints, the sounds of birds and the distant surf provide respite from the constraints imposed on the innocent. In the manner of Luc Ferrari's *Presque Rien* pieces, the environment is laid open before the listener, and yet, as in Ferrari's pieces, it is not continuous but obviously constructed. At times the environment presents itself as an uncanny virtual landscape of synthesized and recorded sounds rich in associations. This is coupled with the use of three-dimensional ambisonic techniques for mixing and moving sound which create lush pools of harmonic pressure within the soundscape, leaving behind odd out-of-phase artefacts in their wake. In some moments, texts enter in the manner of unexpected thoughts. Voices are vocoded and convolved with those of birds, other human voices, or environmental sounds, as they do naturally, in our memories.

As in all of my recent work, a plurality of interpretive approaches on the part of the audience is encouraged. The themes that I have put forth are images and ideas I worked from in creating this island: part paradise, part hell, with an environmental sound dynamic suggestive of geomorphological process. However, I have deliberately withheld any strongly suggestive visual material in the piece itself. In approaching the installation in this way, I intend to create the conditions for creative aural engagement of the sort that can result in apprehension of processes of perception of time, space, and sound, as well as reflection on how narratives are constituted.

Chapter 4

Reflections and Further Developments

In this text, I have presented the thematic fibres that drove or developed within my thought and practice during my research period. At first glance, aspects of this work might seem broadly focused. However, my experimental pursuit of the ideas and methodologies as discussed in this text have uncovered connections between many seeming divergences, revealing these strands to be fibres within a growing braid, the form and trajectory of which are suggestive of future developments.

A key insight I have gained from my present work is that the pieces presented as sound environments are more rewarding in terms of the phenomenological investigations at the centre of my practice than pieces designed for performance. The simple reason for this is that my environmental work offers every engaged audience member a performative opportunity within the work directly, whereas my concert music has increasingly offered the most direct encounter with the sounds and their production to the performers, leaving the audience to a more passive role. I would like to develop my concert works by considering an environmental mode of presentation for them as I have in the case of pieces manifestly framed as environments.

In contrast to a traditional stage presentation with clear beginnings, endings, and focal points, further consideration of the relative autonomy present in the performer's parts of *In Warmer Seasons* suggests that an extension of this autonomy to the entire medium of the concert and hall itself would offer the possibility of surprising and adventurous alternatives to linear concert programming. Taking a cue from Christian Wolff's work with self-structuring complexity in semi-improvised ensembles, forms of environmental mediation involving interactive responsivity could be extended towards the climate of the concert space itself. Composed spatialization of performers within semi-indeterminate environments of lighting, electronic sound, and environmental factors (fog or wind, for example) could be situated within the circumstances of a constructed architectural staging

with the audience free to sit or stand anywhere in the performance space. While such a proposal is both entirely vague and extremely ambitious, small scale growth in this direction is being facilitated by recent technological innovations. The small and inexpensive Raspberry Pi computers, microcontrollers, motors, and the ability to run free and approachable programming environments on a variety of devices provide interesting means of experimentation.

The technologies mentioned above also help to provide solutions for performance work that I began in my research period and intend to continue developing. Specifically, the direction I refer to is presented in seed form in my portfolio pieces *Circular Bridge Squirrel Walk*, and *Magnetic Arch*. These works are focused on structuring time and sound through the adoption of a way of thinking or being, in relation to a proposed task. Performers, in this case, are explorers, and the music becomes an embodiment of their practice, within the practice proposed by the piece.

A technical expansion of such a compositional strategy could involve increasingly subtle and useful forms of feedback for the performer. Taking inspiration from works by Agostino Di Scipio in which ecological ideas inform the design of his electro-acoustic performance instruments and how performers negotiate them, I can clearly imagine a development of my current use of feedback to include my own ecological outlook, in which environments are considered a shared space of semi-autonomous entities in interaction. These are experimental approaches, prioritizing the unforeseen and providing information about interaction and immediate environments. Recent work by composer Luc Döbereiner builds on related directions, suggesting the possibility for approaches to performance that embody a real-time phenomenological investigation within self-regulating performer-instrument systems (Döbereiner , 2014). Scholarship around instability, interference, and responsiveness within Di Scipio's pieces (Bittencourt, 2014, Schröder, 2014) suggest still other technological and theoretical frameworks in terms of which further experimentation may be contextualized.

Diagonal metamorphism, a technique discussed at the beginning of Chapter 1, relies on interference between composed trajectories of information. When applied in the ways I discussed in Chapter 1, interesting emergent perceptual results are produced. Expanding these approaches towards multi-channel electronic sound situations is a necessary area for development. Emergent perceptual phenomena, like stream segregation and textural integration, could be focused on within a flexible set of composed environmental circumstances. The ability to move fluidly between multi-channel speaker arrays and binaural (headphone) sound settings, also provides for interesting musical and perceptual research possibilities, and provides an entry point for further work within interactive virtual reality environments.[62]

Building on my experiences with my portfolio piece *Unnatural Habitats*, I intend to try to expedite the performance of some of my newer works as they emerge through the use of easily available instruments and recent accessible technological approaches. The waveforms used in *Unnatural Habitats* were simple in nature (sine, square, triangle, etc), and this functioned to highlight their differences and interactions in a clear and foregrounded manner. Interferences between tones is a very dramatic experience in this context, and emergent psychoacoustic qualities (like beating) are often enhanced whereas sounds with more internal complexity can subdue or draw attention away from these perceptual qualities. These simple waveforms also suffer less in conditions where sound reinforcement or broadcast conditions are very colourful or in disrepair. The fact that there are a wide range of inexpensive and ubiquitous consumer electronic instruments, many of which are re-tuneable to a degree, that synthesize their sounds based on pulse-width modulation or square waves provides a wealth of exciting possibility in this direction.

A priority within my ongoing material and conceptual research is the further development of both theoretical perspectives and applied techniques for investigating temporal frames of reference. The sculptural and elastic frameworks for musical time

[62] A potential source for collaborative work with artists Pascal Silondi and Jakub Grosz, discussed previously.

discussed in Chapter 1 lend themselves to working with swarm behaviour or massed sound textures. Development of my procedures for working with material within skewed temporal grids or calibrated to 'curious' metronomes present starting points for this. I have been considering improved notational solutions for performers in these types of situations, as I do not feel that I have yet found the most suitable notation for approaches involving transformations of metrical frameworks. Two recent studies, inspired by certain works of Tristan Murail and Trevor Wishart, suggest starting points for experimentation with notation that will perhaps be more suitable for use in these on and off the grid musical situations.

Theoretically, I intend to continue and deepen my application of philosopher William James' notion of the specious present to a consideration of how people experience, conceive of, and discuss musical time. I have begun a study comparing musical metaphors with visual representations of time in the writings of philosophers William James, Edmund Husserl, Henri Bergson, and others.

I have also begun but not completed research regarding prehistoric roots for certain contemporary sound art practices, and I am interested to see how this more speculative work may intersect with notions of time expressed by the thinkers above. Prehistory, like very quiet music, resides on the edge of imagination and material existence. Listening to very quiet music, notions of what is constituted by a listener and what is present in a material environment are blurred. Consideration of prehistory similarly resides on a border of imagination and materiality, yet we depend on it for our present existence.

In a similar manner some of my very recent artistic experimentation investigates the contemporary world as a source of media artefacts, and explores imaginary linkages between material specificity for time and place within the subjective experience of listeners. In a continuation of the motivating inquiry that drives my portfolio work, listeners to these new works simultaneously embody linkages between materially constituted environmental circumstances and their own presence within them, perceptually constituting unfolding

encounters within phenomenological situations of sounds and their contexts, to include listening minds.

Bibliography and Works Cited

Aldrich, J. (2005, updated 2012). *Figures from the History of Probability and Statistics*. Retrieved from http://www.economics.soton.ac.uk/staff/aldrich/Figures.htm.

Ars Electronica. (2017). *Ars Electronica Archive: Maryanne Amacher*. Retrieved from http://archive.aec.at/media/assets/14006af3fe7bec64d189b3f4a8bc2002.pdf.

Ablinger, P. (2014). Cezanne and Music. In *Historical and Contemporary Modes of Musical Listening, International Symposium," Kunstuniversität Graz, January 2013*, Retrieved from http://earwaveevent.org/article/cezanne-and-music/.

Ablinger, P. (2005). *Phonorealism*. Retrieved from http://ablinger.mur.at/phonorealism.html.

Ablinger, P. (2006). *Quadraturen*. Retrieved from http://ablinger.mur.at/docu11.html#principles

Amacher, M. (1999). Head Rhythm 1 and Plaything 2, Sound Characters: Making the Third Ear. New York: Tzadik.

Andersen, H. (2014). *The Development of the "Specious present" and James's Views on Temporal Experience*. Cambridge, MA.The MIT Press. Retrieved from http://philsci-archive.pitt.edu/id/eprint/10721.

Arnheim, R. (1987). The State of the Art in Perception. *Leonardo, 20*(4), 305-307. doi:10.2307/1578523.

Arp, H.J. (1948). *On My Way (Documents of Modern Art)*. New York: Wittenborn, Schultz, Inc.
Baudrillard, J., Pōtriyā, L., Bodrijar, Z., Бодријар, Ж., & Glaser, S. F. (1994). *Simulacra and Simulation*. Ann Arbor, Michigan: University of Michigan Press.

Barrett, G.D. (2009). Between Noise and Language: The Sound Installations and Music of Peter Ablinger. *Mosaic : a Journal for the Interdisciplinary Study of Literature,* 42(4), pp. 147-164.

Bellhouse, D. (2005). Decoding Cardano's Liber de Ludo Aleae. *Historia Mathematica, 32*(2), 180-202. doi:10.1016/j.hm.2004.04.001

Bergson, H. (1968). *The Creative Mind.* Andison, M.L. (trans.). Westport, Connecticut: Greenwood.

Bergson, H. (1988). *Matter and Memory* . New York: Zone.

Bergson, H. (2001). *Time and Free Will : an Essay on the Immediate Data of Cconsciousness* . Mineola, N.Y.: Dover Publications.

Bertalanffy, L. (2015). *General System Theory : Foundations, Development, Applications* (Revised edition.). New York, New York: George Braziller.

Birds and Nature in Natural Colors. Chicago: Nature Study Publishing Co.,1898-1900.

Bittencourt, P. S. (2014). The Performance of Agostino Di Scipio's Modes of Interference n.2: A Collaborative Balance. *Contemporary Music Review*, 33(1), 46-58. doi:10.1080/07494467.2014.906697.

Brecht, G. (1966). *Chance-Imagery.* New York: Something Else Press.

Bregman, A. S. (1994a). Auditory Scene Analysis. *The Journal of the Acoustical Society of America, 95*(2), 1177. doi:10.1121/1.408434.

Bregman, A. S. (1994b). *Auditory Scene Analysis: The Perceptual Organization of Sound*. London;Cambridge, Mass;: MIT.

Cage, J., & White, R. (1978). *John Cage*. Oakland, Calif: Point Publications.

Capra, F., & Luisi, P. (2014). *The Systems View of Life : a Unifying Vision* . Cambridge: Cambridge University Press.

Cheng, J. (2000). *Signal Processing Approaches on Otoacoustic Emissions* (Thesis). Karolinska Institutet, Stockholm.

Chion, M. (2006). *David Lynch* (2nd ed.). London: BFI.

Clayton, M., Sager, R., & Will, U. (2005). In Time with the Music: the Concept of Entrainment and its Significance for Ethnomusicology. *European Meetings in Ethnomusicology*, 11, pp. 3–142.

Cremer, L., Heckl, M., & Petersson, B. (2005). *Structure-Borne Sound*. Springer Berlin Heidelberg. doi:10.1007/b137728.

Darton-Moore, T. (2018). *Test Channel Alva Noto*. Retrieved from http://www.straylandings.co.uk/interviews/test-channel-alva-noto-interview.

Darwin, C. (1981). *The Descent of Man, and Selection in Relation to Sex* . Princeton, N.J.: Princeton University Press.

Davis, S. (2006). Implied Polyphony in the Solo String Works of J. S. Bach: A Case for the Perceptual Relevance of Structural Expression. *Music Perception*, 23(5), 423-446. doi:10.1525/mp.2006.23.5.42.

Davis, S. (2011). Stream Segregation and Perceived Syncopation: Analyzing the Rhythmic Effects of Implied Polyphony in Bach's Unaccompanied String Works. *Music Theory Online*, 17(1).Retrieved from http://www.mtosmt.org/issues/mto.11.17.1/mto.11.17.1.davis.html.

Deleuze, G. (1988). *Bergsonism* . New York: Zone.

Derrida, J., Husserl, E., and Leavey, J. (1989). *Edmund Husserl's Origin of Geometry, an Introduction* . Lincoln: University of Nebraska Press.

De Salvo, D. (2005). *Open Systems : Rethinking Art c.1970* . London: Tate.

Descartes, R., Anscombe, G., & Geach, P. (1970). *Philosophical Writings* (Revised ed.). London: Nelson for The Open University.

Descartes, R., & Veitch, J. (1986). *A Discourse on Method ; Meditations on the First Philosophy ; Principles of Philosophy* . London: Dent

Deutsch, D. (2013). *The Psychology of Music* (Third edition.). Amsterdam: Academic Press.

Di Scipio, A. (2013). Sound object? Sound event! Ideologies of Listening and the Biopolitics of Music. Proceedings of *Music and Ecologies of sound*, Université Paris 8.

Di Scipio, A. (2015). *The Politics of Sound and the Biopolitics of Music: Weaving Together Sound-Making, Irreducible Listening, and the Physical and Cultural Environment.* Organised Sound, 20(3), 278-289. doi:10.1017/S1355771815000205.

Döbereiner, L. (2014). Resonances of Subjectivity: Hegel's Concept of Sound and Di Scipio's Audible Ecosystemics. *Contemporary Music Review*, 33(1), 19-30. doi:10.1080/07494467.2014.906696.

Dodd, J. (2005). Reading Husserl's Time-Diagrams from 1917/18. *Husserl Studies*, 21(2), 111. doi:10.1007/s10743- 005-6403-2.

Doyle, Richard.(2003) LSDNA: Consciousness Expansion and the Emergence of Biotechnology from *Data Made Flesh: Information and Human Body*. Robert Mitchell,R., & Thurtle, P (ed). London and New York: Routledge.

Dowling, W. J., Lung, K. M., & Herrbold, S. (1987). Aiming Attention in Pitch and Time in the Perception of Interleaved Melodies. *Perception & Psychophysics, 41*(6), 642-656. doi:10.3758/BF03210496

Drake, C & Bertrand, D. (2001). The Quest for Universals in Temporal Processing in Music. *Annals of the New York Academy of Sciences, 930*(1), 17-27. doi:10.1111/j.1749-6632.2001.tb05722.x.

Duchamp, M., & Schwarz, A. (1997). *The Complete Works of Marcel Duchamp* (Rev. and expanded ed.). London: Thames and Hudson.

Duchamp, Marcel. (1920). *Oculist Witnesses.*

Duranti, A. (2010). Husserl, Intersubjectivity and Anthropology. *Anthropological Theory,* 10(1-2), 16-35. doi:10.1177/1463499610370517.

Eagle, A. (2018). Chance versus Randomness. *The Stanford Encyclopedia of Philosophy*. Zalta, E (ed.). Retrieved from https://plato.stanford.edu/archives/spr2018/entries/chance-randomness/.

Eco, U. (1989). *The open work* . Cambridge, Mass.: Harvard University Press.

Feinstein, L., Irwin, R. (1997). *Robert Irwin: The Beauty of Questions*. Berkeley, CA: University of California Extension Center for Media and Independent Learning.

Fried, M. (1967). Art and Objecthood. *Artforum*, *5*(10).

Friedman, K., Smith, O. F., & Sawchyn, L. (2002). *The Fluxus Performance Workbook*. Performance Research Publications.

Ford, C. (2010). Musical Presence: Towards a New Philosophy of Music. *Contemporary Aesthetics*, 9(1). Retrieved from https://contempaesthetics.org/newvolume/pages/article.php?articleID=582.August 2018.

Forster, M., Friedrich Daniel Ernst Schleiermacher. (2017).*The Stanford Encyclopedia of Philosophy.* Zalta, E (ed.). Retrieved from https://plato.stanford.edu/archives/fall2017/entries/schleiermacher/

Gammerman, A., Vovk, V., & Vapnik, V. (2013). Learning by transduction. Proceedings of the *Fourteenth conference on Uncertainty in artificial intelligence.*Pages 148-155.UAE.

Glaser, B. (1966). Questions to Stella and Judd. *Art News*, September.

Glover, R., & Harrison, B. (2013). *Overcoming Form : Reflections on Immersive Listening*. Huddersfield: University of Huddersfield Press.

Gottschalk, J. (2016). *Experimental music since 1970*. London: Bloomsbury Academic. 137-139.

Haarh, M. & Randomness and Integrity Services Ltd. (1998). Retrieved from https://www.random.org/company/. February 2017.

Hall, T. (2007). Vague Relations: Notational Image, Transformation and the Grid in the Late Music of Morton Feldman. *Current Issues in Music*, 1(1).7-24.

Hallam, S., Cross, I., & Thaut, M. (2011). *The Oxford handbook of music psychology* . Oxford: Oxford University Press.

Harrison, B. (2007). *Cyclical structures and the organisation of time*. University of Huddersfield, Huddersfield.

Haworth, C. (2011). Composing with Absent Sound. In *ICMC 2011.*from *Proceedings of the International Computer Music Conference*. Huddersfield.

Heidegger, M., & Krell, D. (2008). *Basic Writings: from Being and time (1927) to The task of thinking (1964)* (Rev. and expanded ed.). New York: Harper Perennial Modern Thought.

Heidegger, Martin, (1927/1962), *Being and Time*. J. Macquarrie & E. Robinson (trans.), New York: Harper & Row.

Hofstadter, D. (1979). *Gödel, Escher, Bach : an Eternal Golden Braid* . Hassocks: Harvester Press.

Hopkins, D. (2014). Duchamp, Childhood, Work and Play: The Vernissage for First Papers of Surrealism, New York, 1942. *Tate Papers*, (22).

Huron, D. (2001). Tone and voice: A Derivation of the Rules of Voice-Leading From Perceptual Principles. *Music Perception: An Interdisciplinary Journal*, 19(1), 1-64. doi:10.1525/mp.2001.19.1.1.

Husserl, E. (1928/1964), *The Phenomenology of Internal Time-Consciousness*, (tr. J. Churchill.), The Hague: Marinus Hijhoff.

Husserl, E., & Moran, D. (2012a). *Logical Investigations* (Vol. 1 and II)

Husserl, E. (2012b). *Ideas: General Introduction to Pure Phenomenology* . London ;: Routledge.

Institut fur Medienarchaologie. (2009). *portrait #04 E Éliane Radigue*. Retrieved from https://ima.or.at/en/imafiction/video-portrait-04-eliane-radigue/.

Inaba, J. (1999). *Carl Andre's Same Old Stuff*. Assemblage, (39), 36-61. doi:10.2307/3171259.

Irwin, R. (1977). *Robert Irwin*. [Whitney Museum of American Art] New York, 1977.

James, William (1890). *Principles of Psychology* (2 vols.). New York: Henry Holt.

Johnson, P. C., Wigley, M., & Museum of Modern Art (New York, N.Y.). (1988). *Deconstructivist Architecture*. New York: Museum of Modern Art.

Joyce, J. (1992). *Finnegans Wake* (New ed.). London: Penguin.

Judd,D. "Specific Objects," *Arts Yearbook 8* (1965): 74–82 and 183, reprinted in *Complete Writings, 1959– 1975: Gallery Reviews, Book Reviews, Articles, Letters to the Editor, Reports,*

Statements, Complaints. Halifax: Press of the Nova Scotia College of Art and Design, 1975), 184.

Kim-Cohen, S. (2009). *In the Blink of an Ear : Toward a Non-Cochlear Sonic Art* . London ;: Continuum.

Kirk, J. (2010) *Otoacoustic Emissions as a Compositional Tool*.University of Michigan, Michigan.

Kluft, I.(2007). *San Andreas Fault in the Carrizo Plain, aerial view from 8500 feet altitude.*https://creativecommons.org/licenses/by-sa/4.0/.

Kramer J. (1981) New Temporalities in Music. *Critical Inquiry*. 7:539-556.
Kramer, J. (1985). Studies of Time and Music: A Bibliography. Music Theory Spectrum, 7(1), 72-106. doi:10.2307/745881

Kramer, J. (1988). *The Time of Music: New Meanings, New Temporalities, New Listening Strategies*. New York: Schirmer.

LaBelle, B. (2006). *Background Noise: Perspectives on Sound Art*. London: Continuum.

Kostelanetz, R. (1970). *The Theatre of Mixed Means: an Introduction to Happenings, Kinetic Environments and Other Mixed-Means Performances.* London: Pitman.

Lautréamont.(1994). *Maldoror and the Complete Works of the Comte de Laureamont*. Lykiard,A. (Trans.). (3rd ed.). Cambridge: Exact Change.

Lerdahl, F. & Jackendoff, R. (1983). *A Generative Theory of Tonal Music*. MIT Press. Cambridge, MA.

Lippard, L. (1967). The Silent Art. *Art in America*. January. 58-63.

Lobeck, A. K. 1. (1939). *Geomorphology: An Introduction to the Study of Landscapes*. United States.

Lucier, A. (1965). *Music for Solo Performer*. New York: Lovely Music.

Lucier, A., Gronemeyer, G., & Oehlschlägel, R. (1995). *Reflections = Reflexionen : interviews, scores, writings 1965-1994 = Interviews, Notationen, Texte 1965-1994* (1. Aufl.). Köln: MusikTexte.

Lucretius, C. T., & Latham, R. E. (1951). *On the Nature of the Universe*. Harmondsworth, Middlesex: Penguin Books.

Macpherson, F. and Baysan, U. (2017), "Waterfall Illusion" in F. Macpherson (ed.), *The Illusions Index*. Retrieved from https://www.illusionsindex.org/ir/waterfall-illusion.

Mattietti, G. (2011). The Strings of the Canon: The Evolution of Aldo Clementi's Contrapuntal Writing Through the Compositions for Solo Violin. *Contemporary Music Review*, 30(3-4), 276-289. doi:10.1080/07494467.2011.647282

Merleau-Ponty, M. (1962). *Phenomenology of Perception*. London: Routledge.

Merleau-Ponty, M., & Edie, J. (1964). *The Primacy of Perception, and Other Essays on Phenomenological Psychology, the Philosophy of Art, History and Politics* . Evanston (Ill.): Northwestern University Press.

Merleau-Ponty, M., Johnson, G., & Smith, M. (1993). *The Merleau-Ponty Aesthetics Reader: Philosophy and Painting*. Evanston, Ill.: Northwestern University Press.
Meyer, J. (2000). *Minimalism*. London: Phaidon.

Micheyl, C., Hunter, C., & Oxenham, A. J. (2010). Auditory Stream Segregation and the Perception of Across-Frequency Synchrony. *Journal of Experimental Psychology: Human Perception and Performance, 36*(4), 1029-1039. doi:10.1037/a0017601

Morris, F., Bell, T., & Martin, A. (2015). *Agnes Martin* . London: Tate Publishing.

Morris, R. (1970). *Some Notes on the Phenomenology of Making*. *Artforum*, *8*(8).

Nicolai, C. (2009). *Grid index*. Berlin: Die Gestalten Verlag.

Ordinance Survey (1948). *Yorkshire West Riding Sheet CCXLVI.SE*.Revised 1948. 'Reproduced with the permission of the National Library of Scotland'. (CC-BY-NC-SA).

Potter, K., & Gann, K. (2013). *The Ashgate Research Companion to Minimalist and Postminimalist Music*. Retrieved from https://ebookcentral.proquest.com.

Prigogine, I. (1990). *Time, Dynamics and Chaos: Integrating Poincare's 'Non-Integrable Systems'*. Proceedings of Nobel conference; 26th, Chaos: the new science; 1990; St Peter; MN.55-88.

Prigogine, I., & Stengers, I. (1984). *Order Out of Chaos*. London: Heinemann.

Pure Data.(2018) *https://puredata.info/*. Retrieved from https://puredata.info/.

Radigue, É. (2009). The Mysterious Power of the Infinitesimal. *Leonardo Music Journal, 19*, 47-49. doi:10.1162/lmj.2009.19.47

Reynolds, C. (1987). Flocks, Herds and Schools: A Distributed Behavioral Model. Proceeding of *SIGGRAPH '87, 14th annual conference on Computer Graphics and Interactive Techniques,*25-34. doi: 10.1145/37401.37406.

Reynolds, C. (2001). *Boids*. Retrieved from http://www.red3d.com/cwr/boids/. February 2018.

Riley, B. (2015). *Bridget Riley - Learning From Seurat.* London: Ridinghouse.

Rosenboom, D. (1990). The Performing Brain. *Computer Music Journal, 14*(1), 48-66.
Reps, P. (1957). Zen Flesh, Zen Bones : A Collection of Zen & Pre-Zen Writings. Tokyo: Charles E. Tuttle.

Rose, B. (1965). ABC Art. *Art in America*, *53*(5).

Rosenboom, D, (2012). *David Rosenboom*. Retrieved from http://davidrosenboom.com/about. retrieved February 2018.

Rosenboom,D. (1984). The Qualities of Change: 'On Being Invisible': Steps Towards Transitional Topologies of Musical Forms. In *Collected Articles* (1968-1982). Santa Clarita, Ca.: David Rosenboom Publishing.Distributed by Frog Peak Music, Hanover, NH.

Rosenboom, D. *Invisible Gold*. Pogus Productions, 2000.
Rubin, E. (2001). Figure and Ground. In Yantis, S.(Ed.), *Visual Perception*. (pp. 225-229). Philadelphia: Psychology Press.

Schwitters,K. (1921) in: *Abstract Art*, Moszynska,A (trans.). Thames and Hudson: London 1990,68-69.

Schwitters,K. (1920); 'Merz. Für den Ararat geschrieben' in *Kurt Schwitters, das literarische Werk*, Lach,F. (trans.). Dumont Cologne, 1973–1981, Vol. 5 p. 77.

Schröder, J. H. (2014). Emergence and Emergency: Theoretical and Practical Considerations in Agostino Di Scipio's Works. C*ontemporary Music Review*, 33(1), 31-45. doi:10.1080/07494467.2014.906722.

Sloboda, J. (1987). *The Musical Mind : the Cognitive Psychology of Music* . Oxford: Clarendon Press.

Stanford, A., & Tanner, J. (2014). *Physics for Students of Science and Engineering*. Elsevier Science.

Stevens, C., & Byron, T. (2016). Universals in Music Processing: Entrainment, Acquiring Expectations and Learning. In S. Hallam, I. Cross, & M. Thaut (eds.) *Oxford Handbook of Music Psychology* (2nd ed), pp.19-31. Oxford: Oxford University Press.

Steinway & Sons. (2018). *Spiro*. Retrieved from http://www.steinway.com/spirio.

Stockhausen, K., 1928-2007. (1963). *Texte Zur Elektronischen und Instrumentalen Musik*. Germany:Stockhausen-Verlag.

Temperley, D. (2001). *The Cognition of Basic Musical Structures*. London: Cambridge, Mass: MIT Press.

Tenney, J., & Polansky, L. (1988). *META-HODOS : a Phenomenology of 20th Century Musical Materials and an Approach to the Study of Form, and META Meta-Hodos* (2nd ed. / with corrections and revisions by the author.).Frog Peak Music: Hanover, NH.

Thoreau, H. (2016). *Walden ; and, On the Duty of Civil Disobedience* . North Charleston: CreateSpace.

Thoreau, H. (1961). *A Week on the Concord and Merrimack Rivers ; with a Foreword by Denham Sutcliffe.* New York: New American Library.

Tougas, Y., & Bregman, A. S. (1990). Auditory Streaming and the Continuity Illusion. *Perception and Psychophysics, 47*(2), 121-126. doi:10.3758/BF03205976.

Valdes, C. & Thurtle, P. (2005). Biofeedback and the Arts: Listening as Experimental Practice. Paper presented at *First International Conference on the Media Arts, Sciences and Technologies*, Banff Centre.

Weschler, L., & Irwin, R (2008). *Seeing is forgetting the name of the thing one sees : over thirty years of conversations with Robert Irwin* (Expanded ed.). Berkeley, Calif.: University of California Press.

Whitman, W., & Pearce, R. (1969). *Leaves of Grass* . Ithaca: Cornell University

Wright, G. (2007). *Éliane Radigue: A Portrait* [Motion picture]. United Kingdom: Revolver Entertainment.

Yantis, S. (2000). *Visual Perception : Essential Readings* . Philadelphia: Taylor & Francis.

Young, J. (2004). *Heidegger's Philosophy of Art* . Cambridge: Cambridge University Press.