The Continuum of Indeterminacy in Live Computer Music

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ABSTRACT

The laptop ensemble (sometimes dubbed “laptop orchestra” depending on its size) is an exciting new type of ensemble emerging all over the world. The aural and interactive possibilities afforded by these ensembles are attractive to composers, but many of the performances by these groups favor improvisation over composition. This project includes five compositions for laptop quartet which explore a continuum between determined composition and pure improvisation. Each work is an attempt to engage the performer as well as the listener, encouraging exploration and expression while controlling form and ensemble interaction in order to create coherent and identifiable compositions.

1. INTRODUCTION

The laptop computer has become an increasingly important musical instrument in the field of contemporary music. Laptops have been used for some time by composers performing live processing and by solo musicians in the field of electronica. In recent years, there has been a growing interest in forming groups of laptop performers. Some of these groups, depending on their size, have been dubbed “laptop orchestras” (Dannenberg, 2007; Trueman, 2006; Toop, 2006). Musically, these groups blur the lines between art music and pop music, but they function similarly to chamber groups, performing improvisations or composed works in concert halls. Despite performing in some of the same venues, the modes of performance for these groups (such as player roles, timbres, instrument operation, etc.) can be much more varied than the modes of performance in traditional orchestras and chamber groups. So far, much of the music written for these groups is based upon improvisation or upon manipulating computer algorithms. Perhaps composers employ these methods because the methods allow for the participation of people with various levels of musical skill, or perhaps composers are merely writing for the natural strengths of computers themselves. Neither reason dictates that improvisation and algorithmic music are the only appropriate compositional approaches for such groups.

Laptop groups are a new type of chamber ensemble, but they are also a new method of presenting electroacoustic music. Emmerson (2001) wrote that there was an ‘increasing divide’ between acousmatic composers who present works in concert halls and laptop performers who present work in clubs and alternative venues. By 2008, the divide has begun to close as musicians from both backgrounds inform the

approaches of each other. In a way, the proliferation of laptop groups in academia has brought electronic music full-circle. Originally, electronic music was created in institutions (national radio, universities, and the like), which had the funding and space for large and expensive equipment. Over the past 60 years, technology has improved in quality, portability, and price. The most obvious technological advance was the computer; by the 1980s, machines which were once large enough to take up an entire floor of a building were small enough to be placed in a consumer's lap. This allowed computer music to go "on the road," and the computer became important as a musical instrument for composers as well as DJs. However, instead of merely replacing instruments or turntables, the laptop became the ultimate fully-customizable portable instrument and composition studio (Weidenbaum 2006).

For all its practicality and attractiveness to its practitioners (not to mention its over 20-year history), laptop performance is still forcing audiences to adjust their perceptions of music and performance. As Cascone writes (2003, p.101), "audiences experience the laptop's use as a musical instrument as a violation of the codes of musical performance." They do not see a relationship between a laptop performer's actions and the resulting sounds. Typical acousmatic presentations are also criticized, for the audience only sees the loudspeakers. However, in these presentations, the composer is in the audience, diffusing sounds at a mixing desk. When laptop performers present their music, they sit on stage, setting up expectations of visual spectacle which are left unfulfilled (Stuart, 2003). In a club setting, the audience is now accustomed to the non-virtuosic displays of DJs, because the DJs themselves are not the focus of the experience. Chamber music is intended for listening rather than dancing, so the musicians are the only focus of the

experience. Thus, it seems even more inappropriate to use laptops in a classical chamber setting than it is to use laptops in a club setting.

If a laptop is the ultimate customizable instrument and studio, and if laptop performance is unfulfilling to audiences, why would people form laptop groups, much less compose for such groups? One reason is social: computers are ubiquitous, and most people (in the western world) have at least a basic understanding of how to use a computer. By using computers as instruments, these laptop groups encourage more people to participate in the music. As Burns (2005) notes, music for computers and electronics can expose the intellectual challenges of performance without the burden of a traditional musical education. Players learn about roles, balance, and other issues of ensemble performance, while both the players and audience can experience new forms, gestures, timbres, etc. However, by inviting the participation of people with varying degrees of musical knowledge, composers must reexamine how they compose.

1.1 Motivations

My previous compositions have included works for instrumentalists, electroacoustic works for fixed media, and game pieces for improvisers. With this project, I hope to combine these relatively separated streams of my work. As computer-based works, the works in this portfolio fall into the electroacoustic category. However, unlike my previous fixed-media work, these pieces are written to be performed by a chamber group: a quartet of laptop performers. In addition, all of the pieces are improvised or indeterminate to some degree. Coming from a modernist and largely deterministic aesthetic, I have long been interested in indeterminacy but felt as if employing indeterminacy showed a lack of effort and

seriousness. I began to wonder what constitutes a work, at what point a work is considered finished, and if effort and determinacy are the true measures of the value of a work.

I also wondered about the role of performance in electroacoustic music. I have read (Bach, 2003; Cascone, 2003; Stuart, 2003) and encountered firsthand the audience desire for visual information in performances. This happens in acousmatic diffusion concerts where the audience sees only the loudspeakers, as well as laptop concerts where the audience cannot see any causality between the understated actions of the performers (typing, mouse movements) and the resultant sounds. Although concerts with no visual stimulus other than loudspeakers or stationary performers do not bother me personally, I wonder how the presence of human performers will affect the presentation of electroacoustic music. What effect will performers have on music which could have been realized in the studio and presented in the typical “loudspeaker-only” manner?

1.2 Essay format

The idea of a continuum of indeterminacy forms the basis of a portfolio of five pieces for laptop quartet. Before describing the portfolio, I will present a brief historical overview of indeterminacy in western art music, relating to the contemporary genre of laptop ensemble music. Next, I will describe the five works in the portfolio, placed in what I consider to be the order of increasing indeterminacy. Through these pieces I hope to highlight different aspects of performance that can be indeterminate, such as form, gestures, timbres, rhythms, and pitches. After this descriptive section, I will report on the pieces in practice, with a summarized commentary of performer and personal reactions. Finally, I will explore the pieces

through a more theoretical lens relating to the historical and introductory discussions. This exploration will reiterate the notion of a continuum of indeterminacy, question the presence of performers, and comment on means of notation and interaction in laptop compositions.

2. HISTORICAL CONTEXT

2.1 The continuum of determinacy

Although many compositions for laptop groups follow a process or improvisation-based idea, other methods can be implemented instead. Performers can follow some kind of score, which could be rigorously controlled and quite deterministic. However, in electroacoustic music (of which laptop ensemble pieces are a subgenre), a composer has tremendous control over the sounds, their spatialization, and their temporal structure. A piece that is too deterministic in these respects would not require human performers, but rather could exist in a fixed form on tape or disc. Although a rigidly deterministic piece may not be ideal for laptop ensembles, a piece for the group need not forgo a structure or other determinate elements. An important element that players can bring to a piece is the same element that they bring to acoustic music: interpretation. In *Silence,* Cage (1968) mentions Bach's *The Art of Fugue* as an example of music which is indeterminate in performance; the rhythm and pitch structures are determined but dynamics and timbre are not. In any composition, the performer 'fills in color where outlines are given;' in other words, they must interpret the outlines presented by the composer. Each composition contains a different amount of determinacy, and therefore allows a different amount of interpretation.

Eco's (1989) conception of the composer-performer relationship was that a composer offers the performer a work 'to be completed.' According to Reynolds (1965), the composer's job is to propose an 'occasion for experience.' The complexity of the conditions which the composer proposes varies from composer to composer and from work to work. The less determined the proposal, the closer the experiences resemble improvisation. Composition and improvisation are closely related, and many have said that composition is "slow-motion improvisation." Since his process is relatively slow, the composer can reflect on what has passed and what will come, while the improviser must always concentrate on the moment. As opposed to a fully improvised performance, in a performance of a composed or "closed" work, the composer can reinforce the temporal and aural relationships between events (Sarath, 1996). Between the extremes of determinate composition (especially fixed-media) and free improvisation is a continuum that includes pieces in which a rigid structure allows some improvisation, and pieces in which a basic structure reinforces the relationships of improvised events.

2.2 What constitutes a work?

Where on this continuum does a piece cease to be a "work" and instead become an "improvisation?" Dahlhaus (paraphrased in Lewis, 1996) wrote of several characteristics that must be present for a piece of music to be considered a composition (or "work"): a fully worked-out structure, fixed in written form, with the intention of performance, which contains the essential *identity* of the piece. The term 'identity' is also noted by Benson (2003) and Levinson (1980), both explaining that a work has an ideal quality which is recognizable in each performance but is never fully realized. Borrowing from the work of Charles Peirce, Benson notes that a work

is a *type* and that all performances of that work are *tokens*, or incomplete realizations. The score can help judge the correctness of a performance, but due to the nature of notation itself, performances are destined to be incomplete or incorrect. The performer must interpret how to execute a set of instructions encoded 'more or less completely' by the composer (Alperson, 1984).

Since the 1950s, many more works have fallen into the 'less completely' category. In the 'open works' cited by Eco (Stockhausen's *Klavierstück XI*, Boulez's *Third Piano Sonata,* and Pousseur's *Scambi*), structures are not completely determined, yet these are still considered 'works.' If it is not the structure which determines the identity of a work, it must be some other factors. Perhaps it is the decision to include and discard certain sounds (instruments, for example). Emmerson (2000) writes about the 'fixity of personnel,' a concept unique to Western music (as is the nature of a 'work' in the first place). Despite this concept, some works are written deliberately for open or indeterminate instrumentation. Perhaps the identity of the work is merely the directions for its realization. Arthur Danto considers the current period of art to be 'post-historical' and writes that art is now concerned primarily with concepts and the methods used to present these concepts. Thus, a composition is no longer limited simply to its sound or its structure; the idea of a compositional work could include rule-based improvisation frameworks, computer interface design, or other means for directing the creation of sound (Hamman, 2000).

2.3 Increase of determinism in music: Notation

Western Art music is unique among the world's musics primarily because of its use of written notation. Originally simply a mnemonic device to aid performers, notation has gradually become more specific, enabling composers to demand more

or less specific actions (Bailey 1993). Notation allowed composers to determine vertical sonorities (McLean, 1982) and gave composers time to reflect on the local and global relationships between these sonorities. By virtue of being able to reflect on all events in a piece, composers have been able to create complex harmonic and temporal structures. This contrasts greatly with other music; for example, Indian music emphasizes improvisation and therefore emphasizes the present over the relationships between past and future (Sarath, 1996).

Notation is not particularly deterministic, and over the past few centuries, composers have sought to make notation more deterministic. Notation can fix some elements of performance, primarily pitches and rhythms, but other factors, such as tempi and dynamics, are often left to "musicianship." Traditionally, the mark of a good musician was his ability to "breathe life" into the music, but over this development of increasingly deterministic notation, the mark of a good player became his ability to execute the notation accurately, and nothing more (Behrman, 1965). This romantic-modernist view stems from the increase of determinacy in notation, which in turn stems from the increasingly higher status given to composers in the 19th century. Composers created works which had ideal existences; thus, composers were deemed more important than the musicians who merely performed the works (Benson, 2003).

2.4 Composer-as-god: Beethoven through modernism

The romantic idea of an artist or composer is that he is a genius, or a god. Benson (2003) traces the idea of the artist-genius to Immanuel Kant, but names Beethoven as the idea's first proponent in music. Benson compares Beethoven with his contemporary, Rossini, who had a different opinion about the nature of a "work." Beethoven viewed his works as 'inviolatable texts' which were to be interpreted

exactly. Rossini viewed his works as simply ‘recipes for performance’ which only truly came to life during a performance. It is unsurprising that Beethoven’s scores are more detailed than Rossini’s scores, but as Benson notes, performers are no more obligated to accurately follow Beethoven’s score.

Since the traditional view of composing is “a godlike activity in which the artist brings into being what did not exist beforehand – much as a demiurge forms a world out of inchoate matter” (Levinson, 1980), a certain level of authority is bestowed upon composers, rather than the musicians who bring their works to life. After Beethoven, the perception of a composer’s work changed from acting as a recipe for experience to acting as an arbiter of correctness in that experience. At the same time, conservatory musical education began to emphasize correctness over creative interpretation, causing many future musicians to be quite self-conscious about their interpretations and performances (Moore, 1992).

Playing incorrectly would violate the intentions of the composer-god. After all, the work belongs not to the players, but to the composer, its creator. This attitude is perhaps inevitable in Western capitalist society. As Emmerson (2000, p.125) explains:

> “Our western world is obsessed with ownership; copyright and royalties are a central plank of the system of remuneration for composers. This was made easy through notation (the score – an object) and, later, recording (initially an object but now, problematically, simply ‘a stream of binary information’). Performances were more important as purveyors of these objects, than they were valued uniquely in themselves.”

The goal of composers was to notate so accurately that performers would have no questions (or freedom). The trend toward complete determinism, or complete composer control, reached its apex in the 20th century.

2.5 The Apex: Electroacoustic music

The most indeterminate aspects of music notation are timbre, dynamics, and tempi. These elements of music have traditionally be interpreted by performers, but with the advent of electroacoustic music, composers could control all of these aspects of a work without the intervening medium of a performer. The piece could simply exist, exactly as the composer had imagined and created it. For some, recording technology supplanted the need to notate for a future performance. The composer could take the sounds themselves and stitch them together exactly as he would like. Although the earliest recordings were representations of past performances, after the development of *musique concrète* in the 1940s, the recording became compositional material. In the end, the recording became the music itself; the music existed in a fixed form (Grossman, 2008).

One might suppose that electroacoustic music (and much pop music, which also uses sampling and synthesis extensively) could lead to the death of the performer. Earle Brown (1986) dismisses this idea, writing that electronic music exists because of an unlimited world of timbre, space, and density, not super-human accuracy; humans are not obsolete. Truax (1998) justifies the practice of electroacoustic music, saying that the use of technology simply gives a composer "new perceptual experiences and new compositional ideas, things that could not be achieved in any other way." Still, tools such as the computer allow composers to

create sounds which will be, as Varèse said, ‘obedient to [their] thoughts’ (Varèse 1967).

2.6 Reaction: Indeterminate works

In the 1950s, while highly deterministic music was in vogue (notably total serialism), a small group of composers was interested in indeterminacy. Their aim was to leave some of the decision-making process to the performers (or to chance) in hopes of creating a more collaborative work (Lewis, 1996). This idea was radical at the time, since indeterminacy and chance “invade some of the most tender areas of the artistic ego: craft, expressiveness, and individuality” (Reynolds, 1965, p. 136). Indeterminacy did not fit with the prevailing Kantian view of the composer as a god-like creator of ideal objects. However, as Eco (1989) points out, these musical objects have always been, to some degree, open to interpretation by the performers or by the audience. These indeterminate, “open” works more accurately reflected the modern aesthetic of visual arts, in which the ideal is to view a work from multiple perspectives. Eco compares music which enforces one viewpoint to medieval paintings, which similarly enforce a particular perspective.

These composers became interested in creating musical works which potentially had radically different realizations from performance to performance. For Earle Brown (1986, pp. 192-3),

> “the most fascinating aspect [of composition] was the ambiguous relationship existing between the artist and the work, and the delicate balances one had to deal with between subjective-objective contact with the work; between freedom and control; explicit-implicit notations; and between compositional necessity and performance reality as an intimate collaborative process. I

wanted (and still want) very much for the work to have a 'reality' of its own in addition to the specific controls imposed by myself and by the performer." Brown's artistic ego was not diminished by allowing performers to inject decisions into his works. The instructions and suggestions he makes form the identity of the works, for they elicit certain reactions and decisions from the performers.

Earle Brown, Morton Feldman, and Christian Wolff are often unfairly grouped with John Cage (Thomas, 2007; Welsh, 1967). Cage was the most prominent proponent of indeterminate music, but his methods differed greatly from the other three composers. The works of Cage are indeterminate in their composition, while the works of the other three composers are indeterminate in performance (O'Grady, 1981; Thomas, 2007). In *Music of Changes,* Cage used the *I Ching* to create the score, but intended for the performer to realize the score faithfully, in the traditional manner. Cage enjoyed unique performances with unique sounds, and some of his works required creativity on the part of the performer, such as choosing instruments or choosing how to interpret the notation. Interestingly, Cage generally rejected outright improvisation, especially when it was similar to the improvisation found in 'hot jazz' (Kutschke, 1999; Lewis, 1996).

Hoogerwerf (1976) contrasts traditional determinate music with indeterminate music by comparing the thoughts of Stravinsky with Cage. In contrast to Stravinsky, Cage hoped to relinquish control when selecting sounds, and saw that the uncontrollability of chance reflected and affirmed the uncontrollability of everyday life. Stravinsky believed in the composer's individual expression; by choosing and controlling elements, a composer deliberately sets a work of art apart from everyday life. By choosing not to set his work apart from life, Cage's approach reflects a modern view that is observational, experimental, and scientific (Kutschke, 1999).

The other composers mentioned above shared an interest in indeterminacy but approached it in different ways. Like Cage, Feldman did not favor improvisation. After experimenting with open “graph” scores in which he gave only minimal directions for tessitura, Feldman decided to dictate the pitches he desired (Thomas, 2007). Still, he left rhythm free, allowing flux within the ensemble and performances which would always be unique compared to each other, yet still share a ‘family resemblance’ (O’Grady, 1981).

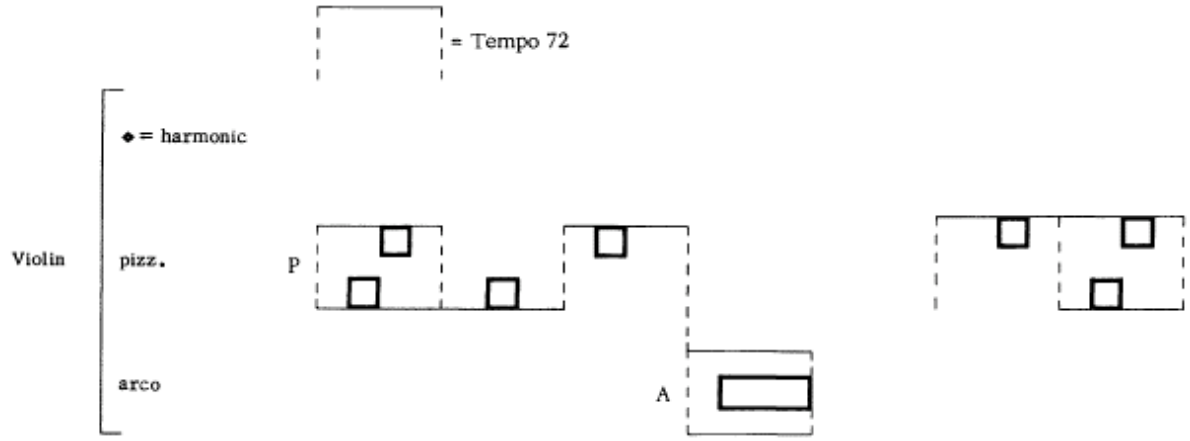

Figure 1: Feldman, *Projection IV* (Behrman, 1965, p.62)

The works of Earle Brown and Christian Wolff emphasize the interactions of performers over matters of time and pitch. Brown compares his music to mobiles, and he allows musicians to reassemble his materials as they please. In *Available Forms* and *Mobiles I* and *II,* the decisions are made by the conductor, but in other pieces, such as *December 1952* from *Folio,* performers see a graphic score which can be interpreted in various ways (Welsh, 1967). Similarly, much of Wolff’s music is based on a system of visual cues which help players determine how to coordinate attacks and releases (Behrman, 1965). The focus of the piece is social rather than musical, and has a much more democratic point of view than traditional, dictatorial composition (Nelson, 1989). Still, the composer’s voice is not lost, since the types of

interactions used by the composer become recognizable as his ‘signature moves’ (Behrman, 1965). Also, listeners can perceive the structures he has created in traditional terms, such as contrast, balance, and repetition (O’Grady, 1981).

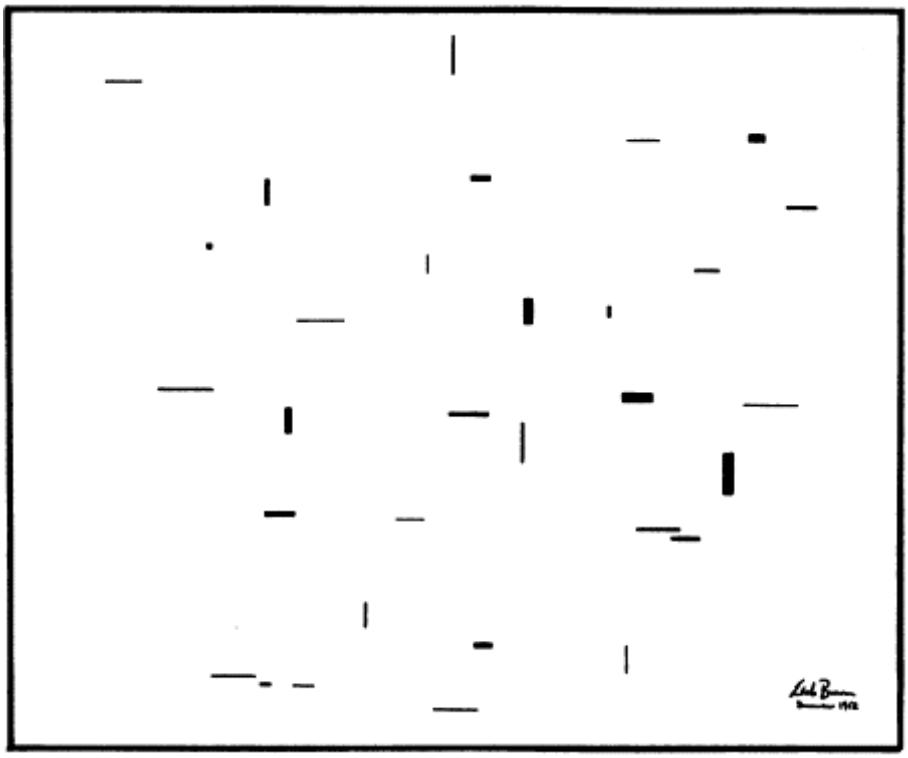

Figure 2: Brown, *December 1952* from *Folio* (image from Welsh, 1994, p. 263)

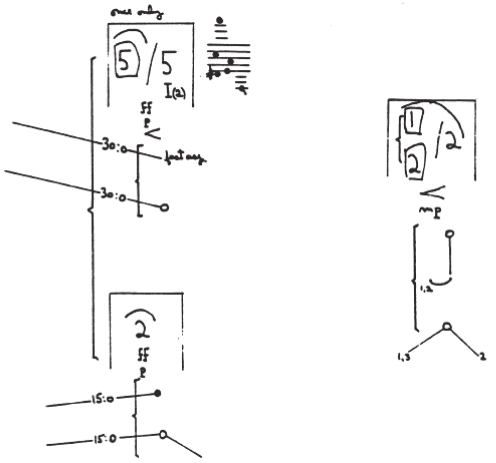

Figure 3: Wolff, *For Five or Ten People* (image from Nelson, 1989, p. 5)

2.7 Indeterminacy in electroacoustic music

For much of the history of electroacoustic music, composers have sought ways to enliven the listening experience – essentially adding indeterminacy. Two notable manners for accomplishing this were to create pieces for an instrument accompanied by a recording, or to actively diffuse the sound in the space during a concert (Chadabe 1997). In 1957, Belgian composer Henri Pousseur composed *Scambi,* a tape piece in which the form could be rearranged like the Boulez *Third Piano Sonata* and the Stockhausen *Klavierstück XI* (Lansdown Centre, 2008). Performance (instrumental or diffusion) and open forms add indeterminacy, interest, and life to otherwise fixed works.

In the mid-1970s, The League of Automatic Music Composers began a different approach by using computers to create music during a performance. According to Gresham-Lancastre (a member of the League's offspring, The Hub), their music grew out of the experimental tradition of Cage and others who used or created new instruments and thus were forced to devise new notation or instructions for using these instruments. For the League/Hub performances, the players generally adapted "solo" compositions for the group performance; they determined whose data could be sent to whom in order to make interesting results. Bischoff and Brown (2008) describe a typical performance situation:

> "Gold's station executed circular readings at audio rate of a virtual 3-D landscape that resulted in looping patterns of tuned noise . . . Horton's algorithm spun a thread of continuous melodic invention built from just-intoned pitch relations, and Bischoff's machine played a punctuating role as it looked for chance tunings between Horton's melodies and Gold's timbres, beeping in agreement when it detected them."

Gresham-Lancastre (1998) considers the most important contribution of these groups to be the idea of a machine that invites participation but allows for intricate algorithms. Computers were super-instruments with which a performer could interact but with which a performer could create a higher level of complexity than he could with other instruments. The way of working started by the League and the Hub continues today with laptop performance; it brings together algorithmic computer music and improvisation.

As stated in the introduction, free improvisation and manipulations of algorithms do not have to be the only possibilities for live computer music. Works could be composed in which the performers recreate a score, in the manner expected by late romantic and modernist acoustic composers. Due to the precision of computers, these pieces could be realized exactly as intended, basically eliminating the need for performers. However, imprecise human interpretation can add interest to the work, both to the performance and to the piece's overall identity. According to Garnett, by performing a piece many times, the identity of a work becomes clouded and unfixed. Because it is unfixed, the work can adapt to changing contexts and therefore have a longer life. He cites this adaptability as the primary reason for the longevity of Western classical music (Garnett, 2001). Likewise, Alperson writes that when a performer interprets a work, he comments on the work; the work is imbued with new possibilities, but retains the essence of the original (Alperson, 1984).

2.8 Notation for electroacoustic music

The composer can control the formal structure, the nature of ensemble interaction, and the general timbral world of a piece. The performers will create the

moment-to-moment realization of the structure and timbral world, with varying amounts of freedom. In live computer music, the composer will often create idiosyncratic instruments unique to each piece. Burtner (2003) observes that most composers working in live electronics play their own instruments, and that most performances of these instruments are basically improvisations displaying the instrument's capabilities, rather than works exploring the musical potential of these instruments. If a composer intends for someone else to play his new instrument, he must find a method to explain how to play the instrument, as well as how to play the instrument in a musical context. In this way, the score may be even more detailed than traditional acoustic scores. Emmerson (2000) describes the "super-score of the future," as a multimedia object which brings together traditional and extended notation, all of the necessary sound files and software, explanatory texts, and an audiovisual presentation of a previous performance.

Emmerson's idea is thorough and would provide a solid foundation for performance, but it is perhaps impractical to produce such a multimedia object for every piece (plus, there is the question of what the composer would be able to provide for the musicians who premiere the piece). Still, traditional notation is not designed to describe the sound changes present in electronic music, so new systems must be used. Some systems are more detailed than others; some try to graphically represent the sounds while others serve as shorthand for the methods used to create the sounds.

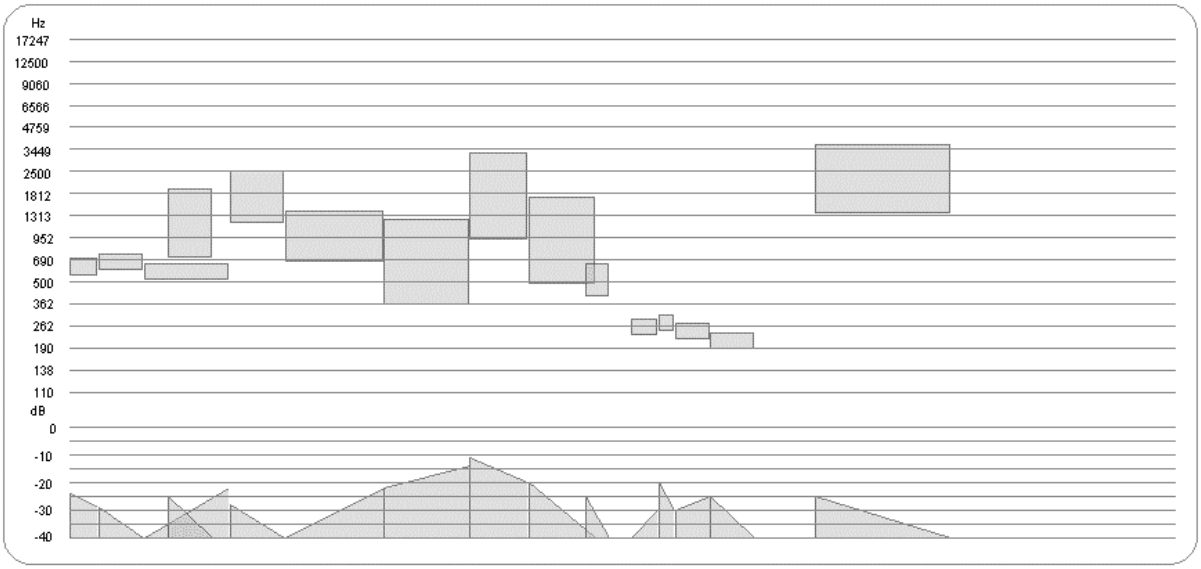

Figure 4: Stockhausen: *Studie II* (1954). Max/MSP recreation by Georg Hajdu

Graphic notation has been used for some time in electronic music, dating back to the famous scores of Stockhausen's *Studie II* and *Kontakte.* Although it is beyond the scope of this paper to provide an exhaustive list of previous methods for notating electronic music, I will highlight some recent examples. In Burtner's (2003) *(dis)Appearances* for acoustic, electric, and physical model violins, the physical model violin has a single staff with numbers representing variables of control, such as frequency range, bow force, bow position, and noise; the staff also has a graphic representation of curved lines which connect the numbers and show the contour of interpolations between these numbers. Patton (2007) describes a notation system which combines three qualities of sound in a single staff: time space is represented in the X-plane, register and pitch space are represented on the Y-plane, and spectra is represented on the Z-plane. This three-dimensional representation depicts harmonic sounds as being further away and depicts noise sounds as being closer.

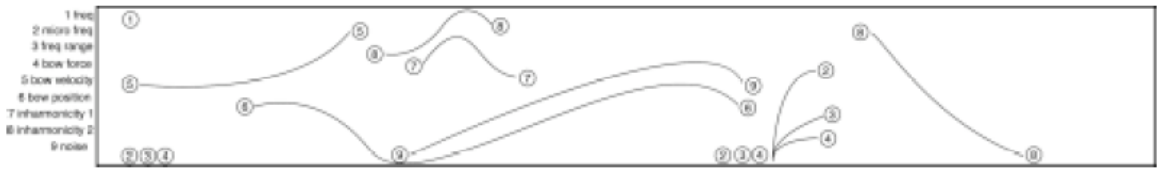

Figure 5: Burtner, *(dis)Appearances* (Burtner, 2003)

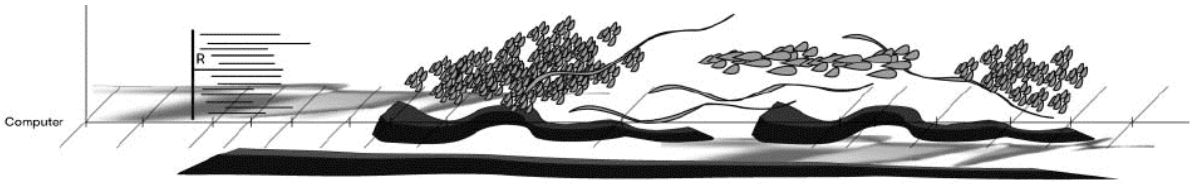

Figure 6: Patton, *The Foldability of Frames* (Patton, 2006)

Both of these scores represent the deterministic end of the continuum. Many of the documented works for laptop groups are much more indeterminate in character. The Milwaukee Laptop Orchestra (MiLO) focuses on free improvisation instead of composition (Burns, 2008). The Carnegie Mellon Laptop Orchestra's system allows players to improvise in given styles (blues, techno, etc.) with traditional roles such as drums or bass guitar (Dannenberg 2007). *Hide and Seek*, created for the Worldscape Laptop Orchestra at the University of York, is primarily a game in which players try to hit increasingly smaller targets (Harker 2008). Most of the documented pieces from the Princeton Laptop Orchestra (PLOrk) are improvisatory, but Trueman's *Plahara* provides a sign language system for directing precomposed motives (Smallwood, 2008). *Bliss.net*, a piece created for the Belfast Legion of Improvised Sights and Sounds (BLISS) at Queen's University Belfast, consists of a timeline which guides four improvisers and also filters the improvisers into separate frequency bands (Rebelo, 2006).

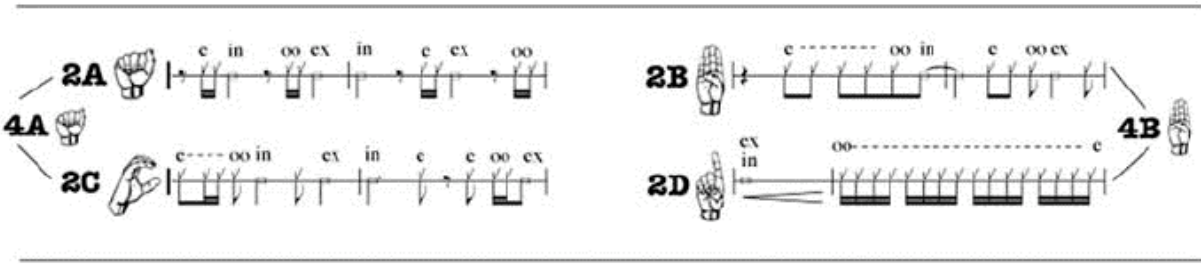

Figure 7: *PLahara* by Trueman (Smallwood, 2008)

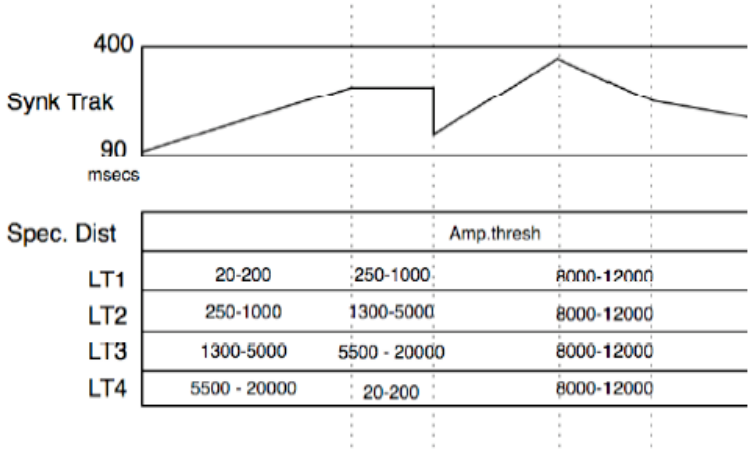

Figure 8: *Bliss.net* by Rebelo and Renaud (Rebelo, 2006)

Notation serves the function of controlling the ensemble, of enabling several people to function as a cohesive unit. The pieces mentioned above do not generally use notation in the traditional sense, but instead use graphics and text to explain the ways in which the composer wishes to control the ensemble. In their articles about PLOrk, Smallwood (2008) and Trueman (2006) describe different approaches composers have taken to control the ensemble. Some pieces required a human conductor to direct the ensemble, while other pieces used a primary “conductor computer” to send control messages to the ensemble. The urge to play and improvise on a computer is great, as it is the ultimate instrument, capable of limitless possibilities of sounds. Trueman notes that one of the primary challenges in PLOrk

rehearsals is preventing players from distracting themselves and each other by improvising at inappropriate times. In a similar study on his Laptop Orchestra at the London College of Communication, David Toop (2006) lists 15 qualities that make an improvisation satisfying for both player and listener. This list is slightly repetitive (perhaps for pedagogical emphasis), so it has been paraphrased here into five key points:

1. The urge to play
2. The ability to produce interesting sounds, and to react to the ideas of others
3. A sense of form and an awareness of time
4. A knowledge of your instrument, and confidence in using it
5. Patience, tolerance, knowing when and when not to play

Even in fairly loose improvisational frameworks, composers dictate some of these qualities. Before a performance, the composer produces ideas and reactions to ideas, determines the form and the sense of time, and determines when voices will play and when they will be silent. Using a portfolio of five new works as a case study, in the next section we will explore different methods by which composers can encourage or enforce certain actions and interactions with their players.

3. CASE STUDY: PORTFOLIO OF FIVE WORKS

This portfolio explores several overarching aesthetic concerns. The first concern the idea of a continuum of indeterminacy. To approach this, I created five pieces which display unique levels and elements of indeterminacy. For example, *Baffin Bay* contains a simple structure that informs players when to begin and end their improvisations but which also limits the players' pitches. The surface gestures

are improvised, but the harmonic content and orchestration are determinate. In *Presets,* the players are given instruments that have relatively set timbres with several changeable parameters. A hub computer receives the settings of these parameters from all of the players, analyzes the data, and sends new parameters back to the performers. Although the class of sounds remains the same in each performance, the exact direction of each performance will sound quite different.

A second aesthetic concern I had was to compose pieces featuring a variety of sounds and approaches for creating sounds. I explored various synthesis and signal processing ideas, as well as different forms and methods of interaction. *(Not)For Tape* and *Morty's Mood* feature processing of samples, *Baffin Bay* features primarily subtractive synthesis with some additive synthesis and sample processing, *Presets* features resonant and comb filters, and *Freq Out* features oscillators and bandpass filters.

Variety of interface design was also important. I decided to limit my interfaces to the computer only (no external controllers, sensors, etc.). Therefore, on the surface, each interface is the same: a combination of the QWERTY keyboard and the mouse. However, the way in which the performers use the computer interface is different each time. For example, in *(Not) For Tape,* the players articulate new sounds by pressing the numbers 1 through 0 on the keyboard, and manipulate the sounds my using their mouse to navigate a color swatch object. In *Presets*, the performers again use keys 1-8, but this time the keys articulate different notes much like they would on a keyboard. In the end, I found that the pieces were easy to learn, but still provided interest and unique challenges to the performers.

The concern for performer engagement is directly related to the question of a need for indeterminacy in electroacoustic music. As mentioned earlier, performers

will add interest to the work by adding indeterminacy (deliberate or not) and by commenting on the work as they perform. The common complaint about laptop music is that the audience cannot see the relationship between the musician's actions and the resultant sounds. If this is the case, why have performers for this type of music? The performers must be engaged and must share the responsibility for realizing the work; as Eco would say, they must 'complete' the work.

3.1 Implementation

All of the pieces in this portfolio were programmed in Max/MSP, a graphic object-oriented programming language developed by Miller Puckett and David Zicarrelli. Max/MSP has become the *lingua franca* of electroacoustic music due to its ease of programming and its flexibility for a variety of musical needs. Flexibility was essential for this project, since the five different musical works required five different programs and interfaces. In addition to the objects native to Max/MSP, I used two third-party extensions: the "mmmlist" external by Jasch and the Frequencyliator, a patch created by Alain Renaud at SARC (which uses several of CNMAT's Open Sound Control externals).

As mentioned above, for this project I decided to create interfaces which required only the mouse and QWERTY keyboard available on the computer. There were three reasons for this. One, the music I envisioned would work just as well with the keyboard/mouse interface as it would with any other physical interface that I could create. Two, I had a limited time (three months) to complete this dissertation, which meant that constructing interesting controllers was beyond the scope of the project. Three, I wanted to make the pieces portable, so that they could have a life outside the confines of this paper. The only extra pieces of equipment required are

audio interfaces and PA systems, which are given for any concert of this music. I hope that the ease of implementation will invite more opportunities for performance.

3.2 The pieces

3.2.1 Baffin Bay

Baffin Bay is inspired by the Arctic, an environment that continues to fascinate me, although I have never visited. The piece is also a response to ambient and aleatoric music. The term 'ambient music' was coined by Brian Eno, and who described it as a type of music that invites close attention but allows little attention, music that is 'as ignorable as it is interesting' (Eno, 1978). Eno's work, along with other artists of the genre such as Harold Budd and Biosphere, influenced the mood and pacing of this piece. Aleatoric music, sometimes synonymous with indeterminate music, involves chance procedures. The sounds in this piece are controlled in a manner similar to the technique of "box notation," which was used by Luciano Berio in *Circles* and many other composers since. This technique shows a pitch collection contained within a box, which directs performers to improvise with this set of pitches for an allotted time.

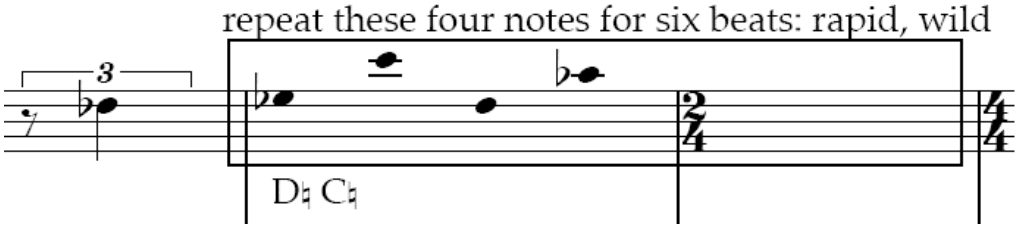

Figure 9: Box notation, from the author's *Travels*

The performers will realize the piece through improvisation, but many aspects of the work are controlled. There is no score *per se*, but each performer is given instructions in their patch to tell them when to fade in sounds and fade out sounds (each performer plays two different types of sounds). The clock in their patch also controls the pitches available to them at any given time, so that they are improvising, but always projecting predetermined sonorities (similar to box notation). The formal structure is defined by the presence of different instruments and by this harmonic structure. Each instrument plays four sections, and there is a general scheme for duets, trios, and quartets, as outlined in the formal graph below.

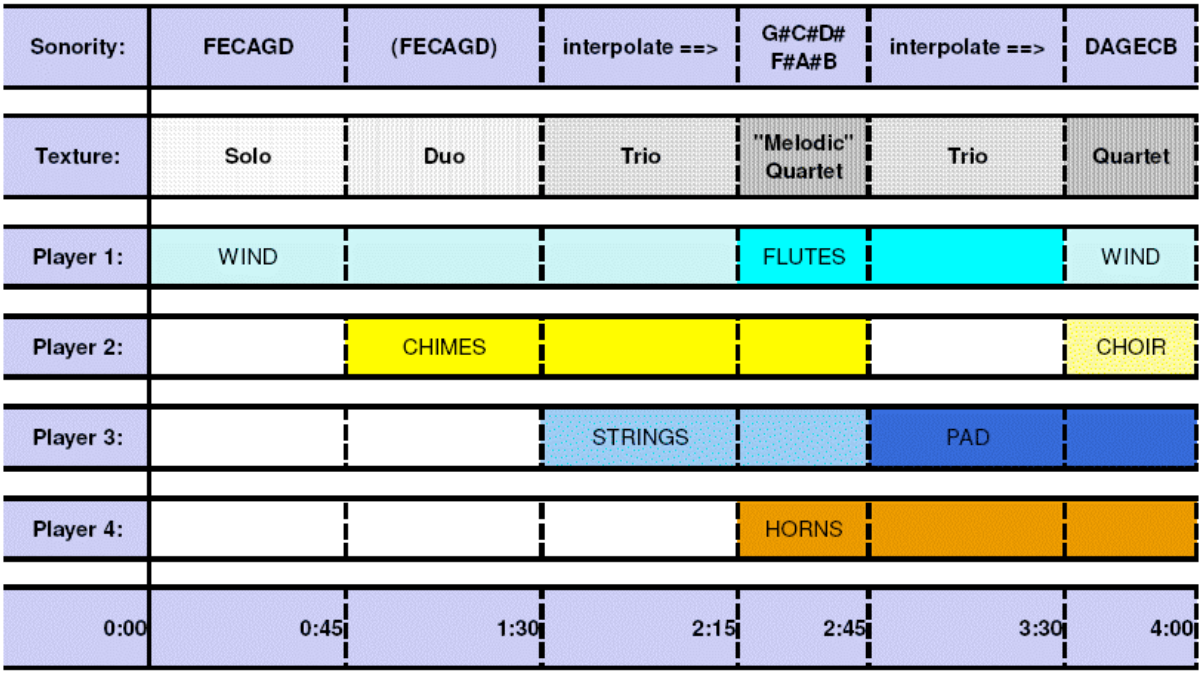

Figure 10a: *Baffin Bay* timeline/score

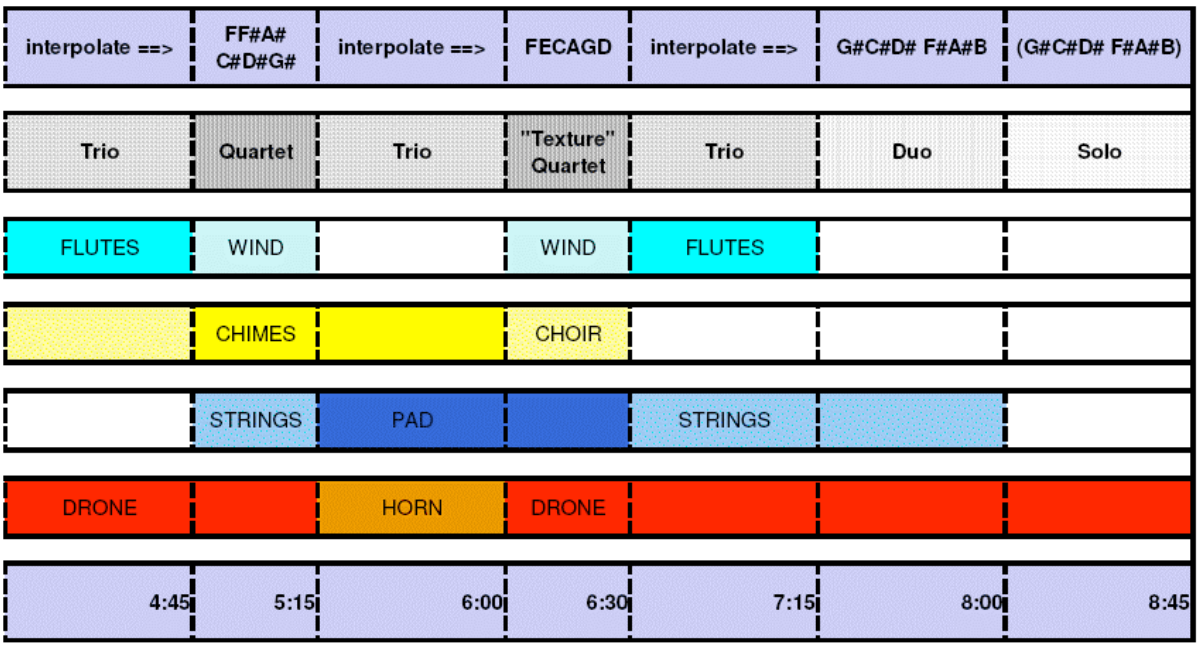

Figure 10b: *Baffin Bay* timeline/score

Given the aesthetics of this work, precise timing is not needed, so the piece is not networked. Players must begin their patch clocks at roughly the same time, but it is not necessary for them to start at precisely the same time. As the patches count through the piece, the sonorities will change automatically. This occurs even when a player's sound is supposed to be off; if they forget to fade out a sound, they will still be playing the correct sonority. I attempted to make the transitions between sonorities very smooth. For many of the sounds, the computer slowly changes tones one at a time, interpolating between the current sonority and the new sonority. The "wind" and "drone" sounds are continuous, so the interpolation between pitches makes slow, independent glissandi.

The sonorities for Baffin Bay are derived from the tone row of Alban Berg's *Lyric Suite.* This row has several unique properties: it contains all of the intervals smaller than an octave, it creates only 24 forms instead of the usual 48, and its two constituent hexachords project two different tonal centers (F major and B major). I

took the hexachords from the prime and inversion forms to make made four sonorities, which form the basis of the pitch-space of the piece.

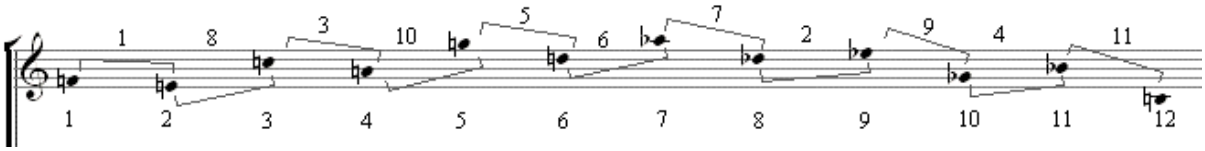

Figure 11: *Lyric Suite* row, showing order numbers (bottom) and interval size (top numbers)

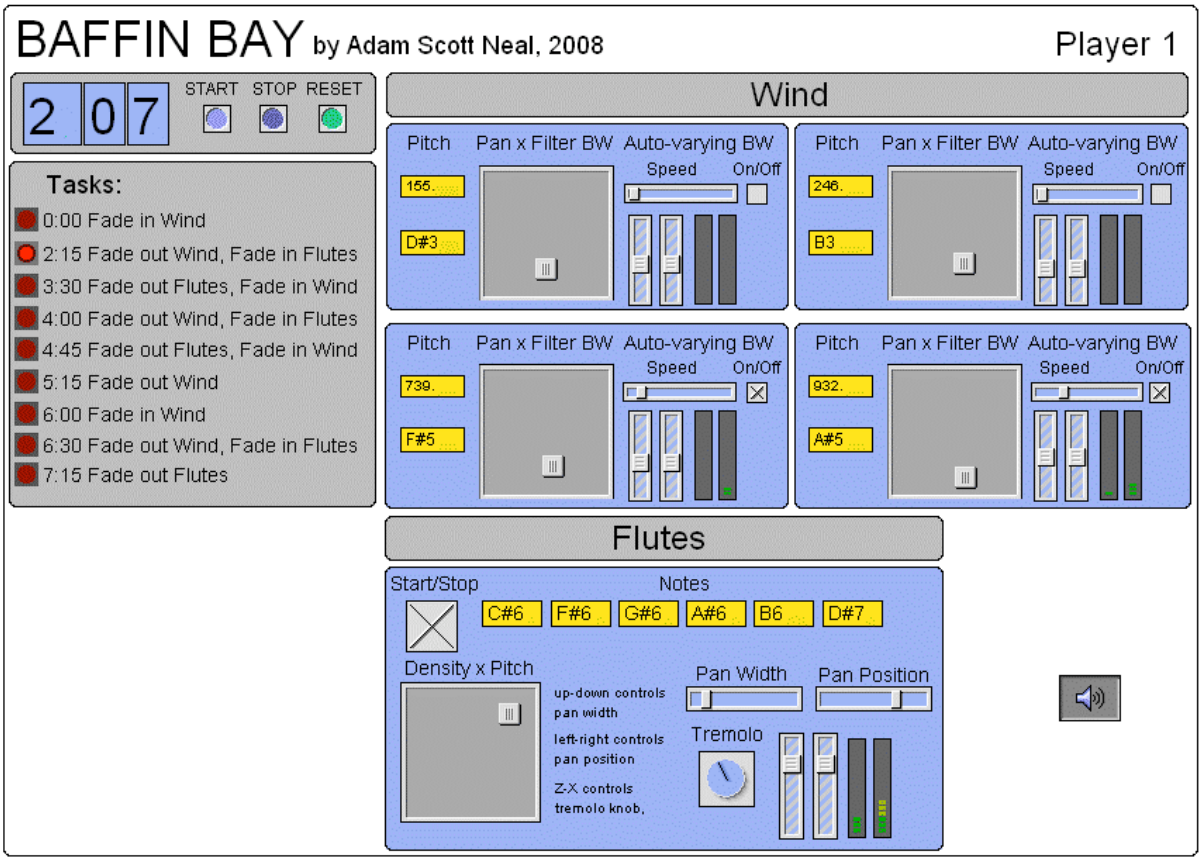

Figure 12: *Baffin Bay*, Player 1 interface

Player 1 has two sounds, “wind” and “flutes.” The “wind” part of the patch is a set of four resonant filters. The player has a trackpad with which they can affect the panning of each filter as well as the filter’s bandwidth. An optional function that the

player may select is “Auto-varying BW,” which will narrow and widen the filter bandwidth at a speed specified by the player. This allows the player to create a constantly evolving texture, instead of being able to manipulate only one filter at a time. The “flutes” section also uses resonant filters and it creates quasi-flute or quasi-bird sounds. Six pitches are available at all times and will automatically play pseudorandomly. With the trackpad, the player can change the density of the notes (left-right) and select the range of the notes (up-down). For the range control, the lowest part of the trackpad selects only the three lowest pitches, a little higher selects the second, third, and fourth lowest, etc. A dial allows the player to manipulate the tremolo speed, and several sliders allow the player to manipulate panning.

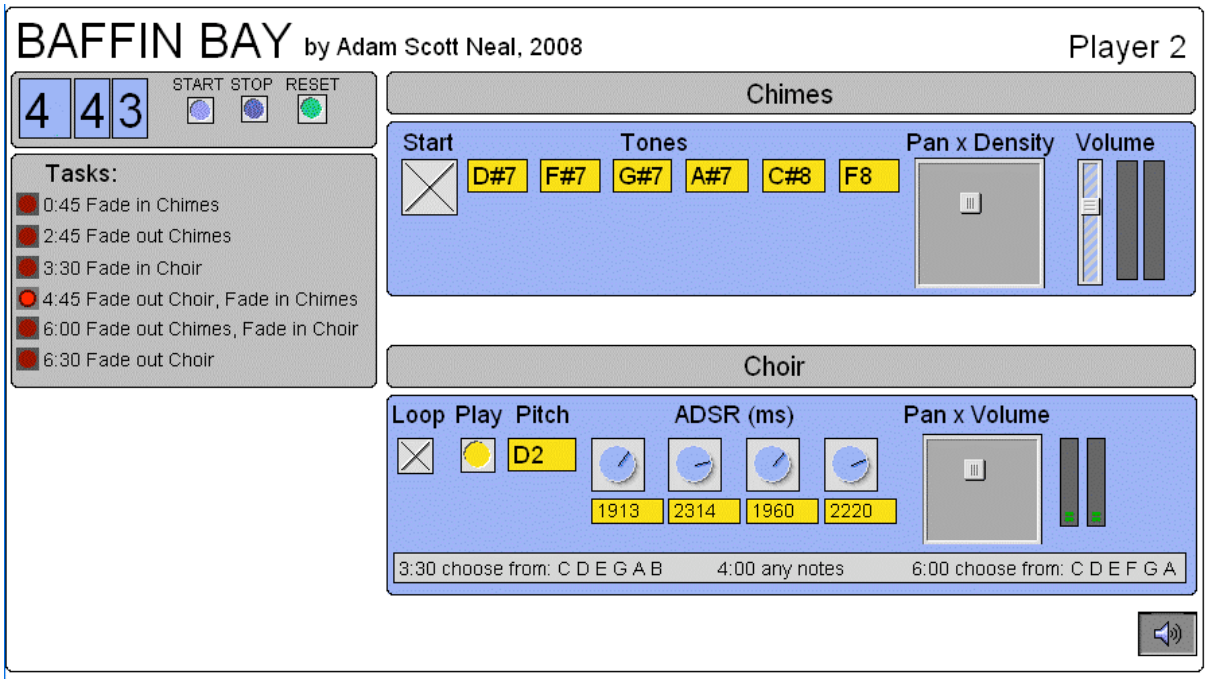

Figure 13: *Baffin Bay*, Player 2 interface

Player 2’s patch includes “chime” sounds and “choir” sounds. The “chimes” section is based on subtractive synthesis (with partials provided by Maarten van Walstijn) and the section functions similarly to Player 1’s flute section. Player 2’s

trackpad changes the panning (left-right) and the density of notes (up-down). The "choir" is the only sound in the work in which pitch is not controlled. This section of the patch plays a soundfile of male singing, one pitch at a time. The player can alter the sound's envelope, and he may loop the sound to extend it indefinitely. Desired pitches are displayed within the patch, but the patch itself does not explicitly limit the pitches.

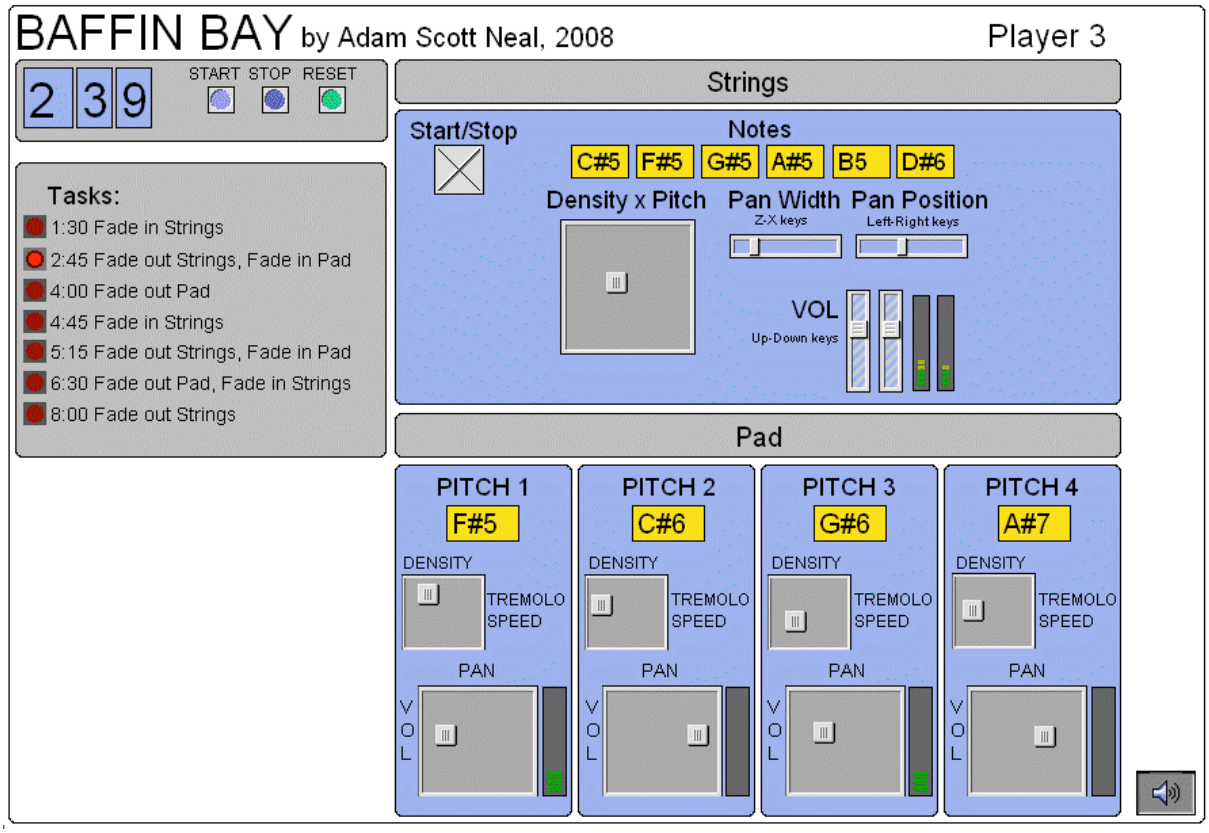

Figure 14: *Baffin Bay*, Player 3 Interface

Player 3 plays string sounds and a synth pad sound. The "strings" section is very similar to Player 1's "flutes" section. Also based on filtering, the strings have more harmonics than the flutes but and lack the tremolo function. The trackpad functions in the same way: left-right affects density and up-down determines pitch range. The "synth pad" plays four banks of sine waves. This section of the patch has

two trackpads: the top trackpad alters density (left-right) and tremolo (up-down), and the bottom trackpad alters panning (left-right) and amplitude (up-down).

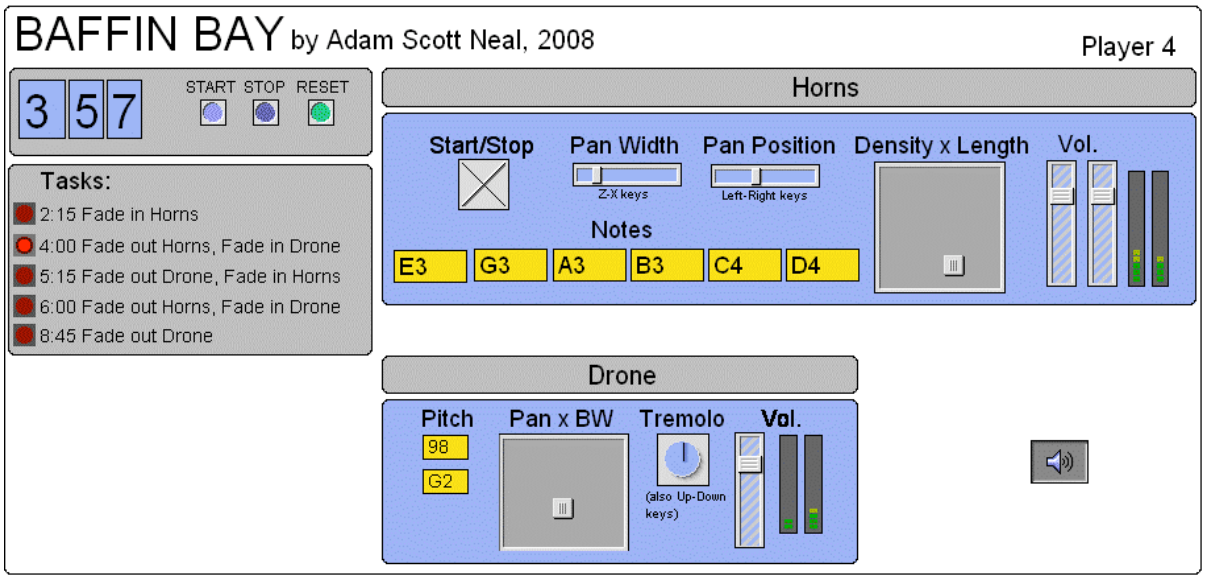

Figure 15: *Baffin Bay*, Player 4 Interface

Player 4's patch includes horn sounds and a drone. Like Player 2's "choir," the "horns" section of the patch plays back soundfiles. However, the section automatically plays the samples pseudorandomly, much like the flutes, strings, and chimes in the other patches. The trackpad controls the density of notes (left-right) and the lengths of the notes (up-down). The "drone" is based on resonant filters, and is a constant sound, like the "wind." It differs from the wind in its use of tremolo, which is controlled by a dial. The trackpad controls panning (left-right) and the filter bandwidth (up-down).

3.2.2 (Not) For Tape

On many contemporary music concerts, fixed-media works are listed in the program as "for tape," much as acoustic pieces are "for flute" or "for string quartet." This tradition has continued long after the demise of tape as the primary medium for

presenting electroacoustic music. It seemed appropriate to comment on this, since I was concerned with the positive and negative effects of adding performers to otherwise fixed works.

The source sounds are taken from a recording I made of myself improvising with adhesive tape. I created a patch for manipulating these sounds using some of the "classic" methods used since the early days of *musique concrete:* speed manipulation, delay, loops, filters, and ring modulation. Originally, I intended for this to be the most deterministic piece in the portfolio, with a rigidly constructed and timed score. However, most of the pieces in the portfolio had some kind of timeline, so I felt it would be interesting to combine deterministic sounds with an indeterminate structure. The final version has an open score inspired by Earle Brown, but still yields fairly specific aural results.

The score was made directly in the patch with number boxes of various colors. Players may navigate through the score in any way they wish, but I constructed the score to increase the likelihood that specific sounds would occur at certain times. For example, the only instances of number 6 are in the center of the score, so it is likely that several players will converge on this area at roughly the same time. There are also areas on the left and right which feature certain numbers (4 and 5 on the left, and 9 and 0 on the right). The number 1 occurs in the center as well as in the corners, ensuring a high likelihood, although not a certainty, that the piece will begin and end with sound number 1.

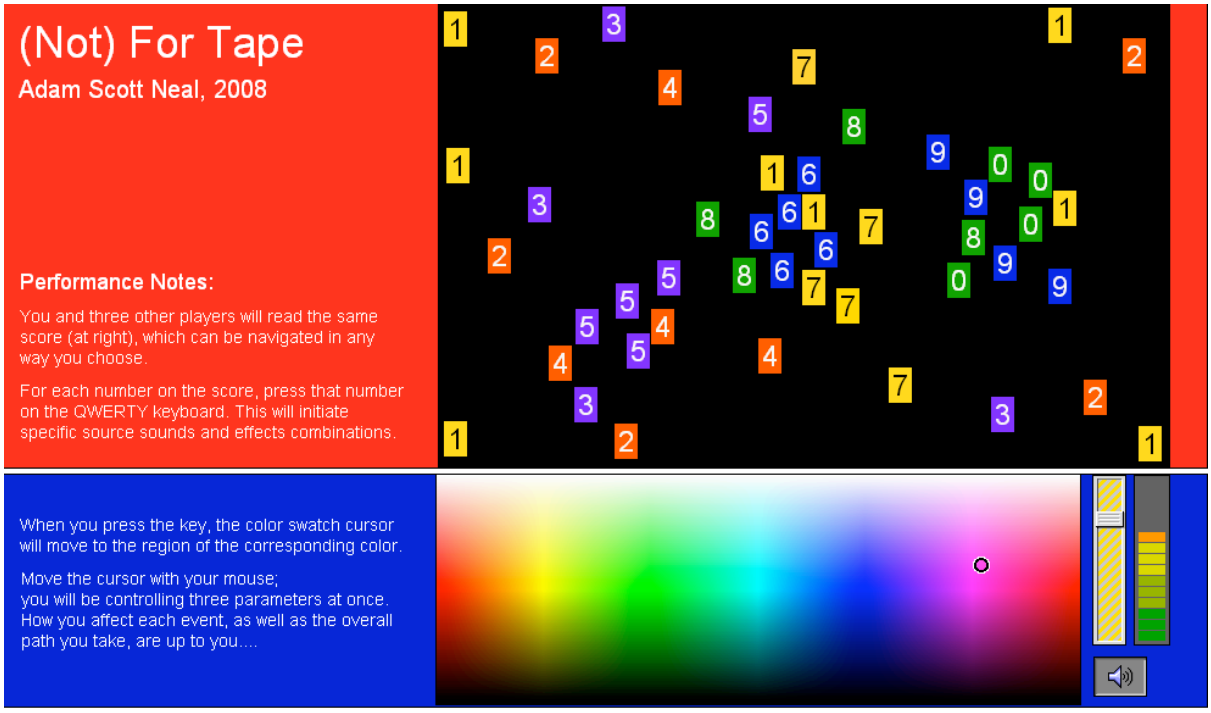

Figure 16: *(Not) For Tape* Interface

The color codes do not mean anything specific, but I listened to each class of sound and assigned colors that the sounds represented to me (though I am certainly not claiming to experience synesthesia). The colors provide a memory aid for the players. When the player presses a number, the cursor on the color swatch in their patch will move to that general area. By seeing the color before they press a number, the players can be prepared to grab the cursor as soon as the sound begins. Some of the sounds are quite short, so the player may miss the opportunity to manipulate the sound if he is searching for the cursor.

Since the Max/MSP color swatch outputs red, green, and blue values, the object can be used to manipulate three variables at once. For each number, I created a unique combination. For example, with number 1, the cursor will move to yellow, and then the player can move it in any direction. If the player moves the cursor in a direction that adds more red, then the amplitude increases. If the player

moves the cursor in a direction that adds more green, then the highpass cutoff frequency increases. Adding more blue increases the playback speed. Since all of these are happening simultaneously, it is not simply one variable moving at a time. If the cursor is directly over red, that means that there is little green or blue, so the playback speed is slow and the cutoff frequency is low.

3.2.3 Morty's Mood

This piece combines the musical influences of jazz and turntablism with the compositional methods of Morton Feldman. The form is typical for jazz: a "head" followed by solos, then the return of the head. Each player is provided with a sample of a well-known performer: Wynton Marsalis on trumpet, Bill Evans on piano, Charles Mingus on bass, and Buddy Rich on drums. All of the samples are solos extracted from different tunes, totally unrelated in style, key, or tempo, making this a disembodied, multistylistic, "all star" band.

The "head" is based on graph notation that Morton Feldman used for a time, showing blocks designated high, medium, and low. The performers are asked to proceed through the graph slowly, taking approximately 30 seconds. To realize the score, the players choose one of three buttons corresponding to high, medium, and low (these buttons are also mapped to QWE, ASD, and ZXC on the keyboard). These buttons skip through the sample to preselected times in which the original performer played in a high, medium, or low tessitura.

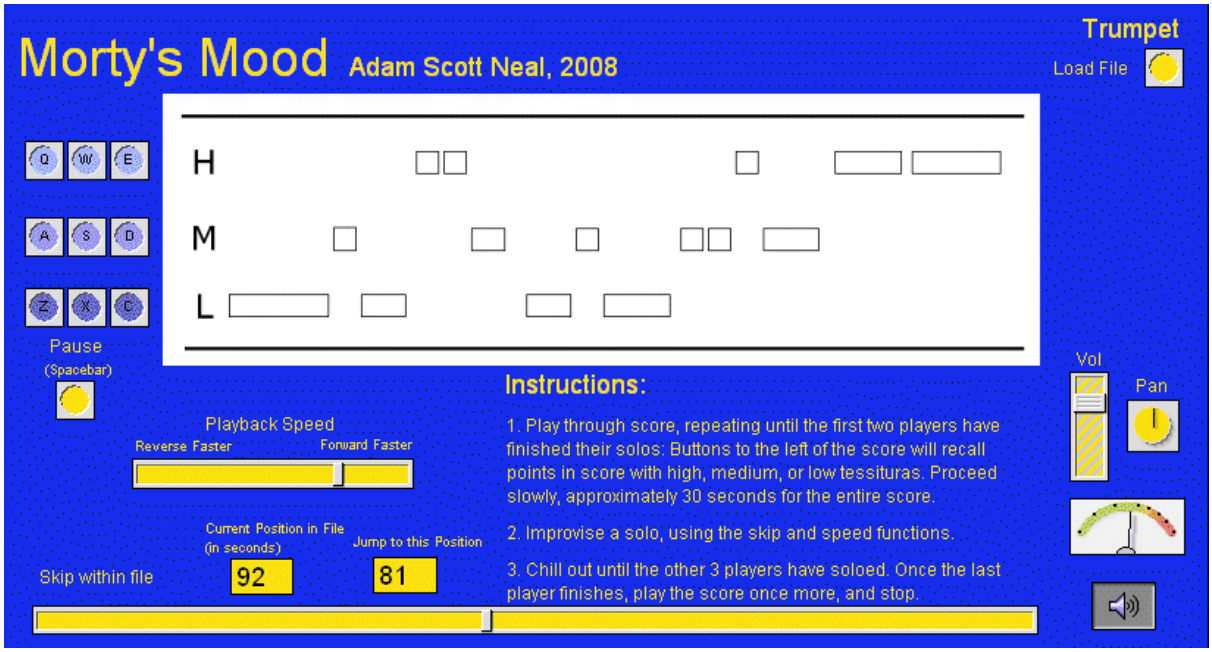

Figure 17: *Morty's Mood* Interface (player 1)

After the head, each player takes turns on a solo. Their solos use the same interface, but the players are free to manipulate the file more, to skip where they wish, and to change the speed and direction of the file. The result is more like a turntablist's solo, than a jazz instrumentalist's solo. While one player takes a solo, the other players continue repeating the head underneath; after the "drummer" finishes his solo, the players advance through the head once more until they reach the end. They will be playing independently of each other, so they will stop one at a time. Like the tessitura graphs, this method of starting together and proceeding independently for the remainder of the piece is based upon the music of Feldman.

3.2.4 Freq Out

I was invited by Pedro Rebelo and Alain Renaud (at the Sonic Arts Research Centre in Belfast) to use their Frequencyliator program for a piece. The Frequencyliator is a Max/MSP patch that presents a composed form to multiple

improvisers, filtering them in particular bandwidths to determine ensemble roles, and using a countdown/warning system to remind players when the next section will begin (Rebelo, 2006). Renaud and Rebelo's main interests for exploration included the Frequencyliator's voting system and methods to articulate form. Originally, I planned to explore the voting system further, looking at this work as a rule-based game. Due to decisions I made about other pieces, I needed to make this piece more deterministic and "composed." I created a fixed form with fixed ensemble roles, and I also created instruments specifically for the piece.

In addition to the cues and filtering available in the Frequencyliator, I decided to also use the patch to control a common pulse. The players' interfaces use the Max keyboard slider, but the pitches that the players select will not be articulated until the pulse reaches the patch. At different cues, the pulse is gated to different speeds, so the players' notes are quantized to that speed. In other words, for one section, a player may be able to play notes every 125 milliseconds, but in another section, he may be able to play notes only every 2 seconds. Along with assigning bandwidths, this stratification of tempi further defines roles, as the player who can articulate notes every 125 milliseconds will probably assume a dominant role, while the player who can articulate notes every 2 seconds will probably assume an accompanimental role. With this quantization, it also enables players to communicate and begin events simultaneously.

The instruments that I created for *Freq Out* are inspired by classic analog synthesizers. Each patch contains a melodic (or "lead") component as well as a drum component. The lead component of two players is made with sawtooth waves, and the lead component of the other two players is made with square waves. The players can alter the envelope of their sounds, change the speed and depth of

vibrato, and add delay. The square wave players can also change the wave's duty cycle to alter the timbre. The drum component is meant to emulate early drum machines such as the Roland 808. It includes synthesized kick, snare, hi-hat, cowbell, clave, and cymbal sounds. The cowbell, claves, and cymbals are based on Gordon Reid's articles in *Sound on Sound* (Reid, 2002).

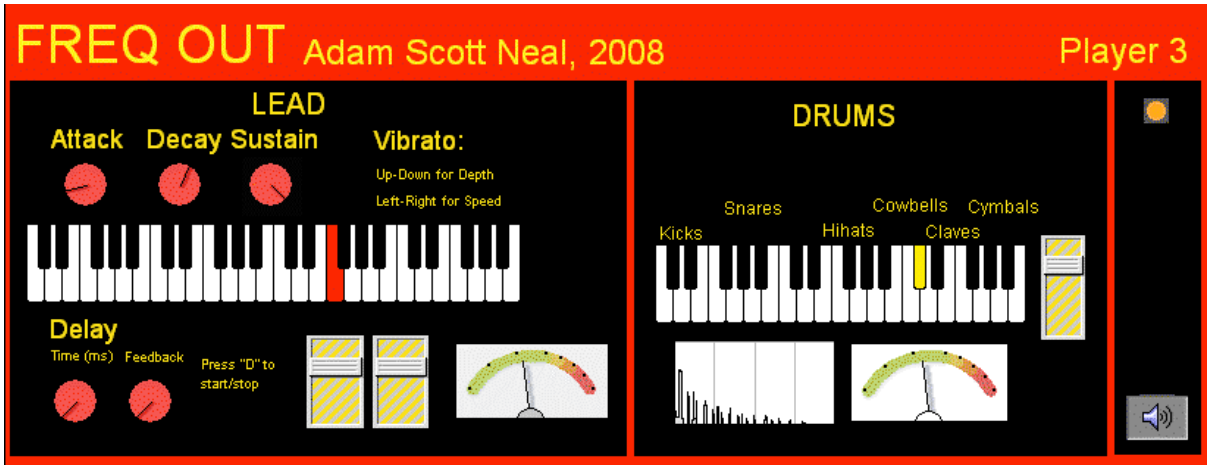

Figure 18: *Freq Out* interface (Player 3)

The score for *Freq Out* is inspired and closely imitated from photos of the Grand Teton mountains in Wyoming, USA. The vertical height of these peaks and valleys is mapped onto the amplitude of the ensemble, so that there are built-in changes of dynamic. The peaks and valleys determined the placement of cues. Each cue assigns a new bandwidth and a new quantization speed to each player; thus, the roles are always shifting. Players will usually have a different quantization speed from their neighbors, but in general, the form of the piece is slow-fast-slow.

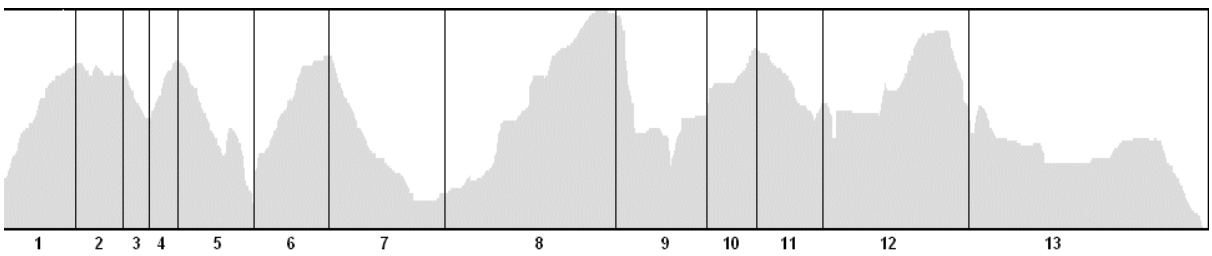

Figure 19: *Freq Out* score – amplitude contour and cues

	Cue 1 (Start)	Cue 2	Cue 3	Cue 4	Cue 5	Cue 6	Cue 7
5500-20000 Hz	P1 / 1000ms	All full	P3 / 1000ms	P2 / 500ms	P1 / 250ms	P1 / 125ms	P2 / 125ms
1300-5000 Hz	P2 / 1000ms	bandwidth	P4 / 500ms	P3 / 1000ms	P2 / 500ms	P4 / 125ms	P3 / 125ms
250-1000 Hz	P3 / 1000ms	and	P1 / 1000ms	P4 / 500ms	P3 / 500ms	P2 / 250ms	P1 / 250ms
20-200 Hz	P4 / 2000ms	1000 ms	P2 / 2000ms	P1 / 2000ms	P4 / 1000ms	P3 / 250ms	P4 / 250ms

Cue 8	Cue 9	Cue 10	Cue 11	Cue 12	Cue 13
All full	P3 / 250ms	P4 / 500ms	P1 / 500ms	P4 / 250ms	P1 / 500ms
bandwidth	P2 / 250ms	P1 / 250ms	P2 / 125ms	P1 / 2000ms	P2 / 1000ms
and	P4 / 125ms	P3 / 250ms	P3 / 250ms	P2 / 1000ms	P3 / 2000ms
125 ms	P1 / 125ms	P2 / 250ms	P4 / 500ms	P3 / 500ms	P4 / 2000ms

Figure 20: *Freq Out* score – filter bandwidths and quantization speeds (ms)

3.2.5 Presets

The primary idea for *Presets* is to alter the parameters of players' patches in unpredictable ways. The players will improvise with a certain set of parameters in place, be allowed to alter these parameters, then suddenly be confronted with a new set of parameters. However, these new presets are not, in fact, "pre set;" the presets are influenced by the changes made by the performers. For example, in one of the presets, the highpass cutoff frequencies from all of the players are read by the main patch, which deduces the highest cutoff frequency overall and sends that frequency to each player. A player may have a cutoff of 300 Hz, but when this new preset begins, he may suddenly have a cutoff of 3000 Hz.

Each player has the same patch, which synthesizes two different classes of sounds. One class is made with an impulse sent through comb filters, and the other is made with an impulse sent through resonant filters. By changing various parameters, these two classes of sounds can emulate different instruments, such as sitars, guitars, drums, and xylophones. The players can alter the delay time and feedback, the note sustain length, the highpass and lowpass filter cutoff frequencies,

and a collection of eight pitches. They can alter these parameters with the mouse, but to play the sounds, they can use the mouse or their QWERTY keyboard. The keyboard is set like a harpsichord with three "manuals" – A-K is the manual with the softest dynamic, Q-I is the medium dynamic, and 1-8 is the loudest. All three manuals play the same pitches, and with some practice, a player can play expressive gestures with accents, crescendi, et cetera.

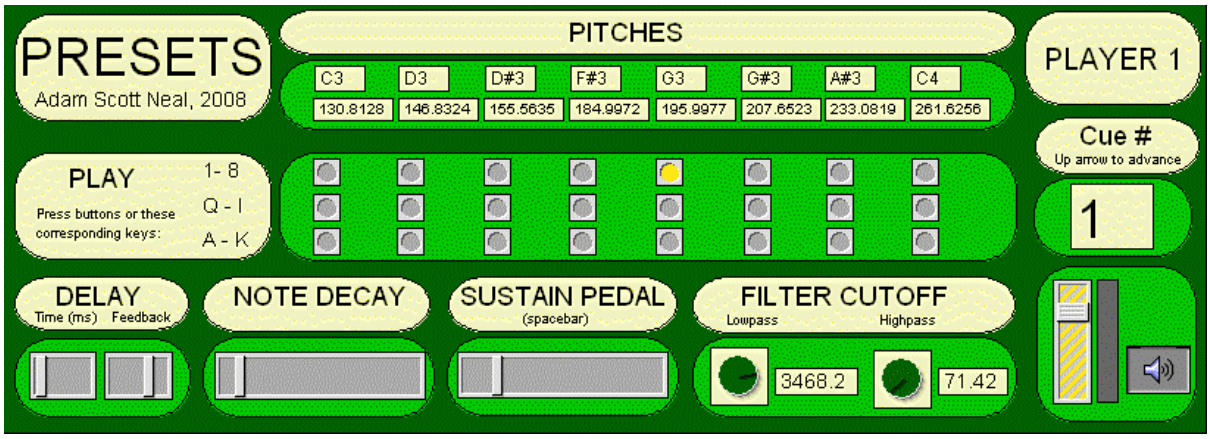

Figure 21: *Presets* interface (player 1 – others lack "cue #")

4. PERFORMANCE DOCUMENTATION

I assembled a group of fellow MA students to help me present these pieces: Christopher Chong, Carey Dodge, and Javier Jaimovich. We had several rehearsals and testing sessions, and held a presentation/performance on 9 September, 2008 in the Sonic Lab at Queen's University Belfast. I would like to acknowledge the patience and enthusiasm of my ensemble, who were immensely helpful with improving the interface design and networking issues in my patches.

For the performance, we set up as shown below. The ensemble is in a semicircle, since I wanted to work like a chamber group. I made use of the existing loudspeaker setup in the Sonic Lab (the two rear speakers are not shown). Each player had a stereo field, but due to the Sonic Lab's configurations, some speakers were shared by two group members. However, all of the players were able to see each other, and the spatialization was very helpful in identifying which sounds belonged to which player.

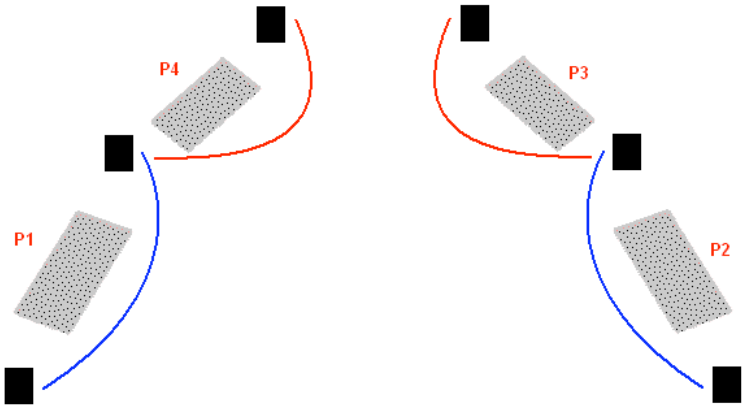

Figure 22: performance setup

We did not present the pieces in the order of the continuum. Instead, I created a program that I felt worked better in the context of a concert: *(Not) For Tape, Morty's Mood, Baffin Bay, Presets,* and *Freq Out.* The performance was part of a day-long showcase of MA student work, so the pieces needed to fit into a 30-minute performance. I needed to make some pieces shorter than originally intended, but after listening back to the recording, I think that the lengths were appropriate. Most of the pieces went quite well; the only disappointment for me was *Presets,* which was disappointing only because the program architecture provided us with similar presets that did not change very much with each cue. Toward the end of the piece, we

started to find interesting ideas, but we needed to stop due to time constraints. A minor disappointment was *Freq Out.* The Frequencyliator patch did not output any sound and I did not have enough time to resolve the issue. Therefore, in the performance, the pulse and quantization functioned correctly, but the filtering and changes in amplitudes did not occur.

The reactions from my performers were quite positive. They found all of the pieces to be enjoyable to play, and liked that each piece presented unique sounds and challenges. They also noted that *(Not) For Tape* and *Baffin Bay* felt more like compositions, while *Morty's Mood, Freq Out,* and *Presets* felt more like instruments that they could explore. Judging from these reactions, my proposed continuum of indeterminacy worked.

5. REFLECTIONS

5.1 The Continuum

With this portfolio, I sought to demonstrate not only several degrees of indeterminacy, but also several approaches to indeterminacy. In all of the pieces, the gamut of sounds were predetermined, so each piece has a timbral identity. *Baffin Bay, Morty's Mood,* and *Freq Out* all have some sort of timeline, while *(Not) For Tape* does not. *Presets* is somewhat ambiguous in this respect; there is a set order in which the instrument variables will change, but the timing and the actual result of the changes are not determined.

Morty's Mood and *Freq Out* enforce player roles the most strictly; *Morty's Mood* accomplishes this with instrumental timbre, following the established tradition of jazz, and *Freq Out* accomplishes this with filter bandwidth and rhythmic

constraints. *Baffin Bay* suggests roles with its form, which tells the players when to play which instruments, but the piece gives much freedom to the players in how they will interact. *Presets* and *(Not) For Tape* expect fairly independent interpretations; the players do not need to interact directly, but the resulting experiences may imply roles to the audience.

Baffin Bay and *Presets* are the only pieces which address pitch specifically. *Baffin Bay* is quite prescribed, as the harmonic content is tied to a timeline and programmed into each player's patch. In *Presets,* the players are supplied pitches, but have the freedom to change them; at certain points, the same pitch or pitches will be supplied to each player. When playing *Freq Out,* the players have control over pitch, and may decide to play together to create harmonies; however, they can elect not to do so, and the patch itself does not constrain pitch. *Morty's Mood* has pitch content built-in, due to its use of existing samples of jazz recordings. However, the samples were chosen because of the players, not the song or the key in which it was played. On top of this, the players can alter the speed of their samples, changing the pitch greatly.

Freq Out is the only piece that deals with rhythm directly, since it enforces a common pulse. However, since players can play single notes with one keystroke in *Presets*, it is quite possible that the performers may decide to play together in a constant pulse. Much of *Baffin Bay* uses pseudorandom algorithms to articulate sounds, so it is nearly impossible to coordinate rhythms. *Morty's Mood* is also difficult to coordinate because it uses samples from different tunes. It would be possible to coordinate attacks in *(Not) For Tape,* but the inherent rhythms of the samples would counteract much of the attempted synchrony.

Other aspects of performance which are indeterminate (even in traditional compositions) include dynamics and tempi. *Freq Out* addresses dynamics by controlling the ensemble's volume with a predetermined score; it also addresses tempo, as described above, regarding to rhythm. *Baffin Bay's* internal pseudorandom structure limits how fast or slow the instruments can play, and its form is rigidly deterministic; however, the players have the opportunity to play their instruments mostly slow, or mostly fast, to different effects. Each instrument includes a fader, so players are trusted to listen to each other in regards to dynamics. *Morty's Mood* simply requests that the instruments play softer when they are not playing a solo, and *Presets* and *(Not) For Tape* present no constraints on tempi or dynamics at all.

5.2 Notation considerations

Since each piece was unique in its implementation, it required unique notation or directions. Three of the five pieces had some kind of timeline, but none were represented the same way. For *Baffin Bay*, the timeline was written in words and supplemented by a clock and flashing LEDs. For *Morty's Mood,* the overall timeline was written in text (e.g. "begin your solo after player 1 finishes his"), but the "head" contained graphic notation representing a succession of high, medium, and low passages. In *Freq Out,* there is a common contour which all players can see, and this is supplemented by flashing LEDs and text messages. *(Not) For Tape* is a graphic score inspired by Earle Brown's *December 1952.* This score allows multiple "paths," but no set timeline. However, the way I constructed the score implies certain paths and ensures a high probability of certain elements occurring at certain times. *Presets* contains no notation, except instructions for Player 1 to advance through a series of 25 cues at his leisure. In a way, this also has a timeline, similar to the way

in which *Morty's Mood* has a timeline: certain types of events will happen in a particular order, but the content and length of each section are somewhat unpredictable.

5.3 Interpretation vs. realization

Although it may have been an interesting factor to test, I felt that creating a piece which required exact realization would not be engaging for performers. Therefore, even the most determinate pieces allowed some flexibility for interpretation or improvisation. For example, I originally intended to make *(Not) For Tape* very deterministic. As I developed the portfolio, I changed the piece to its current open-score form. The players can now choose among multiple pathways, but the particular actions they may take when following these pathways are severely limited. They must press a number, which starts a determined sound file and a determined process which they can manipulate. There are infinite variations in how exactly these manipulations occur, but the types of sounds remain the same. This is in great contrast to *December 1952,* in which the performers are invited to be far more creative in how they interpret each object in the score.

The gestural content of *Baffin Bay* is left up to the performers. Except for fading instruments in and out at appropriate times, they may improvise with the instruments in whatever manner they please. However, pitch is strictly enforced, and the player ends up having less freedom than it may at first appear. Likewise, in *Freq Out,* the players are limited in bandwidth, and limited in rhythm. Their gestures are quantized, so they cannot move faster than the computer allows. Therefore, the texture that the players create is somewhat predetermined, despite the improvisatory nature of the piece.

5.4 The presence of performers

With all this work to circumvent the desired improvisation of the players, one may wonder why I composed for performers in the first place. The reason is the excitement of hearing different versions of the piece each time it is performed (i.e. interpretation). Although the pitches and overall form of *Baffin Bay* are strictly enforced, the ensemble has much room to play with rhythm, gesture, and interaction with each other. I can realize the piece in the studio myself to have a "definitive" version, but I think it is more interesting to invite the possibility of different results, based on the personalities of different players. *Freq Out* is even more open, so the players in one performance may enjoy the slow sections, and play somewhat slowly even when the computer has allowed them to play fast. The next performance may involve more aggressive players who play as fast as possible whenever they have the chance. Although the form and instruments will remain the same, the character of the piece will change significantly.

6. CONCLUSION

This portfolio presents five pieces which address the continuum of indeterminacy, specifically in live computer (or laptop) music. The pieces show that composers can create works for computer performers which have a high degree of determinacy but still allow the players freedom to interpret and improvise. As a demonstration of the continuum concept, the project is reasonably successful. However, in the future, some aspects of the projects could be addressed in better ways. For instance, I did not create a piece which was entirely deterministic, fearing

that it would not be engaging for the performers. This could be done in the future, perhaps with a piece that has a determinate and an indeterminate version. It will also be useful to compare performance-oriented versions with composed, fixed-media versions of the same work. To observe this, I plan to take the original score I created for *(Not) For Tape* to create a fixed-media work titled *For Tape.* Once this is completed it will be interesting to compare the two works.

Still more variety can be explored in this genre of works, in terms of methods for producing sound as well as methods for performer interactions. In the future I plan to test pieces with open instrumentation, allowing the players to supply their own patches; since I created all of the sounds for the pieces in the portfolio, I ensured a certain timbral identity for each piece. It would be interesting to see if the pieces maintain an identity purely through rules and interaction (considering what has been written about the works of Brown and Wolff, I will assume that this will be the case). Also, I made a caveat for this project which dictated that I rely solely on the computer's keyboard and mouse. There are likely many more ways to approach the use of the keyboard and mouse, and of course external controllers could add yet more interest and gestural control.

How will these pieces work when played by different groups? The players I chose for this project had performance experience, but it would be interesting to see how this would work with less experienced players or non-musicians. It seems that, in the context of laptop groups, improvisation is considered "easier to perform" than written compositions and thus improvisation allows less-experienced musicians to participate in the music-making. Perhaps laptop group pieces which are more determinate will be easier (and more effective) for performers who lack performance and improvisation experience, and perhaps improvised pieces will be most effective

when played only by very experienced improvisers. These are all intriguing possibilities for future exploration in this area.

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APPENDIX: PERFORMANCE NOTES

Five Pieces for Laptop Quartet

This document explains how to play the pieces in this portfolio. The pieces may be played separately or in any combination. In the file folder, you will see subfolders for each player, containing all the necessary files. The “Freq Out” folder contains the files for the separate server computer necessary for *Freq Out.* If there are any questions, please email me: adamscottneal@gmail.com.

Baffin Bay

Program Note:

BAFFIN BAY is a body of water between Greenland and Baffin Island, Canada. Near the Arctic Ocean, it is a cold, forbidding, but beautiful place. I have never visited, but I have long been fascinated by the arctic seascape and its indigenous wildlife. This relaxed and contemplative work was written for laptop quartet, and each player is assigned two instruments for a total of eight unique instruments. The form is based around four quartets featuring different combinations of these instruments, as well as duos and trios building up to and receding from these quartets. The players improvise within a structure that determines who will play at a given time, and what pitches will be present at that time.

Performance Notes:

Performance

Each player has a unique interface with two different instruments. On the left side of each patch is a clock and a list of tasks. When starting the piece, all players should press the “start” button next to the clock (it is not essential that this be precisely timed). The list of tasks tells players when to fade sounds in and out. Next to each item is an LED which lights up 10 seconds before the listed time as a reminder. The other aspects of the patches are different for each player.

Each patch displays the available pitches, but these are displayed for reference only. The pitch content of this piece is controlled and tied to the clock, and altering the displayed pitches will have no effect (except for player 2, see below).

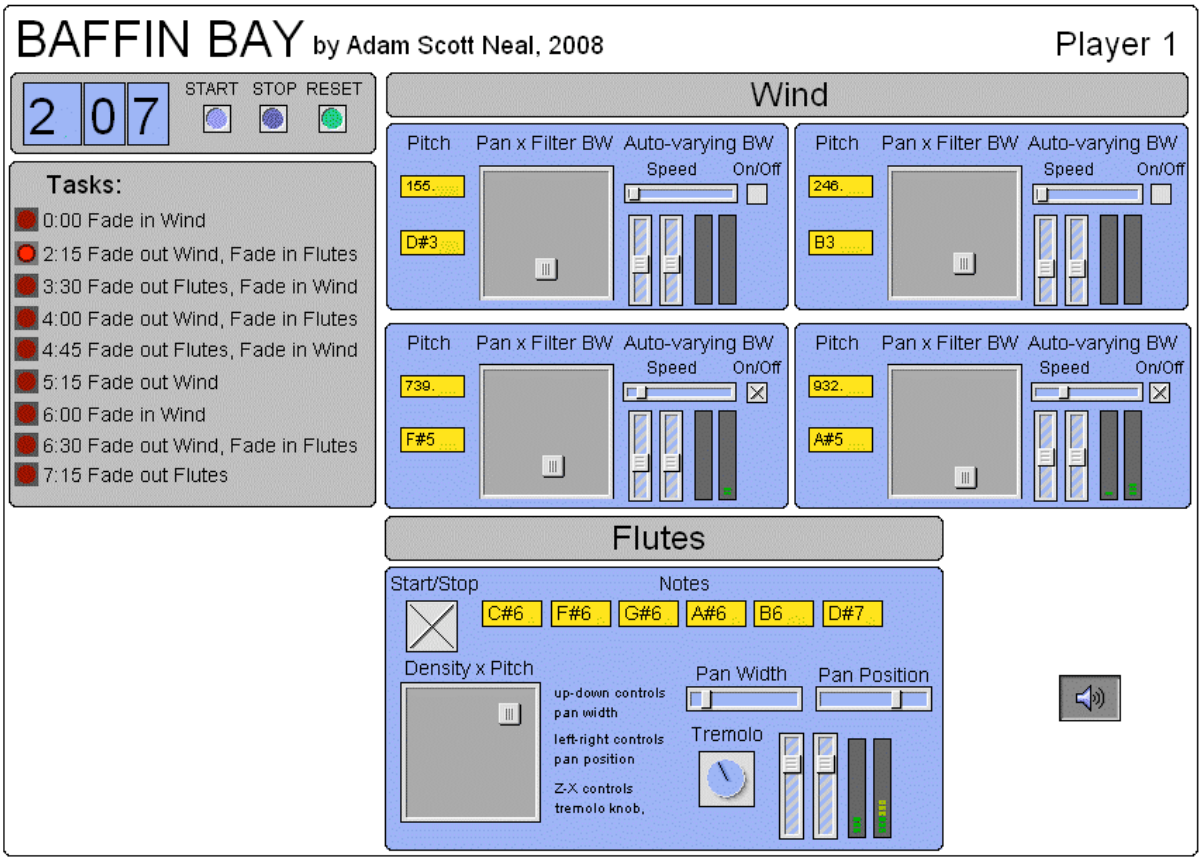
Here is a reference score, detailing the structure of the work. Please note that despite the blocks shown, instruments should not begin and end suddenly. Each instrument should be faded in and out with care. The minimal score shows that this piece is merely a controlled framework for improvisation. The players are free to explore their instruments when realizing the piece.

Score:

Sonority:	FECAGD	(FECAGD)	interpolate ==>	G#C#D# F#A#B	interpolate ==>	DAGECB
Texture:	Solo	Duo	Trio	"Melodic" Quartet	Trio	Quartet
Player 1:	WIND			FLUTES		WIND
Player 2:		CHIMES				CHOIR
Player 3:			STRINGS		PAD	
Player 4:				HORNS		
0:00	0:45	1:30	2:15	2:45	3:30	4:00

interpolate ==>	FF#A# C#D#G#	interpolate ==>	FECAGD	interpolate ==>	G#C#D# F#A#B	(G#C#D# F#A#B)
Trio	Quartet	Trio	"Texture" Quartet	Trio	Duo	Solo
FLUTES	WIND		WIND	FLUTES		
	CHIMES		CHOIR			
	STRINGS	PAD		STRINGS		
DRONE		HORN	DRONE			
4:45	5:15	6:00	6:30	7:15	8:00	8:45

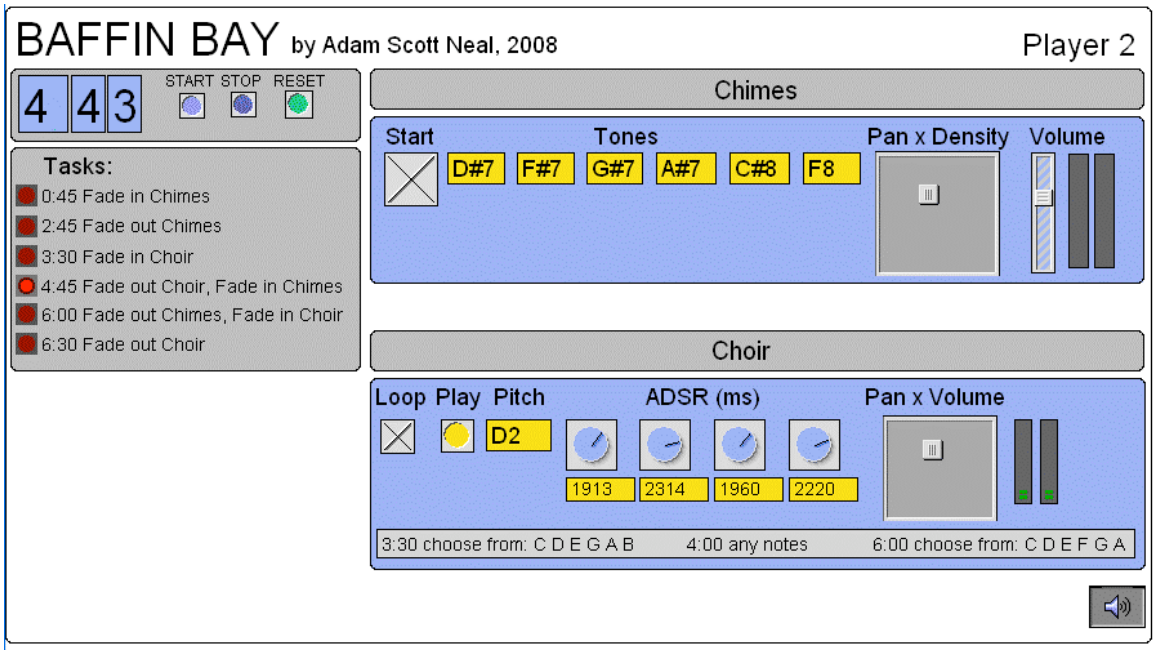
Interfaces:



The Wind instrument plays four different pitches, which have identical and independent controls: a trackpad allows the player to change panning (x-axis) and filter bandwidth (y-axis). The bandwidth is widest at the bottom. The player can also use the slider labeled “Auto-varying BW,” to let the computer change the filter bandwidth automatically. This allows the player to focus on other controls while still having dynamic changes. The volume of each pitch is also controlled separately.

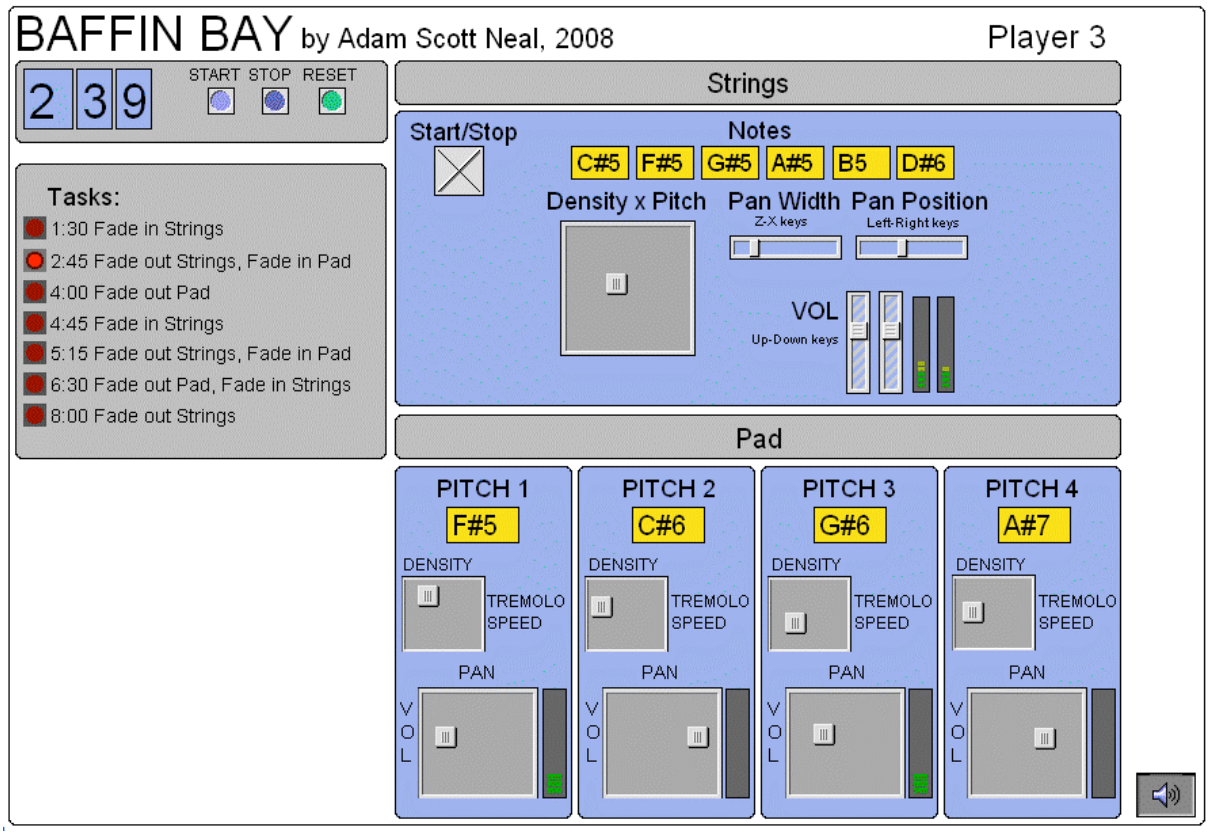
The Flute instrument also has a trackpad, but this trackpad controls density (x-axis) and pitch (y-axis). When the player presses “start” on the Flute instrument, flutes will play automatically; however, the density increases as the player moves to the right of the trackpad. Not all pitches are played at once; the player chooses a range by his position in the y-axis: the very bottom allows only pitches 1-3, while moving slightly higher allows only pitches 2-4, etc.

The instrument includes sliders to control pan position and pan width. A center position and width can be set, and pitches are placed randomly within this range. These sliders can be moved with the mouse or with the keyboard, as indicated. The tremolo knob can be used to introduce tremolo at speeds of 1 to 20 times per second. This can be also be controlled by the keyboard, as indicated. Finally, a stereo fader controls the Flute instrument’s volume.



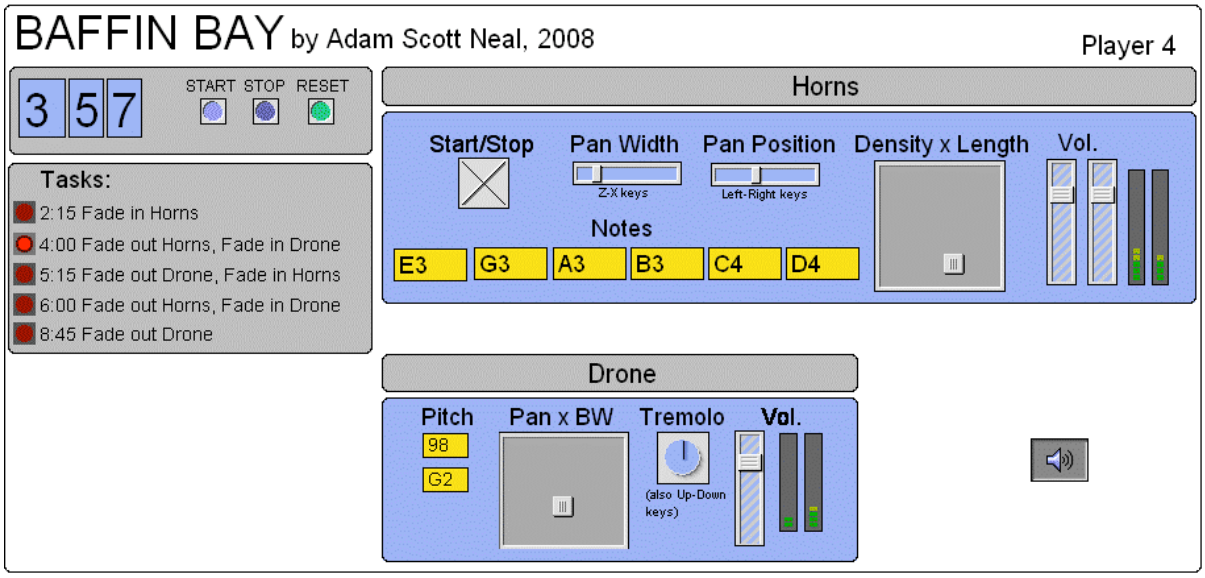
When Player 2 presses “start” in the Chimes instrument, chimes will play automatically. With the trackpad, the player can control panning (x-axis) and density (y-axis). The density of chimes is highest at the top of the trackpad. Next to the trackpad is the volume control for the Chimes instrument.

The Choir instrument plays samples of men singing. The player may elect to play single notes, or may elect to loop the sounds in order to create a continuous texture. Unlike the other instruments, this patch does not play pitches automatically. The player is free to select pitches (in the number box), but the selections should be based on the lists indicated at the bottom of the instrument. The other controls in this instrument are knobs for creating envelopes, and a trackpad to control panning (x-axis) and volume (y-axis).



When the Player 3 presses “start” on the Strings instrument, strings will play automatically; however, the density increases as the player moves to the right. Not all pitches are played at once; the player chooses a range by his position in the y-axis: The very bottom allows pitches 1-3, while moving slightly higher allows pitches 2-4, etc. The instrument includes sliders to control pan position and pan width. A center position and width can be set, and pitches are placed randomly within this range. These sliders can be moved with the mouse or with the keyboard, as indicated.

The Pad instrument has four pitches, which can be controlled individually. Like the Strings instrument, the Pad will play pitches automatically. Each pitch in the instrument has two trackpads. The top trackpad controls density (x-axis) and tremolo speed (y-axis). The sounds are most dense at the left, and the tremolo speed is fastest at the top. The bottom trackpad controls panning (x-axis) and volume (y-axis).



When Player 4 presses “start” on the Horns instrument, horn samples will play automatically; however, the player can use the trackpad to affect density (x-axis) and note lengths (y-axis). The texture is more dense on the right, and the notes are longer on the bottom.

The instrument includes sliders to control pan position and pan width. A center position and width can be set, and pitches are placed randomly within this range. These sliders can be moved with the mouse or with the keyboard, as indicated. Finally, a stereo fader controls the Horn instrument’s volume.

The Drone instrument plays a single continuous pitch. The trackpad controls panning (x-axis) and filter bandwidth (y-axis). The filter bandwidth is the widest at the bottom. Next to the trackpad is a knob controlling tremolo, a rate between 1 and 20 times per second. Next to the tremolo is a volume fader.

(Not) For Tape

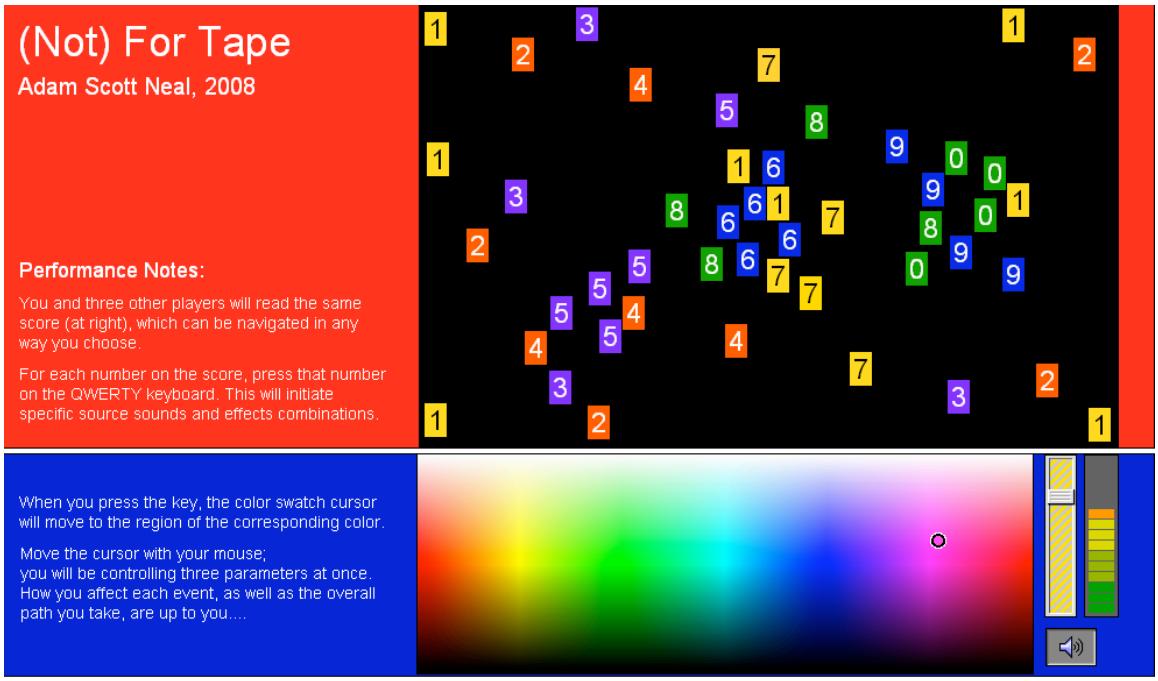
Program Note:

Since the first medium for composing electronic works was magnetic tape, many concert programs describe a piece as written “for tape,” much like a piece might be written “for piano.” This tradition persists today, despite the fact that most pieces are no longer presented from tape, but rather from digital media (e.g. hard disk). This piece is to be performed by four musicians, rather than simply presented from fixed media such as disk or tape. However, the source sounds of the piece are adhesive tape, so the piece is simultaneously “for tape” and “not for tape.” As an homage to early works for tape, I relied on sound manipulations used since the early days of *musique concrete,* namely speed manipulation, filtering, reverberation, and ring modulation. Again, there is no fixed form for this work. To further remove this piece from fixity, the players are presented with a graphic score that can be interpreted in multiple ways, rendering each performance substantially different.

Performance Notes:

Interface

Below is a screenshot of the player interface, which is the same for all four players. The instructions are written directly into the interface for reference.



The top area, with the numbers, is the score. The numbers have no function. Each player will follow this score independently, taking any path they choose. The duration for this piece is open, but players should decide an approximate duration beforehand so that they may proceed at a similar pace. Each number corresponds to one event.

Since there are 48 events in the score, one suggestion could be to play for 8 minutes, which would mean approximately 10 seconds per event. It is worth noting, however, that playing a new event every 10 seconds would sound very regimented and would not be ideal!

Performance

To create an event, the player will type the corresponding number on their keyboard. Doing so will start a soundfile and a predetermined type of sound process. Once the file begins playing, the player can move the cursor around the color swatch to affect the process. The numbers on the score have corresponding colors. When the number is pressed, the cursor on the color swatch will move to that color area. This was done as a memory aid for the players, and it allows the players to anticipate where the cursor will move.

Morty's Mood

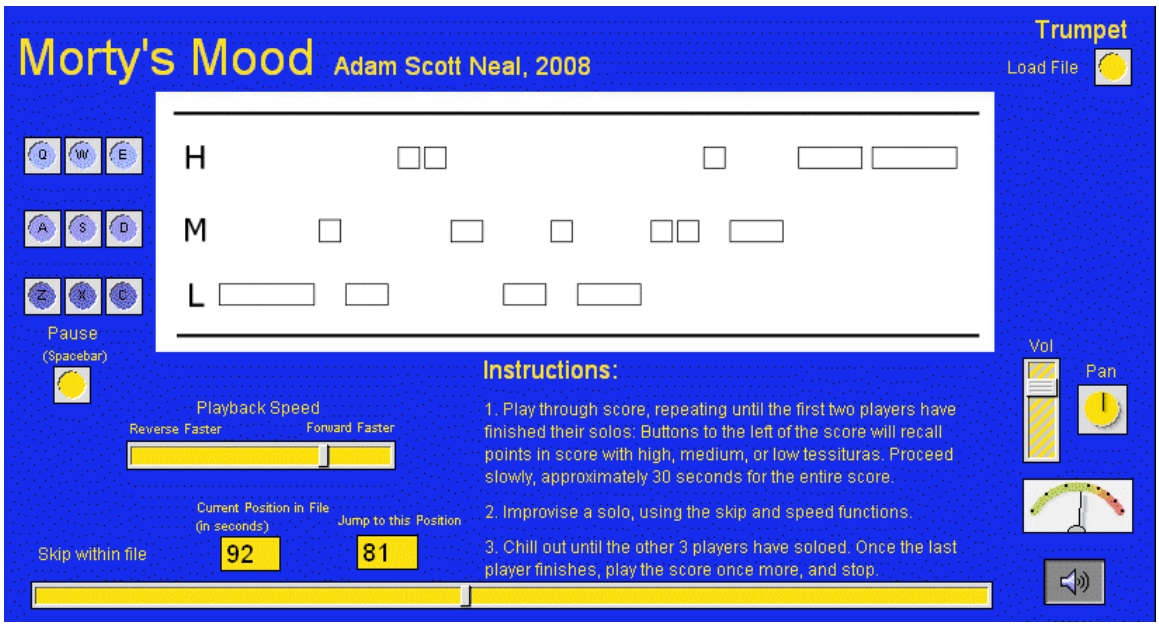
Program Note:

Morty's Mood combines the sounds of jazz and turntablism with the compositional ideas of Morton Feldman. In this piece, each player is given a graphic score with blocks directing them to play in a high, medium, or low tessitura. The players use interfaces which play soundfiles and allow the player to skip to phrases in which the recorded soloist played in a high, medium, or low tessitura. This piece is written for laptop quartet, and each player is assigned samples from famous players, creating a disembodied all-star band: Wynton Marsalis on trumpet, Bill Evans on piano, Charles Mingus on bass, and Buddy Rich on drums. After playing the initial score, each player takes a solo, just like a jazz quartet, but the solos involve manipulating the sound files, so they more closely resemble a turntablist's solo.

Performance Notes:

Interface

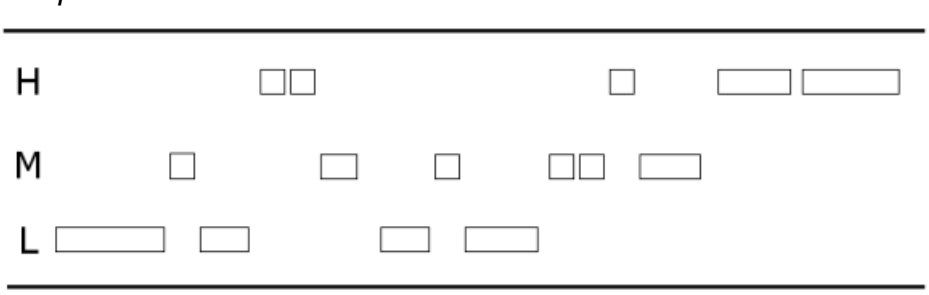
Each player has the same interface, which looks like this: The differences are the score and the sound file skip times, which correspond to the sample used.



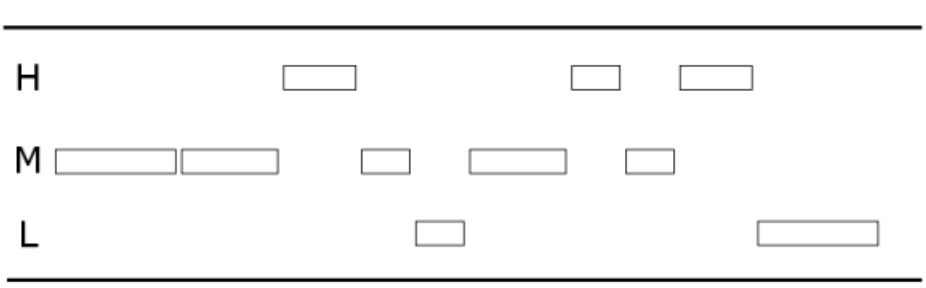
The score should last approximately 20-30 seconds, but it is not intended for the players to begin and end at the same time. Since the samples used in this piece are taken from different players and different songs, it is unlikely that the music will have much cohesion anyway.

Scores

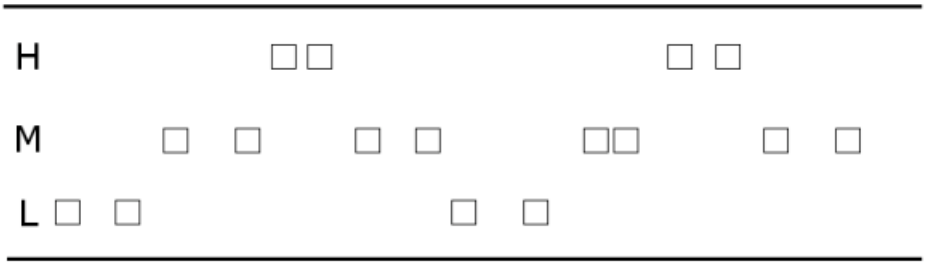
Trumpet



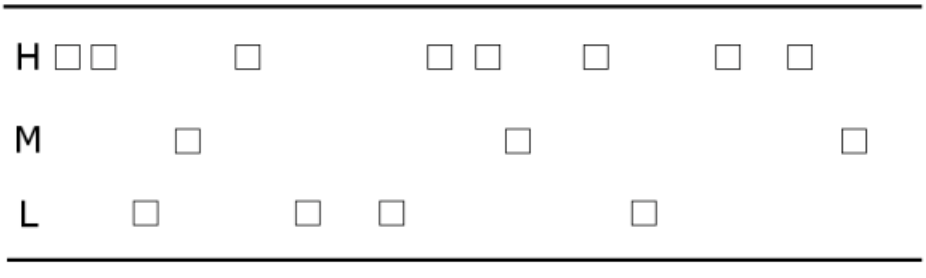
Piano



Bass



Drums



When playing the score, the players will use the buttons to the left of the score. For a block on the “H” line, the player may choose any of the 3 buttons on the same line. They can play these buttons with the mouse, but the buttons are also mapped to the keyboard, on the keys written on the buttons (e.g. Q, W, E). These buttons will skip to predetermined points in the soundfile.

Performance

The players all begin together, playing through the score at their own pace. Once a player has completed the score, he shall repeat it until it is his turn to solo. The order of solos is: trumpet, piano, bass, drums. The length of each solo is up to the players, and the players should listen carefully for the end of the previous solo in order to begin their solo soon after. Once the “drummer” completes his solo, all of the players should proceed through the score once more, then stop. Players do not need to end together.

For the solos, the players are free to use the program however they choose. The interface includes a slider for skipping to different points in the sample (besides those determined by the buttons), and it includes a slider for altering the speed and direction of the file. It may be helpful for the players to think of this as a turntablist’s solo rather than a jazz instrumentalist’s solo.

Freq Out

Program Note:

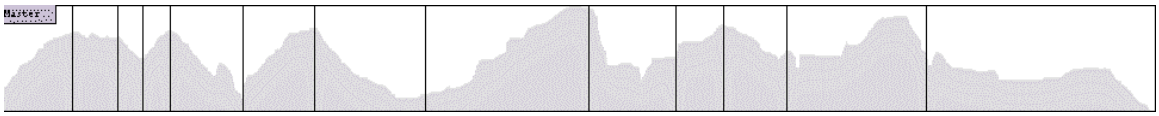
Freq Out for four networked laptop performers uses a program designed by Alain Renaud called The Frequencyliator. This program distributes a common timeline and a common pulse to the performers, and allows the master computer to filter each performer in order to carve out unique frequency bands for each. The "score" for *Freq Out* is based upon the contours of the Grand Teton mountains in Wyoming, USA, and these contours determine the amplitude of the ensemble. The peaks and valleys also determine the beginnings of new sections; in each section, the performers' frequency bands are reassigned, and their notes are quantized to new note values (i.e. only half-notes are allowed in one section, but sixteenth-notes are allowed in another). Thus, the roles of lead and accompaniment players are always changing. The sound-world for this piece is quite "retro," since I provided instruments to the players which resemble classic synthesizers and drum machines.

Performance Notes:

The Frequencyliator control program

On a separate computer, set up the Freq Out server patch. Load in the score and cues, check the outgoing IP addresses in the "sequence" subpatch and the incoming audio in the "input" subpatch. After this, the server should be ready.

Freq Out score, with cues superimposed

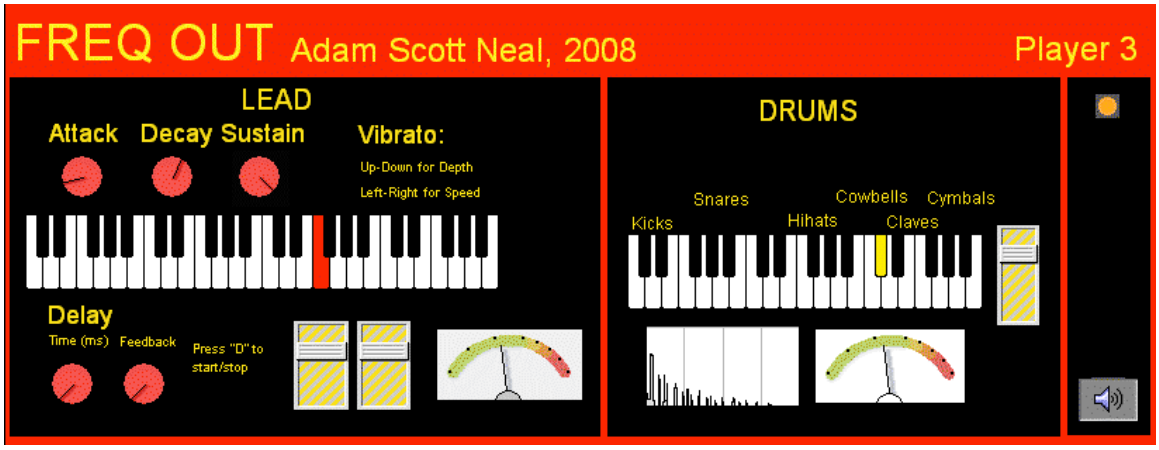


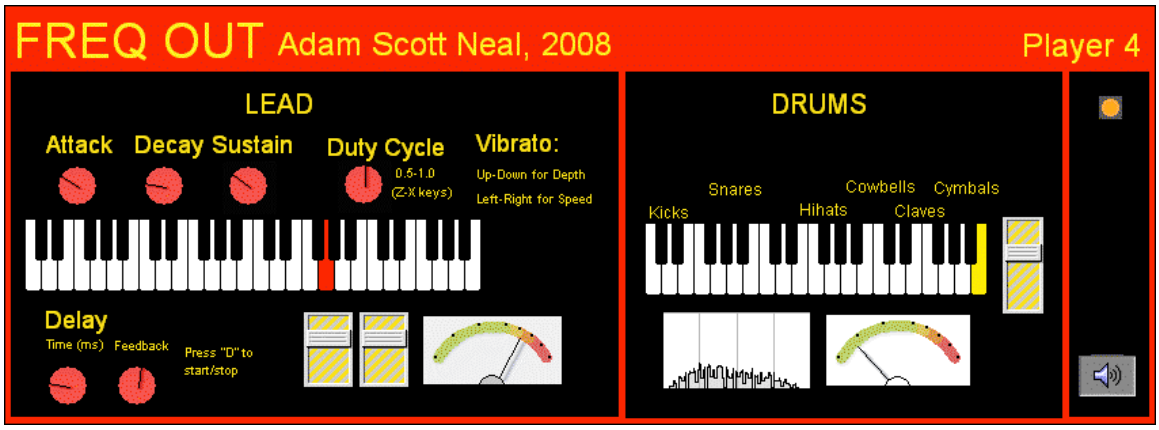
The person controlling the server computer should signal when to begin. The player patches will make no sound until the patch begins.

There are no directions other than to improvise sensibly. The server and internal workings of the players' patches will alter the performance in terms of bandwidth and quantization speed.

Interfaces

In addition to the Frequencyliator patches, each player will be provided with one of the two patches shown below:





There are two versions of the *Freq Out* patch. One uses sawtooth waves, while the other uses square waves. The patch that uses square waves has an additional knob for changing the wave's duty cycle. Otherwise, both patches work the same way. Both patches have two components: a pitch-based "lead" component and a synth drum kit component. Each component has a fader, but players should note that it is controlled by the server and will therefore move automatically against their will!

The player has three knobs to control their lead instrument's envelope, and they play new pitches by using the keyboard slider. Since their notes are quantized to the Server's pulse, players should not be alarmed if the pitches do not play immediately. By using the arrow keys on their keyboard, the player can change vibrato speed (left-right) and vibrato depth (up-down). The player also has two knobs for controlling delay time and delay feedback. The delay can be toggled on and off by pressing "D" on the keyboard.

The drum component is also controlled by a keyboard slider. Sections of the slider are mapped to different sounds as shown.

Presets

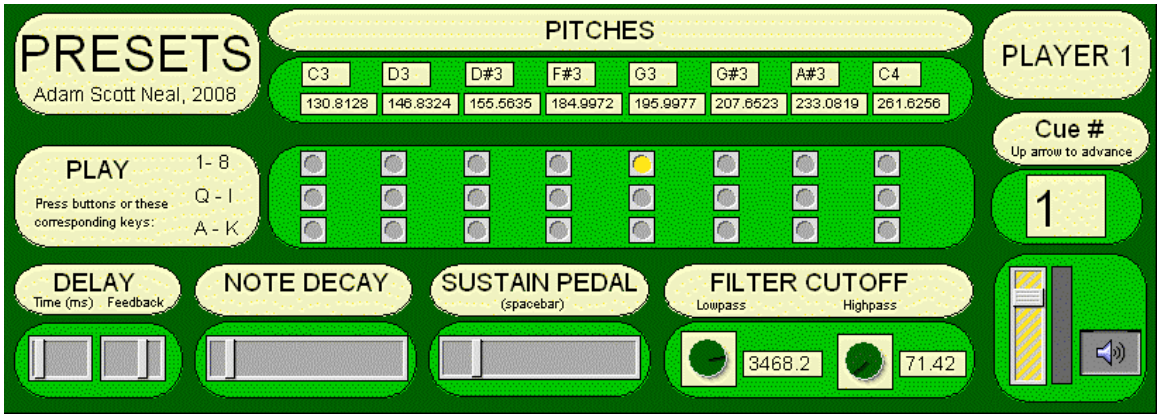
Program Note:

In *Presets* for four networked laptop performers, each player is provided the same synthesizer program. A master computer reads the settings from each player and periodically redistributes new settings to all of the players. For example, during one cue, the master computer will determine the lowest overall pitch (from all four of the players), and distribute that pitch (and only that pitch) to all of the players. During another cue, the master computer will find the shortest note length and send that to all of the players. The piece is completely improvised, but performers must be ready to confront sudden changes to their instrument.

Performance Notes:

Interface

Each player has the same interface, except for player 1, whose patch also contains controls for scrolling through cues. He can scroll by pressing the up-arrow key.



The interface has 8 pitches available at all times. Players are free to change the pitches, and may be forced to do so at different times during the piece. The players need to be careful to click away from the number boxes after they change the pitch; they will be articulating notes by typing numbers and letters, so they may inadvertently change the pitch, often to a subaudio frequency.

Beneath each pitches are three buttons, which articulate the pitches at different dynamic levels. Although the player can articulate the available pitches by pressing these buttons with the mouse, the player can also use the computer keyboard to articulate the pitches, using the buttons as visual feedback. The top row, 1-8, is the loudest, followed by the second row, Q-I, and the bottom row, A-K.

Beneath the manuals are controls for parameters. At the left corner, there are sliders for delay time and delay feedback. Moving to the right, there are sliders for note lengths. The “sustain pedal” only works with the resonating filter setting, and the player must hold down the spacebar to sustain the notes. To the right of the sustain

pedal slider are two dials for controlling lowpass and highpass cutoff frequencies. Please note that these filters are in series, so you may accidentally filter yourself out. To the bottom right is the volume control.

Performance

The piece is totally improvised. Each player is given a preset to start, and may play or make changes to that preset. While playing the piece, Player 1 needs to periodically move to the next cue by pressing the up-arrow. There are 24 cues in all, but Player 1 need not feel that he must proceed through all of the cues. The duration of the piece is variable; like any free improvisation, this piece will end when the performers feel that it should end. It is hoped that the piece will last longer than, say, one minute, but if that feels appropriate to the players, then that is permissible.

When a new cue occurs, players will be supplied a new value for one of their parameters. Many changes will be subtle, but some changes will not. For example, one cue finds the lowest overall pitch and sends that to all of the players. Suddenly, one may go from a high tessitura to a very low tessitura. The primary compositional goal of this piece is to elicit reactions toward these sudden changes. If your patch suddenly makes no sound, turn dials and change pitches until it works. If all else fails, hit the “initial preset” button and you will start with a new preset.