

Graduate Composition Recital Paper

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November 25, 2007

Introduction

This paper endeavors analyses of the works on my master's recital program. This process, however - this analysis - is peculiar. A quandary exists in invoking a particular methodology in order to analyze (or abstract), the sonic information of which my music consists. Since analytical methodologies emerge from a desire to describe the essence of a body of works, an extant body of works is first necessary. And yet, however the methodological structure is conceived, it is an abstraction of all the existing sonic materials within a range of works. A good example of this is the music of the Common Practice Period. It is, of course, not the only example. Wherever a large body of art objects exists (that was produced within a narrow cultural context), analytical tools emerge with which to name elements in common. However, methodologies are only useful inasmuch as the theoretical structures that they impose actually describe the sensory experience. While some analytical tools may have a use in reducing large bodies of work created with similar design goals (popular music, with its innumerable variations within compact parameters, comes to mind), the ultimate use is for imposing the constructed rationalization onto each member of the collection – for mediating the essence of each of the objects in their category. These tools may actually be irrelevant when yoked to works outside of a “practice” that holds the organization of primary sonic elements in “common”.

This is not to say, of course, that my work is not produced within some kind of cultural context. That would be absurd. However, the methodologies and analytical tools with which I have been equipped, deal primarily with issues of pitch and duration. This

makes sense in that the vast body of works that make up my western art music heritage is a product of the reification of particular pitches and distinct durations. This development owes itself not only to the “lattice”¹ of distinct pitch centered notation, but also to instrument design technology (which has historically selected and reinforced particular timbres – thus demoting the importance of timbre, subjugating it to the pitch/duration abstraction).

Some of the more recent developments in analytical methodologies have been attempts to describe music from several different practices that emerged in the latter half of this past century. These analytical methodologies attempt to describe music that is associated with certain “schools” or “movements” such as aleatoric music, serialism, neo-classicism, or minimalism. Both serialism and neo-classicism continue to operate within pitch/duration constructions, and exist primarily as abstracted, notated instructions. It is not surprising, then, that analytical methodologies have quickly followed to describe these stylistic concentrations (and in the case of serialism, analytical methodologies crossed over from description to proscription).

With regards to minimalism, works such as *Violin Phase* by Steve Reich are often analyzed in theory and history textbooks, while his *Come Out* is often passed over. This is because the former exists in the form of abstract musical notation, and the latter exists

¹ Trevor Wishart, *On Sonic Art* (New York: Routledge, 1996), 11-43. In this chapter of his treatise, Wishart discusses in depth the historical socio-economic and political developments of what he calls the “scribe class”, where abstractable knowledge (what can be written down and notated through pictures or graphics) is favored over immediate, sensory-based knowledge. This, he argues, was a main reason for the development of a system of notation that communicates certain elements (pitch and duration) at the cost of others. Over time, a “lattice” of musical conceptualization developed, where music space was thought of as discrete “notes” (pitches of a certain duration) hung on a lattice; the notation thus rationalizes the sonic possibilities, and reifies the practice of music making.

as a recorded sonic artifact. These analytical constructions do well when used to analyze notated pitch and duration values, but not as well with recorded sonic events. Of course the *process* of generating *Come Out* can be discussed (which I'm sure delights the composer), but the sensory experience of the resultant sonic relationships are not as easily (if at all) objectified.

With regards to aleatoric music, music the parameters of which are “open” to varying degrees, the particular sonic instantiations are mostly unknown outside of the music’s realization. Consequently, how can such a work be analyzed outside of simply describing available performance instructions? Such is the case in Miguel A. Roig-Francoli’s *Understanding Post-Tonal Music*. In his discussion of Cage’s *Winter Music*, Roig-Francoli explains,

An analysis of this piece cannot go much beyond what we have already done [quoted and discussed the performance notes]. Because we are not dealing with any fixed musical elements at all (each performance will be based on different orders of pages and sound events, different reading of the actual pitches for events, different durations, dynamics, and so on), we have no fixed material that we can focus on for discussion.²

Again, due to the lack of abstracted and fixed notated pitches, available methodologies are inappropriate in this context. However, what Roig-Francoli misses in his analysis of *Winter Music*, is that there are points for discussion – they simply lie outside of the realm that deals with abstracted pitch/duration relationships.

One attempt to account for sound, separately from its abstracted, symbolic instruction, is a technique known as spectrographic analysis. In this technique, developed

² Miguel A. Roig-Francoli, *Understanding Post-Tonal Music* (New York: McGraw-Hill, 2008), 286-7.

by Robert Cogan and Pozzi Escot³, the respective frequency contents and strength in a piece of music is represented in graph form, along a series of preconceived parameters. The strengths of this technique is that one element of the music can be viewed graphically, namely the makeup of the present frequencies and strengths in the analyzed music within a predetermined unit of time. This may be a helpful tool when wanting to reduce a piece of music to a visual representation of its timbral morphology – particularly if no score exists, as is the case with much electronic music.

However, there are significant shortcomings as well. First, the spectrograph will only show what the technician predetermines to see, by way of selecting graphic parameters – what one sees is not necessarily what one hears. Which introduces the second point; the real music is constructed from perceived relationships in the mind of the listener. While timbral elements are a component of that process, the constructs of the mind of the individual listener cannot be represented as a graph. It should be underscored that, much like notation, a spectrographic representation of music is a significant abstraction. In the discussion of my piece *Transfiguration*, a spectrographic representation is included as an example of that tension.

Biographical Information

My work in the graduate composition program at Towson University has been a response to my more recent aesthetic and technological (primarily, an expanded discussion of technological applications) discoveries there. Electronic music is generally created independently of any abstracted notation, in that the need to communicate

³ Ian D. Bent and Anthony Pople, “Analysis: History, Since 1970”, *Grove Music Online*, ed. L. Macy (Accessed 25 October 2007), <<http://www.grovemusic.com>>

musical information from composer to performer is unnecessary.⁴ Also, music that is constructed with concern for “openness” (as opposed to fixity), also limits the ability to describe the sonic relationships that emerge in a piece from its notation alone - without its realization. These two very rich areas of investigation are where I spent most of the time exploring in my experience in the graduate program at Towson.

When I began the graduate program, there were deficiencies in my comprehensive understanding of the contemporary issues among “art” music creators (not all of my music is intended for the concert hall). Not only that, there was a deficiency in my knowledge of many points of dialogue regarding art music from the last 100 years, give or take. It is odd, then, that I was more conversant with the histories, vocabularies and concepts of contemporary film, dance and the plastic arts (such as painting), than I was within the realm of the one art form in which I had received a bachelor’s degree. How, I wondered, could I engage in creating music without a richer understanding of the issues of my time and place? I was fortunate to enroll in a course dealing with these issues my first semester, in which I became more familiar with several contemporary aesthetic dialogues. This gave me a place to start exploring some of the issues with which I felt a kind of resonance. Of course, I was also able to engage with these issues further in subsequent courses and seminars as well.

Transfiguration

⁴ I will amend this statement in the discussion of my piece *(re)Formations*.

Before I arrived at Towson, one contemporary aesthetic issue that had interested me was the notion of music as a gradual process.⁵ I had briefly encountered the music of Steve Reich earlier (I performed *Clapping Music* with the percussion ensemble at The Ohio State University), and independently investigated his music further, along with the music of Arvo Pärt (particularly, the works *Fratres*, and *Cantus for Benjamin Britten*). In the works of both of these composers, I discovered a tool for unifying compositional materials through the use of process, while simultaneously generating form. With this contextual information in hand, we can now turn to a discussion of works that will appear on my recital.

My first composition at Towson (as well as the first work on my recital program) was *Transfiguration*, a work that owes much to my investigation into the works of the two composers just mentioned, Reich and Pärt, as well as the writing and work of conceptual artist Sol LeWitt.⁶ This work also engages technological applications that were previously beyond my grasp: digital signal processes such as phase vocoding and granular synthesis, as well as constant power panning in an 8-channel environment. In the initial stages I had planned to use samples of phonemes taken from a recording I had made of a female singer singing several plainchant melodies. Early on, however, I discovered that I was not achieving the effect I had envisioned. This led to the process I

⁵ Steve Reich, *Writings on Music, 1965-2000* (New York: Oxford University Press, 2002). In the essay *Music as a Gradual Process*, I encountered my first glimpse into the possibility of conceiving a musical work that has an internally cohesive organizational scheme, yet wholly different from the organizational schemes of western diatonic music.

⁶ Sol LeWitt, "Paragraphs on Conceptual Art", *Artforum* (June, 1967). When Reich was asked about the influence of these statements on the development of his aesthetic values (*Music as a Gradual Process* was written in 1969), he says he was not aware of them until much later. LeWitt's *Paragraphs* did serve, however, as a watershed for many artists in every artform concerned with automation, or art as process.

ultimately used. Using a single 8-second sample from a setting of the *Kyrie Eleison*, I constructed a process whereby that sample would be repeated via “virtual” reel-to-reel players (as in *Come Out* and *It’s Gonna Rain*). However instead of using my hand to slow down one reel-to-reel manually while the other remained constant (as Reich did), I used 8 distinct digital sample players. Each sample player repeated the phrase with a digital delay between repetitions - the first was assigned a delay of 5 milliseconds, the second 10, then 15, 25, 40, 65, 105, and 170 – the difference between each subsequent number being a multiple of 5 in the Fibonacci sequence (1,1,2,3,5,8,13). Although the largest delay (170 milliseconds), is still very short, these delays occur between each repetition of the sample and are therefore cumulative. Over multiple repetitions, I found these delays to produce a sense of a quasi-organic “growth”, which becomes more and more pronounced. What was initially presented as a single repeated sample becomes “smeared” as the phonemic signifiers within the phrase gradually become less clear, and timbral and rhythmic relationships emerge from each new combination of temporal reallocation.

While submitting to LeWitt’s descriptive *Paragraphs* would have been seductive (“The process is mechanical and should not be tampered with. It should run its course”), I could not simply let the process run its course. Instead, I chose to intervene on the mechanical process – to create more processes, each subsuming the preceding one. In doing so, the initial delay process based on the Fibonacci series became an introduction to the piece. Like the original sample, the result of the introductory process was now the source out of which the subsequent material emerged. At 1’44” into the piece I resampled the current permutation and continued the same process of delays with the

newly generated material replacing the original. In a sense, I had folded the process onto itself. At 2'48" I used the same technique again and resampled the most current permutation. These punctuations in the process quicken the perceivable elements so that the music is gradually moving towards a wash of sound - generated by a single sample.

At 3'52", the second major section of the piece begins. The process of cumulative delays between the 8 "voices" (8 distinct digital sample players) has continued, and continues further through the end of the piece. However, in the second section digital filtration is introduced on each voice. This happens on the same number of repetitions in each voice. The temporal displacement by now has grown substantially, making the introduction of the new timbre quasi-canonic. This change in timbre is also arguably the most significant event in the piece thus far.

The type of digital processing used here was spectral envelope filtration. Using the Fast Fourier Transform, the input signal was converted from its time-domain state into a signal in the frequency domain. The resultant signal was then convolved (multiplied) by another signal, generated by the desired spectral contour. The product of that convolution was then converted back into a time domain signal at the end of the process. The reason for doing this was to utilize a high level of resolution (512 frequency bands) in attenuating each band in the frequency spectrum of the sample.⁷ I used this application at that point to filter out high frequency spectrum bands, further obfuscating some of the remaining recognizable vocal elements in the sound. For clarification I will

⁷ Cort Lippe and Zack Settel, *Forbidden Planet – 2003*, in *Max/MSP v.4.6.3* [Computer Software] (Cycling '74/IRCAM, 1990-2005), Examples. I reference this example patch from the software application *Max/MSP*, because I used it as the basis for my spectral processing component in the piece.

refer to this new general timbre as “B” material, and the introduction, consisting of its own timbral character, I will call “A”.

The B material remains as the primary environment until 5’20” into the piece; however, throughout this section other timbral gestures emerge and recede within the B context at an increasing rate. At 4’37”, the A material returns for a brief, punctuated, 5-second gesture. This happens again at 5’07”; however, the A material is accompanied by a new timbre (which will be further developed later), as C material. The C material was also treated with spectral envelope filtration; however, in this case the higher frequencies are accentuated, giving a brittle or cracking effect as contrast.

Also accompanying these two timbres is a third, which I will call the D material. This sample has been transposed down 2 octaves, using the digital process known as granular synthesis. In this process, the sample is segmented into multiple smaller samples (in this case, 50 milliseconds in length) or “grains”. Each grain is played (or looped) long enough so that the original sample is resized to fit the intended new length (whether shorter or longer) or pitch (higher or lower), each separate from each other. This is one of several ways that attempt to separate frequency from time in recorded sound.⁸

There was another similar gesture at 5’15”, but this time only the A and C material is represented. At 5’20” the “environmental” context shifts, at which point the previously introduced C material was cycled through the 8 delayed digital sample players. At 5’23”, another punctuated gesture of the A and B material, combined with the previous gesture, obfuscates the shift in the 8 voices from the B to C material. At

⁸ Les Stuck and Zoax, *Granularized*, in *Max/MSP v.4.6.3* [Computer Software] (Cycling ‘74/IRCAM, 1990-2005), Examples.

5'30", another gesture of the A and B material returns, then the C material persists for some 30 seconds without interruption.

At 6'05" (and approximately at the "golden section" of the piece) there is another simultaneous timbral gesture, at which time the A and D material is represented, along with new E material. This sample was transposed down 4 octaves from the original sample, as well as resized in length to approximately 1 minute. This is the lowest frequency representation in the entire work, and also marks the forthcoming boundary of the second section of the piece.

At 7'10" the 8 voices transition through the B material for one final repetition, followed by new material, F, at which point we arrive at the third and final section of the piece at 7'25". This material has also undergone spectral filtration, however in this case, and for the rest of the piece, the filtration is extreme. In the 3 distinct timbres represented in the final section, each only represents a handful of frequency bands, and the result is significantly amplified so that the amplitudes mix relatively seamlessly with the previous amplitudes, the frequency spectrums of which are much broader. At 8'13", the F material gives way to the newly introduced G material. Then at 8'50", this was replaced by the final timbral permutation that is characterized by even further spectral filtration - H. In the final section, there are essentially no recognizable indications remaining of the vocal identifiers from the initial sample. What is left is a quasi-harmonic pulsing, the result of a relatively seamless, organic process from beginning to end.

The spectrographic representation of the piece, Illustration 1, is included as it is arguably an appropriate abstraction in the discussion of the work. The center of the graph, where the concentrations of yellow are located, shows the frequency undulations

of the vocal line. The most striking features revealed by this graph are the gradual obfuscation of the spectral resolution in the vocal line, as well as the different sections delineated, as previously discussed, by their respective spectral processes. However, what the spectrograph can show is, at best, several steps removed from the music, which is the phenomenon of experiencing the sound. The component of sound that I was primarily concerned with in this piece was time. The repetitions and temporal re-allocations of the sample create a sonic environment where the perception of time is (or can be) altered. This alteration of perceived time, if it happens at all, can only happen in the mind of the listener. Moreover, the spectrograph does not account for the perception of the sound in an immersed, multi-channel environment, in which this piece is diffused.

Alone / Together

The second piece on my recital program will be *Alone / Together*, for percussion trio. This piece is scored for vibraphone, orchestra bells, tubular bells (chimes), lion cymbal, triangle, Chinese opera gong, stroke rod, two wine glasses, timbales, low tom, and bongos. I conceived of the piece in terms of relationships or tensions between differing elements. For example, in scoring the piece, I treat the instruments separately as groups of pitched and non-pitched forces. I also take into account other sonic elements with relation to their respective counterparts, such as simultaneity, loudness, articulation, metered pulse and silence.

Treatment of pitch in this piece is somewhat arbitrary. While I am not at all concerned with issues of pitch relationships on a macro scale, distinct pitches become an issue in this piece, due to the presence of pitched percussion instruments that are products

of an industry that actively reifies a particular pitch system. The issue thus imposes itself. Ways in which I have attempted to get around this are by incorporating performance techniques (such as bending pitch in the vibraphone with a hard epoxy mallet), and treating these distinct pitches in a context of waxing and waning clusters amongst the three performers.

The most prominent influences on my conceptualization and use of pitch in this way are György Ligeti's works *Atmospheres* and *Lontano*. In these pieces, Ligeti is dealing with forces that can take advantage of frequencies in between the frequency nodes on the dodecaphonic lattice. One of my compositional goals in this piece was to achieve a similar cluster effect in places, even with the limitations of instrumentation and ensemble size.

Other influences on this work were the treatment of silence, tempo and musical space in such works as John Cage's *Quartet for Four Percussionists*, and Morton Feldman's *Rothko Chapel*. In *Alone / Together*, I incorporate more liberal usages of silence as a tension with sonic gestures more so than in much of my previous work. I intended the use of silence as punctuation, to add a sense of internal deliberation to the sonic elements.

The notation employed is based in standard, western notation, employing staves, noteheads, meters, and the like. However ensemble time tracking fluctuates between strict, metered passages, and more temporally open passages, where time is indicated in ranges of seconds. An example of this can be seen in Illustration 2. The overall form of the piece is loosely strophic. There are essentially four cycles of the component materials, which are discussed below. These separate components fluctuate in time and

interrelation with each other, and provide broad aural cues that provide a semblance of continuity. These relationships are abstracted in Illustration 3.

The piece begins with an opening gesture that echoes throughout the work. Each performer introduces a figure on their respective pitched percussion instrument (vibraphone, orchestra bells, and chimes), which is more or less centered on a particular pitch, although undulating around the pitch with non-metric and approximate rhythmic relationships. The entire gesture temporally spreads out, and recedes back into silence (m. 1). After a pause (m. 2), the first simultaneity is introduced, with the addition of the triangle and Chinese opera gong, followed again by a substantial moment of silence (m. 3). At this point, two separate and essential elements have been introduced. The first is a gradually decaying gesture of an asynchronous frequency-cluster, the second, a simple, simultaneous punctuation within silence. In order to draw connections with subsequent moments in the work, I will refer to similar gestures such as the first as “A”, and subsequent gestures that share some characteristics with the first simultaneity as “B”. Illustration 4 shows examples of each of these ideas.

The following gesture combines the timbres of the pitched percussion instruments with several non-pitched instruments in what is somewhat similar to the A material, in that there is a cluster of frequency around a similar pitch. However in this gesture, the cluster gradually dissipates away from the center, continually enlarging the frequency boundaries of the cluster. I will call this “C” for the sake of drawing connections (m. 5-7). What comes next is a metered interlude (m. 8-11), where each performer is playing the same rhythm on their respective membranophones (low tom, timbales, bongos). The

entire gesture is *pianissimo*, remaining within the same dynamic character of the piece thus far. At this point, all of the main sonic elements have been introduced.

Next, the A material is recalled, this time twice - the second iteration consisting of a temporal diminution of the first (m. 12-14). This is followed by a substantial augmentation of the B material (11 punctuations total). Some are embellished here, and a new timbre of rubbed wine glasses is introduced here as well (m. 15-22). What follows is a recurrence of the metered interlude, this time louder (*forte*) and rhythmically augmented, before the return of the C material. In this instance, the pitch cluster parameters have remained open, as if it has continued, from the previous instance, unheard, adding to the growing discontinuity of the emerging form. A similar slowing gesture is presented in this cycle as well, however beginning much louder (*fortissimo*), yet decaying in loudness in conjunction with the temporal slowing (m. 27-34).

Having reversed the order of the C material and the interlude, the piece returns now to the A material, repeated twice. This time, the second repetition is a temporal augmentation of the first (m. 35-37). The following B material contains only two punctuations, but includes augmentation of the gestures, the second of which last almost 20". The expected reiteration of the C material here is slightly altered, in that it is overlapped by three additional punctuations from the preceding B material. The C material is altered further, in that it is significantly diminished temporally, and then repeated again in conjunction with the overlapping B punctuations (m. 43-47). The metered interlude follows, dynamically undulating (m. 48-56).

The final series begins again with the A material, although only once this time (m. 57-58). Following are two unadorned B punctuations (59-60), followed by C material,

which is dynamically reversed, starting soft then growing louder (m. 61). This gesture is broken by the final *pianissimo* interlude (m. 62-64), which is followed by a solo chime gesture (*pianissimo*), which fades out as it is temporally augmented.

Looking closely at this work, one could argue that obvious connections could be made in naming relationships among the focus pitches in the clusters of each instance of the A material, for example. And perhaps such a case could be made. But I submit that those relationships are not experienced aurally inside the pitch clusters, and furthermore, such relationships were unintended. These pitches were chosen arbitrarily, as part of a process of creating larger gestures of pitch cluster – an attempt in using Morton Feldman’s “secret” (Feldman: “I don’t push the sounds around.” Stockhausen: “Not even a little bit?”).⁹

Indivisible

Indivisible is an interactive, 8-channel sound installation. Although it is a significant departure from concert music, it is a kind of project that has been in the back of my mind for several years. In one session of the composition seminar in my junior year at The Ohio State University, we investigated Pierre Boulez’s *Third Piano Sonata*. At that time, I had just discovered the notion of using multiple discrete channels (greater than stereo) as a technology that was commercially available for creative work in music. In fact, the sound synthesis studio at the university had a Quad system (four channels) in place. Of course I had encountered Lucas’ THX in theaters for several years, however, like most people, I imagine, I simply thought that it was some kind of Hollywood magic,

⁹ Morton Feldman, *Give My Regards to Eighth Street*, ed. B. H. Friedman (Cambridge: Exact Change, 2000), 143.

and certainly not a technology available for probing by the uninitiated. This recent discovery was the backdrop for my experience with the Boulez *Sonata*.

When introducing the piece, the leader of the seminar explained how Boulez referenced Alexander Calder's *Mobiles* as an inspiration for the piece. What I discovered later, was that the *Third Piano Sonata* was also used by the composer as a polemic against contemporaneous aleatoric music. Boulez argued that music required greater compositional control. In realizing the Boulez piece, the performer is instructed to play the movements (or "formants") in any order he/she wishes. In doing so, the composer surmised, he opens up the experience of the work in the same way Calder's *Mobiles* are open as the viewer engages them in space. I failed to follow Boulez's logic, in that, as a listener, one's situation has not changed. A person listening to Boulez's *Third Piano Sonata* is receiving sonic information, and frankly has little to no control over his or her perspective. The performer is given slightly more control over the order of "formants", however all possible permutations remain relatively small, and the listener, outside of a large number of performances, could not begin to tell a difference in the order of the movements, never mind perceiving any visceral control over their impact on the sonic experience. What is most disappointing, is the fact that the concept of engaging in sonic construction like a giant mobile is quite rich, and unfortunately, not at all engaged in Boulez's work as promised.

That experience with *Third Piano Sonata* led me to explore further multi-channel diffusion, and ultimately to my first multi-channel work, *Study I*, which was created for an 8-channel environment. In this piece, I utilized my basic knowledge of the computer-programming environment, Max/MSP, in order to achieve basic control of simultaneous

signal outputs in 8 distinct channels. At this time, I considered that the freedom of the audience members to explore the sound in the multi-channel space was a step towards a more open experience. This would change later, as I discovered the possibility in adding feedback through real-time sensor data, which I employed in my most recent installation, *Indivisible*.

The work was ultimately limited by my knowledge of the programming environment, as well as the equipment – the speakers used to diffuse the sound (8 sets of powered desktop computer monitors) were not able to produce high-resolution audio at high amplitudes in a large gallery space. The success of the work, was that in the presentation of the piece, I found that people intuitively knew they could walk around in the space, thus embracing the fact that the limitations of the experience (listening in one “zone” at the opportunity cost of another) could also add a richness and depth (what was heard was a result of their choices in where to locate themselves). That is certainly one major distinction between cultural suppositions of music and sculpture: when seeing a mobile, one’s first reaction is not to think that the impossibility of seeing the sculpture from every possible angle and all at once is unfortunate. These experiences have been the main influences on my current installation, *Indivisible*.

Because of the depth of technical work that went into this installation, I would like to spend some time discussing those components, as well as some of the aesthetic issues that they raise. The physical setup consists of 8 powered speakers in a horizontal ring around the perimeter of a space. In the first presentation of the installation, the chosen space was the atrium in the Center for the Arts at Towson University. The second presentation will be in the same space, in conjunction with my recital. Attached to each

speaker is a small module, which I constructed. Each of these modules contains a passive infrared sensor that detects the movement of the people in the space through the heat signature they produce. These infrared sensors operate on 5 volts, and alternate between 0 and 5 volts based on what they are detecting. When nothing is detected, the voltage is “low”, or 0. When the sensor detects an infrared signature, it sends a “high” signal via 5 volts. In my installation, these voltages are sent to an interface called MIDITron, a device created by Eric Singer. This device converts the voltage information to MIDI signals, which after going through a MIDI to USB converter, I am able to program and control in Max/MSP, the programming environment in which all of the sonic information is centralized and diffused. Illustration 5 shows the software component that collects and routes this information.

Ultimately the human interaction with the 8 infrared sensors (paired with each speaker) drives the selection and diffusion of sound. In doing so, this installation is the closest I have come to implementing a sonic organization within which a person is free to control his/her experience through movement, as well as through feedback into the sound generation. The limitation of the latter, that individuals cannot by themselves control the entire experience, is related to the programmatic element of the installation, as referenced by the title and source material of the sound. The title of the piece, *Indivisible*, is taken from the United States’ “Pledge of Allegiance”. The sonic materials come from several sources, the bulk of which are 13 samples I made of individuals reciting the pledge. The relationships between the samples, title, and conceptual design of the environment lend themselves to somewhat of a programmatic element to the work. This conceptual element took shape during my time serving in the military forces of the United States of

America. Through that experience, or rather collection of experiences, I became interested in the pervasive interconnectedness of individuals, and institutional constructs, both large and small.

The structure of the work consists of five modules, the order of which is chosen randomly by the software during the presentation. However, each module is to be realized once before any further repetition of any other module. Each module is also fixed in terms of its length. The first is 2'24", the second and third are both 3'53", and fourth is 6'17", and the fifth is 1'29". Illustration 6 shows both the random form generator, and an example of its interface with an individual module, in this case, the 3'53" module. When a previous module has finished, it informs the form generator, which in turn selects a new module. That number is broadcast to each module, which is looking for its own particular number. In the case of the 3'53" module, it is looking for the broadcast of number 1. If it detects this number, the module begins its idiosyncratic processes, as well as a timer. When this timer reaches the end of the predetermined duration, the module stops its processes, and informs the form generator, at which point the entire processes repeats.

Different settings of the text are used in different combinations (with the exception of the fifth module). In this fifth module, the source material is of a different nature altogether. In this, the shortest of the five, I have used samples of a toy piano, and samples of explosions. The module serves to add a period of (relative) discontinuity to the overall sound in the installation, as well as more depth to the relationships within the programmatic element of the work. In this module I employ a two-voice polyphony in the toy piano sample playback (selected from among pitches of the C-major diatonic

scale within one octave). I also employ a method called “gating”, so that no new sample can be triggered while the decay of one of the current two samples is still sounding (these decays are quite long). This contributes to an atmosphere of sparse punctuations of the silence by each note from the toy piano. The sensor data in this module triggers the toy piano sample playback on a one to one basis; each time a sensor is triggered, a random pitch is selected from the set of toy piano samples and panned to the specific speaker where the sensor was triggered (assuming there is at least one “voice” open in the two-voice polyphony). Throughout the entire module a timer keeps track of the elapsed time, as well as controls the playback of the explosion samples. The playback of these samples is not related to the sensor data, and therefore produces unintended temporal relationships with the playback of the toy piano samples. I should also state that these samples, unlike the samples within all other modules, are untreated with any digital filtration, although the toy piano samples are randomly attenuated within a small dynamic range.

The first module (2’24”) consists of two-voice polyphony as well, except that each voice has three digital sample players nested in each trigger, and delayed with a similar technique used in *Transfiguration*. However, in this instance, the series of delays after the initial sample is 300, then 500 milliseconds. Each trigger selects one sample at random from the bank of available samples of the pledge. Then from that sample, a 5 second chunk is selected (also at random) and then played by digital sample players with their respective delays. All of these signals are aggregated, and then sent through a spectral filtration process that selects a predetermined (albeit random) number of partials

in the signal, and re-synthesizes them at the output of the process.¹⁰ These gestures are triggered in the same way as mentioned in the sixth module, however the spatialization was diffused differently in the first presentation of the installation. In the first version, these gestures were diffused peripherally, with regards to the position of the triggered sensor, and then panned further away from the triggered source, in a horizontal arch pattern. I did not feel that this was as clearly perceivable in the first version, and so have changed this process so that these gestures are diffused in the same way the toy piano gestures in the fifth module are diffused.

The second and third modules reduce the source material further so that the set from which sound is being selected is made up of only the word “indivisible” from all the sampled pledges. There are five digital sample players in the third module, and the attack of each player is temporally quantized to a pulse. This pulse cycles through each player, and when one of the sensors is triggered, the following pulse in the cycle opens a gate, and the sample is played. This produces an interesting assemblage of rhythmic relationships, in that not every beat of the pulse triggers a sample, only when a sensor is triggered. The tempo of the pulse is slightly variable. When fewer participants are in the space (determined by time between sensor input data points), the pulse decreases in tempo, and when more participants are in the space, the pulse increases in tempo. Also built into this system are random instances where sample triggers would be blocked. This is in place for the occasion when the space is crowded, and a sample would otherwise be triggered on each beat of the pulse. The spatialization of these gestures were originally configured to be random, however in the second presentation of the installation, they will

¹⁰ Eric Lyon and Christopher Penrose, *Dentist~*, in *FFTease* [External Objects for Max/MSP].

coincide with the position of the sensor, so that the listener receives more direct feedback as a result of their participation in the installation.

In the fourth module (6'17"), the samples are treated in a manner more similar to the kind of digital filtration that I used in my fixed media work *Transfiguration*. In the original presentation of the *Indivisible*, this module existed as a standalone piece inside of the context of the installation. An amalgamation of treated samples of the pledge along with gestures generated from electronic sources (digital sine wave generators and phasors) were used, creating a much denser sonic palette than in the accompanying modules. Fixed points in relation to the module's internal time keeping device originally triggered these gestures, and they were panned in the environment the same way – via predetermined means. I believe this added to some of the confusing elements in the first presentation. In the second presentation, the sonic source will remain the same. However, data from the infrared sensors will play into the sonic diffusion in a similar manner to the other modules. The difference is that in this module, infrared data triggers the opening of an envelope with a very long decay (8 – 13 seconds), so that there is a greater chance that each new envelope will dovetail with a preceding envelope, thus maintaining a kind of linearity while still supplying feedback (in terms of position and amplitude) to the participant.

(re)Formations

Many of the values that have informed the creation of my most recent work, *(re)Formations*, are the results of inquiry from my coursework in the MM program at Towson, as well as reflection upon the performances of my earlier works created and

performed while at Towson. The first presentation of my work *Transfiguration* took place in November 2006. Not too long before, I had come across an interview of John Cage from 1962. One issue stood out to me as a practitioner of electro-acoustic music. Within a larger discussion of musical theatrics, the interviewer, Roger Reynolds, asked,

[RR] Do you think that lack of theater may be partially responsible for some of the negative response to electronic music?

[JC] Definitely. I think that the most important thing to do with electronic music now is to somehow make it theatrical, and not through such means as turning the lights out, but rather through introducing live performance elements. That is to say, people actually doing things . . . the actual, visible manipulation of the machines, to begin with; the distinct giving to the audience of the impression that something is happening then which is unique to that particular experience. If the audience, if any of us, felt that what is being played at that time can be played at any other time, and result in the same experience, then a kind of *deadness* falls over everyone.¹¹

An argument could certainly be made, with regards to theatrics, that a listener is generally responsible for his/her experience, and therefore considering the audience at all is unnecessary. Coming down on one side or the other of this question is uninteresting for me. I feel, rather, that the more interesting application of this issue is related to the question of repeatability and uniqueness of the art experience. Surely no experience is ever precisely the same (fluctuating environments, perpetual reproduction of cells in our bodies, etc). However on a continuum with one side representing extreme difference, and the other representing extreme sameness, electronic music that is fixed previous to playback is generally closer to the side of extreme sameness. The closer music moves toward the status of a fixed object, the more it can be considered not alive (as articulated by Cage), and consequently able to be possessed or owned (as in commodified, recorded

¹¹ John Cage, *Interview with Roger Reynolds, 1962* in *Contemporary Composers on Contemporary Music*, ed. Elliot Schwartz and Barney Childs, (Da Capo Press, 1998) 342.

music objects). The recent issues between the recording industry and those who share files of recorded music is illustrative of this point. For example, how often can one repeat a listening experience of a work when it exists as one among tens of thousands of others on a hard drive? By definition of the economic, it necessarily becomes devalued (which is where the problem lies for an industry who brings it to market). One's attitude towards that kind of object is different than towards an experience that is not as repeatable (or able to be owned), or even ephemeral.

In addition to this, other issues contributed to the context out of which my most recent work was created. Another was a collection of Essays by Arthur C. Danto, entitled *The Philosophical Disenfranchisement of Art*. In one particular essay, "The End of Art", Danto writes "But I think it very generally true that works of art often, and perhaps always in the traditional concept of the masterpieces, are about the virtuosity exacted in their execution, so that the immediate subject of the work, if it has one, is typically merely an occasion for the *real* subject, which is the display of virtuosity."¹² Here also, Danto echoes that the weight of the human presence in a work has a historical precedent. But Danto overstates it by arguing that a work is merely a pretext for a performance of virtuosity. However, the lack of human physicality in "traditional" electronic music (in the dimly-lit concert hall) is underscored.

Before moving into the technical and sonic elements, the final influences on my most recent work are the book *New Digital Musical Instruments: Control and Interaction Beyond the Keyboard*, and NIME (New Interfaces for Musical Expression), a conference I attended in June 2007. The book, which was written as a result of the

¹² Arthur C. Danto, *The Philosophical Disenfranchisement of Art* (New York: Columbia University Press, 1986), 95.

growing number of collaborators in the NIME international conference series, attempts to introduce several streams of inquiry into gestural controllers as digital music instruments. Having already coincidentally broached this subject in the construction of the IR sensor field for my installation *Indivisible*, this book reinforced issues I had previously encountered. It also shed light onto new considerations related to the capturing of human gesture and mapping it onto digital sound control parameters.

In the conception of this work, *(re)Formations*, I was first concerned with the sounds, their sources, and their contextualization. I wanted to make a piece that used sounds from as many recordings of one piece of symphonic concert music as I could find. I chose the fourth movement, *Allegro* of Beethoven's *Symphony No. 5*. This process functions in drawing out what is the same within each recording, yet treats that sameness with a much higher degree of openness, because of the ability to fluctuate substantially from performance to performance. In doing so, not only does the work invoke one surface level of the individual recordings – a general timbre, but also draws on the cultural connotations of that particular work, the idiom of the late Classical Period, the reification of the work through each recording (as well as through its notation and instrumentation) and psychological relationships between recorded concert music and its consumers.

I also wanted the piece to be performed, and so conceived of a means whereby the performers would trigger and manipulate these sounds, within certain parameters, by means of some kind of gestural controller. I ultimately chose to use USB game pads as controllers, in that they are economically feasible, and because they also bring with them a ready cultural connotation – being identifiable as game controllers. I chose to

orchestrate the piece for 3 performers, each with their own console, consisting of a computer running the software I would write, the USB game controller, and a multi-channel audio interface.

A series of treated sounds is made available to each performer within his/her individualized software instrument (which maps the game pad data to the control of these sounds). Each instrument contains several sound modules through which the prepared samples can be routed (Illustration 8). These modules include distortion, reverberation, spectral filtration, pitch shifting, and dynamic equalization. Each performer also has the ability to recall a myriad of custom (created by the performer) articulation and duration pairs, which can easily be recalled during the performance. In addition to these controls, each performer also has the ability to pan his/her audio signal dynamically in a multi-dimensional environment.¹³

As I worked on the piece, my conception of it grew, and it seemed to call for a larger sonic vocabulary from which to draw, although I wanted the “symphonic” portion to retain its individual identity. I chose to divide the piece into three movements, each with a distinct set of sonic sources as its vocabulary.

The issue of notation was also a logistical challenge. I had conceived of the work in a particular way, and so I wanted to communicate those parameters to the performers without arbitrarily over-specifying that conception with any kind of notation that would be restrictive – as any discursive description would do. What resulted was a graphically oriented notation, in which the bulk of what is communicated is temporal information

¹³ The software allows for individual, 8-channel diffusion, however the performance space may impose limitations. For the remainder of the discussion I will assume an 8-channel performance space.

that gives the performers cues for their individual parts as well as how their parts interact with the ensemble. The notation also employs the use of color, in an attempt to communicate information on when to change samples or timbral effects (via signal routing, for example) without specific indications of text.

The first movement came to be titled *(re)Constituted*, and it includes samples from mechanical sounds, popular music, and the recorded speech of celebrities as sources. This conceptualization (and arguably parts of the entire work) owes itself to John Oswald's essay "Bettered by the Borrower: The Ethics of Musical Debt", in which he states "All popular music, essentially, if not legally, exists in a public domain. Listening to pop music isn't a choice . . . Although people in general are making more noise than ever before, fewer people are making more of the total noise . . ." ¹⁴ This first movement is an amalgamation of sounds in the world, most of which make up what could be called environmental sounds - sounds that persist with or without our consent.

Part C, in this movement, fulfills the role of a tradition rhythmic contributor. This part reproduces samples taken from machines of all sorts – clocks, coffee grinders, helicopters, bicycle chains, car doors, etc. Some of these samples have been prepared by "stacking" and concatenation, so that while they are noticeably mechanical sources, some of the gestures are either so close together or simultaneous, that they are not necessarily identifiable. They are perceived as straddling the temporal gap between sounds fused into a single event, or rhythmic groupings. ¹⁵

The samples provided for Part B are generated from spoken text, namely celebrities

¹⁴ John Oswald, *Bettered by the Borrower: The Ethics of Musical Debt* in *Audio Culture: Readings in Modern Music* (New York: Continuum, 2004), 131.

¹⁵ These terms, "Event Fusion" and "Rhythmic Groupings" are taken from Bob Snyder, *Music and Memory: An Introduction*, (Cambridge: The MIT Press, 2000), 3-18.

whose voices are recognizable to a general public, have written books, and have recorded themselves reading their books. Several short, unprocessed samples have been made available to the performer of these recordings, however most have been prepared through such processes as granular synthesis and phase vocoding (primarily for the purpose of time stretching).

Part A fulfills something of a melodic role in this movement, or, at least, the performer has that option. The sources for this part are samples from ten popular commercial songs that have been fused and reduced to a one-minute stream. This stream has been prepared in several different ways, and given to the performer of part A as a repertory of sources. The notation for this part is the most temporally specific, limiting the performer significantly more than the other parts. In Illustration 7, the blue horizontal segments consist of the notation for part A.

Some elements extend outside of the individual parts. Additional one-second gestures of relative discontinuity are provided to all performers at several points, all from the same sample – an amalgamation of wine glass and steel pan samples. Also, in one particular moment of this movement (175 seconds in), Part A and B both record a 10 second segment from their outputs, only to recall and reprocess them during the final 15 seconds of the movement. This gesture foreshadows the bulk of the process used in generating the sonic material in the following movement.

The second movement, “(re)Cycled”, is entirely generated from controlled feedback. In a sense, the source for this movement is the sound already present in the space (predetermined by the architectural dimensions), then amplified, filtered and captured through an instrument that I designed and built called the Recycler. The

Recycler part is played by the performer of part C. This instrument consists of a 5' length of PVC pipe with a 2" diameter. Inside is a lavalier microphone, with its output connected to the input of a dedicated speaker onstage, as well as the audio interface for the software of part C. Controlled feedback is produced by manipulating the instrument in the direction of the speaker, producing a fixed set of pitches determined by the size of the room, and the movements of the performer. Attached to the PVC pipe is a module that includes two analog proximity sensors (Sharp GP2D12), and a 2-axis accelerometer. These sensors capture gestural data from the instrument, namely inclination, rotation, and acceleration, and map them onto several processes in its software component. Downstream of the processing of part C, the signal is fed into the audio interfaces of the performers of parts A and B, and are either filtered again live, or recorded into buffers to be recalled as indicated by the score.

The third movement, "(re)Generated", consists of various samples from 24 distinct recordings of Beethoven's 5th Symphony, *Allegro* (fourth movement). In this movement, each performer plays from the same part in the score, which indicates temporal edges between prepared sampled materials. Each particular segment in the score corresponds with the same sonic material from the *Allegro*, however each performer is using the same material from different recorded versions of that material simultaneously. In fact, no sample is greater than 8 seconds, and when preparing the samples, I did not exceed 3 rotations of the 24 recordings. Each performer continues to have access to the same effect modules as in the other movements, and is given total freedom in determining how they will use those resources. The structure that results, in that each segment of the movement is generated from the same several seconds of sampled sound, fulfills my

conception of minimum cohesion, and yet produces an aural perception of something familiar, yet discontinuous, and fundamentally other. Moreover, the level of cohesion and resultant connotative relationships will be vastly different for each listener.

Illustration 1.

Spectrograph, *Transfiguration* (2006)

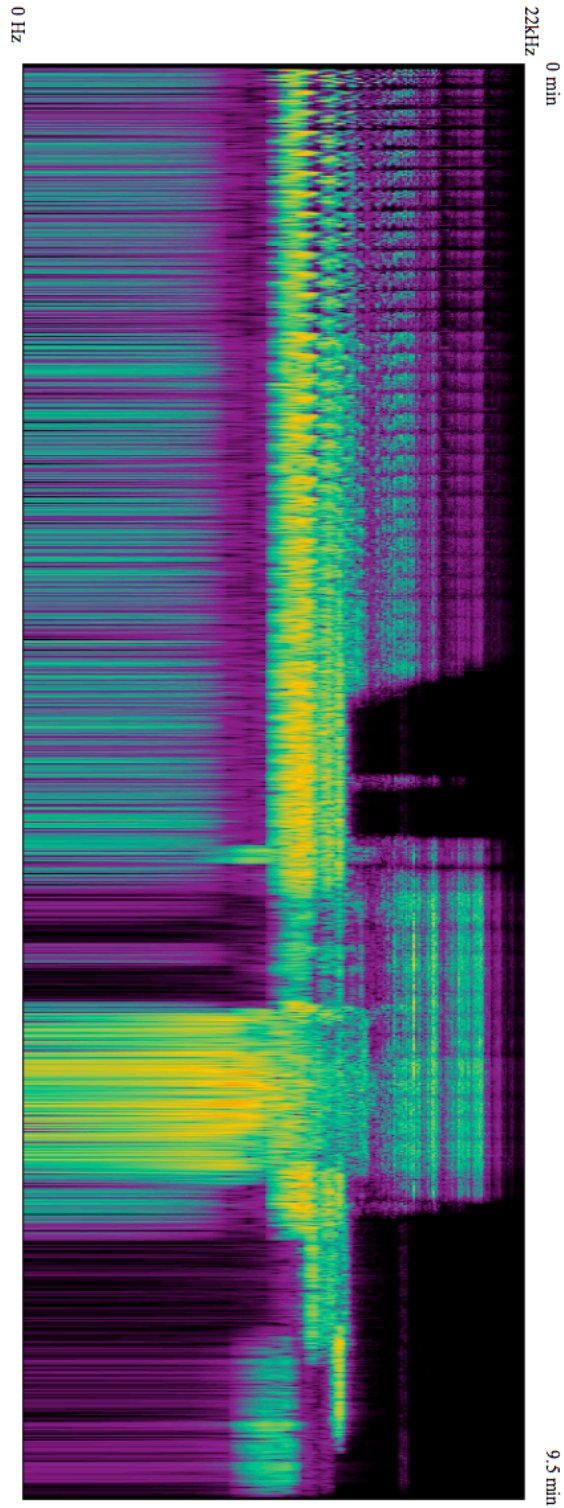


Illustration 2.

Excerpt, *Alone / Together* (2007)

P.1 $\text{♩} = 72$ *Rigid* *With Abandon*
soft rubber *mf* *f* *f* *ff* *ff*
P.2 $\text{♩} = 72$ *Rigid* *With Abandon*
hard plastic *mf* *f* *mf* *f* *ff* *ff*
P.3 $\text{♩} = 72$ *Rigid* *With Abandon*
medium rubber *mf* *f* *f* *f* *ff* *ff* *mf*

23 24 25 26 27 28

Illustration 3.

Macro Structure, *Alone / Together* (2007)

<u>one</u>	two	three	four
A B C inter.	A B inter. C	A (B/C) inter.	A B C - (inter.) -
m. 1 2 5-7 8-11	12-14 15-22 23-26 27-34	35-37 38-47 48-56	57-58 59-60 61 62-64 65-66
46'' - 52''	1'54'' - 2'06''	1'31'' - 1'46''	44'' - 53''

Illustration 4.

Alone / Together, “A material”

Slow, tentatively
medium yarn mallets 8 - 10"

pp

Slow, tentatively
triangle beaters 8 - 10"

pp

Slow, tentatively
hard cord mallets 8 - 10"

1

“B material”

bowed 4 - 5"

pp

4 - 5"

pp

4 - 5"

pp

3

“C material”

Energetic *mf* 4 - 5" *Gradually deflating* 9 - 12" 3"

Energetic *mf* 4 - 5" *Gradually deflating* 9 - 12" 3"

Energetic *mf* 4 - 5" *Gradually deflating* 9 - 12" 3"

5 6 7

“Interlude material”

♩ = 72 Distant
sticks *pp* 4/4 3/4 4/4 3/4

♩ = 72 Distant
sticks *pp* 4/4 3/4 4/4 3/4

♩ = 72 Distant
sticks *pp* 4/4 3/4 4/4 3/4

8 9 10 11

Illustration 5.

Detection Software Component, *Indivisible* (2007)

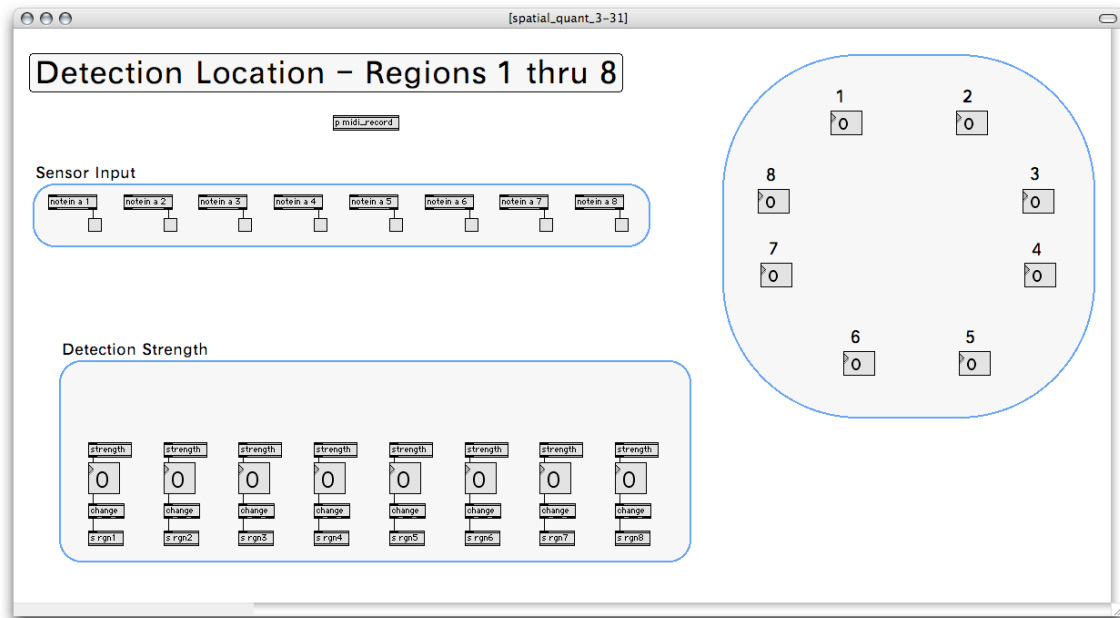


Illustration 6.

Form Generator and Module Example, *Indivisible* (2007)

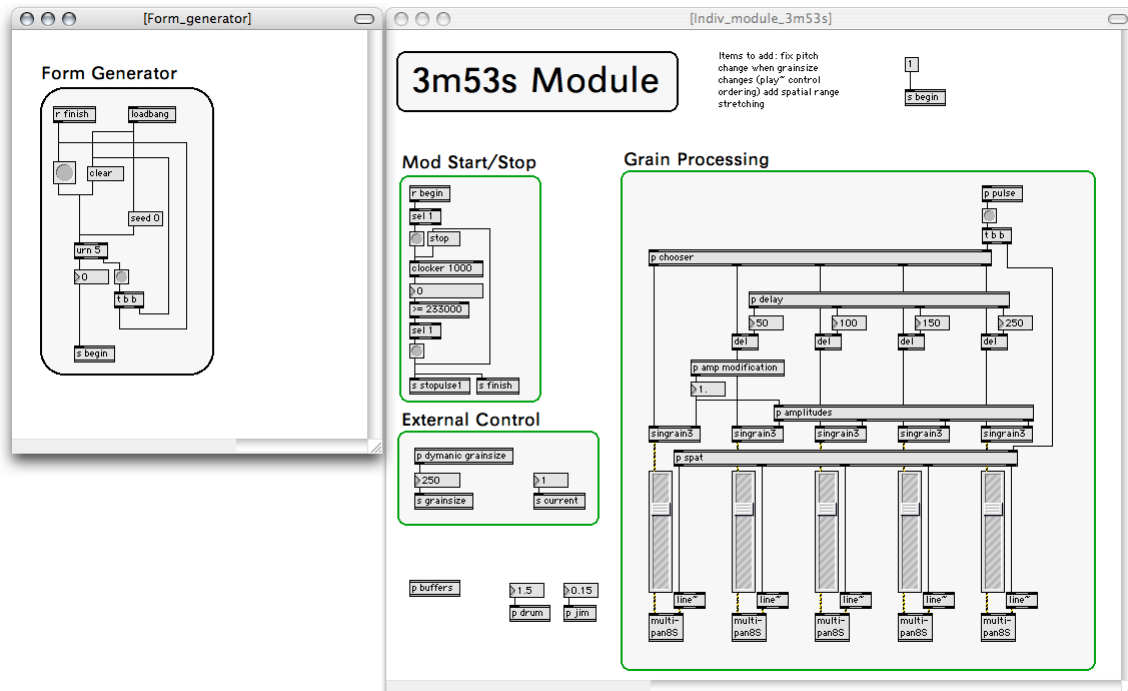


Illustration 7.

Excerpt, *(re)Formations, i. (re)Constituted* (2007)

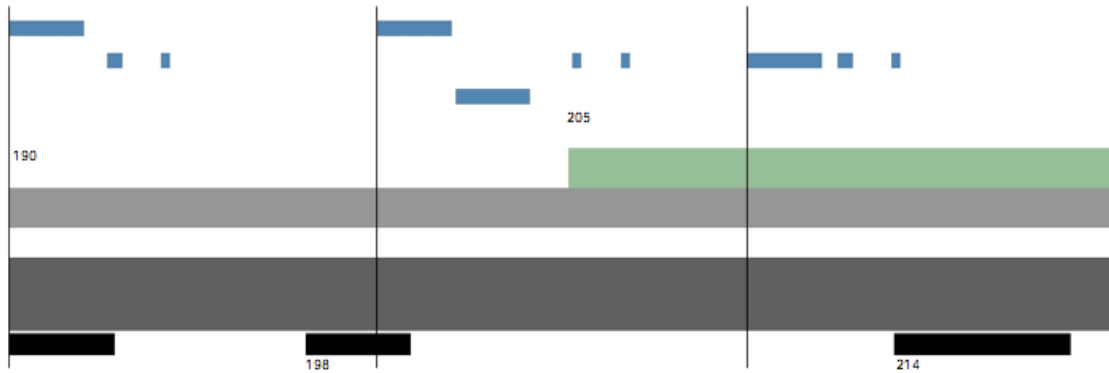
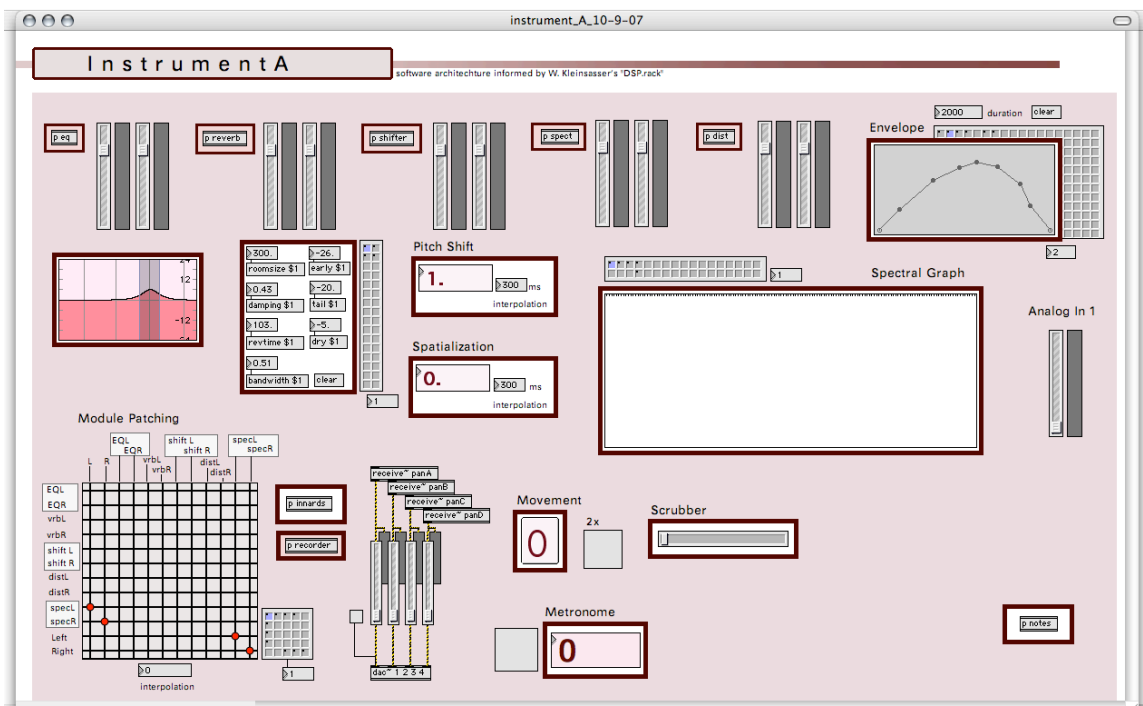


Illustration 8.

Main software component from *(re)Formations* (2007)



Appendix I

Sources for material used in *(re)Formations* third movement, *(re)Generated*.

Beethoven, Ludwig Van. Symphony No. 5. Gewandhausorchester. Kurt Masur. Philips Classics Productions, 1996.

Beethoven, Ludwig Van. Symphony No. 5. Wiener Philharmoniker. Georg Solti. Decca Music Group Ltd., 2001.

Beethoven, Ludwig Van. Symphony No. 5. Zagreb Philharmonic. Richard Edlinger. HNH International Ltd., 1995.

Beethoven, Ludwig Van. Symphony No. 5. The Hanover Band. Monica Huggett. Nimbus Records Ltd., 1988.

Beethoven, Ludwig Van. Symphony No. 5. Concertgebouw Amsterdam. George Szell. Phillips Classics.

Beethoven, Ludwig Van. Symphony No. 5. Milwaukee Symphony Orchestra. Andreas Delfs. MSO Classics, 2005.

Beethoven, Ludwig Van. Symphony No. 5. NBC Symphony Orchestra. Arturo Toscanini. BMG Entertainment, prior to 1972.

Beethoven, Ludwig Van. Symphony No. 5. Boston Symphony Orchestra. Seiji Ozawa. Telarc, 1981.

Beethoven, Ludwig Van. Symphony No. 5. Cleveland Orchestra. Christoph von Dohnanyi. Telarc, 1988.

Beethoven, Ludwig Van. Symphony No. 5. Chicago Symphony Orchestra. Fritz Reiner. BMG Entertainment, prior to 1972.

Beethoven, Ludwig Van. Symphony No. 5. Philharmonic Promenade Orchestra. Adrian Boult. Vanguard Classics, 2003.

Beethoven, Ludwig Van. Symphony No. 5. Wiener Philharmoniker. Carlos Kleiber. Polydor Intl GmbH, Hamburg, 1975.

Beethoven, Ludwig Van. Symphony No. 5. Lubov Orchestra. Karel Fichter. YOYO USA, Inc., 2006.

Beethoven, Ludwig Van. Symphony No. 5. Radio-Sinfieorchester Stuttgart. Roger Norrington. Haenssler Classic.

- Beethoven, Ludwig Van. Symphony No. 5. Tafelmusik Orchestra. Bruno Weil. ANALEKTA, 2005.
- Beethoven, Ludwig Van. Symphony No. 5. Tasmanian Symphony Orchestra. David Porcelijn. ABC Classics.
- Beethoven, Ludwig Van. Symphony No. 5. Budapest Symphony Orchestra. Tamas Vasary. Hungaroton Classic.
- Beethoven, Ludwig Van. Symphony No. 5. La Scala Philharmonic Orchestra. Carlo Maria Guilini. Sony Classical, 1995.
- Beethoven, Ludwig Van. Symphony No. 5. Simon Bolivar Youth Orchestra of Venezuela. Gustavo Dudamel. Deutsche Grammophon, 2006.
- Beethoven, Ludwig Van. Symphony No. 5. Philharmonia Orchestra. Benjamin Zander. Telarc, 1999.
- Beethoven, Ludwig Van. Symphony No. 5. Boston Symphony Orchestra. Charles Munch. RCA Victor, 1993.
- Beethoven, Ludwig Van. Symphony No. 5. Cleveland Orchestra. George Szell. Sony Classical, 1991.
- Beethoven, Ludwig Van. Symphony No. 5. New York Philharmonic. Kurt Masur. Telarc, 1993.

Appendix II

Sources for material used in *(re)Formations* first movement, *(re)Constituted*.

Voices

Armstrong, Karen. *The Great Transformation: The Beginning of our Religious Traditions*. Karen Armstrong. Books on Tape compact disc 6923-CD.

Carter, Jimmy. *Our Endangered Values*. Jimmy Carter. Recorded Books compact disc C3446.

Clinton, Bill. *My Life*. Bill Clinton. Random House Audio compact disc RHCD611.

Dobbs, Lou. *War on the Middle Class*. Lou Dobbs. Penguin Audio compact disc 305901-7.

Kiyosaki, Robert T., with Lechter, Sharon L., C.P.A. *Rich Dad Poor Dad*. Stephen Hoyer, with Robert T. Kiyosaki. Time Warner Audio Books compact disc 2-32959.

O'Reilly, Bill. *Culture Warrior*. Bill O'Reilly. Books on Tape compact disc 7118-CD.

Trump, Donald, with McIver, Meredith. *Trump: Think Like a Billionaire*. Donald Trump. Recorded Books compact disc CT063.

Popular Songs

Callait, Colbie, and Reeves, Jason. *Bubbly*. Colbie Caillat. Universal Republic. 2007.

DeAndre Way. *Crank That*. Souljaboy. Collyparl Music, Interscope, and Stackon Deck Ent. 2007.

Fergie, Toby Gad. *Big Girls Don't Cry*. Fergie. A&M. 2007.

Kingston, Sean. *Me Love*. Sean Kingston. Beluga Heights. 2007.

Kroeger, Chad, and Nickelback. *Rockstar*. Nickelback. Roadrunner. 2007.

Laird, Luke, Underwood, Carrie, and Lindsey, Hillary. *So Small*. Carrie Underwood. Arista Nashville. 1997.

Timbaland, Danja, Hilson, Keri, Muhammad, Belawa, Nelson, Candice, and Maultsby, J. *The Way I Are*. Timbaland, Keri Hilson, and D.O.E. Blackground/Interscope. 2007.

Thomas, Rob, Doucette, Paul, Cook, Kyle, and Yale, Brian. *How Far We've Come*. Matchbox Twenty. Atlantic. 2007.

West, Kanye, Bangalter, Thomas, de Homem-Christo, Guy-Manuel, and Birdsong, Edwin. *Stronger*. Kanye West. GOOD Music, Island Def Jam, Roc-A-Fella. 2007.

Winnie the Pooh. *Shut Up and Drive*. Rihanna. Def Jam. 2007.

Sound Effects

100 Spectacular Sound Effects. Madacy compact disc. 1994.

Classic Sound Effects. ASV Living Era compact disc. 1996.

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< <http://www.grovemusic.com>>
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- Reich, Steve. *Writings on Music, 1965-2000*. New York: Oxford University Press, 2002.
- Roig-Francoli, Miguel A. *Understanding Post-Tonal Music*. New York: McGraw-Hill, 2008.
- Snyder, Bob. *Music and Memory: An Introduction*. Cambridge: The MIT Press, 2000.
- Stuck, Les and Zoax. *Granularized*, in *Max/MSP v.4.6.3* [Computer Software]. Cycling '74/IRCAM, 1990-2005.
- Wishart, Trevor. *On Sonic Art*. New York: Routledge, 1996.