ONE SOURCE, ONE SIGNAL

Thesis

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by

Nicholas Wang

Approved by:
Reading Committee

____________________________
James Fei
Director of Thesis

____________________________
Chris Brown
Reader of Thesis

____________________________
Chris Brown
Head of the Music Department

____________________________
Dr. Sandra C. Greer
Provost and Dean of the Faculty

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## Introduction

Over the course of my graduate studies at Mills College, I developed a compositional practice that is derived from an interest in building hardware and software instruments for live electronic music performance. Despite myriad different aesthetic and compositional concerns addressed from one piece to another, many of my recent works focus on the use of a single extra-musical sound source in conjunction with simple signal processing as the basis for all musical material. Unlike some approaches to signal processing, which work to drastically mutate input sound sources, my approaches generally focus on processes that retain the integrity of the original input signal. That is to say, I deliberately build my instruments such that a clear connection between input and output is maintained, lending them a relatively limited timbral vocabulary. The functionality and limitations of my electronic instruments place particular constraints on the ways in which I am able to organize sound, as they generally function to rearticulate the source material (e.g. rhythmically, dynamically, et cetera) rather than generating fundamentally new material through more transformative processes. With these limitations in mind, I strive to compose works with a nearly singular focus on the input sound source, utilizing my instruments to explore different articulations of relatively static material. In this sense, I understand my practice as a means to explore the musical possibilities presented by a single sound.

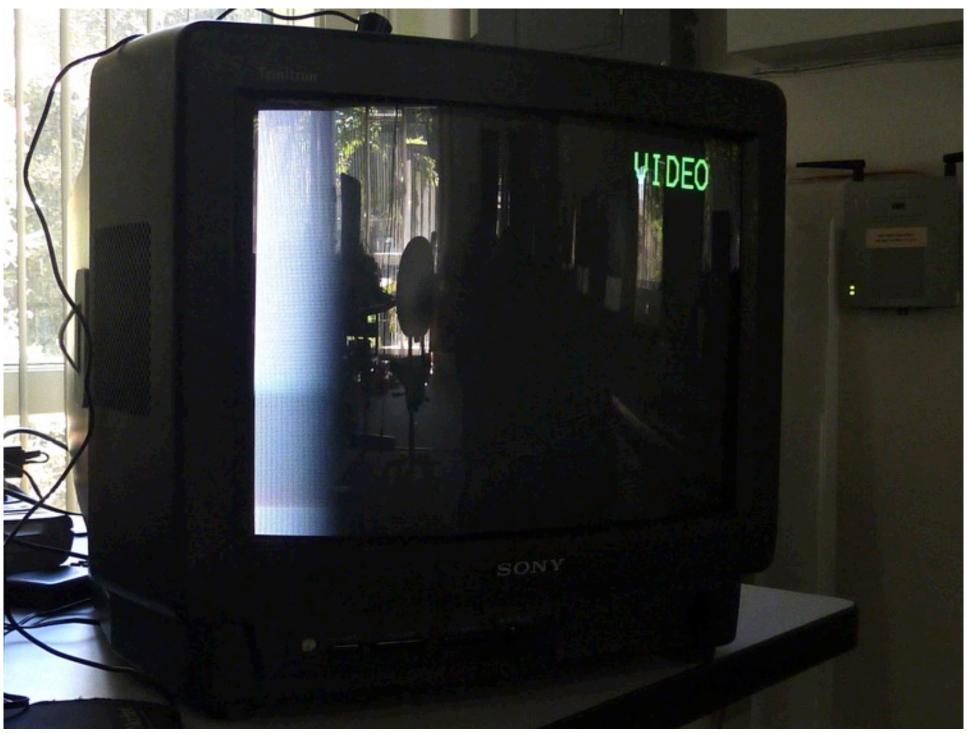
Below, I detail the evolution of this compositional practice in the context of work completed during my time at Mills. I begin with *TV Party* and *Long Live the New Flesh*, two audio-visual works involving television, and then discuss *Just A Very Few Things*, a collaborative work for music and dance with Ryan Ross Smith and Eli Morales. I conclude with a discussion of *Chirality (For Bass Drum and Quarter-Inch Cable Hum)*, my thesis composition presented at Signal Flow, the Mills College graduate music festival.

### ***TV Party***

During my second semester at Mills, I began working with an inductive pickup in conjunction with a headphone amplifier to transduce electromagnetic waves into sound. I was immediately drawn to the kinds of sounds I was able to hear while probing different electronic devices, such as compact disc players and radios. I was also intrigued by the sensitivity of the pickup to its proximity to sources of electromagnetic wave emission. I found that I was able to fluidly increase or decrease the level of the audio signal by physically moving the pickup towards or away from electronic devices.

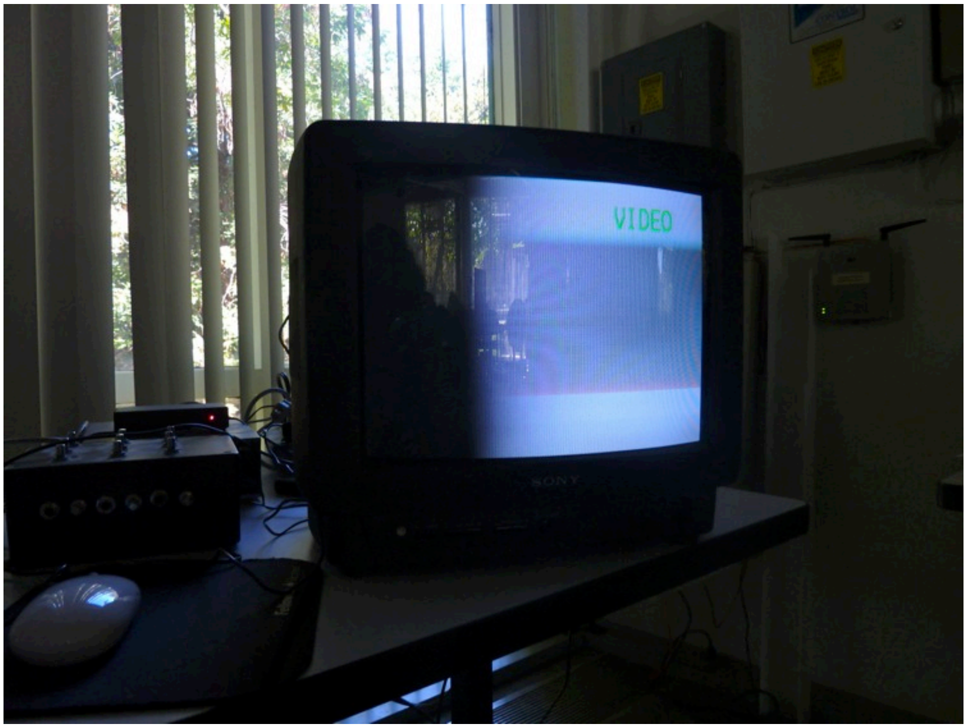
Eventually, I used the inductive pickup to probe an old cathode ray tube television monitor. Because of its relatively large size, the CRT monitor offered me a greater amount of space to probe with the pickup compared to smaller objects. I found several sweet spots (where the pickup and amplifier would produce sound) and dead spots (where the pickup and amplifier would produce little to no sound) around the monitor, and I noticed that moving the pickup between sweet spots and dead spots would produce slight timbral modulations in the sound. This aspect, coupled with the aforementioned sensitivity of output amplitude to proximity, suggested that the CRT television monitor and inductive pickup could potentially be used in musically interesting ways.

After noticing that the CRT monitor used a female RCA connector as its video input, I built a simple preamplifier for the inductive pickup and connected the output of the circuit to the monitor. Though the audio signal lacked video sync, the monitor displayed the signal, yielding flashes of white light on parts of the screen.[1] As I adjusted the gain of the preamplifier, I found that I could change the display quite dramatically, ranging from large rectangular regions to more irregular patterns of horizontal lines. In addition, the display of the pickup signal on the monitor behaved in a remarkably similar manner to the pickup's transduction of electromagnetic waves into sound – the intensity of the brightness and the kinds of shapes and patterns displayed on the screen were sensitive to the spatial placement of the pickup as well as its physical proximity to the monitor.




**An example of a pattern displayed with relatively low gain on the inductive pickup.**

[1] Newer video display devices, such as computer projectors or plasma television sets, display a blank blue screen in the absence of a video sync on the input signal.




**An example of a pattern displayed with relatively high gain on the inductive pickup.**

**An example of a pattern displayed when probing a particularly active spot on the monitor.**


**An example of a pattern displayed when probing another particularly active spot on the monitor with a higher gain setting.**

Around the same time, I had been using two-input NAND gate Schmitt triggers in conjunction with a preamplifier to build simple gating circuits. By replacing the NAND gate feedback resistor with a photoresistor, I could use varying amounts of light to modulate the rate at which the input signal was gated. I then plugged the inductive pickup into the circuit, fixed the photoresistor to the CRT monitor's screen, and split the circuit's output between a speaker and the video input of the monitor, effectively building a self-modulating tremolo effect for the audio from the pickup as I probed the monitor. I liked the visual element of the system, but I was somewhat dissatisfied with the sound. It seemed too much like a constant, always turned-on sound, and the gating was too fast to get a clear sense of the effects of the optoelectronic feedback on the audio.

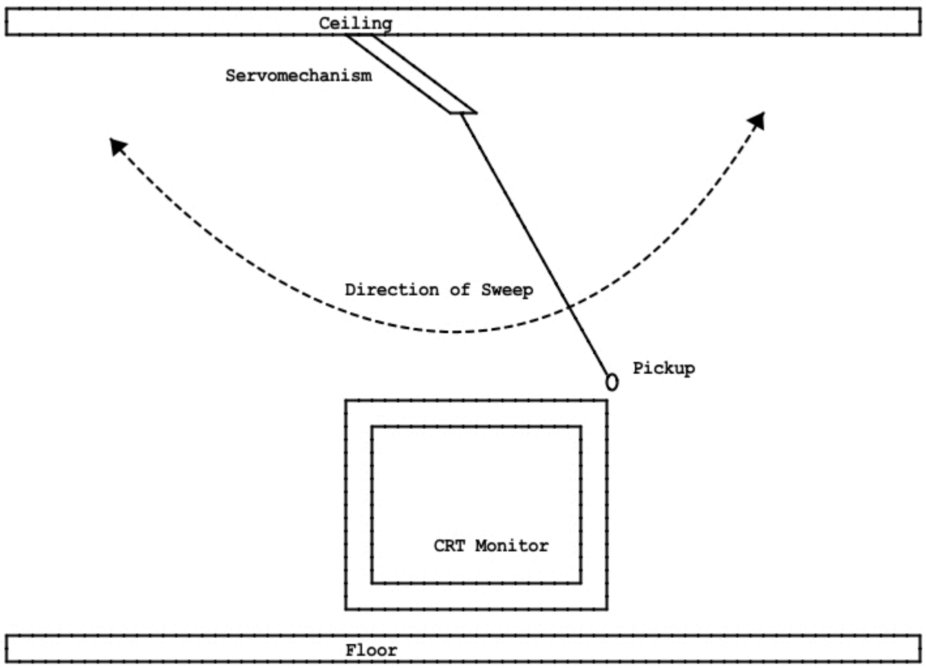
To introduce a greater feeling of space in the audio output of the electronics, I modified the circuit to slow down its overall frequency range in order to accentuate rhythmic aspects of the gating. By introducing more silence, this modification yielded a more obvious connection between the sound and the visual element: as the screen became brighter, the gating frequency would increase, producing rhythmic interruptions and modulations that corresponded well with the visual patterns and distortions displayed on the screen.

While I found the interactions of the inductive pickup in conjunction with the CRT monitor and my homemade gating circuit sonically and visually engaging, I was also interested in the conceptual implications presented by the system. By using the inductive pickup to probe the electromagnetic waves emitted by the CRT monitor, all of the audio-visual material produced by the system was inherently related to the monitor itself based on the electrical characteristics of its normal function. It was as though the audio-visual material germinated from within the monitor rather than from without, seemingly subverting the role of the television as a means to display externally received and produced signals and content and finding a means to consider the idea of television as a physical object as opposed to a medium for the experience of media. Augmenting the pickup and the CRT with electronics to create self-modulation through optoelectronic feedback, then, seemed to reinforce in my mind the image of a television set producing its own material internally. As such, when I listened and watched the system at work, I felt as though I was watching television itself rather than material produced explicitly for display on television.

Following this period of technical experimentation, I started work on *TV Party*, an installation focusing on audio-visual interaction as a source of rhythmic modulation utilizing the inductive pickup, light-controlled gating, and CRT monitor configuration described above. Because most of the CRT "sweet spots" were located on and near the top side of the monitor, I reasoned that it would be optimal to suspend the inductive pickup above the CRT and have it move freely around the monitor, probing the different areas to introduce slight timbral changes in the audio output of the electronics based on the changes in the position of the pickup. I then started considering ways to automate the movement of the pickup around the CRT. Initially, I considered using wind created by a floor fan to cause the pickup to move in a somewhat indeterminate manner. Though I liked the amount of randomness that wind could provide, I decided against using it, as I was worried that it would make too much sound on its own and would be visually distracting, adding material clutter to the piece.[2]

Eventually, I settled on attaching the pickup to a servomechanism with a slow moving, 180-degree sweep fixed several feet above the monitor. Compared to the floor fan, the servomechanism was relatively quiet and had a significantly smaller spatial footprint, as it could be mounted near the ceiling of the installation space, theoretically focusing a viewer's visual attention more closely on the CRT monitor. In spite of this, I was initially dissatisfied with the regularity of the sweep – it gave the pickup's movement a fixed, almost robotic quality. I feared that the regularity of the movement would draw too much attention to the movement itself, thereby minimizing one's attention to the interaction between the sounds and the visuals.

[2] I also considered using the breeze from an open window to activate movement. I was similarly worried about the amount of external sound permeating the space, and I was also concerned that leaving the window open would be a potential security risk given that the piece was installed continuously for several days.




**A drawing of the initial installation mockup with the servomechanism fixed to the ceiling.**

However, my initial mock-up with the servomechanism ameliorated my concerns. Despite the regularity of the path of movement, the system responded differently on every sweep, as the pickup would naturally twist and turn as it moved, yielding different kinds of interactive responses between the electronics and the monitor. In addition, the regularity of the sweep seemed to give the piece a sense of internal time with each excursion constituting a single, repeated gesture. At the beginning of the sweep, with the pickup far away from the CRT, the opening and closing of the gate produced a relatively constant frequency of percussive clicks (corresponding with a slim, horizontal flash of light across the CRT's screen). As the pickup neared sweet spots, the sound and visuals would modulate one another, producing a somewhat unpredictable rhythmic variation. Because the system would respond differently on each excursion (due to variations in the pickup's directional orientation and the nonlinear behavior of the optoelectronic feedback), the mechanical regularity of the servomechanism seemed to reinforce the sonic and visual differences from one excursion to the next by demonstrating the virtually infinite permutations of rhythmic behavior within the same basic gesture.  In other words, the sweep of the servomechanism constituted a fixed phrase that was indeterminately modulated by the idiosyncrasies of the electronics.


***TV Party*, installed in Lisser Hall.**

I eventually installed the piece in a room in Lisser Hall on the Mills Campus, letting it run continuously over the course of several days. I was generally satisfied with the results of the installation, but in retrospect, I feel that the piece has some weaknesses that lower its overall efficacy.  For one, the use of the servomechanism to move the pickup around the CRT seems to detract from the initial concept of a television set generating its own content, as the regularity of the sweep yields the sense of an outside force acting on the system to produce results.  Barring finding another way to move the pickup, I could have made the sweep even slower, or I could have restricted its path of motion to a smaller angle, rendering its movement less obviously noticeable. In addition, the ambient light from the window in the room caused the electronics to behave quite differently during daylight hours compared to during the evening. Had the room been held more consistently dark, the photoresistor coupled to the screen would have been more responsive to the light from the CRT. It would have perhaps been advantageous to select a space without windows, affording me a greater amount of control over the ambient light of the room.

***TV Party*, installation view.**

### *Long Live the New Flesh*

While completing work on the electronics for TV Party, I began thinking of ways to use my circuit in live performance. Initially, I had some difficulty conceiving of ways to organize the kinds of sounds I could produce using the inductive pickup, the gating circuit, and the CRT monitor coherently in a performative context. While I was intrigued by the rhythmic modulations and irregularities the electronics were capable of producing through the interaction between sound and light, I wanted to avoid a rehashing of the technical and aesthetic concerns explored in TV Party. I eventually decided to focus more on the visual element of the electronics, using improvised sonic gestures to create a live video performance piece. I wanted to avoid working with the stark, flashing white light (as it would be too similar to TV Party), so I built a simple circuit that could mix the audio signal from my electronics with an external video signal as input to the CRT monitor with a potentiometer. In doing so, I found that I could gesturally alter the video playback with my improvisation, generating real-time visual distortions and modulations. I then started to consider the framing of the performance.

Initially, I wanted to perform in an alternative space, such as a “living room” setting to evoke a surreal television viewing experience. However, I found that playing with the electronics required me to sit in front of the screen with my back to the audience, which would make it difficult for audience members to focus on the images on the screen. As such, I chose to perform in the concert hall, taking advantage of its large projection screen. Although projecting the video detracted in a way from the piece’s focus on the CRT, I felt that the projection would add a nice effect of scale, amplifying the visual content (somewhat analogous to the high-gain amplification of the inductive pickup by the electronics).

When I started searching for source material for the fixed video content, I wanted to use something that was somehow related to television as a physical object in order to visually reinforce centrality of the CRT monitor to the piece as a generator of source material and modulation. After considering a number of options, including documentaries about the invention of television, I settled on a five-minute excerpt of David Cronenberg's 1983 science-fiction thriller Videodrome in which the protagonist of the film, Max Renn (portrayed by James Woods), is physically absorbed into a television set. In addition to serving as a visual reminder of the physicality of the CRT in the performance, the excerpt also seemed to provide an effective visual frame for the "junky," low-fidelity sounds I was producing with the electronics. In my mind, I often associate the kinds of quasi-dystopian sci-fi themes explored in Videodrome to evoke feelings of instability, especially with reference to technology. It seemed rather appropriate, then, to use this material to explore chaotic visual distortion through optoelectronic feedback.

With the excerpt selected, I proceeded to practice playing the pickup and electronics along with the video to get a sense of the kinds of visual effects I could achieve with the electronics. Through my practice with the electronics and the video, I developed a set of different combinations of effects, including color distortion, image misalignment and flickering, and modulation of brightness.


**A still image from the performance (0'40").**


**A still image from the performance (0'58").**


**A still image from the performance (3'06").**


**A still image from the performance (4'18").**

Despite the relatively indeterminate aspects of the video modulations produced by the electronics, I found that through practice I could achieve a level of global control over the visual modulations, particularly with respect to pacing and organization. The addition of supplementary electronics, such as a volume pedal and a few guitar stomp-boxes, afforded me an additional level of control over the audio signal, giving me a wider palette of options for modulating the video with the audio. This allowed me to more fluidly react to the content in the *Videodrome* excerpt, allowing the general arc of the scene to be preserved while abstracting its content with visual distortion, yielding a sort of pop culture, multimedia performance spectacle.

***Just A Very Few Things***

During my third semester at Mills, I enrolled in Professor Chris Brown's Seminar in Computer Music in order to learn how to use the SuperCollider programming language for sound synthesis and audio processing. As a result of a newly instituted program of cross-disciplinary collaborations within the Fine Arts Division at the College, we had the opportunity to work with graduate dance students enrolled in Professor Shinichi Iova-Koga's Sources and Inventions course.

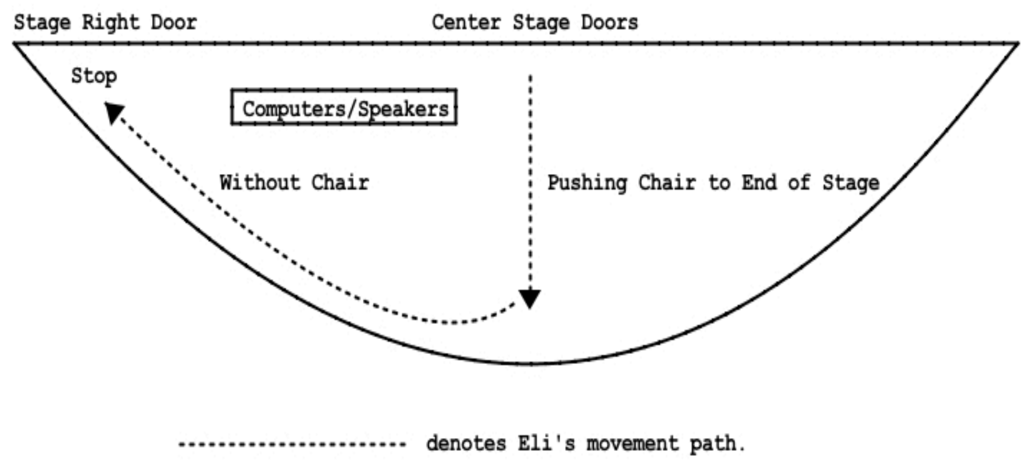
Within the first month of the class, Ryan Ross Smith, a fellow graduate student in the Music Department, and I were discussing ways to facilitate the interaction between sound and movement in the context of a collaborative composition for the final class concert. We considered a number of ideas, most of which were related to utilizing the movement of a dancer or dancers to control sound synthesis parameters, but we found them largely unsatisfactory and beyond the scope of our immediate technical abilities. In my mind, such approaches do not always demonstrate a clear visual connection between sound and movement (barring, for instance, the use of a sophisticated motion tracking system), causing one to question why the interactive aspects of the performance are necessary.

Eventually, Ryan and I realized we shared a mutual interest in composing a piece in which all of the musical material is drawn from live sampling of the incidental sounds of the dancer's movement. I was attracted to this idea because of the strength of its connection between musical and choreographic materials. In the context of this idea, the sonic material itself (as opposed to its modulation) is inherently related to and dependent on the movement. In a similar vein, I felt that this idea exploited a particular reality of dance (in that dancers inherently make sound whenever they move on stage) and integrated it into the music as the impetus for all of the sound emitted through the loudspeakers.

Ryan and I proceeded to write SuperCollider software to record input sound from microphones placed on stage, playing back the original signal as well as short bursts of the recordings processed through a simple granular synthesis script. In our scripts, we built in the ability to control the wet/dry mix of the microphone signal, allowing us to utilize a mix of effected and non-effected sounds of movement as our sound material. We then started testing out our software with PZM microphones running into the audio interface inputs, walking in front of the microphones to see how the software would respond to movement sounds. With quieter movements, our software produced a good deal of satisfying sounds, ranging from simple amplification of the movement to soft granular clicking and slight pitch modulations. On the other hand, louder movements tended to produce relatively uncontrollable feedback. Though I liked the possibility of incorporating feedback as an additional sound source in the piece, I felt that it would have to be used sparingly, as an excessive amount would detract from the original concept of using the sounds of movement since the feedback would wash over and cover up successive incidental sounds.

With these ideas in mind, we began working with Eli Morales, a graduate student in the Dance Department, to compose the piece. Because we did not want the piece to be explicitly about acoustic feedback and wished to preserve the connection to Eli's incidental sounds, the three of us developed a compositional/choreographic dynamic centered on small, quiet movements. This naturally led us to move in a minimal, almost inactive direction for the final performance.

The piece developed into a large opening gesture followed by a long moment of micro-level choreographic and musical gestures, yielding a sense of a grand opening statement punctuated by a prolonged period of resonance and eventual inactivity. When the piece began, Eli emerged from the center stage doors, pushing a chair across the stage, producing a loud, grating scrape against the floor. As she made her way to the end of the stage, Ryan and I increased our output levels to produce a loud, dense texture of feedback. We sustained the texture as Eli stood atop the chair and decreased the gain to well below feedback levels as she stepped off the chair and onto the stage. As she walked to the stage right door, our software picked up and processed the sounds of her walking, producing a quiet cloud of small sounds. She then stood against the door (illuminated by a single lamp), making extremely slight movements that were accompanied by equally slight sonic material and gestures. The piece concluded when Ryan stood up from his seat on stage and turned the light off, producing a final, moderately loud gesture to punctuate the piece.




**A map of Eli's movement on the stage during the performance.**

Overall, I felt that the piece could have more clearly placed the incidental sounds at the forefront of the music. We admittedly spent a less than ideal amount of time figuring out the microphone placement techniques on the stage, making it somewhat inefficient to amplify the sounds of Eli's movement without generating feedback. It would have perhaps been more effective to use an array of PZM and air microphones placed over a larger area, establishing a greater number of reactive points on the stage. In addition to our issues with microphone placement, I felt that the piece could be improved by having more dancers or perhaps a few more moments with louder movements in order to more firmly establish a connection between the sound and dance. On the whole, however, I found the concepts of the piece to be interesting and would like to further develop and engage with these kinds of ideas in future works.

***Chirality (For Bass Drum and Quarter-Inch Cable Hum)***

**Concept**

My initial inspiration to work on a piece for quarter-inch cable hum was largely accidental. During the summer before my third semester at Mills, I was improvising with no input mixing board feedback, monitoring the audio output over headphones so as to not disturb my neighbors. When I finished, I began putting away gear with my headphones still on, neglecting to mute the input channels and the main output of the board. While I was wrapping some cables, my bare foot stepped on a quarter-inch plug that was still connected to an input on the mixer. I became intrigued by the buzzing and listened for a few moments, reaching over to the mixer to adjust the gain on the input channel. As I heard the ways in which the timbre of the hum changed slightly in response to my knob turning (as well as the hum's responsiveness to changes in how my foot touched the plug), I felt that I had found an interesting, tactile sound source to use in my work with live electronics. After continuing to play around with the plug for a while, listening intently over my headphones, I became compelled to work on a new piece using the cable hum as an instrument.

I was drawn to the cable hum for a number of reasons. First of all, I liked the cable's potential as a gestural instrument. Because of its sensitivity to touch, minute changes in the way one's hand held the cable could alter the sound produced. For instance, briefly touching the tip of the plug and then quickly releasing one's finger could produce a percussive attack, while holding the tip and the sleeve of the plug with one's finger while rubbing the tip and the sleeve back and forth with one's thumb would produce a hissy, rhythmic rumble (with more or less sixty cycle buzz appearing, depending on how hard the tip of the plug was pressed). As I explored these different kinds of gestures, I found that I could build a palette of material connected to each movement of my hand, yielding a somewhat controllable, physically responsive sound source.

I was also intrigued the limitations of the cable hum. In spite of its inherent gestural nature, the overall timbre of the hum was relatively compressed and depended largely on the amount of gain applied to the signal. In this sense, the vocabulary I developed in these initial experiments with the hum consisted largely of micro-variations of a single sound that could be articulated differently through gestural variation. The cable hum, then, presented an interesting challenge: How could I organize an extremely limited set of sound materials to produce an effective and engaging composition?

Finally, I was drawn to the absurdity of using a quarter-inch cable as a musical instrument. As a guitarist and performer of live electronic music, I often find cable hum to be a pestering annoyance that rears its ugly head during the careless plugging and unplugging of cables during sound-checks and post-performance equipment teardowns. There is a certain humor, I think, inherent in using such a commonplace, often disregarded, sometimes infuriating (if the gain is turned up to a high enough level) sound, particularly in the context of a performance at Mills, wherein most audience members, due to their higher-than-average levels of exposure to electronics and music technology, have encountered cable hum at some point in their lives.

**Development and Composition**

After spending time exploring the possibilities for sound material presented by the quarter-inch cable hum, I began to work on composing for it. I knew that I wanted to highlight the role of the cable as an instrument – as such, I felt that performing alongside an acoustic instrument would help to visually reinforce this concept. In addition, I felt that the introduction of another instrument would be compositionally helpful, as it would at some level force me to be more careful and deliberate in making musical choices and would push me away from more open-ended, “noodly” approaches for performance with live electronics. Indeed, in much of my work for solo electronics, I often find that I tend to play too much (or, perhaps more accurately, too actively), moving around from one musical idea to the next in quick succession, leaving different materials little room to exist on their own for extended amounts of time. Playing music with other people, on the other hand, makes me on the whole more mindful of the musical moment itself, allowing me to focus more intensely on creating a coherent work and refrain from jumping around too spastically.

As I began considering the different acoustic instruments with which I could work, I immediately gravitated to either a single bass drum or a single snare drum. First and foremost, I had an intuitive sense that a snare or bass drum and the cable hum would sonically complement each other well. Prior to beginning compositional work on *Chirality*, I felt that the respective sounds of the cable hum and a snare or bass drum would fit together in a coherent way, particularly with respect to the relative lack of flexibility in terms of pitch content of the cable hum. To play the cable hum alongside an instrument with a greater range of pitch content (say, for instance, a wind or string instrument) would potentially diminish the role of the cable hum in the performance, as it would at the outset be less interesting by comparison. I also felt that the large dynamic range of the snare drum and bass drum would match the dynamic range of amplified electronics, facilitating a more full exploration of dynamics in the performance.

Moreover, when I first started working with the cable hum as an instrument, I was drawn to the ways in which I could produce percussive sounds by touching the plug and quickly releasing my fingers. Though this gesture theoretically afforded me the ability to play rhythmic phrases with the cable hum, I was limited to relatively slow tempi. I wished to augment the cable hum with some sort of signal processing that would create fast-paced rhythms while preserving the integrity of the original input signal. As such, I built a preamplifier with switchable gating (via multiplication of the input signal with a pulse wave oscillator) to rapidly turn the cable hum output on and off, enabling me to easily produce rhythmic content at rates which are exceedingly difficult to perform with manual manipulation of the plug. Given the functionality of the gating circuit, it seemed logical to work in conjunction with a snare drum or bass drum to explore different rhythmic interactions.

I also felt that having a percussion player on stage would provide an element of strong visual contrast. Percussion instruments, by virtue of how they produce sound, require relatively large physical gestures in performance. Set adjacent to my physical manipulation of the quarter-inch cable, the performative gestures of the percussion player establish a stark juxtaposition of macroscopic and microscopic physical movement, working to draw attention to the tactile physicality of the music.

After considering the compositional parameters outlined above and building a gated preamplifier, I started to work with Anna Wray, a percussion student at Mills, to begin fleshing out the composition. At our first meeting, we recorded several brief improvisations of snare drum and cable hum and bass drum and cable hum. During the session, it became clear relatively quickly that the snare drum and the cable hum had too much common frequency content, making it difficult for the electronics to stand out alongside the snare drum given that its volume can easily exceed that of the electronics. After settling on bass drum, we spent the next few rehearsals recording more of these improvisational exercises. We would listen to the recordings, discussing what kinds of things worked (or failed to work) and building a catalogue of raw materials for the composition.

After listening to these initial recordings, I found that the best way to compositionally engage with the material would be to think about the work as a set of discrete sections. During our improvisations, I would generally stick with one kind of articulation of the cable hum while we recorded a given take: sustained tones, gestural manipulation (through changing my grip on the plug and playing with a volume pedal), fast gating (which produced a flanging quality), and slower gating (for a driving, rhythmic pulse). Hence, it seemed natural to structure each section of the piece around a single one of these techniques. I then listened to our recordings again, finding the kinds of sounds and phrases Anna played that seemed to fit well with the given cable hum articulations. Given the centrality of our rehearsal recordings to this process, I found my work in this stage to be analogous to sequencing previously recorded material in a digital audio workstation for a fixed media composition.

At subsequent rehearsals, I started to bring in “bare-bones” scores for Anna and me to follow. These scores, which consisted of a timeline, dynamic markings, and (mostly) text-based instructions for each part, helped to frame the previously recorded improvisational material linearly. In addition to helping us continue to refine these ideas individually, rehearsing with these rudimentary scores contextualized the musical material in a fixed time frame, giving us a better idea of how different ideas worked with one another. Anna and I continued recording and discussing each rehearsal, figuring out what about the recordings worked well, what could be changed, and what kinds of changes to existing material could be made in future rehearsals to improve. In addition, I would bring in my score and the recording for each rehearsal to my practicum meetings with Professor James Fei for additional feedback and suggestions. With all of these ideas for improvement in mind, I would then prepare a new revision of the score for the next rehearsal. Over the course of the next few months, Anna and I would go through several iterations of this process of recording, discussion, and revision as Signal Flow approached, developing and refining the piece until its completion.

Despite the fact that the score for *Chirality* is extremely open, the piece itself is relatively fixed. When we first recorded our improvisations in early rehearsals, Anna had a considerable amount of room to build her bass drum parts. As I listened to the recordings and began putting together a score, I was not particularly interested in transcribing her music from the recordings, as I wanted the piece to retain the openness of our initial work. Thus, I began thinking of ways to give text instructions that would replicate certain kinds of musical material with reference to our improvised recordings. As we listened to and discussed the recordings of each rehearsal, I would continually revise the instructions in the score for each subsequent rehearsal. The instructions were still open, but they became more specific and focused on the kinds of material on which we worked and agreed would be effective after listening to our recordings.

As we continued to workshop ideas, both in rehearsal and in post-rehearsal discussion, the piece became gradually more refined and fixed (in terms of its sound material and structure). Consider, for instance, the second and third sections of the piece (5'10" to 13'00").[3] From the outset of working on the piece, I wanted these two sections to function as a way to transition away from the more dense, sustained textures of the

[3] See Appendix A for the *Chirality* score.

beginning of the piece, and to gradually introduce the gating of the cable hum for the more driving, rhythmic final section. Initially, the two sections consisted of improvisational imitation. In the second section, I would imitate the envelope of Anna's bass drum gestures by modulating the cable hum with the volume pedal. The section concluded with a loud bass drum gesture that allowed me time to switch on the gating circuit. The third section, on the other hand, reversed the dynamic – Anna was to mimic the implied pulse of the higher-frequency gating of the electronics with mallets. As we rehearsed the second section, it proved to be difficult for me to coordinate tightly with Anna's playing. Eventually, I decided to avoid mimicking her gestures and moved towards a more loose interplay between the sounds (while focused on achieving greater timbral variability from the electronics), yielding a sense of the electronics punctuating increasingly dense percussion gestures. For the third section, I preserved the instructions for Anna to imitate the gating pulse, but we replaced the timpani mallet strikes with rubbing the drumhead with a superball mallet. After listening to our recordings of the third section, I became more conscious of setting the gating frequency of the electronics to produce a resultant lower frequency modulation band that would mesh well with the longer, sustained tones from the drumhead friction.

In the case of each section, the instructions in the score necessitated openness. The second section specified improvisation for the bass drum and the electronics (with instructions to increase density and dynamic amplitude over time), while the third section could not be precisely notated, as the continuous control over the gating frequency of the electronics made it difficult to dial in an exact rhythm from one rehearsal to the next. However, as we rehearsed these sections and discussed our recordings, we achieved a strong sense of how the sections should sound. Even though the score gave relatively open instructions, we would intuitively know when the sections were not played properly – our long process of rehearsing, as well as our referential knowledge of previous recordings, established a relatively fixed standard of how the sections sound.

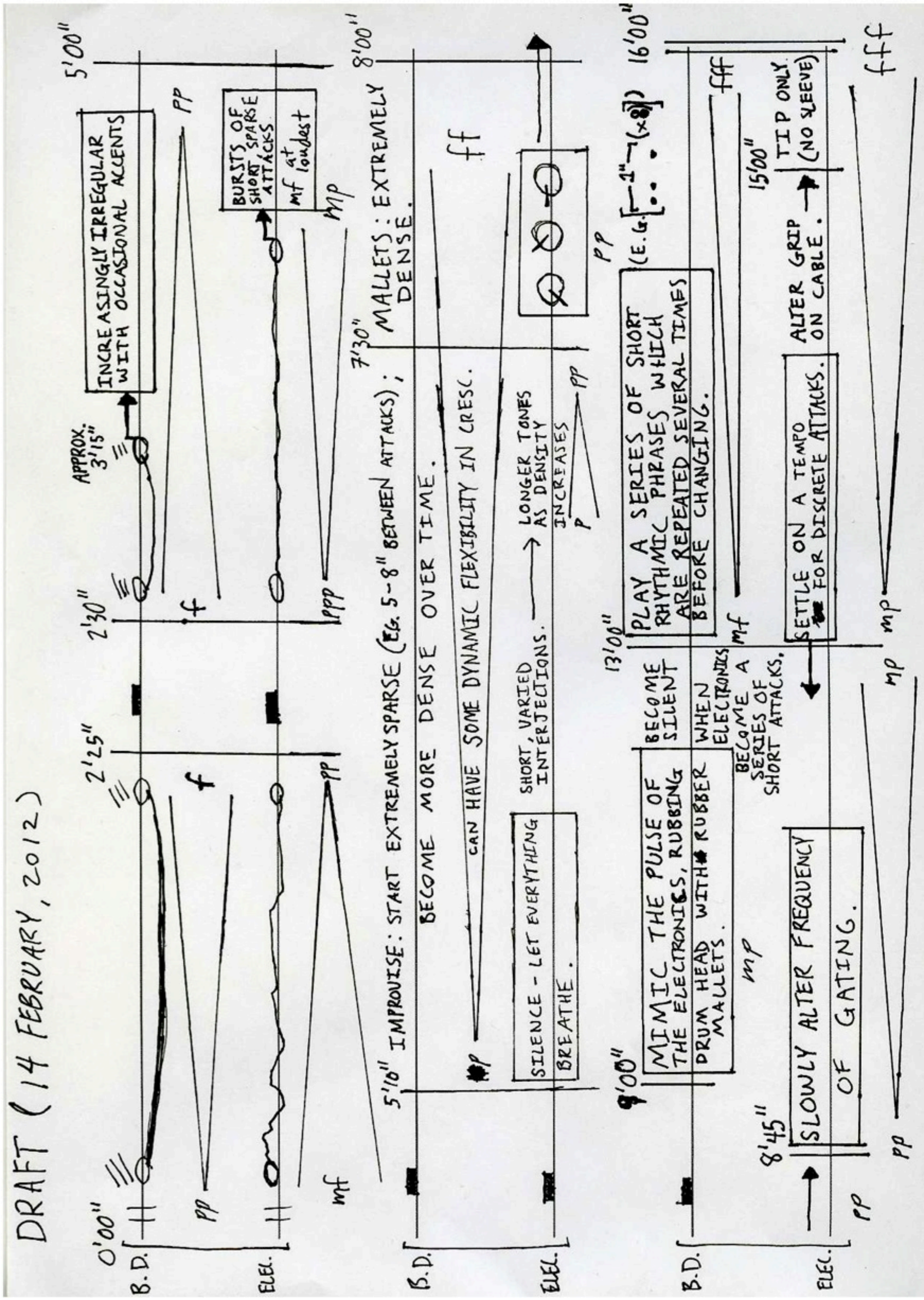
To this end, the recordings and our discussion thereof seemed to constitute the notation of the piece while the physical score, on the other hand, seemed to exist more as a reminder of how to sequence our material in performance. Through months of rehearsal and listening to recordings, Anna and I established a sort of embodied knowledge of how the piece should sound. This knowledge, in conjunction with the timing instructions written in the score, functioned to effectively fix the piece in spite of the open, improvisatory nature of much of the material.

I find this process to be an effective way to develop an electroacoustic composition, and I greatly enjoy being able to work so closely with another player in developing material and musical ideas. However, I suspect that it renders *Chirality* difficult to be performed by other musicians. Because of the strong "oral tradition" of the compositional process, I question the extent to which the piece could be accurately played by a percussionist other than Anna. If I were to work with another player to perform the piece again, I would most likely need to have extensive rehearsals with the percussionist in order to fully develop the kind of internalized knowledge of the music that Anna had. It would likely be useful to provide a supplemental disc with recordings to accompany the score, including a recording of the Signal Flow performance as well as verbal descriptions and instructions accompanying recordings of the various kinds of techniques and interactions between the bass drum and the electronics in the different sections of the piece.

**Conclusion**

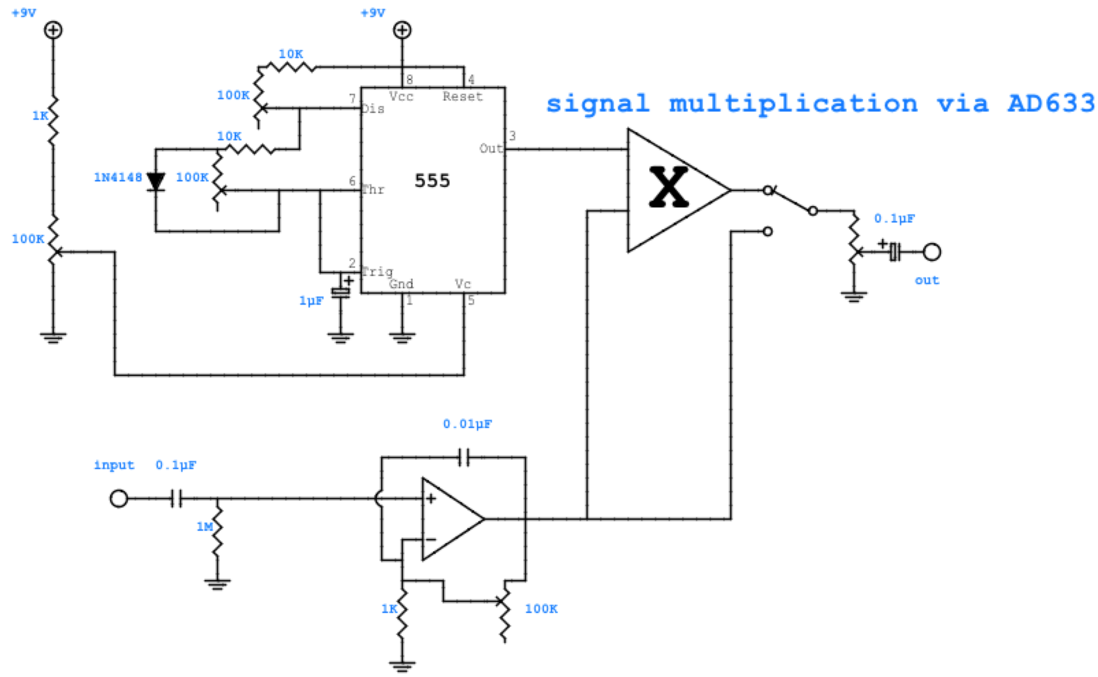
My time at Mills has constituted a period of considerable artistic growth. When I think about the work I was doing prior to beginning my graduate studies, I am amazed by the extent of the differences. Rather than developing older skills, such as synthesized computer music in Max/MSP, I focused on tackling new challenges, such as building analog electronics and collaborating with acoustic instrumentalists. By engaging with these artistic challenges, I found that I strengthened and refined my personal aesthetic sensibilities, lending a more well thought out compositional direction to my work. Overall, I am highly enthusiastic about the aesthetic concepts and compositional processes that I explored at Mills; I will continue to engage with and develop these ideas in my future artistic work.

**Appendix A (*Chirality* Score)**



**Appendix B (Technical Documents)**

*Chirality (For Bass Drum and Quarter-Inch Cable Hum)*

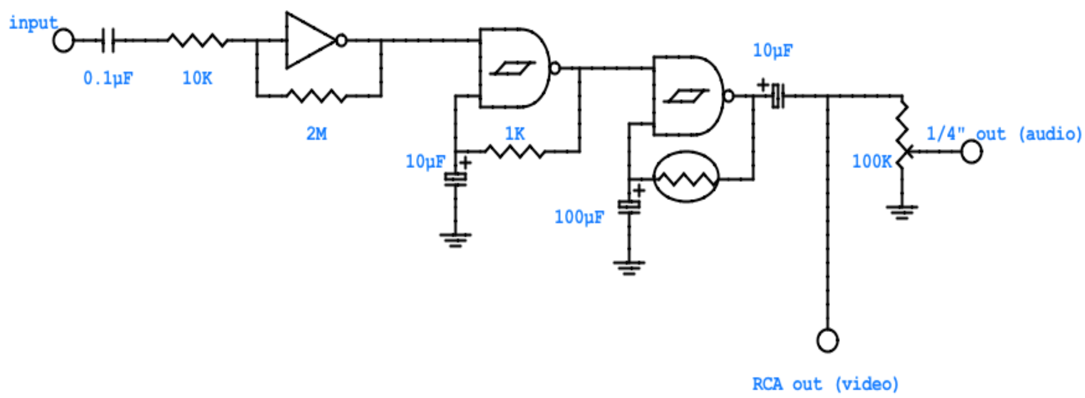



**Audio preamplifier with selectable gating.**

The circuit above consists of a pulse wave oscillator (the 555 timer), a preamplifier, and a dedicated signal multiplier integrated circuit (the AD633). When the multiplication output is selected, the pulse wave oscillator gates the input signal of the preamplifier. Otherwise, the circuit outputs the dry signal of the preamplifier.

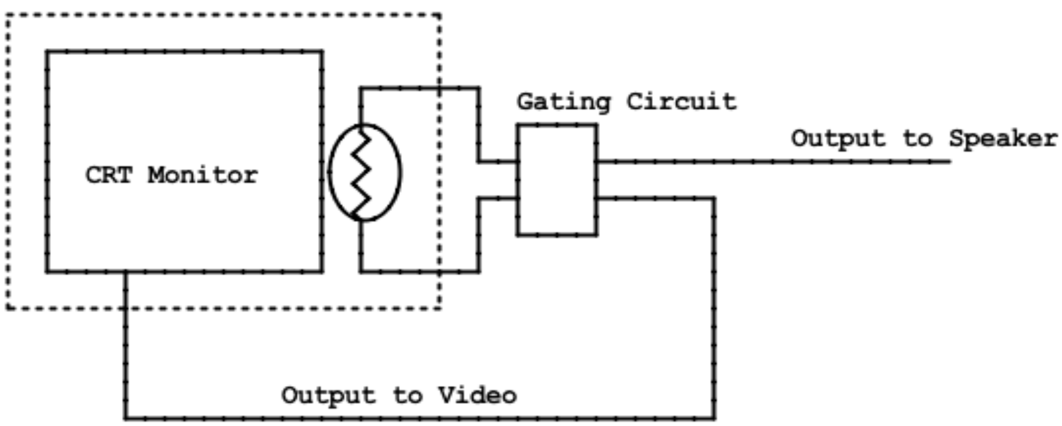
Because pins seven and six on the 555 timer are connected with a diode and resistor in parallel, the circuit is capable of outputting a pulse wave signal whose duty cycle is less than fifty percent, facilitating a shorter, more percussive gating of the input signal when multiplication is selected.

*TV Party* and *Long Live the New Flesh*




**Light-Controlled Gating Circuit**

The circuit above utilizes a 4049 Inverter to amplify an input signal by a factor of two hundred. The signal is then routed through two cascaded NAND gate Schmitt-trigger oscillators running at sub-audio frequencies to gate the audio input. The photoresistor in the feedback path in the second NAND gate is coupled to the screen of a CRT monitor, causing its gating frequency to be dependent on the light from the screen. Below is a general block diagram for the two pieces:




**Note: In *Long Live the New Flesh*, the audio signal from the gating circuit is routed through a few additional effects boxes and filters before reaching the sound system.**

*Just a Very Few Things*

Below is the source code for the SuperCollider software I built for the performance of *Just a Very Few Things*.

```
(
	/*
		nick wang, october 16, 2011

		a script for performance utilizing external audio signal inputs
		and granular synthesis.

		though it is designed to be used with a korg nanokontrol midi
		controller, a gui is created which can be used as a control
		surface.
	*/

	//initialization and environment variables

	(
		s.boot;
	);

	(
		~buf = Buffer.alloc(s, 44100 * 2.0, 1);
		~cva = Bus.control(s, 1);
		~in;
		~grain;
		~gate;
		~inamp;
		~grainamp;
		~glev;
		~inpan;
		~grainpan;
		~density = 0.0;
		~rate = 1.0;
		~dur = 0.0;
		~sliders;
		~pspec = [-1.0, 1.0, \lin, 0.01].asSpec;
		~thresh = 0.5;
		~sa = 0.4;
		~attack = 0.01;
		~release = 0.01;
		~randParam = [0, 0, 0, 0, 0];
		~cspec = [0.1, 0.99, \exp, 0.01].asSpec;
		~rspec = [1.0, 0.1, \lin, 0.01].asSpec;
		~atspec = [0.002, 0.01, \lin, 0.0001].asSpec;
		~respec = [0.01, 0.4, \lin, 0.001].asSpec;
		~freq;
		~pw;
		~fspec = [0.005, 5, \exp, 0].asSpec;
		~pwspec = [0.0, 1.0, \lin, 0].asSpec;
		~count = [0, 0, 0, 0, 0];
	);

	//synthesizer definitions

	(
		SynthDef("comp-in",
		{
			//compression and stereo panning for external audio signal

			arg in = 0, out = 0, amp = 0.5, pan = 0.0, gate = 1.0,
				thresh = 0.5, sb = 1.0, sa = 0.4, att = 0.01,
				rel = 0.01;
			var input, sig, output;
			input = SoundIn.ar(in);
```

```
		sig = (Compander.ar(input, input, thresh, sb, sa, att, rel) *
		gate);
		output = Pan2.ar(sig, pan, amp);
		Out.ar(out, output);
	}).store;

	SynthDef("gran",
	{
		//performs granular synthesis using a sound sample buffer

		arg bufnum = 0, pan = 0.0, rate = 1, startPos = 0.0,
			amp = 0.5, dur = 0.1, out = 0, thresh = 0.5,
			sb = 1.0, sa = 0.4, att = 0.01, rel = 0.01, level = 0.5;
		var grain, sig;
		grain = PlayBuf.ar(1, bufnum, (rate * BufRateScale.kr(bufnum)),
				1, (BufFrames.ir(bufnum) * startPos), 0) *
				(EnvGen.kr(Env.sine(dur, amp), doneAction: 2));
		sig = Compander.ar(grain, grain, thresh, sb, sa, att, rel);
		Out.ar(out, Pan2.ar(sig, pan, level));
	}).store;

	SynthDef("lfo",
	{
		//control-rate lfo to use as a signal gate

		arg out, freq = 0.01, phase = 0.0, width = 0.5;
		Out.kr(out, LFPulse.kr(freq, phase, width, 1.0, 0.0));
	}).store;
);

//interface and execution

(
	//set up midi controller

	MIDIClient.init;
	1.do { |i| MIDIIn.connect(i, MIDIClient.sources.at(i))};
	MIDIResponder.removeAll;

	//begin recording to buffer

	b = {RecordBuf.ar(SoundIn.ar(0), ~buf, 0.0, 1.0, 0.0, 1, 1, 1, 1);
			0.0;}.play;

	//initialize synthesizers

	~in = Synth("comp-in", ["out", 0, "amp", 0.0]);
	~gate = nil;

	//set up gui

	w = Window.new.front;
	w.name_("performance instrument");
	w.view.decorator = FlowLayout(w.view.bounds);

	//slider controls in gui

	~sliders = [
	EZSlider(w, 390@16, "input level", \amp, initVal: 0.0,
		action: {|ez| ~in.set("amp", ~inamp = ez.value)}),
	EZSlider(w, 390@16, "input pan", ~pspec, initVal: 0.0,
		action: {|ez| ~in.set("pan", ~inpan = ez.value)}),
	EZSlider(w, 390@16, "efx level", \amp, initVal: 0.0,
		action: {|ez| ~glev = ez.value}),
	EZSlider(w, 390@16, "grain pan", ~pspec, initVal: 0.0,
		action: {|ez| ~grainpan = ez.value}),
	EZSlider(w, 390@16, "grain level", \amp, initVal: 0.0,
		action: {|ez| ~grainamp = ez.value}),
	EZSlider(w, 390@16, "density", [0.0, 1.0, \lin, 0.01].asSpec,
		initVal: 0.0, action: {|ez| ~density = ez.value}),
	EZSlider(w, 390@16, "grain size", [0.0, 1.0, \lin, 0.001].asSpec,
```

```
      initVal: 0.0, action: {|ez| ~dur = ez.value}),
EZSlider(w, 390@16, "rate", [0.1, 10, \exp, 0, 1].asSpec,
      initVal: 1.0, action: {|ez| ~rate = ez.value}),
EZSlider(w, 390@16, "threshold", ~cspec, initVal: 0.1,
      action: {|ez| ~thresh = ez.value; ~in.set("thresh", ~thresh)}),
EZSlider(w, 390@16, "ratio", ~rspec, initVal: 0.2,
      action: {|ez| ~sa = ez.value; ~in.set("sa", ~sa)}),
EZSlider(w, 390@16, "attack", ~atspec, initVal: 0.002,
      action: {|ez| ~attack = ez.value; ~in.set("att", ~attack)}),
EZSlider(w, 390@16, "release", ~respec, initVal: 0.4,
      action: {|ez| ~release = ez.value; ~in.set("rel", ~release)}),
EZSlider(w, 390@16, "frequency", ~fspec, initVal: 0.01,
      action: {|ez| ~gate.set("freq", ~freq = ez.value)}),
EZSlider(w, 390@16, "width", ~pwspec, initVal: 0.5,
      action: {|ez| ~gate.set("width", ~pw = ez.value)})];

//some text

//null

//enable midi control of gui with korg nanokontrol

CCResponder.removeAll;
CCResponder ({arg src, chan, num, val;
      switch(num,

      //input level - fader one

      2, {~in.set("amp", \amp.asSpec.map(val/127.0));
            {~sliders[0].value_(\amp.asSpec.map(val/127.0))}.defer},

      //input pan - knob one

      14, {~in.set("pan", ~pspec.map(val/127.0));
            {~sliders[1].value_(~pspec.map(val/127.0))}.defer},

      //master volume for granular effect - fader two

      3, {~glev = \amp.asSpec.map(val/127.0);
            {~sliders[2].value_(\amp.asSpec.map(val/127.0))}.defer},

      //granular effect pan - knob two

      15, {~grainpan = ~pspec.map(val/127.0);
            {~sliders[3].value_(~pspec.map(val/127.0))}.defer},

      //grain level - fader three

      4, {~grainamp = \amp.asSpec.map(val/127.0);
            {~sliders[4].value_(\amp.asSpec.map(val/127.0))}.defer},

      //grain density - fader four

      5, {~density = [0.0, 1.0, \lin, 0.01].asSpec.map(
                  val/127.0);
            {~sliders[5].value_([0.0, 1.0, \lin, 0.01].asSpec.map(
                  val/127.0))}.defer},
      //grain size - fader five

      6, {~dur = [0.0, 1.0, \lin, 0.001].asSpec.map(val/127.0);
            {~sliders[6].value_([0.0, 1.0, \lin, 0.001].asSpec.map(
                  val/127.0))}.defer},

      //grain rate - fader six

      8, {~rate = [0.1, 10, \exp, 0, 1].asSpec.map(val/127.0);
            {~sliders[7].value_([0.1, 10, \exp, 0, 1].asSpec.map(
                  val/127.0))}.defer},

      //compressor threshold - knob three
```

```
            16, {~thresh = ~cspec.map(val/127.0);
                  ~in.set("thresh", ~thresh);
                  {~sliders[8].value_(~cspec.map(val/127.0))}.defer},

            //compressor ratio - knob four

            17, {~sa = ~rspec.map(val/127.0);
                  ~in.set("sa", ~sa);
                  {~sliders[9].value_(~rspec.map(val/127.0))}.defer},

            //compressor attack - knob five

            18, {~attack = ~atspec.map(val/127.0);
                  ~in.set("att", ~attack);
                  {~sliders[10].value_(~atspec.map(val/127.0))}.defer},

            //compressor release - knob six

            19, {~release = ~respec.map(val/127.0);
                  ~in.set("rel", ~release);
                  {~sliders[11].value_(~respec.map(val/127.0))}.defer},

            //lfo frequency - fader eight

            12, {~gate.set("freq", ~freq = ~fspec.map(val/127.0));
                  {~sliders[12].value_(~fspec.map(val/127.0))}.defer},

            //lfo pulse width - fader nine

            13, {~gate.set("width", ~pw = ~pwspec.map(val/127.0));
                  {~sliders[13].value_(~pwspec.map(val/127.0))}.defer},

            //enable gate - record button

            44, {if(val == 127,
                  {~count[0] = ~count[0] + 1;
                        if((~count[0] % 2) != 0,
                        {~cva.set(0.0);
                              ~gate = Synth("lfo", ["out", ~cva]);
                              ~in.map("gate", ~cva);},
                        {~gate.free;
                              ~gate = nil;
                              ~cva.set(1.0);
                              ~in.map("gate", ~cva);});})}
            )});

      //granular synthesis routine

      r = {inf.do{arg i;
                  var pos, timestart, timeend;
                  pos = ((i % 300) / 300);
                  timestart = (pos * 0.8);
                  timeend = (pos * (0.8 + (0.1 * (1.0 - ~density))));
                  Synth("gran", ["bufnum", ~buf.bufnum, "startPos", timestart,
                        "rate", ~rate, "amp", ~grainamp, "pan", ~grainpan,
                        "dur", (0.01 + (~dur * 0.5)), "thresh", ~thresh,
                        "sa", ~sa, "att", ~attack, "rel", ~release,
                        "level", ~glev]);
                  (((~density * 0.2) + 0.01)).wait;
      };}.fork;

      //stop all processes on window close

      w.onClose_({s.freeAll; r.stop;});
);

)
```

**Appendix C (DVD Index)**

/audio

- *Chirality (For Bass Drum and Quarter-Inch Cable Hum)* – chirality.wav
- *Just A Very Few Things* – just_a_very_few_things.wav

/video

- *Long Live the New Flesh* – long_live_the_new_flesh.mov
- *TV Party* – tv_party_01.mov, tv_party_02.mov

/other

- *Chirality* score – score.pdf
- *Just A Very Few Things* software code – gran-script.rtf