Wednesday, December 4, 2002:

On the stage of Grinnell College’s Sebring-Lewis Hall stands the product of my senior music project, *Cycles*—three kinetic sound sculptures. People arriving through the main doors see them first from the back of the hall (Figure 1). To the left, a metallic gray cylinder rises roughly four feet tall. In the middle, stands a narrow seven-foot box of pale wood. And on a table to the right, two opposing aluminum triangles arch over a wooden base. As the viewers approach the stage, they become listeners; they are immersed in the sound and movement of these objects. A metal dish held above the gray cylinder is dripping water onto latex membranes tightly stretched over small colored-glass cylinders.
(Figure 2). On the front of the tall pale box, a small rod hung from a spinning motor twists and dances, randomly striking brass strings or knocking the wooden shell (Figure 3). On the table, aluminum chimes swing from each of the triangular frames, their movement driven by two wooden rotators with interlocking metal fingers (Figure 5). The stage itself is accessible, inviting viewers to move around the objects for a closer look or a different mix of sounds (Figure 4). As the creator of these strange objects, I spend the afternoon answering questions: How do they work? Why did you use this material? How is this tuned? Where did your ideas come from? Yet for me these sculptures are the answer to quite a different question: How do I resolve my love for music technology with my reservations about technology-driven performance?
Motivations

New music necessitates new sounds, techniques and technology. In the past century, developments in travel, electronics, and recorded media have thrown open the doors for the creation and dissemination of musical ideas. Yet along with new musical possibilities come new problems for those creating and consuming music. Particularly troubling is the difficulty of meshing new musical ideas with older, more established musical practices.

As a composer working with music technology in an academic setting, I have repeatedly dealt with the tenuous position of newer technologies in concert spaces designed for the live performance of acoustical instruments. With the addition of a few loudspeakers, a concert hall can accommodate electronic music. Yet in many ways, the performance of technology-driven music remains problematic. For example, after attending an electronic music performance at the 291 Gallery in London, I wrote the following review, based on Christopher Small’s techniques of evaluating musical experiences in *Musicking* (Small 207-221):

*The directness of the [electronic] musician’s control over the vast range of possible sounds produced is at odds with the distance between the musician’s actions and what the audience actually hears. A single twist of a knob could have many possible effects on the sound produced (or no effect at all). The press of a button could trigger numerous complicated patterns of sound. While the possibilities of control are greater and more direct, the physical actions of the musician are detached from the sonic result. This fundamentally alters the nature of performance and raises questions about the role of the performer. Most importantly, why maintain the classical performer-audience relationship? Why not explore new physical, social, and sonic relationships to better reflect the ideals of involvement and interactivity?*

Many electronic musicians, myself included, have simply sidestepped these problems by removing the performer. There are several benefits to this arrangement. The
composer can perfect the ‘performance’ prior to the concert. Visual distractions are removed, so the listener can focus purely on the sound. And with the physical environment subdued, illusions of space and movement can be created with sonic material and placement. A performance of Karlheinz Stockhausen’s *Hymnen* that I attend last fall provides a direct example of this strategy. The two and a half hour piece of electronic music (presumably prerecorded) was presented in the main concert hall in London’s Barbican Center, a hall designed for an orchestra. Yet after giving a short introduction, the composer left the stage and the lights dimmed. The audience sat respectfully staring at the dark empty stage as the music swirled around them on the eight-channel speaker layout. It was clear that for Stockhausen the sounds and sonic relations he had developed were far more important than human performance or social interaction. For me, parts of *Hymnen* were effective, while others were uncomfortable or even rather dull. The more interesting sections were the ones that used movement of sound or recordings of recognizable soundscapes—ducks at a lake, for example—to replace the darkened hall with a new implied spatial orientation.

My most recent work in electronic music has been motivated by a similar theme of spatial orientation. My compositions *Vicinity* (2000) and *Iowa: Lines, Borders, Boundaries* (2001) are based on recordings of local environmental sounds that have been edited and layered to reflect my own experiences living within these soundscapes. The creation of these compositions has been personal rewarding. However, my focus on the integrated sounds, sights, spaces, and social experiences of locations outside of the concert hall has left me wanting for similar experiences within the concert hall. Playing
back my compositions to an audience sitting in the dark is pale reflection of my actual experiences collecting and processing a world of acoustical sounds.

Numerous composers, performers, and inventors have striven to make electronic performance more meaningful while maintaining the role of a performer. One strategy is to create technology that more directly connects electronic sound to a performer’s movements. Perhaps the earliest example of such an instrument is the Theremin, an electronic device designed by Russian inventor Leon Theremin in 1920 (Glinsky 23). The Theremin produces a surrounding electromagnetic field, which allows contact-free manipulation of pitch and volume (for a recording of the Theremin, see Hopkin’s CD compilation, *Gravikords*...). The capacitance of a hand moving through the field directly alters the frequency or amplitude of an audible output wave (Glinsky 25). The direct translation of physical movements into sound makes the Theremin fascinating to use and watch. However, the instruments sweeping portamento and heavy vibrato under the hands of unskilled users relegated the instrument to merely a novelty item, used to create eerie effects for early science fiction movies (Glinsky 199). Eighty-two years later, modern inventors are still trying to refine devices that create direct links between movement and electronics. Active Space technology, developed by musician John Crawford and dancer Lisa Naugle at UC Irvine, allows dancers to directly control sound, lights, and video (http://dance.arts.uci.edu/lnaugle/). Yet, from my observations of the set-up in Spring 2001, Active Space is still bleeding-edge technology in the more unfortunate sense of the term. A simple acoustic instrument provides more delicate musical control with far less hassle.
These deficiencies of electronic performance—with or without a performer—prompted me to explore other technology-driven sonic experiences during my conceptual development of the project resulting in *Cycles*. Artistic work combining music and visual arts can successfully create a rounded experience by reconnecting sight and sound in a carefully utilized spatial environment. It should be noted that because of their distinct environments, social experiences of visual art and music are different. Most visual art lacks a performer, so the divisions between subject and audience lie on different scale. In a museum you are invited to look closely, but not touch, while in a concert you are invited to observe from a distant, but not get up on stage. It is hard to image a concert where one could walk around the stage and carefully scrutinize each performer. I hoped to accomplish precisely that situation with my presentation of *Cycles*, by changing the physical and social boundaries of the concert hall.

Video art, when carefully presented, can immerse the audience in visual and sonic stimulus. I found this type of experience highly successful in Doug Aitken’s *New Ocean* exhibit at the London’s Serpentine Gallery in fall, 2001 (the exhibit moved to Japan this fall, see [http://www.operacity.jp/en/ag/exh34.html](http://www.operacity.jp/en/ag/exh34.html)). The darkened gallery was filled with striking moving images of glaciers, caves, cities, machines, and water matched with a delicate music of water drops and electronics. In a round central room, mirrored images of waterfalls covered 360 degrees of wall space, forcing viewers to sit or lie on the floor to get the full experience. This alteration of physical orientation changed the audience’s social expectations of the gallery and gave the room a pleasant communal feel as strangers huddled together around the perimeter.
Change in orientation is also a theme developed in Rebecca Horn’s sound-art installation *Concert for Anarchy*, displayed at London’s Tate Modern. This piece takes an instrument from the concert hall, a grand piano, and quite literally changes its spatial orientation; the piano is suspended upside-down from the ceiling of the gallery. The working mechanism for this piano has been thoroughly altered, as well. After a period of silence, the piano lid drops open and the keys are partially ejected with a cacophony of strings simultaneously set in motion. Slowly the instrument pulls itself back together, and after another period of silence, the process repeats. Automata, machines that work without human intervention, have a special fascination. Rebecca Horn’s skillful use of automation gives this work a potent sense of being. With *Concert for Anarchy*, she directly combines movement with sound and physically alters spatial expectations, making for a powerful sensory experience (images of this piece and a related one, *Rebel Moon*, can be found in the Guggenheim Museum’s book *Rebecca Horn*, plates 74, 89).

These successful works of multimedia art helped me define my goals for my senior project. I already knew I wanted to work with acoustic sounds in a more direct physical way. Aitken’s and Horn’s work, along with other sound-art experiences, gave me the goal of creating immersion by integrating sound, sight, space, and social experience. Combined with my interest in electronics and the physics of sound, I developed the ambition to create an installation of kinetic acoustical sound sculptures. The articulation of this objective set in motion my work on *Cycles*, and brought with it a new set of problems to solve.
Design Process

Moving from the electronic manipulation of sound to the direct creation of acoustic sound poses both new possibilities and new limitations. Reconnecting sound to physical movement requires a working knowledge of acoustical sound production. For an electronic composer used to a myriad of precise editing tools and powerful sonic effects, acoustic instrument design can seem somewhat restrictive. As Bart Hopkins writes in his article “Trends in New Acoustic Musical Instrument Design” in Leonardo Music Journal:

*Most activity in the field [of acoustic instrument design] involves ‘found’ acoustic systems: people either make use of already familiar sound-generating methods or, through attentiveness and good fortune, they come upon new sound-generating methods*” (Hopkins 13).

Acoustic musical instruments come in four basic types: membranophones, chordaphones, idiophones, and aerophones, each defined by how they set air in motion. A membranophone, such as a drum, has a thin vibrating membrane. A chordaphone is any type stringed instrument. An idiophone is any solid object that vibrates to create sound. And an aerophone contains a vibrating column of air (for more on kinds of instruments and their classification see Margaret Kartomi’s *On Concepts and Classifications of Musical Instruments*). For, *Cycles*, I challenged myself to make one of each kind. While this restricted my possibilities for sound generation, it provided a framework for a vast range of sonic discovery.

Luckily for instrument-design neophytes, such as myself, the path of experimental instrument construction is well tread and full of fascinating stories. Many composers and musicians, dissatisfied with the constraints of available instruments and performance techniques have set out to create their own. An innovator in the area of experimental instruments was Harry Partch, a composer who in the 1920’s set himself a new course of
sonic experimentation. Dissatisfied with the direction of the European music tradition and its imperfect equal-tempered tuning system, Partch designed his own elaborate form of just tuning, which he termed Monophony (Partch xi-xiii). Central to this system is a forty-three-tone scale comprised of consonant pitches (Partch 133). Partch needed new instruments to realize his theories and to allow for the performance of such a complicated system. His experimentations ranged from the adaptation of violas, guitars, and reed organs to the design and construction of marimbas, and kitharas with elaborate systems of keys or strings (Partch 194-218) (For a Partch recording, again see Hopkin’s Gravikords…).

Besides getting inspiration from Partch’s designs, I adapted some of his tuning theory for the aluminum chimes of my idiophone. I used the most basic set of pitch interval ratios Partch discusses in his book Genesis of a Music, those containing prime numbers no greater than five ("the 5 limit") (Partch 109) While my tuning system doesn’t expand the listener’s aural limitations in the way Partch hoped to do, it does provide the tonal purity of just tuning and it reflects my fascination with the simple math of Partch’s system. The set of pitches I chose were the 'minor' tones of the 5 limit ratios: 1/1, 6/5, 4/3, 3/2, 8/5, and 2/1—the tonic, minor third, perfect fourth, perfect fifth, minor sixth, and octave (the ratios are the frequency of a given pitch over the frequency of the tonic). By contrast, the closest tones on an equal-tempered piano have ratios of roughly: 1/1, 44/37, 578/433, 433/289, 100/63, and 2/1 (Partch 333-5).

Not only does the realm of sculptural instruments provided room for interesting research and development of sound design and instrumental forms, in the presentation of Cycles, it changed the social expectations the listener. The audience could enter the sonic
space of the sculptures and interact with them by moving among them. Yet, these advantages came with other limitations. Ultimately, though I found a solution to the issue of divided sound, sight, space and social experience, I didn’t resolve my problem of finding successful modes of technology-aided human performance.

While Rebecca Horn’s automata have the power of carefully designed graceful machines, within the realm of musical instrument design, this lack of performer becomes a problem. *Concert for Anarchy*, however dramatically chaotic it seems on first viewing, continuously repeats one set of actions. Machines are made to cycle. This repetitive quality works poorly within the tradition of classical European music based on contrast and change. Furthermore, machines simply don’t have the powers of articulation of the elegant human mechanism. I came to fully appreciate this as I devised motorized methods to set a string in motion. I could easily pluck, rub, or strike the string with my untrained hand, yet motor-driven methods quickly become overly complex.

This problem became central to the development of my aerophone sculpture—the one sculpture missing from the stage on December 4. Most aerophones, such as flutes, whistles, horns, and reeds, are mouth-blown instruments. Without lungs available, aerophones must be edge driven (a rope whirled through the air, for example) or employ a system of bellows (an organ, for example), requiring difficult feats of engineering (an interesting simplification of the bellows system is Leonard Solomon’s rubber squeeze ball driven *Majestic Bellowphone*, see Hopkin’s *Oribitones*… pg. 83). I found it exceedingly tricky to develop a driving mechanism for my aerophone. My ultimately unsuccessful solution was to move the entire air column against a surface to set the air in motion. With the attentiveness—although not necessarily the good fortune—that Hopkins
refers to, I had come across an unusual acoustic sound-making mechanism while recording material for a soundscape composition. The waves of a river splashing through a large drainage pipe made loud pitched sounds as they sealed off the pipe. By striking the end of much smaller pipe with the palm of my hand, I found I could create a similar form of sound (though higher pitched and quieter). This proved more difficult to do replicate without a soft articulate palm to quickly seal the end, and I finally developed a complicated system that would drop tuned pipes into a tub of water. Unfortunately the driving mechanism was too loud, the pipes were too quiet, and I couldn’t get my amplification system to work properly. The final straw came when the tub, despite many layers of sealant, began to leak. I find consolation in the fact that although Partch adapted organs to his tuning system, he never designed his own aerophone, “Wind instruments in relation to Monophony have not been tackled. Any one of them would require wide inventive and mechanical talents and would encompass almost the dimensions of a career” (Partch 218).

For the other instruments, I solved the problems of machine articulation by remaining open to constant adaptation during the design process. When my ideas for a rotating motorized set of membranophones and a water-driven idiophone ran up against a wall, I switched the two. Water drips could set a membrane in motion far better than a solid chime (Sound sculptor Will Mentor did make a water drop idiophone with slate keys and bamboo resonators, see perso.wanadoo.fr/willmentor/sculp.htm), while hanging chimes lent themselves to my idea for two interlocking rotators (sketches from journal). My stringed instrument also went through numerous conceptual faces – hanging beaters, friction wheels, bouncing balls, a fan-powered mobile, and finally a striker suspended
from a winding motor. My only sculpture that looked vaguely like my original drawings was the aerophone that didn’t work. Ultimately, the process of trial-and-error development became more important than my original conceptual designs.

My solution to the boring receptiveness of motor-driven machines came from a different kind of process: the process-driven composition of experimental composers, such as Steve Reich and John Cage. As Michael Nyman writes in his book Experimental Music; Cage and Beyond (published in 1974):

> Experimental composers are by and large not concerned with prescribing a defined time-object whose materials, structuring and relationships are calculated and arranged in advance, but are more excited by the prospect of outlining a situation in which sound may occur, a process of generating action… (Nyman 4).

Cage, in particular, is known for using randomizing processes in his composition. For *Music of Changes* (1951), he used a series of coin tosses to consult the *I Ching* about musical decisions (Nyman 61). My membranophone and chordaphone use more direct processes of randomization. This has a somewhat different effect than Cage’s process of removing intention from composition. As Steve Reich commented,

> John Cage has used processes and has certainly accepted their results, but the processes he used were compositional ones that could not be heard… The compositional process and the sounding music have no audible connection… What I’m interested in is a compositional process and a sounding music that are one in the same thing (Reich 35).

My sculptures follow more directly from Reich’s idea of combining composition directly into sounding process. After I turn on the membranophone’s water pump, the water flow is variable, making larger or smaller drips hitting different drums at varying speeds. The chordaphone’s beater hangs by a monofilament that is wound by a motor at the top. The brass rod spins, hitting strings and spinning in the opposite direction, getting more
wound-up as the process continues. This creates a random set of sound events: one string is hit or a chord or a sequence, or sometimes the rod knocks against the wooden frame or quickly spins as wound-up tension is released. These randomized sound events, like rain on the roof, or subtle wind chimes, have a soothing effect on the listener, and the direct connection between sound and process makes them fascinating to watch. Through simple randomizing processes, I used repetitive cycling to produce more chaotic and interesting sound events.

My idiophone is even more directly influenced by Reich’s work. Reich’s earliest work used identical tape loops that were slightly out of phase to create a continual process of changing sound (Reich). He later adapted this phasing process to instrument works such as *Piano Phase*. This composition requires incredible discipline from two pianists who must play the same pattern at slightly different speeds. My sculpture brings mechanized phasing into the acoustic realm. Two opposing identical sets of chimes are set in motion by rotators at slightly different speeds. Ideally this creates two patterns moving continuously in and out phase. This phasing creates continual sonic change from simple cycling patterns.

**Reflections**

The presentation of *Cycles* was a successful musical experience because it reconnected sound with the physical process of sound creation and because it redefined the social expectations of the listeners by removing the spatial divisions between composer, performers, and audience. This unity of sound, sight, space, and socialization created a rich experience for both the audience and myself. However, the construction and presentation of kinetic sound sculpture may have limited application. The set
varieties of acoustic, while limited, provide many possibilities for the sonic explorer, but remain difficult terrain those interested in pure sound design and detailed manipulation (Hopkin 13-4). Furthermore, the delicate control of the human mechanism is impossible to reproduce. Kinetic sound sculpture remains a compromise between the vast possibilities of electronic experimentation and the dynamic performance control of acoustic music. Still, my experience with Cycles proves that there is fertile ground here for new sensory and social experiences.
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