

IMMERSIVE INSTRUMENTS AND BREATHING SYSTEMS

Thesis

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Preamble

This paper describes the conception and creation of the author's piece entitled *Two Violins and a Theatre: A Triptych of Resonances*. This installation-performance took place on April 3, 2006, from 3-4 p.m. in the Studio Theatre in Lisser Hall, Mills College.

This piece is within a body of work called *Vibrational Matrix*. Instruments and performance are considered in the widest sense, allowing the perceiver-performer to regard interact using various modalities of sound, light, movement, and water.

The first part of this paper expands on issues of instruments and performance, and the second portion describes the design and implementation of a "breathing system."

Part I: Instruments of Sound/Instruments of Performance

The first definition of an instrument according to the American Heritage Dictionary is "*a means by which something is done; an agency.*" An instrument somehow embodies a means to an end, the path relating intention and action, whether of a mechanical or electrical source.

driving preference

A car may be driven or performed by a computer or person, depending on which controls are mapped to automatic sensors or a human interface. Different modes of interactivity with the environment depend on the desired result of this relationship.

Agency can be pre-programmed in an electrical or cultural manner. For example, replacing the natural movement of bodies from the pace of walking to hundreds of miles an hour. This mode of traveling compresses our temporal experience while expanding the spatial. Instead of steering a vehicle, sensors and computers may guide vehicles as an alternative to active attention. Technology will replace our learned behavior of driving culture with other activities.

Preferences are altered by new experiences and temporal compression. In this changing protocol of behavior, higher speeds allow less attention to the details of our surroundings, and allow us to focus on something other than the fact of our movement in space. By relinquishing our learned instrument of driving we may undergo more preferred experiences of interaction and perception within our environment.

In a formal music concert, silence and lack of movement are behaviors expected of the audience members. Performers face and actively address the audience, and the audience views performers passively. In the age of pervasive

interactive electronics and budding cybernetics, technology can subvert these expectations, suggesting new preferences for the concert-goers' experience.

musical instruments

Another aspect of an instrument as agency is that it requires skill for proper use.¹ Whether cars or musical instruments, there is an expectation that one has acquired a set of skills to achieve a desired result. Over time, these desired results evolve, and so do the skill required to attain them.

The performance practice surrounding this desired result forms the instrument's structure and function. This raises the questions:

1. What is the desired result we seek from a (musical) instrument?
2. Are customs of performance replaceable by other preferences?
3. Can discovering these new experiences result from the mediation of art, agency, and technology?

crafting instruments of sound

Musical instruments are objects crafted for their special resonant capabilities and "playability" or modes of interactivity. Sound is mechanical energy whose propagation is influenced by the medium through which it travels. In the case of musical instruments special materials determine an instrument's specific sound. Vibrations travel through paths of least resistance, much like electricity. These paths are created by the properties of the material, such as

what type of wood is used, its thickness, and even the glue holding the parts together.

Besides specific vibrational characteristics, the playability of the instrument as a means of expressing musical ideas is key to instrument-building and design. These musical ideas are culture-bound and often tied to the instrument's creation, for example, in the case of the European violin.

violins

The history and culture of the violin is tied to the physical object. The craft of building the instrument developed a few hundred years ago in parallel with the methods of playing, all driven by the goal of producing an ideal, saccharine tone. Conservatories train violinists to play the same musical compositions with one ideal of performance. As a child growing up in classical music culture, my violin performances were expected to show off this specific type of virtuosity in a solo performance context.

New technologies such as electric violins (ZETA violins) and interfacing projects (such as Jon Rose's Hyperstring) utilize sensors, MIDI, and electronics to amplify the instrument's acoustic properties and extend the its capabilities of interacting with computer technology; yet the modes of performance are not very different. The instrument's specific function or desired result may be considered unaltered.

constructing tone through resonance

Through resonance, certain frequencies of vibration are intensified through a material, while others are attenuated. The two plates of the violin are tuned to have a broad range of resonant properties, to give the instrument a more even and smooth sound.

For the piece *Two Violins and a Theatre*, I found the main resonant frequencies of the two plates of both violins by sending sine waves through each plate and listening for peaks in amplitude (see Figure 3, page 14). The first violin is the 1954 Italian-made instrument I played through my training as a young classicist and still use today. The other violin is a student violin passed on to me by a good friend when he moved out of town.

As expected, the tones and volume of sound produced by these two violins is drastically different, and the resonant structures vary in complexity. However there are similarities in their resonant structures, most obviously that the first peak of both violins is at 141 Hertz and that both have a peak around 529 Hertz as well. Both violins have a fairly consonant-sounding resonance as a whole, implying an inherent harmonicity in structure.

found instruments

The musical instrument may be crafted for the specific purpose of generating sound, but also may be “found” and re-appropriated from an object

that usually performs a different function. Percussion instruments are often unsuspecting pieces of metal with everyday functions such as cooking food.

When we consider everyday objects outside of their everyday function, or the musical instrument outside of its customary musical function, we transcend learned behaviors and stereotypes. This allows us to further focus on the relationship between our expectations of the sounding object and the perceived result.

strings as a speakers

In the “self-oscillating violin” each of the four strings functions as an audio speaker, with mechanical motion created by electromagnetism. The tone is colored by material characteristics and tuned frequency of the string through which the audio signal travels. I began to conceive of the “self-oscillating violin” when searching for a way for violin strings to resonate without my touch. My goal was to keep the structure of the violin intact, but to alter its usual function within a different performance context. The context I imagined was of electroacoustic generation and interface rather than purely mechanical structure-function bound to traditional performance-practice.

In part, this served to free my attention as a performer from trying to focus on playing an instrument while simultaneously monitoring a laptop. Additionally, I wanted to create a wider palette of sounds from the violin, with a sustained texture and feedback generator which would not require constant

input from me (inspired by the Ebow). It was through this realtime performance and interaction that I hoped to play the violin as an object, modified.

space as instrument

Sound is modified by the space in which it travels, much in the same way that vibrations travel differently through various instruments or media, such as water, air, or a violin string. Together with a sounding source, space may be considered an instrument much like a violin (see Figure 1). Audio speakers “perform” the space as a string excites the body of a violin: by absorbing and shaping sounds by the nature of the matter and space through which it travels.

Figure 1 *Linking Instruments*

Functions of Instrument	Violin	Space
1. sound generator	string	speaker
2. sound modifier or resonator	body	space
3. agency of performance	human (mechanical) computer (electrical)	computer (electrical) human (mechanical)

The resonance of a space is characteristic of architectural dynamics: some factors are transient and others are semi-permanent, some are situational and others structural. Reflections of the waves bounce off of the walls and

interfere with each other, thus the materials and dimensions of a room alter the sounds we hear.

Transient, temporal or environmental phenomena such atmospheric conditions and even the bodies and furniture in the room also affect the way a room responds to sounds. By considering resonance a balance between these elements, it may be considered a type of dynamic equilibrium, which is fixed relative to changeable environmental factors.

Furthermore, our position in a room alters what we hear. Placement and movement of the body determine which physical vibrations in the space are audible at any given time. Even if we're in the same room, or sitting next to one other, we can be hearing quite different sounds. Psychoacoustic phenomena, such as difference tones, combination tones, and spectral amplitude changes augment these personal differences in perception. These phenomena are more perceivable in less complex sounds.

dematerialized instruments and environments

What if the instrument is not one object or space, but a collective whole?

Is the soundscape of the world an indeterminate composition over which we have no control, or are we its composers and performers, responsible for giving it form and beauty?

—R. Murray Schafer²

Like performing the instrument of space, our navigations through everyday life and the world around us may be passively beheld or actively composed. What if we could record our focus of attention throughout one day,

sonically or visually? This print may trace our sight, hearing, or feelings, however the recording's form is guided by the indeterminate composition of the whole of our surroundings. Our intervention and fixation with the material and immaterial (sound, light, space, objects, and people around us) creates the composition of experience.

In our image-and-sound-saturated culture, someone else supplies the stimulus and beauty, and we simply watch it or ignore it. We lose a sense of agency if beholding the world as a given, unalterable. Traversing our surroundings requires focus and intention, whereby our actions and movements shape the sounding structures around us. Activate this sense of ownership to a concert-going situation.

time binds space and movement

All modern perception theories are based on the fact that human perceptions of time and space are interdependent. A distance covered by a person—or a sound—in space is initially perceived as a temporal phenomenon, allowing a person to develop a subjective notion of space and time by measurement and comparison.

—Randal Davis on the works of Alvin Lucier³

Time and position translate the features of space we are aware of at any given moment. Movement shapes our unique position within the sounds of a space. We perform the instrument of space like traversing a sculpture from the inside.

Traditionally composers place elements of a composition in time, however sound may also be used to translate features of space-time perception.

One idea which I am interested in is locating [elements of composition], instead, in space ... and letting the listener place them in his own time.

—Max Neuhaus⁴

We may navigate these sounding sculptures with movements large and small, by moving our heads slightly, or by walking across the room. This effectively blurs the barrier between personal perceptions, private spaces, and the listening environment; it is immersion in the instrument of space.

water-space prints

The instrument of space is not empty, but vibrantly shaped by our bodies and the objects around us. If we imagine this space as a placid pool, our movements and the shapes around us interfere and reflect the equilibrium of waves standing and traveling.

*water-space
shaping*

*instead of air
submerged in water
embedded in the wood of violin
immersed in sound and light
sensing symbiosis*

In a swimming pool, the sun casts one's shadow onto the bottom surface of the pool. Immersive "breathprints," these shadows make visible the way we shape matter around us, whether sound, water, or air.

*my shadow
pushing shaping
felt-seen
projection-reflections*

Part II: “Breathing Systems”

overall description

Two Violins and a Theatre: a Triptych of Resonances takes place in a black box studio theatre (see Figure 2, page 13). The set is dark, except for two violins on white pedestals placed symmetrically about the center of the stage with spotlights on them, and a screen illuminated by reflections of water surfaces.

One of these violins is “self-oscillating” or has no visible performer. A violinist, dressed in white and lying down on the pedestal, performs the other violin. The layout of the set creates an opposition between “self-oscillating violin” object and the human violinist-performer.

Between the two violins three round trays are mounted on top of black boxes. The tray nearest each violin symbolizes and is directly related to that violin. The center tray represents the surrounding space.

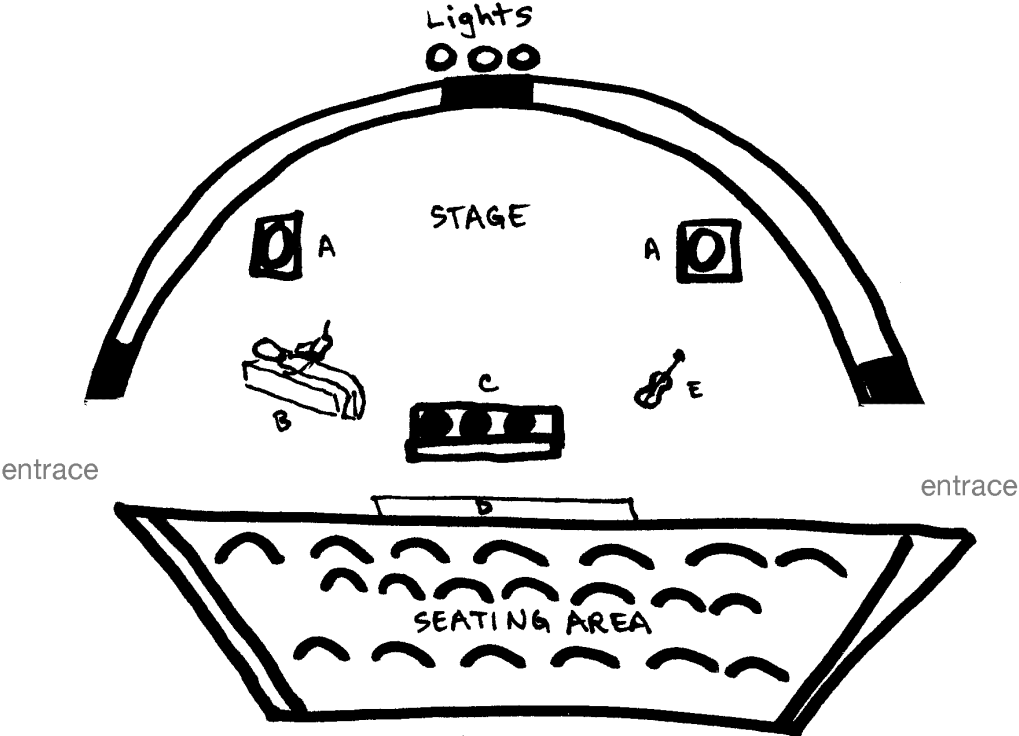
Each tray is filled with a thin layer of black water, and has an audio driver (or small speaker) attached to the bottom. The sounds we hear in the two large speakers placed behind the violins are fed to these speakers.

The vibrations created by the driver create visible and invisible waves in the water. Lights from behind the stage magnify these waves. The angle of these lights and placement of the trays generate projections of the water reflections, which are directed onto a screen. This 6’x11’ semi-transparent screen separates the built-in seating area from the performance area.

In front of each of the violins is one proximity detector, connected to the sound-generating Max/MSP patch. As a body approaches one or the other violin, it triggers the resonant frequencies of that particular instrument to sound in the speakers. Similar sounds emanate from the strings of the “self-oscillating violin” when someone moves in front of it. These sounds also create visual patterns on the water surface of the tray nearest the violin, amplified onto the screen.

Sometimes one of the violins is played (either mechanically or electrically), and this also triggers the resonant frequencies of that particular violin to sound in the speakers. When there are no triggers for an interval of time (no bodies moving near the violins or violins sounding), the resonance of the room is heard in an evolving continuum of tones and visualized as water waves from the middle tray. *Two Violins and a Theatre* is a never-repeating installation or an environment without predetermined temporality. Its form arises from the “breathing system” interactions between objects and the agency of perceiver-performers.

Figure 2 Studio Theatre Layout



- A Loudspeakers
- B Violinist
- C Three Trays with Water
- D Screen
- E "Self-Oscillating Violin"

“breathing system” as state of being

The interaction between the elements described above is a “breathing system,” which emerges from the “amongness” of space, composition, and improvisation. A homeostatic system traces the relationship among these elements.

Figure 3 *Main Elements of “Breathing System” Interactions*

1. people’s presence, perceptions, actions (improvisation)	(perceiver-performer)
2. acoustics, objects, and architecture of the space	(common space)
3. guidance of composed elements (sound and light)	(composition)

The system encompasses actions, behaviors, architecture, and socio-cultural issues. “Breath” traces the interconnectedness of sound, light, and the perceiver-performer with the objects and the architecture of the site.

“Amongness” is a new place born from the relationship of space and situation, between people’s actions and motivations within the surroundings they inhabit.

Each perceiver-performer brings with them preconceptions and motivations, weaving their personal thought narrative to the collective frame of presence.

The word “breath” implies life, growth, nature, meditation, oscillation, continuity, connectedness and homeostasis. As beholders we take the temporality of a composition as given, however, in this work, temporality is actively driven by the “breathing system’s” integration of movement, intention, and performance. This

system of interaction is intended to provoke a state of being, more than just an experience.

Private-public experience is highlighted by natural phenomena such as water waves, reflections, and bowed strings. These phenomena are readily perceivable and understood in the world outside of the theatre. This transformative context connects the perceiver-performer's presence to thought-networks of everyday life, memories, and experiences.

perceiver-centric goals and ideal experience

An artistic frame can create a haven of experience, offering moments to “just be” and focus on the experientiality of existence, a deep-seated need often overlooked. A conceptual and emotional goal of this work is to create an environment conducive to contemplative consideration of the body in space and its influence/interference on the auditory and visual waves of the world around us. It is an ideal state of personal contemplation, regarding the nature of instruments and the relationship between agency and perceptive experience. These perceiver-centric goals led me through the selection of the theatre site, augmenting its architectural plan with the set design, and shaping the modes and layout of performance and composition.

To allow a thoughtful focus on experientiality rather than mechanics, the surface of the design is simple: white and black, dichotomies and symmetry in layout, noncomplex sounds. No wires and laptops and amplifiers are visible,

only the objects themselves. Technology is not a distraction from presence, it is an instrument of perception.

immersive entrance augmenting architecture

The two entrances to the Studio Theatre in Lisser Hall (see Figure 2) are at the level of the stage. In choosing a theatre whose stage is not elevated, the performer, installation, and audience are all of the same perspective: immersed in the environment.

The particular architectural design of the theatre immediately instigates a question of one's intention upon entering the space. The entering person must turn away from the space of the stage to enter the seating area, addressing the questions: "Do I want to be on stage, or do I want to sit in the comfy plush chairs facing the stage?"

During the performance, most of the audience members were on stage facing the screen, while only a few sat behind the screen observing inward. This reversed set design highlights the decision of the participant to adhere to social protocol or to accept a role of more active agency.

Still there remains the option for the user to simultaneously assume the role of the observer as well as the observed. Because for each space there exists an outer space, from which it can be observed, where the transformation-processes can be followed, from where it becomes a stage. The separating line between stage and audience as spaces of different experiences is drawn to be crossed.

-Beatrice von Bismarck⁵

Through an immersive entrance the viewer must extend their participatory role to one of active agency, or performance. The viewer-turned-perceiver may question:

Is this an installation or a performance?
Am I an audience member or a performer?
How am I supposed to behave, where do I sit, or should I move?

This may initiate anxiety, for as viewers we are asked to play an active role, to forfeit our enclosed interiority to the external interplay of forces: to initiate experience.

Yet we are already bound up within the work, a part of its production—before we know it, the work is already in motion. As viewers we participate in a situation which asks from us more than we are used to: no comfortable distance between object and viewer, stage and audience, cause and effect.

—Brandon LaBelle on the works of Achim Wollscheid⁶

The distinction between stage and audience does not exist in this piece, creating an uncertainty of the audience role and social protocol. This is spatially magnified by a reverse-theatre set design and the role of body movement as shaping performance.

homeotracing (dis)quietude

movement as interruption-shaping

When bodies are near both of the violins, both sets of harmonies are mixed into the speaker system. So that both harmonies are not at full volume, an amplitude mixing system guides the interaction of multiple bodies in the space. Tracing the proximity of the nearest body to each violin, the violin with the closest body will have a harmony sounding at full volume, visible as waves in its respective tray. The violin with the further body will be quieter relative to distance.

During the performance, this shaping served as a type of interruption, creating breaks and peaks in the sounding system. The disruptive nature of this interaction was exaggerated by the placement of the motion sensors, which sensed the movements of unassuming spectators upon entering the space. Bodies served as a disruptive agent, instigating doubt and unassuredness.

homeotraces of homeostasis

Over the course of the performance, people began to avoid disturbing the system by moving more slowly in front of one or the other violin, sitting, or standing still. The result of these actions is the system's state of motionless suspension or quietude.

Without stimuli from either violin or motion sensor for a certain period of time, a system called "homeotraces" is triggered. Sounds trace the resonant

frequencies of the theatre space which are made visible on the center tray.

“Homeotracés” functions as a perpetual state, a homeostatic feedback system in “rest” until disturbed by environmental stimuli.

performance trial

The violinist installed in the system does not face the audience, but regards only the black empty ceiling above and the reflection-patterns on the screen. With gravity working against bowing, the vulnerability of her position is apparent.

At work is a desire to remain within the uncertainty of social reality and the gentle instabilities of public space—in essence, to remain susceptible to the viewer.

—Brandon LaBelle on the works of Achim Wollscheid⁷⁸

The violinist is unresponsive to the audience, but does not play mechanically. She is a perceiver-performer, at once engaged and disengaged from the space, people, and the system, immersed and integral yet autonomous.

Conditions of Violinist’s Performance:

1. to play long tones with lots of silence
2. *to take time performing, to stop, listen (experience) react*
3. To establish a consonance and dissonance structure between two harmonies
4. Not to look at the audience but at the ceiling above.

Unknowns:

1. Would the violinist break these conditions? Would she stand up, move around, play other notes, play melodies?
2. Improvisatory elements of performance, such as exact pitches, timing, vibrato, and melodic creations.

waking shadows

As the violinist installed in this system, I refused to look at anyone or recognize any of the familiar people and loved ones around me. Surrounded by bodies and sensing movement, I listened to the sounds and shadows of people shifting and sitting around me. When I felt agitated and claustrophobic about the unrecognized clusters surrounding me, I allowed myself to express these feelings musically, for example, through more agitated bow movements.

When I sensed the rustle quieting I took the opportunity to stop playing, and allowed the system to “rest.” A performance goal of achieving homeostasis emerged unexpectedly, and prolonged silences traced stasis on four occasions.

After a predetermined duration of an hour, the piece ended rather abruptly. I remained lying down for several minutes afterwards. There were several minutes of uneasiness on the part of the audience: some people left quietly, others remained and twittered about how to “wake the sleeping nymph.” Though uncomfortable because the bench on which I lay was unpadded, I could not help but to smile secretly, because nobody clapped or shouted “bravo...encore!”

consonance and precedence

Both the “self-oscillating violin” and the violinist’s instrument are tuned to the unique resonant frequencies of that instrument. The oscillators triggered in the computer are derived from this same list of frequencies (see Figure 3). New notes are triggered either when one of the instruments is played or the motion sensors are active. The “self-oscillating violin” is “played” by the computer from time to time, during periods when no movement is detected.

These tunings created a relationship of consonance and dissonance in the transitions between the “state” of one violin or the other. Even though there are C#3’s in all three “states,” each group of frequencies are different enough to establish an overall harmony. For example, if the “self-oscillating violin” system is sounding, and the violinist enters with a B-flat, that pitch will sound dissonant to the listener. If the violinist continues to play, or motion is detected in front of her, the overall harmony of that violin will begin to sound. As the B-flat becomes consonant to the ear, we enter the resonant space of her violin.

Figure 3 *Resonance and Tuning*

Object or State	Measured Resonance (in Hertz) and Oscillator Frequency Inputs	Approximate Note Name	Tuning of Strings (Hz) in <i>Two Violins</i>
"self-oscillating violin"	141	C#3	354
	262	C4	529
	354	F4	354
	529	C5	529
	1011	B5	
mechanical/human violin	141	C#3	141
	334	E4	334
	527	C5	527
	667	E5	667
	940	B-flat5	
surrounding space	80	E-flat1	
	220	A2	
	273	C#3	
	368	F#3	
	495	B3	
	556	C#4	
	661	E4	
	683	F4	

Indwelling concordance

The environment of *Two Violins and a Theatre* highlights the body's perspective as integral to the world: the inherent interconnectedness of perception and action. Direct and intuitive connections are perceived between movement, sound, and light by augmenting natural phenomena with technology and composition.

aural-visual mersion

Rather than separate systems, the auditory and visual are different manifestations of the same sources. A direct visual-sonic association requires sounds that are easily distinguishable from each other, and without too much movement within them. The sound design employs sine and triangle oscillators, which have low harmonic content, creating clearer visual patterns in the water which are more easily distinguishable to the ear as well. Small-scale amounts of frequency modulation and phase modulation create aural interest without blurring distinctions.

In general, lower auditory frequencies drive the water waves more readily. The relationship between frequencies heard and seen is directly proportional. This creates more visually-apparent beating patterns than their aural counterparts, while maintaining the direct correlation between sound and light.

Beating patterns are heard when two very close frequencies are sustained. Each frequency generated may be multiplied by a small factor to

encourage these interactions between sounds. Along with difference tones and combination tones these beating patterns are variable by the position and motion of the perceiver in the space.

visible motion

The visual projections may be viewed from on stage, or from the seating area as rear-projections on the semi-transparent screen. Behind the screen, the audience watches the motion of others as shadows interrupting the light patterns, while maintaining an overall understanding of the set, space, and motion of active perceiver-performers. On stage, a corridor is created between the seating area and the set. When the perceiver-performer walks along it, his or her shadows interfere with and shape the reflections of the water wave projections in an obtuse manner, highlighting the sense of agency and interconnectedness between these elements.

The visuals magnify certain physical phenomena such as the sonic beat patterns (discussed above) and the subsonic frequencies created by walking in the near vicinity of the trays. The wooden stands holding the water trays transfer vibrations from the floor of the theatre to the surface of the water, visualizing movement literally and further binding the perceiver to the system's state.

inside intentions

I never played the violin with a shoulder rest. The vibrations traveled directly through the instrument into my collarbone and jawbone, the sounds felt traveling throughout my body. Closing my eyes I imagined I was inside the violin, modulating its spaces from the inside out.

Motion sensors emphasize the intentions of the perceiver, creating a direct and intuitive connection between body motion and the sounding-visual system. The proximity of a body to one or the other violin correlates to the curiosity of this person and the intention to come closer. As they approach a violin, new notes of that violin's resonant harmony are triggered.

A system of frequency-mapping is inspired by imagining what an environment inside a violin would sound like. High frequencies lose amplitude rapidly over distance, so that when far away from a sound source lower frequencies are more perceivable. Moving closer or even inside of the instrument, higher tones become more audible. In *Two Violins and a Theatre*, as someone approaches a violin, their intentions to be closer are magnified by a higher frequency range of harmonies, evoking a sense of nearness.

release

In offering many views of the body in space and our influence, interference, and immersion in our surroundings, the piece is released from this conceptual guidepost by performance. The form and temporal elements are determined by public and private improvisation of the perceivers in the environment.

By connecting natural phenomena such as reflections of water waves with the context of performance, a rich environment with many possible viewpoints connects the perceiver to the piece personally and emotionally. In conversations with audience members after the show, it became apparent that the environment of *Two Violins and a Theatre* transforms into rich personal landscapes of personal memories relating to water, light, experientiality and spirituality: the “breathing system” evokes a ritual place of “amongness.”

internalized place

evoked by

repetitious evolutions

waters shift

secret chambers

I modulate your spaces

we breathe presence

together

Notes

¹ WordNET Definition, <<http://www.wordnet.com>> (accessed online April 2006).

² R. Murray Schafer, *The Tuning of the World*, (New York: Alfred A. Knopf, 1977), 5.

³ Randal Davis, "'...and what they do as they're going...': sounding space in the work of Alvin Lucier," *Organized Sound*, Vol 8:2 (York, England: Cambridge Press, 2003), 206.

⁴ Max Neuhaus, "Program Notes," *Inscription: Sound Works Volume 1*, (Ostfildern: Kantz, 1994), 34.

⁵ Beatrice von Bismarck, "spatial interference," *Achim Wollscheid: Selected Works*, (Frankfurt a.M.: Selektion, 2001), 11.

⁶ Brandon LaBelle, "system intervention and the ethics of art production," *Achim Wollscheid: Selected Works*, (Frankfurt a.M.: Selektion, 2001), 21.

⁷ LaBelle, 20.

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