

SQUARING THE CIRCLE
An Artist's Exploration of Space, Time, Frequency and
Sound.

©1996 - 2003, Steve Heimbecker,

The Qube Assemblage for Art in Motion,

280, rue Rose de Lima,

Montréal, Québec, Canada

H4C 2L2

telephone: 1 514 932 2481

qubeassm@sympatico.ca

SQUARING THE CIRCLE
©1996 - 2003, Steve Heimbecker,

Table of Contents

1. THE OBJECT OF SOUND, THE SOUNDPOOL AND RELATIVE LISTENING
Page 3

2. ACOUSTIC MAPPING PROCESS, DYNAMIC VOLTAGE MAPPING AND SONGS OF PLACE
Page 5

3. WIND ARRAY CASCADE MACHINE
Page 6

3.1. Wind Array Cascade Machine - Phase 1
Page 6

3.2. Wind Array Cascade Machine - Phase 2
Page 7

3.2.1. Wind Array Cascade Machine: Pod
Page 7

3.2.2. Wind Array Cascade Machine: Si(g)n(e)
Page 7

3.3. Wind Array Cascade Machine - Phase 3
Page 8

SQUARING THE CIRCLE - An Artist's Exploration of Space, Time, Frequency and Sound.

PUBLICATION OF THIS ARTICLE IN WHOLE OR IN PART, WITHOUT PERMISSION FROM THE AUTHOR, IS STICKLY FORBIDDEN

Steve Heimbecker,
The Qube Assemblage for Art in
Motion,
280, rue Rose de Lima,
Montréal, Québec, Canada
H4C 2L2
telephone: 1 514 932 2481
qubeassm@sympatico.ca

1. THE OBJECT OF SOUND, THE SOUNDPOOL AND RELATIVE LISTENING

As a visual artist I have created objects. As an audio artist and sound sculptor I have created sound objects. A sound artist, by my definition is one who sculpts or creates four dimensional sound spaces using acoustic technologies. To me, sound itself is a tactile, plastic material to be sculpted and shaped over time.

In the spring of 1992, through the Sounds of A.i.R. (Artist in Residence) at EM/Media, Calgary, Canada, I composed "Engine: An Octaphonic Movement", which was conceptually based (in part) upon the language collage processes of James Joyce when he created his extraordinary sound novel "Finnegan's Wake", 1939. I designed "Engine" for eight channels of playback sound (see Figure 1), surrounding the listener in the sound space or what I call the "soundpool". In this, my first multi channel audio production, I was intrigued by the notion of using a drone for the basis of the sound composition. Once the drone was established, other sounds and tonalities were considered to be taken out of / from the drone.

When composing "Engine" I realized that the drone, already representing silence, could also be represented metaphorically by mathematical zero. Sound can be likened to numbers, and the relationship of zero to numbers is like silence to sound. Each is a defining form of the other, one half of a kind of binary system, an opposite of sorts, existing to establish the content and context of the system it represents. This is also true of space as it relates to solid form. In visual arts the space around an object is paradoxically called negative space. From the context of art making, I postulate that the drone, zero, space, and silence all represent the same binary value / position.

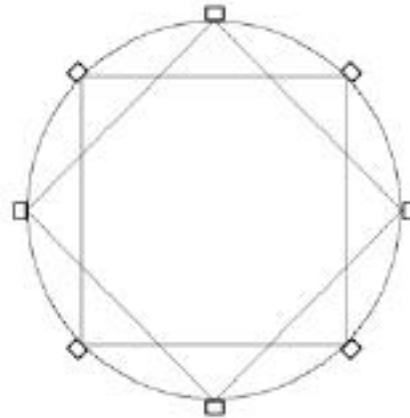


Figure 1. Squaring the circle, top view of the 8 channel surround sound speaker configuration created for "Engine", 1992.

Conceptually in the soundpool, the formal binaries can be identified as first, the sound inherent to a specific space, which is the culmination of all acoustic factors in this space at rest. Second, the soundpool is the interaction of new external sounds within the context of the first binary element. These binary sound elements, sound and silence, are fated together by our observation.

However, these elements are also interchangeable and reversible, like a room being half full of something as opposed to being half empty. This is the space of programmable and unprogrammable acoustic events. This is the soundpool, the object of sound. The soundpool is like water in a swimming pool. When we swim the water surrounds us. However, our presence affects the pool, perhaps not as visibly as the pool affects us, but we do affect each other. We affect sound space in the same way, a giving and taking.

With “Engine: An Octaphonic Movement” I was able to gain an insight into the potential of multi-station sound systems, leading me to research sound recording and live mixing techniques for quadraphonic and octaphonic sound systems. It is during this early period of research that I created the project “The Acoustic Line as the Crow Listens” (1993). Three significant results came from this project. First, I was able to design a successful sound recording system that could capture simultaneous sound from eight (or more) vantage points, covering as much as a mile (1.5 km.) of acoustic environment (see Figure 2). Second, by using the physical distance encapsulated by this sound recording system in relation to the fact that time (event time) would remain constant within the recording, the speed of sound could be captured as an event object, and rebroadcast in a smaller acoustic model as a re-playable event object (see Figure 2). In the exhibited acoustic model, because space had been compressed, it was conceptually possible for the listener to travel faster than the speed of sound. The third result was the conceptual and philosophic affirmation of my research in multi-station sound broadcast systems and, that these systems could be modified to suit other audio projects. The success of “The Acoustic line as the Crow Listens” was promising. With this system I had designed a process of sound recording and broadcast where the physical scale of the listener could be changed conceptually by manipulating the spatial boundaries of the broadcast system relative to the original acoustic environment and recording.

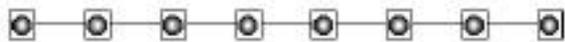


Figure 2. Sound recording and presentation format of “The Acoustic Line as the Crow Listens”.

“The Acoustic Line as The Crow Listens” was presented at The Tuning of the World Conference and Exhibition, in Banff and Calgary, Alberta, Canada respectively in the summer of 1993. Through this conference I realized that my multi-station recording project with eight discrete vantage points, was a sophisticated multidimensional process of sound mapping and, was the early developmental stages of a system of sound recording analogous to a hologram which I now call the “Acoustic Mapping Process” (AMP). In my AMP system it would not only be possible to capture a single vocalization or series of vocalizations, but in addition, I could capture these vocalizations multi-dimensionally within the affected habitat of the object (as the object exists within the soundpool).

My early works in the development of octaphonic recording techniques were primarily concerned with the bringing together, musically and poetically, of sound images and icons of common relationships. It was the bringing together of these sounds, and their placement and movement in the sound space, that created the form and content of the work.

In contrast to this, with various AMP recordings since 1993 I have tuned my technique to include the expansion and contraction of individual sound images through the use of time and space. In the Acoustic Mapping

Process the content of the work is found in the phenomenon (phono - sound, pheno - shining/light) experienced after the enlargement or reduction of the individual soundscape relative to the presentation system, and the activity of subsequent fluctuating acoustic images. The image found in the Acoustic Mapping Process is likened to the image of an object viewed through a microscope, or telescope, allowing the listener to “see” the soundscape in greater detail.

In 1995, using AMP, I created / composed “Spin Cycle”, while in residency at La Chambre Blanche, Québec City, Québec, Canada. I recorded the sound of an active casino roulette wheel from four vantage points. I used an analog 4 track recording system with a mechanical variable pitch motor. A 17 second recording was made and then slowed down to approximately a 7 to 1 ratio, so that the original sound recording was expanded to run slightly over 2 minutes in duration. This longer quadraphonic sample was then used as the source material for an octaphonic composition that lasted about 30 minutes.

My exploration of sound expansion and contraction led me to the co-opting of Einstein's General Theory of Relativity in my creative work. I liked the idea of using relative time and space - time to identify unique sonic objects and events. Space and time are one in the same in the relativity theory, and space - time is relative to the perception and position of the individual observer. I began to explore the concept that if space - time is a measurement unique to the realm of the individual observer, and not to the collective observer, the measurement of time would need to be based upon a sliding scale of measurement, relative to the uniqueness of the individual, but common to all things affected by time and space.

To remain true to my interests in the complexities of sound, I proposed sound frequency or hertz as the measuring system for this research, although all frequencies, such as light, were implicated. By replacing standard time with a sliding scale of time measurement such as the frequency of sound, I was able to pose the question, “What does the effect of different sizes (mass) of listeners have upon their perception of sound frequencies?”

It is at this stage in my career with “Spin Cycle” as the lead point, that I began using multi channel simultaneous pitch changes in my “Acoustic Mapping Process” compositions. This technique was used to simulate changes in time to alter space, rather than what I had originally started with, changing space to alter time.

As a side (related to pitch change), I actually created an installation entitled “Soundpool: The Manufacturing of Silence” (1996) that consisted of a custom made 8 channel surround sound system using 7 foot square mechanical woofers designed to produce only low amplitude 3 hertz vibrations timed for durations of 48 seconds (the “on” switch was controlled by the audience). Many related the experience as quite moving.

What I came to realize with this work is that each individual's unique mass to the milligram, will place them in a unique perceptual relationship with time (and reality), affirming the existence of individuality, no matter how subtle

the differences in mass is between individuals. In essence, by incorporating the general theory of relativity in my Acoustic Mapping Process, I could change the perceptual constant in the soundpool from “standard time”, to “event time”, based upon the mass/scale of the individual and their position in the listening space as related to the acoustic object or soundpool that is mapped.

1. ACKNOWLEDGMENTS

- In addition to the artist production centres, galleries and conferences already mentioned, this work was supported by grants from the New Media / Audio Section of the Canada Council for the Arts (1992, 1993, 1994, 1996, 1998), and by the Alberta Foundation for the Arts (1996, 1997).

2. ACOUSTIC MAPPING PROCESS, DYNAMIC VOLTAGE MAPPING AND SONGS OF PLACE

Since the completion of my double CD anthology, “The Enormousness of Cloud Machines” (multi - channel compositions from 1992 - 1998), released in the autumn of 1999, I have continued to develop my work for multi channel sound systems and the Acoustic Mapping Process. During the years 1998 to 2001, while living on the Saskatchewan prairies, I specifically focused my work on my Acoustic Mapping Process, making many quadraphonic field recordings that capture the space of sonic events in the prairie soundpool. Later in the studio, I took time to experiment and develop compositional techniques and strategies for these unique audio recordings.

The result is a series concept entitled “Songs of Place”. Each composition in the series is to capture an audio portrait of a selected city or country side, by using multiple (8 or 10) AMP (4 channel surround sound) location recordings, recorded in as short a time period as possible, ideally 2 to 3 days. The recordings are usually 45 minute “one take” samples of each the ten locations or soundpools selected. Later in the studio, these recordings are layered and edited together with another invented system of mine, called “Dynamic Voltage Mapping” (DVM). DVM is a surround sound editing technique using analogue and digital technologies in which the surround sound complexities of one set of sounds can be used as an “invisible” amplitude editing template on a second set of surround sounds, tonal patterns, or noises, to create spatial illusions in the second set of recorded surround sounds which refer to the spatial movement of the first set. With DVM, I can use the dynamics of a unique sound source as an editing template to create a strobe like editing affect on each of the 4 channels (directions) of the original AMP recordings. By timing the DVM edits, the strobe affect is designed to open and close four directions of “windows” (represented by the speakers of the surround sound system) which open and close into each direction of each AMP recording site. The result of layering multiple AMP / DVMs is a composition that allows the listener to be in many AMP locations simultaneously (or many places at once), simply by focusing their ear on the object relationships of a specific sonic environment (soundpool) as it strobos.

In my AMP / DVM compositions I am proposing to the listener a new way of listening, a new way of perceiving sound and space. My proposal is a little bit analogous to data compression techniques. In AMP / DVM, my editing technique reduces the linear information from each recording location and replaces it with information from another. In 3.5 seconds 8 to 10 separate recordings are “pasted” together in 4 streams. By using the quadraphonic listening field and by using a different edit sequence for each channel of sound, each of the ten locations appears continuous because of the relationship between the 4 audio channels. At the time of this article, this scale of “compression” seems to be the current maximum level of my own ability to perceive individual AMP recordings. As imagined, the effect of AMP / DVM compositions is quite dense and seemingly chaotic especially upon first listen, but over time the experience typically becomes an expression of expansiveness for the listener.

My first and only developed editing technique in Dynamic Voltage Mapping, is the use of dedicated multiple noise gates which have key trigger inputs. A noise gate is an electronic switch that can be set to open the line signal of an audio source based off the amplitude of the voice, ie: when the voice speaks, the switch opens a few milli seconds later and the source voice is heard. When the voice does not speak, the switch closes, leaving silence. The time the gate stays open (sound is heard), and the level of amplitude used to open the gate is variable, from milliseconds to several seconds. A noise gate with a key trigger, means that the amplitude of an independent, secondary audio source can be used to trigger open and close the noise gate, so that when the gate opens, the original first audio source is heard, based upon the amplitude rhythms, not from itself, but from the second source. This means that the amplitude of one set of sounds is mapped onto another set of sounds. By using four sets of inputs / outputs such as an AMP recording, a very interesting multi channel surround sound listening field is created. When using multiple sets of AMP and DVM combinations, each AMP / DVM layer is mixed with a small time delay from the preceding layer, so that the edit windows (the 4 directions of each AMP recording) in the final composition, can be organized compositionally into incredible spacial complexity and presence.

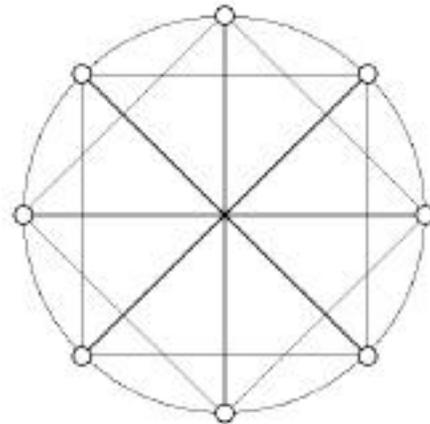


Figure 3. Songs of Place direction template for mapping process (combined with figure 1).

On location, “Songs of Place” production implements a grid like network or mapping to capture a representation of a complex sound space, a space that is far to large in area to be able to record from a single point of view. The idea of the grid mapping is two fold. The first idea is that the nature of the quadraphonic recording of four directions in AMP, means that each site recorded would be in essence, an omnidirectional recording, representing a sphere of listening environment that theoretically could overlap with other spheres of recorded AMP environments. Using equidistant measurements, with north always being true, ensures the possibility of overlap in a proportional way. The second idea is to use a system of applied mapping that could represent the location or subject to be recorded. I decided to use the land or street map of the site as the starting point for my acoustic mapping composition. Therefore, in the series “Songs of Place”, I first look at a detailed land map of the location to be recorded. Then, I try and find the sense and rhythm of the network of streets and geographic conditions that has situated those streets. Thus far in the series, I look for the centre of the community (always geographical), and then expand my view to the outer wall of a circle which must also be informed or constrained by the geographical (see Figure 3). Then I divide the circumference of this circle into 8 locations, each representing one of the four directions (north, east, south and west) plus the four sub directions (NE, SE, SW, and NW).

Songs of Place projects have occurred through artist residencies in Canada at Halifax, Nova Scotia (2001), Montréal, Québec (2001), and Vancouver, British Columbia (2002), and at my own studio in Springwater, Saskatchewan (1999 - 2000). A major production change for this series was the inclusion of video in the mapping process. Each video is a one take continuous shot corresponding to each AMP recording. The audio and video is then formatted for DVD production, complete with Dolby 5.1 surround sound making my multichannel work far easier to present in installation and screening settings. The inclusion of the visual video image has brought me back full circle to my creative beginnings, trained not in sound or music, but as a painter and sculptor.

The “Songs of Place” project is an ongoing project. Residencies and opportunities are being sought on an ongoing basis in Canada and throughout the world indefinitely. In each project I attempt to find a physical theme which is apparent in the environment, geography, activity, architecture, and design of the city or country side. I am interested in creating a sonic and visual portrait of a particular place at a particular time. It is my contention that to fully hear a place one needs to hear the space of that place, the soundpool. By using my Acoustic Mapping Process, and editing techniques such as my Dynamics Voltage Mapping, I am able to create intense spatial compositions unlike any mono, stereo or even surround sound compositions commonly experienced today.

2. ACKNOWLEDGMENTS

- “Songs of Place” has been supported in Canada by artist production residencies at: Centre for Art Tapes, Halifax N.S., Vidéographe, Montréal, QC., and Western Front, Vancouver, B.C.
- Research for the Acoustic Mapping Process, and

Dynamic Voltage Mapping has been funded by individual productions grants in the New Media sections of The Saskatchewan Arts Board (2000, 2001), and The Canada Council for the Arts (2002).

3. WIND ARRAY CASCADE MACHINE

In my life I have viewed with pleasure and fascination, the motion of the wind across a field of tall grass or grain. Very elaborate wave patterns travel and dart across the field, always in motion, always similar from one moment to the next but never exactly the same, an illusion of repetition.

In the spring of 2000, after working for two years in an isolation / retreat situation in a central Saskatchewan village called Springwater (population 20 - 120 km west of Saskatoon), I became fundamentally aware of the effect of the wind across the prairie landscape. The realization that we do not actually hear the wind, but rather we hear and see objects as they are affected by the wind, such as the wind in our ears, the wind through the leaves of a tree, a field of mature grain blowing in the wind, or even the swirling detritus around a city building, has given me the insight to create my project “Wind Array Cascade Machine”.

3.1. Wind Array Cascade Machine - Phase 1

The “Wind Array Cascade Machine” is an array of 64 motion sensors (accelerometers) controlled by individual pic micro controllers, designed to work collectively from a grid of 8 units by 8 units (see Figure 4), covering an estimated maximum area of 50 m. X 50 m. (or 0.25 acres of land). This sensor array is designed to emulate the motion of a mature field of grain while effected by the movement of the wind.

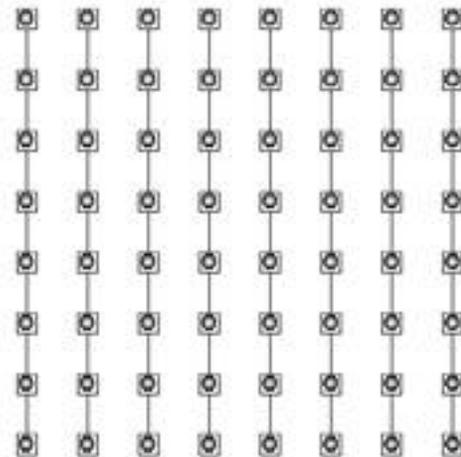


Figure 4. Wind Array Cascade Machine 64 sensor array grid - view from above.

The data collected from these sensors is a multi channel data stream that can be hard disc recorded for later use, or broadcast over the WWW in real time. All data is controlled by the MAX programming environment. This data set can then be used as controller information for innovative

new media exhibitions and performances. Each independent sensor in the sensor array collects and streams data at a rate of 8 bits - 10 samples per second, collected in subsets of 8 (controlled by another set of micro controllers) which are then united using the serial port of a single central Macintosh computer. In addition to the digital components, each sensor stands over 6 feet tall, and uses a complex organization of semi - industrial mechanical systems to insure reliable, accurate, stable, and unrestricted movement in the wind. The sensors measure wind pressure using 0 to 30 degrees of tilt in a horizontal radius of 360 degrees. The mechanisms are weather proof and have even withstood the January winter of Québec City.

As previously discussed, I have been interested in using sound, especially multi channel sound, as a device to measure and map the space - time of physical environments. These concepts, combined with listening to the wind of the prairies, triggered in me the epiphanistic inspiration that the wind is a tactile metaphor for a sonic measurement of time / space. And as such, it is a perfect natural occurrence to map the space - time of outdoor environments.

The wind moves as waves through time / space in a similar manner as sound, but the movement of the wind, unlike sound frequency is technically much less complicated to map. Using the movement of the wind rather than actual sound, means that my digital technology resources can be used in a greater proportion for the mapping process and articulation of a moving space, ie more channels of simple information, rather than a few channels of complex information found with my Acoustic Mapping Process alone. To manifest a believable representation of space - time with sound using multi channel sound production requires the maintenance of a very accurate (albeit representational / analogue / analogous) sonic portrait.

In "Wind Array Cascade Machine" the natural occurrence of the wind is used to measure it's own surroundings. By mapping the wind I map a causal interactive occurrence, where the interface (the wind) acts as a metaphor, not an analogy for the space it interacts with and measures. The interface is the space, remaining original and primary. It is not a representation of the space, thus eliminating one layer of translation in the mapping process.

For the reason of diversity, I am seeking invitations on an ongoing basis from organizations that would be interested in hosting the "Wind Array Cascade Machine" sensor array for periods of time no less than 3 months duration. Security, basic maintenance, and access to electricity and the internet (as well as the wind) are important considerations. It is possible that Universities could facilitate such a project on their grounds, or any organization with a large flat rooftop. Although this project has a creative focus, it could easily include study that is more scientific in nature. The wind array could be used to map many different locations from natural to urban, studying thermal dynamics associated with architecture, urban design, or erosion.

3.2. Wind Array Cascade Machine - Phase 2

3.2.1. Pod

"Pod" is the first visual installation exhibition of the "Wind Array Cascade Machine", and uses 64 light makers in the exhibition space, positioned on a grid corresponding to that of the outdoor wind array, with the exception that the indoor grid is smaller in scale, visually reducing or compressing the scale of the outdoor wind array by a ratio of 3, 4 or 5 to 1. As the wind blows across the 64 wind array sensors, the light markers in the exhibition space illuminate according to the pressure waves of the wind (see Figure 5).

The light markers illuminate in a triad of colours each on the top of a small metal rod pointing vertically. The vertical light pod, resembling the seed pod of a cereal plant (wheat or barley, etc.) and acting as a metaphor of the growing seed pod, range from cool to hot; green at the bottom, yellow in the middle, and red at the top. This is also the same colour organization of LED amplitude meters found on audio mixing consoles and recorders, making reference to both the measurement system used in this project and the sound / amplitude of the wind. The light clusters or seed pods, contain three vertical rows of 15 LEDs each: 4 dark green (early growth), 5 medium green (adolescent growth), 4 yellow (maturity), and 2 red (harvest) at the top. Each LED light cluster is 15 inches long, mounted on copper rods and wooden bases, when combined are approximately 5 feet tall. This height insures that when the viewer is standing, they may easily look into the horizontal centre of the network of LED Pods, and see a 4 dimensional representation of the waves of wind.

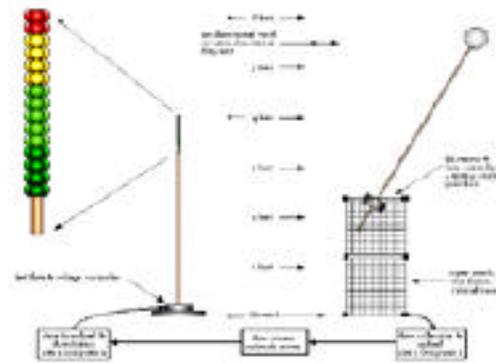


Figure 5. Wind Array Cascade Machine, relationship between one LED Pod and one wind array motion sensor, shown at the maximum value of 30 degrees tilt.

3.2.2. Si(g)n(e)

"Si(g)n(e)" is the first sound installation concept of WACM (production scheduled for spring / summer 2003). It is a multi channel sound diffusion composition for a custom 64 channel sound system that I will design and construct. It will use the controller data collected by the "Wind Array Cascade Machine" via a WWW data stream, as the primary source of creation / representation. It will be a 64 channel audio representation of the movement of the wind from a remote location, to be presented in installation or performance

settings. The position of the 64 speakers will be ideally placed in a grid 8 units by 8 units (approximately 1m. apart) hung from the ceiling (and walls), on perhaps a lighting grid, above the listener pointing downward, allowing the audience the freedom to move and explore the changing and immersive audio composition.

The compositional concept is to use multiple sine waves that fluctuate through several octaves of sound, moving from very low frequency to very high frequency. Each channel of sound will present a single fluctuating sine wave, changing frequency at different rates, controlled by the fluctuating data stream of the WACM wind array. The greater the amplitude (sensor information) of the wind on each sensor, the lower the frequency of the sine wave at each speaker. The lower the amplitude (sensor information) of the wind on each sensor, the higher the frequency of the sine wave at each speaker. The range of frequency of the sine waves will be between 30 - 50 hertz (low) to 20 kilohertz (high).

As all 64 channels of sound fluctuate, different chordal patterns will be created within the sound space, sometimes pleasing, and sometimes difficult (discordant) to the listener, but always representing the real time movement of the wind over the remote location wind array. By using 64 channels of sound diffusion, the various chords and discords will create pockets, or nodes of very tactile sound frequency in the presentation space. These nodes will appear and disappear as the tone of the sine waves fluctuate, and as the audience moves through the listening space (creating physical disruptions in the reflected sound frequencies). The affect is much the same as swimming in water at a lake, passing through warm areas of water, cold areas of water, dirty areas, clean areas, deep and shallow areas. The amplitude of each speaker will be fixed at one output level. This is based upon the idea that it takes more amplitude energy to produce low frequency than high frequency, thus creating the appearance of gradient amplitudes as the frequency changes (low frequencies will appear to be less loud than high frequencies). The final composition created is intended to present a positive tactile, physical sensation, complete with oscillating nodes which float in space with the changing audience. The resulting composition is organic in nature, coming from the pattern of the wind as collected by the WACM wind array.

In the early/mid 1990s I created a series of live octaphonic presentations using a technique I called "Sound Sailing". In this series, simple sound sources such as water dripping or clocks ticking were amplified into a multi channel sound system. Using open microphones in the sound space, the sound of the amplified sound source, through the various sound system speakers, was returned into the mixing

system, via live feedback loops. The feedback was effected by multiple digital delays, which were also mixed live. Waves of sound frequency were generated, sweeping across the audience, throughout the multi channel sound system, creating many oscillating sine waves, in addition to the simple sound source. Examples of this technique are found on my double CD "Enormousness of Cloud Machines" (Avatar / Ohm Editions) called "Tic Talk" and "Drip Doodle".

The proposal "Si(g)n(e)" conceptually comes from the sound sailing series. The nodes created by the sine waves are in part based upon the physical movement of the audience, which deflects the sound waves in "random" patterns, creating a type of architectural / environmental feedback, all within the context of the moving wind.

3.3. Wind Array Cascade Machine - Phase 3

Once my system has been established and debugged through Phase 1 and Phase 2, I hope to open up my sensor array and programming information, through the WWW, to other selected new media artists and composers throughout the world, allowing them to create their own artistic interpretations of the Wind Array Cascade Machine. This final leg of the WACM project is being researched on an ongoing basis. The possibility of creating an exhibition of multiple new media installations and concerts from diverse artists, occurring simultaneously in one or more locations from the streamed data of my Wind Array Cascade Machine, is a very exciting prospect indeed. Phase 3 is scheduled for production in 2004.

Wind Array Cascade Machine is a digital landscape portrait of the tactile and the ethereal and is both innovative and traditional in technology and artistic aesthetic. It is a new interface, a new instrument and a new concept. This project has great creative potential for myself and hopefully for many others, presenting abstraction and representation in the same breath through the simultaneous use of open and closed architectural and network conceptions.

3. ACKNOWLEDGMENTS

- "Wind Array Cascade Machine" and the installation "Pod" was produced through an artist residency at Les Productions Recto-Verso, Québec, QC, Canada.
- WACM electronic and software systems designed, developed, and co-produced by Avatar - Québec City, Québec, Canada.
- "Si(g)n(e)" will be produced through an artist residency at Vidéographe, Montréal, Canada (2003).
- "Wind Array Cascade Machine" has been funded by individual production grants in the New Media sections of The Canada Council for the Arts (2002) and le Conseil des arts et des lettres Québec (2003).