NOISE MUSIC, ENVIRONMENT AND PERIPHERAL PATTERNS

By

Miles Thorogood

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Abstract

The development of the project *Peripheral Patterns* aims toward an autonomous software system for generative music, that takes as a point of departure, how sound is implicated in our experience of the everyday world in the city. This investigation began with the analysis and consideration of the contrasting soundscapes of the city and the natural settings. The analysis was found to show some correlation with the arrangement and frequencies of sounds in soundscapes and post-industrial noise music works. The above observations led me to the further analysis of soundscapes and noise music. My position on the current city soundscape is as follows: As the human is both a creature from the natural and urban environments, these contrasting vistas will create modern sonic topographies which are exhibited in noise music. *Peripheral Patterns* explores these convergent spaces to investigate the potential of the sound that is at the limits of human hearing. Whereas once animals occupied small spectral niches in the soundfield, a sky train can be heard passing over Commercial Drive as the constant white noise roars from the city. Conversely, there is a desire for something that resembles peace, a desire to return to an experience of natural soundscape. This thesis looks at a possible convergence of urban and natural soundscapes.

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Acknowledgements

So that's it, I have finished my MAA thesis, with lots of help along the way. I would like to thank my supervisor Maria Lantin. Maria seemed to know when to let me play and discover, and when to reign me in. She showed me that all things can be approached in a playful and meaningful manner.

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Finally, I would like to thank the Emily Carr University community for your openness and friendship. Through our conversations and interactions you have all shown me the importance of aesthetic difference and the consideration of all things.

CD List

Track #	Name	Duration
1	Banff National Park 1000hrs	1:05
2	Davie and Granville, Vancouver 100hrs	0:13
3	Hastings and Main, Vancouver 1000hrs	0:22
4	Example analysis through synthesis result	3:25
5	Glitch Manifest	0:32
6	One	2:00
7	Three	12:18
8	Eight	8:06
9	Ten	12:00
10	Excerpt 1 of installation piece	1:05
11	Excerpt 2 of installation piece	1:15
12	Excerpt 3 of installation piece	1:41

Introduction

Sound interests me because of its emotive affect and the fracturing of percepts it engenders. Sound art and computer music involve working with events that are not necessarily referential, manipulating and relocating events in space and/or time to create new experiences of being. In the creative process I shape the invisible to be heard and expose the audible. Process, interaction and perception are all part of my practice, inextricably linked. For me, sound shifts perceptions of space and reality. Walking along the street, sitting in the park, or in my studio I will close my eyes and it is here that reality breaks from normality as my mind looks out from the ears and everything is moving as space expands. The sonic experience opens a window to a seemingly virtual reality by creating an unfamiliar outlook on a familiar space, and it is here in these eldritch spaces that I make my art. My practice involves the programming of machines in the creation of sound experiences, often referring to the natural world where the systems at play inform my work at a multiplicity of levels including arrangement and aesthetic. It is in this environment of machine and the natural world that hearing and feeling come together for me to form new bodily sensations.

The history of my interest in observing the experience of sound began when a group of friends and myself would go to into the Australian bush land outside of Sydney with sound making machines. Here we would make a soundscape that would supplement the existing sound space, creating new potentials in the soundscape to experience. Walking a distance from machine sound, an interesting convergence of machine and nature would emerge around us. I was given the chance to explore this expression of sound further whilst taking a contemporary music course in 2001 and being shown experimental music as a discipline. During this period I was introduced to music theory that helped contextualize my work, and open new avenues of investigation by removing the constraints of what music should be. This was also the first time I heard post-industrial noise music, through the works of Yusuno Tone and Nam June Paik. I went on to formalize my engagement further with experimental music at The Australian National University, taking a degree in computer music in 2004 where the focus was on computational algorithms and organization of sound. The study of computer music history divulged a lineage of innovation and explorative practices in computer music beginning in the late 1950s with the MUSIC system by Max Mathews and later Jean Claude Risset, which I took up in my practice. Through these new methodologies it was possible to hack machines for the synthesis of hyper experiences from observations of sensations in the natural world, to which I continued to return.

This thesis explores the lines of inquiry that influenced the project *Peripheral Patterns*. Initially I explored, through the cataloging of observations, the effects of the sound in Vancouver on people in their day to day activities. These observations interested me because as a newly landed immigrant I felt that I might understand the people and their actions better. To investigate the sonic space of Vancouver, I carried out a spectral analysis of several sites in the city in the Downtown Eastside and downtown core. This gave a standard visual reference of the activity in the sound field. This spectral data of the city was put up against data from recordings of the natural environment from Banff National Park in Alberta, to form a comparative study. From this comparison I initially observed two differences. Firstly, there is an apparent balance in the natural environment, whereas there is little room for cooperation in the city soundscape as the noise is overall constant. Secondly, there exists a layer of information where similarities would sometimes occur, at extreme frequencies of human hearing. It is this second observation that compelled me to further inquiry because it was not an area of the audible sound spectrum that I had operated within. I was further compelled to reflect on how artists, and especially post-industrial noise musicians, have responded to the emergence of the sound of the city.

This thesis, in four chapters, examines issues encountered in the research which influenced the timbre and patterns in *Peripheral Patterns*. Chapter One looks at urban and natural soundscapes, contextualizing the discussion from the position of hypermodernity and the response of *The World Sound Scape Project*. Spectrographic analysis of natural and urban soundscapes will show that the patterns and spectral attributes of those soundscapes are evident also in components of noise music. Chapter Two investigates noise music starting from John Cage through to contemporary post-industrial noise music. A discussion regarding the engagement of sound with language is brought into focus. Chapter Three discusses the terminology of peripheral sound and how this type of sound is made manifest through the perception of incidental sounds. Finally, Chapter 4 will discuss the operation and methods employed in implementing a software system that incorporates natural and urban patterns resulting in the sound works contained within *Peripheral Patterns*.

Chapter 1

Nature, Urban & Music

> *Gradually, it became apparent to me that these machine sounds should be allowed to belong in my emerging image of nature. The idea that the true sound of nature is something which excludes the 'interference' and 'noise' of human culture survives as just that - an idea, a nostalgia...*
>
> David Chesworth*, Environment: videowall soundscape,* 1996.

This thesis looks at noise music from the point of view of its natural and urban soundscape influences. The organization of sounds, spectral content, and patterns evident in natural and urban soundscapes will be analyzed and shown to be components of noise music. Using this knowledge, a software system was built that systematically incorporates natural and urban patterns into a noise music composition.

The inspiration for linking urban and natural soundscapes to noise music came as I experienced the soundscape of Vancouver during a walk along the False Creek seawall. The following section is an account of that experience.

Logic of urban and nature sound spaces

Walking along the sea wall at False Creek I wonder if what I am hearing is the sound of the intense feeling that is embodied within me. A feeling of heightened reality, almost like I have held my breath too long and my nerves are tingling in response. I take time to listen to the cityscape that is made manifest by innumerable human events, picking up new detail in the sonic constant. I notice that there is little interest to be found in this sound. Rather it becomes a backdrop to my inner space making connections between thoughts, constructing new ideas from traces of recent and new thoughts that hover, mix, and disappear. As my perceived ability to control the parameters of experience is increasing, there is trust I give to the objects and systems that have helped enable this constructed reality. Certainly, if this feeling is intentionally constructed then I am indebted to the builders of this experience, but I fear, as with God, that there is no one there. The sound space here on the sea wall is not intentionally designed. It is the result of a visual monopoly, an architecture on the far shore where sound escapes through the cracks between the towers, the water in between, and the rise of the land behind, that makes this particular soundscape what it is in this place at this moment. Surely there are too many variables. I am skeptical of the city developers' long term thinking about the effect of sound on everyday experiences.

Urban soundscapes

Although no meaning is inscribed in the constant city sound, the information it contains reflects a culture that has difficulty finding identity and relationships because of this very same low fidelity, low-information non-sound that it produces. Murray Schafer and the *The World Soundscape Project* (Schafer, 1978) spent much time gathering the disappearing soundscape of the world because of the threat of the homogenous and dominant lo-fi[1] sound emerging in the post industrial era. Schafer created a terminology for background and foreground sound spaces that redefines the soundscape as a composition, thereby transforming the way in which we think about the sound space by demonstrating that even what could be considered as minor or incidental sounds are signifiers of community and the state of the world (Schafer, 1993). Individual characteristics are mapped to place and people by the existent sound marks of that locality such as the sound of the Bow River in Banff or church bells in Waterloo, Ontario. The tell tale characteristic of a unique space with separated hi-fi sounds were missing in the city roar along Vancouver's False Creek, telling me that the homogeneity that Schafer and the *The World Soundscape Project* heard coming is in effect.

This realization was heightened during the winter of 2009 when I attended a lecture by Barry Truax at the Simon Fraser University Surrey Campus. He presented several spectrograms[2] of the sound of the forest to demonstrate that there is an apparent turn taking of the audio band between animals. In one example, the insects could be seen to constantly

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[1] lo-fi sound in this context refers to the low information noise produced primarily from traffic and other industrial machinery. The lo-fi sound is a constant imprint on the urban environment. Alternatively hi-fi refers to sounds that offer purposeful information, or add a positive response to the state of being.

[2] A spectrogram is a visualization of spectral density over time. Commonly it is used to analyze the calls of animals, but can be used to analyze any signal. The Cornell Lab of Ornithology have available a free software Raven used for hobbyists and students for analyis of audio signal and musical instruction, available from http://www.birds.cornell.edu/brp/raven/RavenOverview.html. cited 01/08/2010

occupy the upper area of the spectrum, while different bird species occupied the middle of the spectrum at different times. Unlike the natural world, where there is a seeming cooperation in the audio spectrum, the modern city cares little about the distribution of acoustic space. Instead, there is an intensification of the excesses in noise. When overlaid onto the hi-fi soundscape there is degradation on the quality of the soundscape and species can no longer communicate. This city soundscape has a doubly negative effect on people, neither being conducive to community or an understanding of the self in relationship to the environment. Truax believes that sound has now been polarized in the city environment to loud and quiet, good and bad. This binary operation of sound has had the effect of distancing inter human reaction, and elevating the expectation of stimulus. In reaction, citizens plug in to media output devices such as TV and iPods. These devices enable an individual to administer the amount and type of fantasy that suits the desired feeling - an impossibility in the unplugged world. I see this as a cheap solution to the problem of betterment through sound. Instead of providing positive actions like rebuilding the overall sonic architecture, we tend toward consumerist stopgap measures that are false fulfillments to the human soul.

As there is a vacating of awareness of space and the removal of identity, something new is arising. Marc Auge, author of *Non-Places: Introduction to an Anthropology of Supermodernity* (Auge, 1995), views the emerging environments that culture inhabits as non-places: late capitalist phenomena of frequented spaces such as supermarkets, airport terminals and the cash machine. These spaces are something we perceive, but only in a partial and incoherent manner. The engagement with these non-places brings with it a profound alteration of awareness of the excesses of space and information. Auge maps the distinction between place, encrusted with historical monuments and creative social life, and non-place such as airport terminals and thoroughfares to which individuals are connected in a uniform manner and where no organic social life is possible. Unlike the postmodern premise, where old and new are interwoven, supermodernity is self-contained: from the motorway or aircraft, local or exotic particularities are presented two-dimensionally as a sort of theme-park spectacle. Auge does not suggest that supermodernity is all encompassing: place still exists outside non-place and individuals tend to reconstitute themselves inside it. But, he argues powerfully that we are in transit through non-place for more and more of our time, as if between immense parentheses, and concludes that this new form of solitude should become the subject of an anthropology of its own.

I have attempted to seek out the possible space that is given to soundscape within the larger sonic picture of the city and, moreover, in the places within the city that are not deemed significant enough to be called places. The in between spaces that people wait in and travel through, are the necessary vehicles that can have an overall effect upon everyday lives for people who work, play and live within the city. Hi-fi sound experiences still exist in pockets in locations throughout the city. The Granville Island Market outdoor area is one such place, with just the right amount of sonic elements to lift the mind. A background city ambience provides tuning for the foreground sound markings of the birds, the sound of children in the sun and a Spanish guitar. There is separation in the sounding of this place, a place that has been reformed from the industrial area it was not so long ago. If a reformation of the soundscape is possible, it involves re-finding the spaces between the noise, and shaping the surplus of existing noise, "tuning" it. This creates a tuned hypermodern soundscape, and that is what I believe I am experiencing here on Granville Island. So, there is space to reflect and find difference in the soundscape in the peak of civilization, at certain points at least.

Studying the soundscape

The reflective experience of the urban soundscape in Vancouver compelled me to explore in closer detail the soundscapes of urban and natural environments. One method that I adopted was spectrogram analysis [figure 1]. A spectrogram facilitates analysis of sound over time by creating a visualization along three axes.

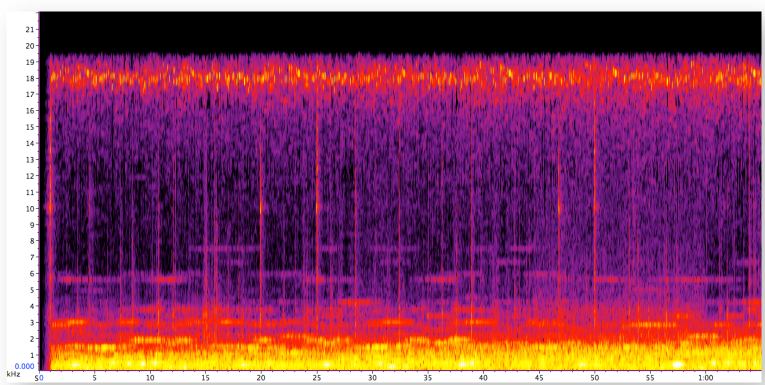

Figure 1. example of a spectrogram

In a spectrogram, time is represented along the x axis where sound events are observed in the vertical segmentation of the image [figure 2].

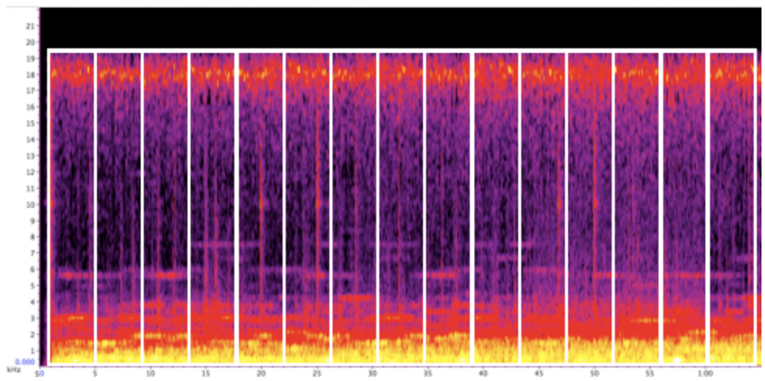

Figure 2. Vertical time segmentation of a spectrogram

Frequency is represented along the Y axis. At each time slice, the intensity of a particular sound frequency can be read from low to high frequencies along the vertical.

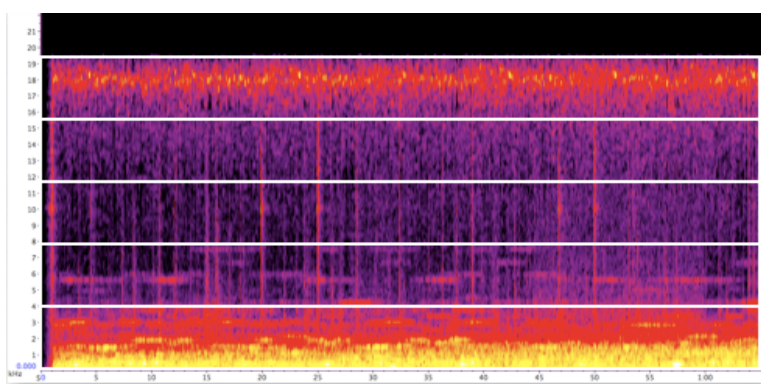

Figure 3. Horizontal frequency segmentation of a spectrogram

The intensity of the color (or shading in a greyscale spectrogram) represents amplitude, or the intensity of the frequency at that time. From the combination of these dimensions we can see how a sound or group of sounds unfolds over time.

Spectrographic analysis

The soundscape comprises the sounds heard in an environment and, like landscape, plays an important role in the relationship between living beings and their sense of a space. The spectrographic analysis of urban and natural soundscapes and noise music was a point of reference for building a software system to investigate the effect of those sounds on the listening experience.

Spectrographic analysis of natural environment

The spectrogram in Figure 4 is of a sound recording taken in Banff National Park during summer at 10 am (CD Track 1). The pattern we see with a fairly regular interval from 5 seconds through to 37.5 seconds is the chirp of a small bird call. The bulk of the intensity in the call is within a frequency range of 3.5kHz to 7kHz. As one can see it is consistent with little change or interruption. At 37.5 seconds the small bird call is interrupted by a lower frequency sound in the 500Hz to 2kHz range. This new sound is in fact the call of a different species of bird. At the point of interruption the small bird appears to stop its call, and wait a small amount of time after the second bird as finished its call before resuming a pattern. After two reports there is a pause of roughly the same length of time as the interruption, one report then a pause of the interval between the previous two reports, the second call is now repeated and precisely when that is finished the small bird calls.

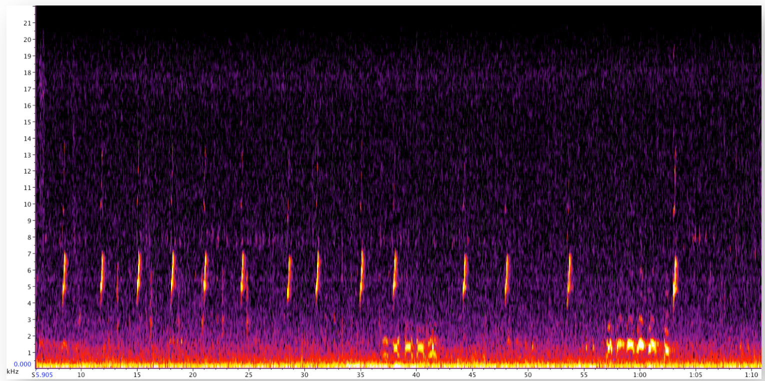

Figure 4. Banff National Park 1000hrs

Bernie Krause in *The niche hypothesis: A hidden symphony of animal sounds, the origins of musical expression and the health of habitats* puts forward that animals tend to occupy small bands of frequencies with temporal segmentation leaving "spectral niches" into which other animals and insects can fit in their sonic markings (Kraus, 1993). The bird call patterns that can be observed in the figure 4, and by ear through the recording, fit with Krause's hypothesis of the give and take cooperative behavior of animal species in the audio spectrum. What interests me is the organization of sounds that are displayed in the spectrum because of the similarities that we may infer to the arrangement of sounds in music.

Spectrographic analysis of urban environment

The soundscape of the urban environment differs from the natural soundscape. Even an initial glance at the spectrogram in figure 5 of the urban soundscape makes this statement plausible. The spectrogram in Figure 5 is of a sound recording taken at the intersection of

Davie and Granville Street during summer at 10 am (CD Track 2). There is seemingly little organization in the audio spectrum with the main auditory intensity coming from the constant traffic noise, which occupies frequencies within a range of approximately 500Hz to 10kHz with a drop in the intensity of frequencies above 3.5kHz. There is a seemingly random pattern of different peaking engines and other machine sounds at around 4.5kHz, which is of equal intensity to material at 2.5kHz.

The second spectrogram [Figure 6] of an urban environment is of a recording taken at the intersection of Hasting and Main during summer at 10 am (CD Track 3). In this spectrogram we see the same low information sound of traffic, which is a feature of this type of soundscape. What is different in this recording are the brake squeals occurring with good intensity at 8.5kHz then at 15.5kHz. This is interesting because there is difference displayed by the existence of these sounds, and although there is seemingly little organization to their temporal placement it highlights the incidental sounds that people living in cities are subjected to in their day to day activities such as their commute.

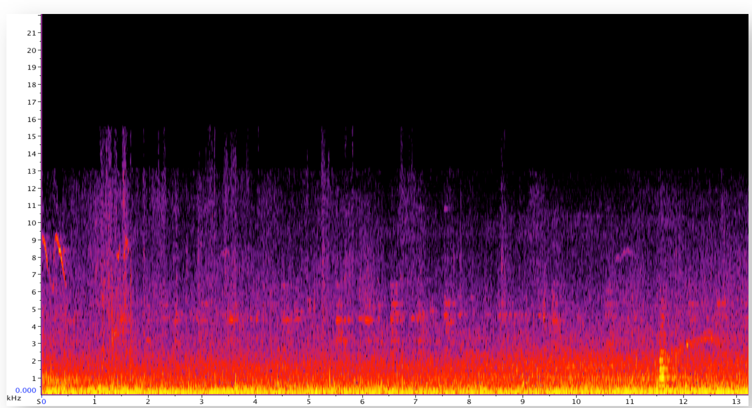

Figure 5. Davie at Granville 1000hrs

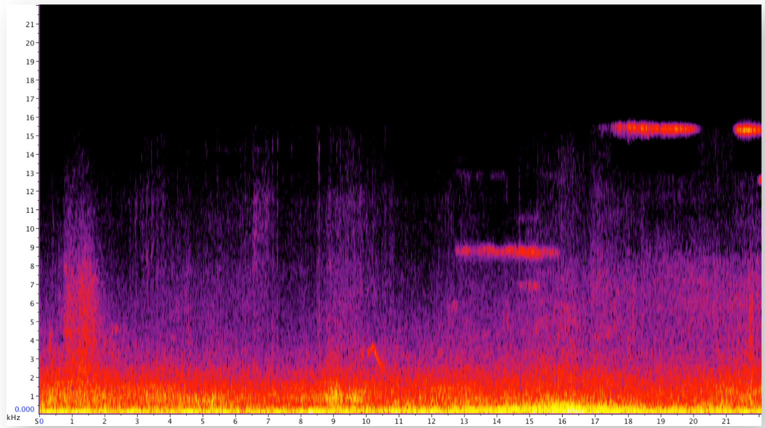

Figure 6. Hastings at Main 1000hrs

In the context of the city, the primary sonic object tends to be car traffic and building tools, and in urban areas of Vancouver, the soundscape is mostly car noise. Studies have shown that natural types of sounds, not man-made sounds, are comforting to human beings (Yang, 2005). According to Schafer (Schafer, 1993), as the ‘hi-fi’ soundscape is eroded the homogenous low information “grey noise” of the city creates a dislocation between humans in the environment, and more heinously, decays their sense of place and identity.

Sophie Arkette picks up on the phenomenology of soundscape in public spaces in her article *Sounds Like City*, and argues that sound is imbued with its own lexical code: "sound as sign, symbol, index" (Arkette, 2004). Arkette goes on to say that Schafer's view of a disappearing hi-fi soundscape fails to read the inscription of economic and cultural communities on city spaces, and that by simply cleaning up city sounds to resemble natural sounds, we fall short in understanding the dynamics of the city. Indeed, there are social and cultural sound markings that signify the identity of different groups, as can be heard at the Sky Train passing over Commercial Drive, or the ringing in of the New York Stock Exchange. What Arkette fails to address is the incidental and acute sounds that appear in a city soundscape, and the effect that these minor sounds have on culture.

Noise music as convergence of natural and urban soundscapes

One contemporary response to the emerging urban and city environment that interests me is noise music. An example is the Japanese noise music artists of the mid 90s, which is to be discussed with further detail in the next chapter. What noise means in the context of this thesis is that the timbre of the sound in the music is of a broadband of frequencies with little or no harmonic arrangement. Japanese artists Merzbow and KCCC were producing unrelenting noise as music that can be seen as an expression of the similarly unrelenting noise of the traffic and progress of city and urban environments.

Since artists such as Merzbow made their impact on music, culture post-industrial noise music has emerged as a genre that continues to implement the noise-like quality of sound in reference to mechanized society. Post-industrial noise music adds a consideration of the placement of sound. This consideration is demonstrated by a removal of the unrelenting broadband noise that was demonstrated with noise music of the mid 90s and takes on the appearance of an organization of sounds with purposeful harmonic content.

The spectrogram in figure 7 shows an excerpt from *The Other Face* by Austrian musician Christian Fennesz (Fennesz, 2007) and demonstrates how noise is organized in post-industrial noise music. The spectral content of this piece indicates a tendency toward noisy timbre qualities and is reminiscent of the low information sound of traffic noise observed in Figure 7. In the listening experience of *The Other Face* there is an apparent harmonic organization in the noise that comes across as multiple rich textures difficult to separate and in flux with one another, as is the propensity of Fennesz. Also observable in the spectrogram is the regular pattern of noise bursts with a mean frequency around 4kHz. The timbre displayed in the pattern is a highly processed machine-like sound that is in dialogue with the other noise profiles in the piece by occurring in an organized arrangement.

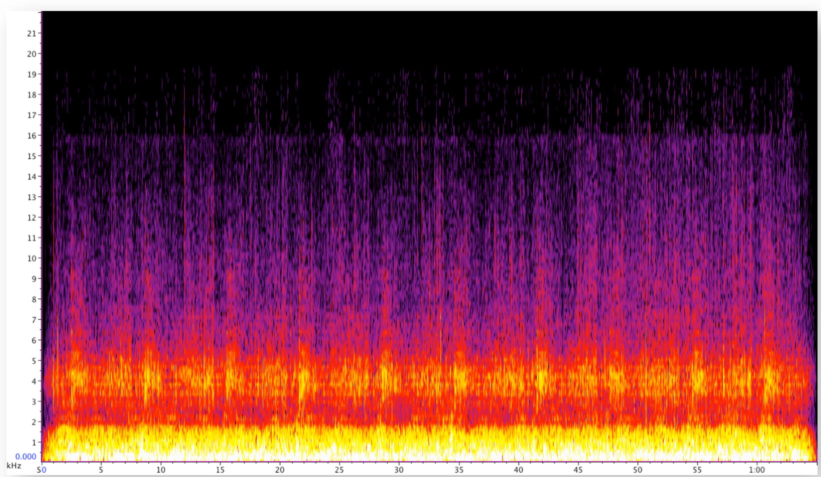

Figure 7. The Other Face, Fennesz

Organization of sounds & spectral content comparison

Through the analysis of patterns found in the spectrograms of natural and urban soundscapes we can see how post-industrial noise music displays a convergence of the organized behavior of the natural soundscape with the spectral or timbre qualities of urban soundscapes. To highlight this argument figure 8 shows the spectrograms of the recordings from Banff national Park (top), Davie Street (middle) and an excerpt from *The Other Face* (below). What I notice from a comparative analysis of the three spectrograms is that there is a regular pattern to the timing of events in the natural soundscape, a consistency in the spectral content of the urban soundscape, and both regularity to the pattern and consistency of spectral content in the noise music piece.

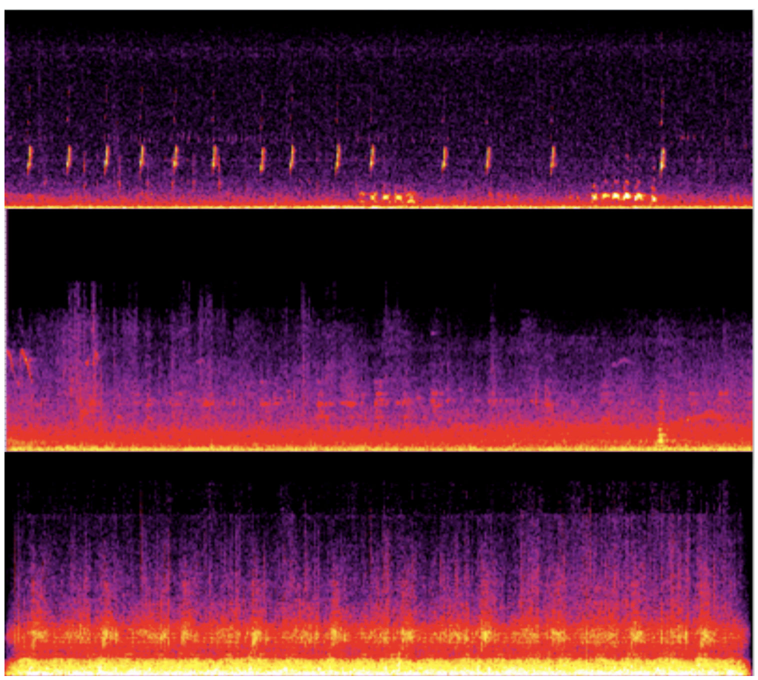

Figure 8. Spectrograms of natural soundscape (top), urban (middle) and noise music (bellow)

The tendency for post industrial noise music artists to practice a more considered approach to the aesthetic of noise coincides with the period where culture becomes aware and active of the impact we have on the natural environment. From this simple analysis of patterns I am suggesting that post-industrial noise music references natural and urban soundscapes as a reflection of the intersection of the post-industrial city and natural environment.

Summary

This chapter has referenced the work of Schafer and Truax as points of departure, and observes their position regarding the effect of natural and urban soundscape in relation to the human. I believe, as do many others, that there is a primary force that exists within the natural world to which we have a connection and that we are impacted by the modern sound world. An investigation of soundscapes from the natural and urban soundscapes has shown that post industrial noise music artists have responded to the surrounding sound world with an awareness of the mechanisms that operate in the natural world. The connection between a Schaferian perspective on modern low information soundscapes and the mechanics as described by Krause provide a strong basis for sound aesthetics and arrangement. My work *Peripheral Patterns* examines the patterns of natural environments for arrangement qualities and extends hi-fi sound markings to be inclusive of subtle and machine sounds as manifested in the non-places of the cityscape. The methods and implementation of patterns found in natural soundscapes and the qualities of urban noise into a software system will be discussed in detail in Chapter 4.

The resulting product of the software system from the research in this thesis tends toward the style of post industrial noise music. Post industrial noise music is a field of practice that facilitates multidisciplinary research and experimental practice which is where I position my work. Chapter 3 will explore noise music more closely in a historical a contemporary context.

Chapter 2

Noise Music

It is an impossible task to document the works perfectly. One can only approximate the experience of them, and try to give a sense of what occurred in the original space. The inclusion of a range of materials, text, photographs, diagrams and compact disc sound examples aims to give a sense of the nature of these works, even though all forms of documentation by themselves are inadequate.

Ros Bandt, *Sound sculpture,* 2001

In the beginning there is noise

Noise music began to emerge in the avant-guarde experimental music of Europe in the 1940s. *Musique concrete*, and artist such as Luigi Russolo, Iannis Xenakis, Karlheinz Stockhausen and earlier futurist experiments were radically breaking with melodic and harmonic traditions. Until this point, there was music, the ornamentation of culture, and the bothersome noise. Further deconstructing the classification of music, John Cage demonstrated that music can be made of all sound, with the pivotal 1952 composition *4'33"* (Cage, 1960). The composition of *4'33"* is four minutes and thirty three seconds of silence, where the sound of the space is put into focus, which asks how we can call something music, when there is no traditional sense of the thing, and thereby questions how is something not music. Cage's statement, as expressed with *4'33"*, guided understandings of presence, body and an expanding contextual frame. Furthermore, from this inquiry it is possible to understand relations between sound, environment and intrinsic spatial phenomenology.

Sound itself has a quality of generating new surfaces in spaces it inhabits, new spatial experiences by augmenting existing spaces. Sound artists have reconstructed noise to invoke a tactile and spatial resonance with their sound. Contemporary noise artists such as Merzbow, Yasunao Tone and Phillip Jeck have helped define the modern sound of noise music as a raw expression. It is this tactile and spatial quality which has the potential of generating new surfaces and spatial experiences.

Computer noise

Computer music is a field of study into the application of computer technologies for the purpose of music creation[3]. Most recently, sound artists such as Ryoji Ikeda, Christopher Bissonette and Alvo Nota have approached the medium in a thought-provoking and aesthetically different manner by interpolating the raw energy of noise into a thoughtful and

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[3] Computer music, now often used to refer to any music made on a computer, was originally a term used within academia refer to a field of study relating to the utilization of computing technologies in music composition. Using programming languages and computational models computer music hinges on an intellectual aesthetic, that involves the study and application of music technologies such as sound synthesis, (psycho)acoustics and digital signal processing.

considered sound. The history of computer music comes from the first sound program (MUSIC) developed for the CIRAC computer by Max Mathews in 1957, and was taken further by artist/engineers such as Jean Claude Risset soon after. Experimentation in computer music has employed scientific research such as psychoacoustics, psychology, computer science and technology, to name but a few. Researchers like Perry Cook, John Chowning and others at institutes such as Princeton and Simon Fraser University demonstrate how computer music interests and methods have different foci.

To encapsulate contemporary computer music composition I will refer to a limited number of examples Evoking spacious landscapes in the soundfield with *Pentes* (Samlley, 1997), Dennis Smalley produces a spatial experience through drones and intense textures of sound. The texture of the sound in *Pentes* achieves a granular and tactile quality that resonates like the rustling of a tall grass. Rosy Parlane assembles a sonorous spatial field in *Iris* (Parlane, 2004). Parlane achieves this, in part, with the purposeful and considered placement of sonic features. Spatial textures are made audible also in the sound works of Christian Fennesz, *Rivers of Sand* and *City of Light* (Fennesz, 2004). The physical quality of sound in a spatial field leads to an abstract sonic topography that positions the listener within an experiential field.

Listening to the compositions of Adrianne Moore, sonorous fields are encountered, arranged with objects that dialogue within a temporal flux. Moore's audio piece *In Paradisum* (Moore, 2006) presents the listener with patterns and textures that bring interest to the listening experience. Also providing texture and surface, Anthony Pateras and

Robin Fox provide the listener with the dialogue of several sounds in the piece *Aphasia* (Pateras, 2008) that make manifest a similar interest in listening.

Relationships

Noise music and computerized sound construct sounds, where spectral and temporal semantic relations develop over time. It is the phenomenon of emerging relationships that piques curiosity and an interaction with a listener. There is an intellectual and emotional aesthetic that arises from the experience of noise music, and the encounter of sound in perceptual space. Equally, a disembodiment occurs, as any known causal relationships of sound and object appear removed. By placing disembodied sounds in known relationships there is a gesture toward the uncanny as it plays with the logic of our experience of the world, being both unknown and familiar. Stuart Jones, author of the article *space-dis-place: How Sound and Interactivity Can Reconfigure Our Apprehension of Space*, sees all spaces of sensation having their own contours and dynamics, pertaining to a perceptual logic (Jones, 2006). In designing the sound for the film and sound work, *These are not my images*, Jones needed to situate the viewer at a position of intimacy with a woman, but where the camera is holding them at a distance, to portray the feeling of both closeness and distance as was the narrative of the film. He resolves this paradox by using noise to form a dialogue with the sound and image, using the experiential attributes of closeness and distance to position the viewer/listener.

The above artistic developments show an evolving praxis towards the ontology of sound that explores a higher relational and experiential field. By facilitating analysis of object, silence and topological space, sound no longer remains just 'the sound' in this context, but an experiential situation that encodes and decodes spatial and conceptual relations. This relationship evolves as a complex situation of reciprocal shaping of event and experience. Sound augments the space as it creates new associations between what is being heard and the space. The space provides a return, as sound permeates the existing surface topology and shifts temporal and phase relations intrinsic to the sound itself. The intervention of space and sound disengages both, assembling new force, activating new potentials.

Talking about it

Even though sound as an experimental medium holds a great deal of potential, it can often go unrealized. Noise music and computerized sound are forms of expression and investigation that have been practiced for more than half a century, although compared to visual art, the awareness of sound and the potential it inhabits are relatively new. Sound and noise as a medium only began with any vigor in the 1940s and 1950s with Musique concrete and John Cage that broke from existing musical archetypes. One of the reasons of the secondary nature that sound plays in culture, is that as a practice, it does not necessitate objective representation such as a score or written word. The ephemeral nature of sound, moreover noise music, means that there exists a growing body of work that has mostly been undocumented. Recent music theory and musicology has called for an analysis and documentation of works that are often, by their nature, an audio recording or computer code without further documentation. This knowledge gap makes it difficult for further study, and the culture of thought and technologies of the music are also lost.

Language is, itself, an inadequate means of relaying the actual experience of sound. Jim Drobnick, author of *Aural Cultures*, debates that as with images, there are problems with sound "not being fully explicable within the paradigm of textuality" (Drobnick 2004). Doubly problematic for a discussion of sound, is that language has been completely involved with the visual domain, leaving a vocabulary of visual analogies for discussing the experience of sound. Although textuality is seen as problematic for sound, a growing list of texts is emerging to help root a discourse of aural phenomena. Most frequently, texts are taking a retrospective on what effect sound has played within cultures, piecing together an investigation from the scattering of documentation and experiences. Investigating sound within a variety of cultural contexts, *Hearing Cultures* (Erlman, 2004) looks at how sound operates in a visually dominated society. Journals and conferences such as *Leonardo Music Journal* and *Australasian Computer Music Conference* tend toward process and technology.

To further aid in the discussion of sound and noise music, Dennis Smalley introduces a language of spectromorphology for describing sound material in a reduced listening context (Smalley, 1997). The ideas laid out in spectromorphology advance a structural analysis of sound by spectral content and temporal change. Since computer and electroacoustic music that use acousmatic[4] sound do not require notation that can be studied, spectomorphology gives us a framework for understanding spectral and temporal relations of sound in non-notated music and attempts to provide a common language in the discussion of sound.

Continuing further along this line of inquiry, and outlining a framework for disassembling and analyzing computer and electroacoustic music researcher David Hirst demonstrates a technique named segregation-integration, assimilation-meaning (SIAM) in his paper *The development of a cognitive framework for the analysis of acousmatic music* (Hirst, 2006). Segregation and integration relies on the identification of sonic objects and their causal linkage over time. Assimilation and meaning refers to the integration of sounds as a creation of timbre or texture, and how the sound and piece affects the listening experience. In an analysis of Denis Smalley's acousmatic piece *Wind Chimes*, Hirst demonstrates SIAM as a system for understanding the acousmatic material, in a reasonably objective manner. From the observations outlined in Hirst's paper it can be seen that there is a process of pulling apart the music to analyze the technical attributes, and that by itself language is inadequate for relaying the actual experience of the sound.

As we have seen the discussion and understanding of computer music is as much a language of process as it is of experience and abstraction. This thesis looks at patterns in the

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[4] The term acousmatic is taken from the probationary period of akousmatikoi to which disciples of Pythagorus were subjected to. For three years hopeful students would sit behind a curtain before they were let into the inner circle of Pythagorus' teachings. Similarly to Pythagorus' curtain, acousmatic sound sits behind the curtain of the loudspeaker, reducing the experience of listening to the sound thing itself. Pierre Schafer used acousmatique to refer to musique concrete compositions, where the sound as object in itself, more than the source of the sounds, is considered.

soundscapes of natural and urban environments. Through the analysis of soundscapes it is shown that components of noise music consist of the convergence of those patterns. An influence for this thesis has been patterns that have characteristics of peripheral sounds. A definition of the periphery in the context of this thesis is described in the following chapter.

Chapter 3

Peripheral Sound

A defining concept of this thesis is the periphery in the context of audition. In clarifying the resulting terminology used for the title *Peripheral Sound* this chapter discusses how, from a phenomenological perspective, a range of frequencies can be viewed as existing within the periphery. Furthermore, from physiological evidence I will look at how that these peripheral sounds influence spatial perception and enhance listening.

Periphery within the horizon

The Oxford dictionary defines periphery as “the outer limits or edge of an area or object, and a marginal or secondary position in, or part or aspect of, a sphere of activity”. From a phenomenology perspective Don Idhe, author of Listening and Voice (Ihde, 2007), discusses human perception in terms of “focus”, “shading off” and “horizon”. Idhe uses these three perceptual zones to outline the phenomenon of visual focus on an object. In vision we have a central point of focus or attention. Secondary to this is an area that shades off; this area of peripheral vision is less distinct. Lastly, the horizon is the border or limit of the perceptive apparatus. Extending this model to audition, Idhe compares the horizon of visibility to that of silence in hearing, and the focal point as louder sounds. For Idhe it is the inclusion of stimulus in the shading off area and horizon that enhances listening (Idhe, 2007, p. 222). As with peripheral vision, peripheral sound is within the shading off area. I argue that in addition to the zone between loudness and silence in human audition, marginal or secondary sounds that hold no particular significance occupy the periphery.

Defining peripheral sound

As discussed in Chapter 1 (Figures 5 & 6) incidental sounds can be heard in the urban soundscape. These incidental sounds are peripheral because they inhabit a range of audition at the outer limits of the high information band that we commonly use to communicate and receive information from the urban environment.

In day to day activities such as conversing and interacting with the made world we encounter sounds that are generally between 30Hz and 5kHz. The frequency range of the human voice, with a fundamental frequency between 100 - 300HZ, is contained within the above bandwidth, and sibilant overtones (as found in the sounds “s” and “st”) extend the range up to 5kHz. Other noises encountered in urban activities such as the sounds of an ATM and mobile phone ring tones are concentrated at the lower end of the range.

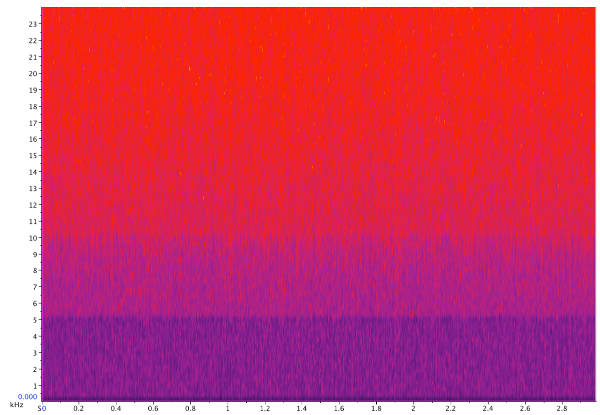

Figure 9. Spectrogram demonstrating the "high information" area and shading off at higher frequencies.

A healthy young adult is capable of hearing frequencies in the range of 20Hz - 20kHz. Although there is some variation between individuals and the range decreases as age increases, we will consider the nominal range to be 20Hz - 20kHz for the purpose of this discussion. Taking into account that the high information band cuts off at 5kHz there is 15kHz of additional auditory space that is not often engaged. As we saw in the spectrograms of city soundscapes in Chapter 1 (Figures 5 & 6), the 15kHz space is occasionally frequented by subtle and incidental sounds that tend not to be purposeful.

In a physiological context, higher frequency incidental sounds may enhance our experience in several ways. One way in which this enhancement takes place is with spatial perception, considered in duplex theory (Mather, 2006). Duplex theory suggests that higher frequency sounds at each ear provide rich information, especially key in discerning the direction of a sound. Another significant factor in the localization of a sound source is the filtering effect of the pinna. The shape and hollows of the pinna induce a series of filters to incoming sound which are related to localization cues. At higher frequencies the length of the sound wave relates to the measurements of the pinna (Raykar, 2005) creating the potential for embodiment of these resonant frequencies.

Although subtle, the addition of peripheral sounds to the normal high information band induces our perceptual apparatus to further enhance the experience of our surroundings.

Chapter 4

Project - Peripheral Patterns

> *It became apparent to me that these machine sounds should be allowed to belong to my emerging image of nature.*
>
> David Chesworth*, Environment: videowall soundscape,* 1996.

Introduction

The project *Peripheral Patterns* is a computer program that generates music to explore the topics covered in this thesis - namely, the convergence of machine sounds with patterns similar to those found in the natural soundscape. I wanted to produce a type of sound that is considered peripheral, i.e. at frequencies and amplitudes that are not often engaged in the high information band of the urban environment. It was my aim to have a generative system for producing and creating patterns of high frequency machine like sounds. I based the success of the generative music on the sensations I felt when listening to the audio. These sensations included my interest in wanting to keep listening to the piece as it unfolded. Another factor considered was the cerebral sensation in response to the quality of the sound, with more cerebral activity being good. Finally, it was desirable to maximize the autonomy of the system so that the system would run and produce a piece of music that was different from the last time the system ran.

Methodology

I took a modular and iterative approach to the design and development of the system, which I will now discuss in detail. The modular and iterative methodology involves breaking up the program design into discrete units that can be worked on individually. An iterative process of building these units is then applied and their worth is checked against a set of criteria, including how they operate within the system as a whole. The system is then evaluated and checked against a set of global criteria. If a failure occurs at this stage of checking - either units or system - then the process is repeated on the problem area. Through this model of development there is a "stepping into" the process, operating intimately with units as understanding of the mechanics of the system is advanced. There is also a requirement of "stepping out" of the process to evaluate the system.

I found a number of advantages to the above methodology. First, by separating the tasks and operating at different positions on the system instead of wholly working in one position, I found there was clarity of mind whilst programming. Second, if a modification to the system was required, because of technical failure or aesthetic choice, then the unit that pertained to the modification could be separated and operated on individually. The ability to easily separate and modify the system in the modular and iterative approach also facilitates experimentation as different parts of the system can undergo minor or major changes to see what happens to the overall shape of the system. The experimental capacity engendered by programming also comes from the ability to take snap shots of the program at stages of development, which I regularly did in *Peripheral Patterns*. By knowing that I could always revert to an earlier version (snap shot), I was more inclined to experiment with different processes and take risks.

Tools

A variety of programming environments, or integrated development environments (IDE), are available to creative practitioners for the development of computer programs. These IDEs focus on making software tools fast to implement and accessible for creative practitioners. A number of these IDEs are open source and freely available. For example, the Processing[5] IDE provides access to advanced graphics and image manipulation through a high-level programming interface. More adept for audio performance is Pure Data (PD)[6] that has aided experimental and new music practitioners to explore and advance their sound through a simple visual interface. Many examples of these projects can be seen through the websites for these IDEs. A programming environment that I have found favorable in prototyping and experimentation for creative audio research is Supercollider3[7] (SC3). SC3 is similar to PD in

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[5] Processing is an open source programming language and environment. Available from www.processing.org cited 12/09/10.

[6] Pure data is an open source programming environment with an interface similar to Max/MSP. Pure Data is freely available from www.puredata.info cited 12/09/10

[7] Similar to Processing and Pure Data Supercollider3 is an open source and free programming environment. Created by James McCartney it is now available at http://supercollider.sourceforge.net// cited 12/09/10

that it conforms to the programming paradigm first developed by Max Mathews in the MUSIC system[8], of connecting unit generators. The unit generators perform functions such as generating a waveform, applying a filter to a signal as well as other audio and control rate functions. Unit generators are connected to one another through their inputs and outputs. Whereas PD is programmed using a visual interface of blocks and patch cords, SC3 uses a text-based client interface that sends commands to an SC3 server to create and manipulate sounds. I am familiar with the SC3 interface and find text-based coding more rigorous and extensible than its visually based counterparts.

Implementation

There were several program design requirements for *Peripheral Patterns*. First, the desired timbrel qualities called for the assembly of high frequency machine like sounds, similar to the incidental sounds found in the urban environment. These sounds are arranged computationally in regular patterns that exhibit interplay, similar to the patterns observed in the natural soundscape. Second, each time the program is run the resulting composition is to be different from the last, fulfilling my expectation of a generative music system. Lastly, to make the system self-contained there should be little or no pre- or post- production required.

In developing the incidental urban sounds I adopted an analysis by synthesis technique. Analysis by synthesis was described by Max Mathews in 1973 (Chowning, 2000)

[8] A good general investigation on computer music, including the MUSIC system, and its history is provided in the text *Electronic and Computer Music* by Peter Manning, Oxford University Press, 2003.

(earlier developed by Mathews and Jean Claude Risset) as a method of synthesizing complex instrument tones. Mathews and Risset achieved a favorable result of synthesizing instrument tones by using a computer to analyze the instrument tones and synthesizing those tones based on the description from the analysis. A subjective comparison was used to determine the success of the synthesis. Similarly, I used the spectrograms of the recordings from urban soundscapes (Figures 5 and 6) to formulate a profile of incidental machine sounds in those environments. I also performed analysis of several post industrial noise music pieces, such as those seen in figure 7, and made subjective judgments on the quality of my synthesis based on a combination of city sound and contemporary post industrial noise music. Figure 10 shows a spectrogram of Track 4 on the accompanying CD and demonstrates the resulting output of the above analysis through synthesis.

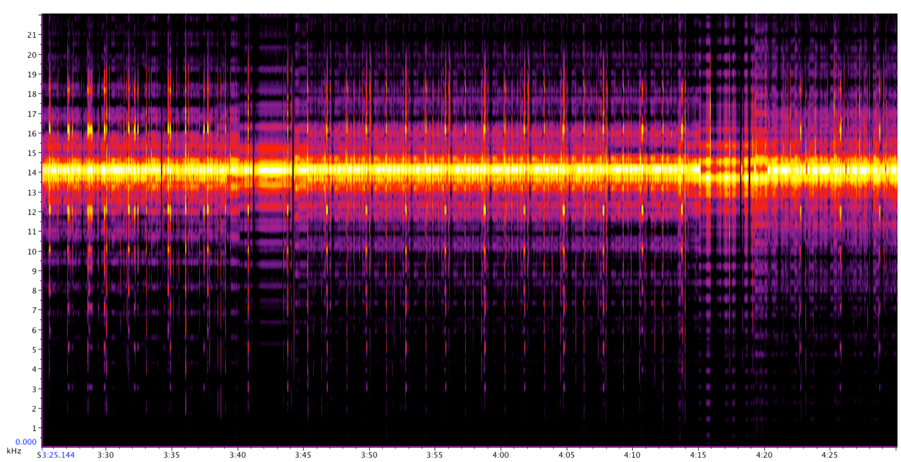

Figure 10. Spectrogram of resulting analysis through synthesis.

The SC3 synth definition code for the generation of the sound of the aforementioned audio clip is shown in Caption 1. A synth definition is a conglomeration of unit generators and operations that make up an instrument or synthesizer.

```
b = Buffer.read(s, "sounds/glitchManifest2.wav") ;

SynthDef(\Peripheral, {|bufnum=0 stpos=0 stretch=1 pitch=1 end|
	var source, env;

	source = PlayBuf.ar(1, bufnum,
					BufRateScale.kr(bufnum),
					rate:stretch,
					startPos:stpos
				) ;
	source = HPF.ar(source, 15000) ;

	source =  PitchShift.ar(source, pitchRatio: pitch) ;

	env = EnvGen.kr(Env.new([1,1,1], [0, end]), doneAction:2) ;

	source *= env ;

	Out.ar([0,1], source)

}).send(s) ;
```

Caption 1. SC3 code of the synth definition for *Peripheral Patterns*

The synth definition in Caption 1, first reads a sound file as an audio data buffer (Track 5). The sound file is a synthesized sine tone generated in the Processing environment using the ESS sound library. Filter and pitch parameters are manipulated from a graphical user interface (Figure 11). When manipulating the parameters, digital artifacts are created which are then used in *Peripheral Patterns* and is the primary reason I chose this tool. The resulting ESS output was piped internally through Sound Flower, and digitally recorded with Audacity, a digital recording software, at a sampling rate of 48KHz and 32bit resolution.

Although the re-synthesis of the signal breaks from the notion of a self-contained system in that it requires an external sound source, I found this process facilitated a higher tendency for varied output from the sequencer routines, which are discussed in the following paragraph.

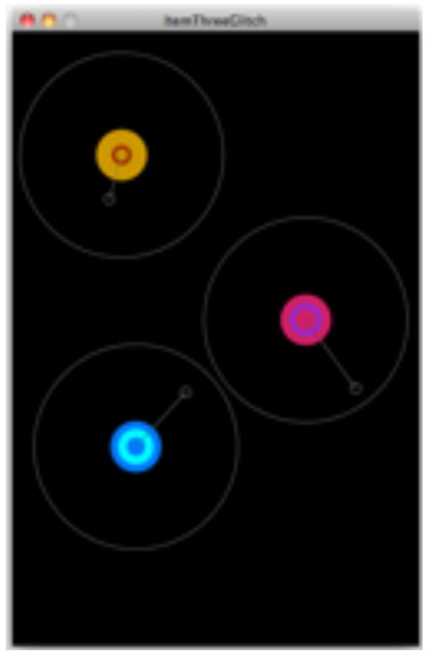

Figure 11. Screen grab of sound generation tool built with Processing and the ESS library.

The dynamic generative quality of using a sound file outweighed the potential loss of a self-contained system in *Peripheral Patterns*. I will now describe the individual unit generators used in the *Peripheral Patterns* synth definition in the order of the signal chain. I will thereafter go in to detail regarding the pattern generation system and how the unit generators operate on the sound for a dynamic output.

A PlayBuf unit generator was used to generate an audio signal from the sound file buffer. The PlayBuf makes parameters available to manipulate the audio signal rate, effectively changing the duration and pitch, and play anywhere along the length of the buffer. The signal is passed into a high pass filter (HPF) that only passes signals above a selected cut off point. A time domain granular pitch shifter (PitchShift) again changes the pitch of the signal, but unlike the rate parameter in the PlayBuf, the granular pitch shifter does not alter the duration of the signal. Along with the ability to change pitch the granular pitch shifter introduces agreeable artifacts to the sound, which are common with granular techniques. A triangular amplitude envelope with a variable end point is then applied to the signal. When designing the above synth definition it was important to consider the resulting sound and also to provide enough flexibility through unit generator parameters for dynamic results.

Patterns

The primary function of the pattern system is to generate patterns that have qualities like those that exist in nature, as previously discussed. Caption 2 shows the SC3 code for the sequencer routine and list generator that provide data to the synth definition parameters and sequencer.

```
Task({
     // Pattern generator
     ~numSequences = 10 ;
      ~numEntry = 10 ;
      ~totalTimes = 100 ;
      ~prime = [2,3,5,7] ;

      ~parts   = {rrand(0, b.numFrames*0.75).asInteger} ! ~numEntry !
~numSequences ;
     ~times  = {~prime.choose} ! ~numEntry ! ~numSequences ;
     ~reps    = {~prime.choose} ! ~numEntry ! ~numSequences ;
     ~rates   = {rrand(0.2, 0.8)} ! ~numEntry ! ~numSequences ;
     ~ratios  = {rrand(0.5, 2.0)} ! ~numEntry ! ~numSequences ;

     // Sequencer routine
     ~numSequences.do({|i|
          Task({
               ~totalTimes.do({|j|
                    ~reps[i][j].do({
                         Synth.new(\Peripheral, [
                                   \bufnum, b.bufnum,
                                   \stpos,   ~parts[i][j % ~parts.size],
                                   \stretch, ~rates[i][j % ~rates.size],
                                   \pitch,   ~ratios[i][j % ~
ratios.size],
                                   \end,     ~times[i][j % ~times.size]
                                             ]) ;
                         ~times[i][j % ~times.size].wait ;
                    }) ;
                    ~prime.choose.wait ;
               }) ;
          }).start ;
          ~prime.choose.wait ;
     }) ;
}).start ;
```

Caption 2. SC3 pattern generator and sequencer

Each of the lists and their uses are in Table 1. Each list is populated by numbers chosen within a random range. The random range was a subjective decision based on the quality of the result through a trial and error process. In the future I would like to further analyze patterns in soundscape recordings to produce more rigorous and coherent methods of generating numbers.

List Name	Use
~parts	Start position of the PlayBuf along the sound file buffer
~times	The length of time to keep the amplitude envelope open
~reps	Number of repetitions of current part
~rates	Speed of PlayBuf
~ratios	Ratio of the pitch shift (PitchShift)

Table 1. Lists generated and their application.

The sequencer starts a Task (a routine wrapped in a pauseable stream) that starts *n* sequences, each seperated by an offset time. Each newly created Task starts a process with a number of repetitions defined in ~totalReps with a wait period after each iteration. A process is started on each iteration with a number of repetitions defined in ~reps[i] with a wait period of ~times[i]. In each iteration, an instance of the *Peripheral Patterns* synth definition is called and the parameters for start position, rate and pitch ratio are retrieved from the corresponding list.

Varying the start position when reading the audio buffer provides a varying signal for processing, as the digital artifacts present in the recording may or may not be read in the current part. Applying a reduction to the rate of the PlayBuf increases the duration of the segment being played thereby providing a greater time to pull out the nuances of the signal. Alteration of the pitch ratio in a positive direction brings the frequency of the signal up into the range of frequencies I was wanting to explore in *Peripheral Patterns*. By focusing only on higher frequencies with no low frequency material I found that there was no requirement for post-production processes of the recorded output. I experimented with several compression and equalizer treatments and found there was little adverse difference made to the recorded output.

Listening experience

It was desirable for *Peripheral Patterns* to reflect interplay between patterns, with a tendency for high frequency machine like sounds. As an overall aesthetic I wanted to aim for the sound of minimal post industrial noise music. From the program described above I was able to experiment with the effect by changing the synth definition and sequencer parameters, recording the resulting output. Table 2 lists the recording names, the corresponding CD track number, and changes to the parameters.

Recording name	# on CD	Parameter adjustment
One	6	numSequencers = 1.
Three	7	numSequencers = 3.
Eight	8	numSequencers = 8.
Ten	9	numSequencers = 10.

Table 2. Track information and adjustments

A component of the iterative working process adopted for this project was to receive feedback from listeners on their response to the *Peripheral Patterns* sound and composition.

This feedback would help in determining the success of components in the current program. For the purposes of receiving feedback on the experience of listening to the recordings, I played the tracks listed in Table 2 to a small audience and simply took note of their responses. The listening space was a large black room with subdued lighting. While not acoustically ideal there was a quadraphonic monitoring system of four (4) Mackie HR824. The recordings, which are two-channel stereo, were played back as four-channel stereo. To prepare the audience for the listening experience I asked them to notice the acoustic and bodily sensation of the size of the space. I hoped they would carry this awareness of their body position within the space into the listening experience. Each recording was played in the order given in Table 2, with a 30 second interval between tracks.

After we finished the listening exercise I asked people to comment on what they felt whilst listening. One person who had previously experienced seeing shapes with sound, commented that they saw spherical and conical 3D shapes whilst listening. The synesthetic phenomena was also experienced by another person who saw colors, she had not previously experienced a strong synesthetic response. On this occasion I experienced textures in my vision and I felt the sound was resonating in my body. There was also a heightened spatial phenomenon that was shared by everyone. People commented that they experienced discrete sound coming from a 3D sound field even though audio was emitted from a left and right 2D sound field.

Exhibition

The application of *Peripheral Patterns* was extended for the inclusion in the 2010 Graduate Exhibition at the Charles H. Scott gallery in Vancouver. I was given a room measuring 3x5 meters to install *Peripheral Patterns*. I was hoping to provoke a similar experience that people had listening on the previously mentioned occasion. Four (4) Mackie HR824 monitors were set up in a quadraphonic arrangement. The ideal listening position was located in the centre of the four-channel layout. A bench was supplied to highlight the listening position and provide comfort for people to experience the piece for longer durations. Due to the smaller dimensions of the room I also built several sound panels that were installed on the walls at key points to limit the reverberant qualities of the room. Figure 12 shows the floor plan for the installation of *Peripheral Patterns* at the Charles H. Scott gallery.

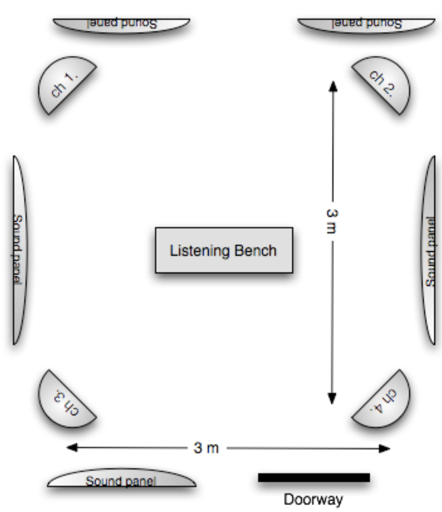

Figure 12. Layout of *Peripheral Patterns* installation in Charles H. Scott Gallery

The installation piece was a medley of studies and experiments made with the *Peripheral Patterns* program. The pieces were arranged into a piece 45 minutes in length using the Reaper digital audio workstation. I drew on my experience of sound design to attempt to create a journey for the listener. Included on the accompanying CD are three (3) excerpts of the piece (Track 10 11 and 12), chosen because of their tendency to exhibit peripheral features and a strong composition style.

During the exhibition of *Peripheral Patterns* I observed how people were experiencing the installation. On several occasions people would walk around the space and towards the speakers, in an organized pattern. Questioned about their behavior they replied, "the piece has a varying interactive response depending on where you stand in the room". I received a similar response from a number of individuals. I surmise that because the installation of *Peripheral Patterns* had no active interactivity, people were responding to the patterns exhibited in the piece and the psychoacoustic qualities of distance and direction in high frequency sound.

A concern was that arranging smaller pieces of *Peripheral Patterns* into a layered and longer piece would contribute to an overcrowding of the sound. I gave consideration to this by arranging the sound so that it would not inhibit the interplay of patterns and still be within the style of post industrial noise music. Two comments that supported the qualities I was seeking were given. One by a person who has experience with experimental music and said that the experience was "sublime", having "thoughtful qualities". Another comment regarded the patterns as something she was "..interested in exploring as the piece unfolded".

The objective for *Peripheral Patterns* was to develop and implement a computer program to explore the convergence of peripheral machine like sounds, and patterns similar to as those found in the natural soundscape. I wanted to investigate the effect of organized peripheral sound on the listening experience, especially concerned with spatial sensation. The program enabled me to experiment with different arrangements and qualities of sound, and make recordings of the resulting output. I had the opportunity to receive casual feedback from a number of people on the recordings. There were not any direct comments regarding spatialization in the sense of "the room is bigger" I can infer a spatial reaction from people's responses.

Conclusion

Motivation for this thesis began with the experience of the Vancouver soundscape. This experience compelled me to delve deeper into the implications of the soundscape on the human psyche. The process of investigation involved the analysis of a number of soundscapes from natural and urban soundscapes through a means of spectro-analysis. The organization of sounds, spectral content, and patterns evident in natural and urban soundscapes were shown to be components of noise music. It was found that in post industrial noise music there was present the seemingly superfluous high frequency machine sounds in urban soundscapes arranged in organized patterns similar as those found in nature. Examining incidental sounds from a phenomenological and physiological point of view I formed the opinion that these sounds can be considered as peripheral within the context of human audition. Taking this perspective of the periphery into account I was further interested in what effect the purposeful arrangement of these sounds would have on the listening experience.

A computer program was created to generate music that explores the arrangement of peripheral sound. The arrangement procedures, whilst generative, were based on qualitative data based on observational analysis of spectrograms. An avenue for further development of the generative system would be to formulate an equation that describes patterns in nature, and its implementation into the software. Equally the spectral content of peripheral sounds would benefit from a more rigorous technique of analysis and synthesis. An initial investigation in this line of inquiry would point toward building a software module to generate synthesis units from the profile of a soundscape recording.

My research and practice is now directed toward deeper thinking of how people experience sound and patterns as an aware body. I still hold the view that the natural world, even in its abstraction, is key to a richer experience of being. It is apparent that cultural producers, especially with sound, have responded to this innate sense within contemporary practice. What I now find at the junction of natural and city environments is an emerging tension between an inherent desire for the essential qualities of the world and a seemingly boundless homogeneity. Working with this problematic, I see potential for exploration and analysis of how sound, interaction, and computational algorithms that represent dynamic qualities of natural systems affect the listening experience.

Bibliography

Arkette, Sophie. 2004. Sounds Like City. *Theory, Culture & Society* 21, no. 1 (February 1): 159 -168. doi:10.1177/0263276404040486.

Augé, Marc. 1995. *Non-places*. Verso, May.

Bandt, Ros. 2001. *Sound sculpture*. Craftsman House, August.

Bandt, Ros, and Ian Mott. Australian Sound Design Project. http://www.sounddesign.unimelb.edu.au/site/index1.html. cited July 10 2010.

Cage, John. 1960. *4'33"*. Henmar Press.

-. 1961. *Silence*. Wesleyan University Press, June 1.

-. 1991. *Works for Percussion Quartet*CD. Wergo.

Cage, John, and Lou Harris. 1941. Double Music. Live concert performance San Fransico, California.

Cardiff, Janet. 1991. *Forest Walk*Audio walk. 12min. http://www.cardiffmiller.com/artworks/walks/forest.html.

Chesworth, David. 1996. *Environment : videowall soundscape*CD and accompion booklet. Sydney, Australia: Museum of Sydney.

Chowning, John M. 1977. The Simulation of Moving Sound Sources. *Computer Music Journal* 1, no. 3 (June): 48-52.

Chowning, John M. 2000. DIGITAL SOUND SYNTHESIS, ACOUSTICS, AND PERCEPTION: A RICH INTERSECTION. *Proceedings of the COST G-6 Conference on Digital Audio Effects (DAFX-00),* Verona, Italy, December 7-9, 2000

Cook, Perry R. 2001. *Music, cognition, and computerized sound*. MIT Press, March 1.

Drobnick, Jim. 2004. *Aural Cultures*. YYZ Books, April.

Eckel, G. Immersive audio-augmented environments: the LISTEN project. In *Proceedings Fifth International Conference on Information Visualisation*, 571-573. London, UK. doi:10.1109/IV.2001.942112.

Epstein, William, and Sheena J. Rogers. 1995. *Perception of space and motion*. Academic Press.

Erlmann, Veit. 2004. *Hearing cultures*. Berg Publishers.

Fennesz. 2004. *Venice*. March 29.

Gaye, Lalya, Ramia Mazé, and Lars Erik Holmquist. 2003. Sonic City: the urban environment as a musical interface. In *Proceedings of the 2003 conference on New interfaces for musical expression*, 109-115. Montreal, Quebec, Canada: National University of Singapore.

Hirst, Dr David. 2006. The development of a cognitive framework for the analysis of acousmatic music.

Ihde, Don. 2007. *Listening and voice*. SUNY Press.

Jones, Stuart. 2006. space-dis-place: How Sound and Interactivity Can Reconfigure Our Apprehension of Space. *Leonardo Music Journal* - (December 1): 20-27. doi: 10.1162/lmj.2006.16.20.

Krause, Bernie. 1993. The niche hypothesis: A hidden symphony of animal sounds, the origins of musical expression and the health of habitats. *Explorers Journal* 74, no. 4: 156-160.

Leitner, Bernhard. Bernhard Leitner Texts. *Bernhard Leitner TEXTS*. http://bernhardleitner.at/texts?CAKEPHP=a8446791af7c5e4141837340193fc68e. cited July 10 2010.

-. Bernhard Leitner Works. *Bernhard Leitner WORKS*. http://www.bernhardleitner.at/works?CAKEPHP=3acf072f93d3148ace59620676c70a1f. cited July 10 2010.

-. 1987. *Sound Start*.

-. 1996. *Firmament*.

Lucier, Alvin. 1969. *I Am Sitting in a Room*Audio recording. 15:23.

Mather, George. 2006. *Foundations of perception*. Psychology Press.

Moore, Adrian. 2006. *CD*CD. empreintes DIGITALes.

Parlane, Rosy. 2004. *Iris*CD. Touch.

Pateras, Robin Fox Anthony. 2008. *Coagulate*CD. Synaethesia, December 22.

Raykara Vikas C. and Ramani Duraiswamib. 2005. *Extracting the frequencies of the pinna spectral notches in measured head related impulse responses* Journal of the Acoustical Society of America 118 (1), July 2005

Schafer, R. Murray. 1978. *The Vancouver soundscape / edited by R. M. Schafer.* World Soundscape Project, Sonic Research Studio, Dept. of Communication, Simon Fraser University, c1978.

Schafer, R. Murray. 1993. *The soundscape*. Destiny Books.

Shepard, Mark. 2007. Tactical sound garden toolkit. In *ACM SIGGRAPH 2007 art gallery*, 219. San Diego, California: ACM. doi:10.1145/1280120.1280176.

Smalley, Dennis. 1975. Pentes. Performance March 20, Auditorium 104 — Maison de Radio France (Paris, France).

-. 1997. Spectromorphology: Explaining Sound-Shapes. *Organised Sound* 2, no. 02: 107-126. doi:10.1017/S1355771897009059.

-. 2000. *Sources/scènes*CD. empreintes DIGITALes.

Truax, Barry. 2001. *Acoustic communication*. Greenwood Publishing Group.

Yang, Wei, and Jian Kang. 2005. Soundscape and Sound Preferences in Urban Squares: A Case Study in Sheffield. *Journal of Urban Design* 10, no. 1: 61-80.

Zhang, Mei, and Jian Kang. 2007. Towards the evaluation, description, and creation of soundscapes in urban open spaces. *Environment and Planning B: Planning and Design* 34, no. 1: 68 – 86. doi:10.1068/b31162.