The Modular Garden: towards real-time synthesis of Japanese garden soundscapes.

A thesis submitted in fulfillment of the requirements for the degree of MASTER OF DESIGN

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DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

Scott Brewer

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ABSTRACT

This exegesis explains the steps taken in designing The Modular Garden, an artistic impression of a Japanese garden soundscape that uses sound synthesis to generate the audio. The project was undertaken in three main stages that culminate in a sound installation, to be presented at examination.

The three design stages of the project were analysis, design and reflection. Analysis was undertaken on recordings taken at two established Japanese gardens located in Tokyo, Kyu Furukawa Teien and Koishikawa Korakuen. This analysis, grounded in techniques taken from the fields of soundscape studies and acoustic ecology, informed the audio events that would be required to compose a Japanese garden soundscape. The eight chosen sound events (suikinkutsu, waterfall, footsteps, crows, pigeons, songbirds, insects and the shakkei) were analysed further and synthesis modules were created that were capable of recreating the sound events. The modules, written using the audio programming language SuperCollider, were designed using a range of synthesis techniques; including additive, subtractive, granular, formant, frequency and amplitude modulation. A composition was created using the eight sound modules. Reflection was undertaken on the modules and their use in the composition. An installation using the modules, and other sound production techniques, will be presented at examination. The installation aims to exhibit lessons learned throughout the undertaking of the project and documented in this exegesis.

1. Introduction

This report documents and discusses a project called *The Modular Garden*, undertaken throughout the course of my study in the RMIT Faculty of Architecture and Design in the field of Design and Social Context. The primary aim of the project was to investigate the ability to design an electronic system, using only synthesised sound, capable of generating soundscapes of Japanese gardens. Apart from the system there were a number of other desired outcomes: personal study of synthesis techniques and soundscapes (particularly those relating to Japanese gardens) and the experience of researching a design capable of combining the two fields, by means of composition and installation. The research was conducted in three phases: analysis of Japanese garden soundscapes; design of sound synthesis modules capable of recreating sounds discovered in the analysis stage; and finally testing of, and reflection upon, the modules use. The study will culminate in an installation to be presented at examination. This installation will draw on discoveries made throughout the course of the study and is outlined in the final pages of this document.

As with many other projects, my research took different forms throughout its duration. In the early days of my study, Peter Downton instructed me that Master's or Doctoral study should take on a pyramid-like form, where one starts with a wide knowledge base with plenty of ideas and slowly narrows in to the fine detail of the particular field of study¹. I believe my study took more of a diamond-like course. I started with some narrow goals, and then the more I researched the wider my goals grew. This growth continued until sometime in the middle of my study when I could see that in order to finish the degree I had to narrow my goals and work solely towards that focus. Interestingly, the final focus of the study ended up being not too far removed from my original concept, involving the synthesis of sounds of Japanese gardens. It was, however, greatly improved by the additional study of soundscapes and composition.

¹ Peter Downton, as well as being a member of the Teimu project (see p.3) also taught a Research Methods class I undertook at the beginning of my degree and wrote a key text on research for design (Downton, 2000)

A graphical representation of the intersection of the three main fields of study involved in this project is show in Figure 1. These fields - sound synthesis, soundscape studies and composition - each represent a key area of study for my research. The intersection of the three sets was my primary focus. The size of each set in the diagram has been adjusted in an attempt to reflect the importance each field had on my work (the 'weight of influence' as I will refer to it). As explained in the introductory paragraph, my initial motivation for this course of study was synthesis techniques. Once I had found a specific direction for my study (the sounds of Japanese gardens) I needed to undertake research into soundscape studies and it became imperative to test my work by a compositional realisation.

The following sections reveal my discoveries in each of these three fields, gained from the literature related to similar projects, as well as from listening to a range of synthesized sound compositions.



Figure 1: Relative importance of fields of study

Each field's size is an attempt to reflect the level of importance I placed on it during my study. Work that intersected multiple fields was my primary focus.

There are four chapters in the body of the exegesis: 'Context of the Study: Literature and Projects', 'Garden Analysis', 'Module Design' and 'Design Outcomes'. These four chapters describe the project chronologically. 'Context of the Study: Literature and Projects' discusses the primary influences in each of the three fields shown in Figure 1. It also describes similar projects, providing some insight into how other people have tackled the problem of creating synthetic environments. The 'Garden Analysis' chapter describes how I analysed recordings made in Japanese gardens, extracting the information required to recreate the soundscapes. 'Module Design' provides detailed information of how I designed eight sound modules using synthesis techniques. When combined these modules created new soundscapes of Japanese gardens. 'Design Outcomes' discusses how I tested my designs by way of a soundscape composition; it starts by discussing how I created the composition before reflecting on it as a way of testing the design of the modules. The chapter also discusses a number of lessons I learnt from undertaking the project (lessons not necessarily a direct reaction to the composition) and how these lessons might be reflected in my future work. As well as the body of the document there are also 'Introduction' and 'Conclusion' chapters. The Introduction provides the reader with a brief overview of how the work was framed, while the Conclusion summarises the work undertaken and makes mention of key discoveries for my future design work.

My work was undertaken at the SIAL Sound Labs at RMIT University, a multidisciplinary research facility focussing on sound and its connection to other fields. The project took place as part of a larger project funded by the Australian Research Council entitled *Teimu (The Garden of Dreams): aural and aesthetic attributes of Japanese gardens as models for spatial environments* (Fowler and Harvey, 2006). The Teimu project team comprises three members of RMIT University - Mr. Lawrence Harvey, Dr. Michael Fowler and Professor Peter Downton, as well as two members from the University of Melbourne - Dr. Greg Missingham and Mr. Alex Selenitsch. The Teimu project is undertaking an investigation of the spatial sounds exhibited in Japanese gardens with the aim of using the results to enhance sound quality in other areas of design.

2. Context of the Study: Literature and Projects

In an attempt to give the reader references to where the work is coming from, an overview of my key motivations can be found in the following chapter. This chapter focusses on the three fields mentioned in the Introduction; sound synthesis, soundscape studies and composition. It also includes an overview of some key projects I was inspired by. By no means an exhaustive account of any of the fields, I have chosen to focus purely on work that was of key significance to my undertaking.

As explained in the introduction chapter my initial motivation for this course of study was synthesis techniques. Once I had found a specific direction for my study (Japanese gardens) I found a need to undertake research into soundscape studies; complete my design based on a compositional realisation. Below I describe my discoveries in each of these three fields and how they informed my work and guided my research; following on from that will be notes on similar projects that have incorporated aspects similar to those I used.

2.1 Sound Synthesis

Histories of synthesis usually contain the seminal names of Bob Moog or Wendy Carlos² - people who were responsible for the synthesiser becoming an instrument associated with modern day music. From the onset of this study I was more inclined to study the use of synthesis for sounds other than those of a musical nature. An early example of a composer using synthesis for creating controlled non-musical sounds was Suzanne Ciani³. While working as a composer in the 1970s, she created sound bites for television

² Bob Moog was the inventor of the Moog synthesiser; Wendy Carlos was a musician and early adopter of the synthesiser. For a greater history of the analogue synthesiser consult *Analogue Days* (Pinch, 2002).

³ See <http://www.sevwave.com/> accessed March 26, 2008.

commercials that were of greatest interest to me. Ciani was capable of getting a synthesiser to recreate non-musical, real world sound effects (perhaps her most famous example being the "pop and pour" sound bite for coca-cola). It was this work that was responsible for my first thoughts about using synthesis as a tool for creating real world sounds. This idea, teamed with the sounds I had already been hearing for years in early computer games, really planted the seed for the research that would be undertaken in this degree. By the 1980s computer games had created a demand for soundtracks that were no longer temporally sequential. In these games it was undetermined when events would occur and what sounds would be be played as a result. Using synthesis as a way of creating these sounds had started as a method of conserving computer memory, as memory became cheaper synthesis was soon passed up in favour of sampled sounds. As David Thiel indicates in his thoughts on the matter though: "Others, this author included [Thiel], feel that synthesized sound affords incredible opportunities for interaction and richness" (Thiel, 2004 p.162), a feeling I was encouraged to research.

In researching the field of synthesis and searching for work that would help me to focus on real world sounds, I was continually drawn to the work of two men, Perry Cook and Kees van den Doel. Particular articles are referred to as they are relevant to the present research. I was primarily influenced in synthesising the sounds of physical interactions, whether human-based or sounds from nature. The research of these two men provided me with two great insights into how I could best carry out my project. These were Cook's insights into physically inspired synthesis and Doel's model of producing synthesis modules for physical sounds.

2.1.1 Physically Inspired Synthesis

The work of Perry Cook was pivotal in my own understanding of synthesising real world sounds. His book, *Real Sound Synthesis for Interactive Applications* (Cook, 2002a), as well as providing a general introduction to types of synthesis techniques, talks the reader

through the research and development of complete synthesis systems based on physical interactions. For example chapter 15, 'Walking Synthesis: A Complete System' (pp. 191-200), provides the reader with the necessary steps to analyse and resynthesise that particular sound (footsteps). Cook follows a standard methodology of: event analysis extracting and analysing the specific elements of the sound, including duration, peaks and periodicity of the event; spectral analysis - investigating the spectral make up of the sound event in preparation for resynthesis; and statistical modelling - building a model to trigger resynthesis, capturing all the elements discovered by the event and spectral analysis. While Cook provides details of how he undertook each of the three steps with particular reference to the creation of his walking synthesis system the methodology can be expanded to fit with most analysis/resynthesis patterns and was the same methodology I employed in most instances of module creation. In Cook's case he presents this methodology with particular focus on physically inspired models. These physically inspired models take the place of event modelling, such as his PhiSEM system (Cook, 1997) and the more traditional physical modelling synthesis techniques such as waveguides or delay lines. In the opening paragraph to Chapter One of his book Cook states "The main purpose of this book is to derive and use techniques for generating digital audio samples directly from physical models" (2002a, p.1). The combination of physically inspired research into sound events of a non-musical nature and their combination with musical synthesis techniques provided a methodology for creating my own physically inspired sounds.

2.1.2 Synthesis Sound Modules

Kees van den Doel's early work has continually built around his interests in interactive simulation using synthesis techniques. I was able to gain insight into how sound synthesis could be used in such interactive situations through work such as his Doctoral

dissertation (Doel, 1998) and various published papers on topics such as using synthesis to generate foley⁴ sounds (Doel, 2001a).

The real benefit of Doel's work to me was that it was made available in many different formats. Take for example his work on bubble synthesis, in which he derives a physically based model of a bubble and then incorporates it into a system to synthesise all manner of liquid sounds, from droplets to streams to waterfalls (Doel, 2004a; Doel, 2004b; Doel, 2005). Doel's findings became import to my own work in synthesising the sound of water, which are described in greater detail in Module Design. Not only has he made available multiple papers and reports through his website but he also has easily accessible synthesis modules available as web based java applets and source code available for download using his sound API JASS ('Java Audio Synthesis System for Sound Programmers') (Doel, 2001b)⁵. The combination of these various formats of his research, and the ease of accessibility provides a helpful insight into his work. As a student trying to understand the field of interactive simulation using synthesis techniques, if I found something was not making sense in one source (a paper for example) it was possible to refer to the source code and find answers to my questions there. When it came time to writing my own synthesis modules, I found the extent of documentation Doel had provided to be of great support, particularly in working physical equations into my synthesis systems.

While Doel and Cook both work in similar fields, primarily synthesising sounds using physically informed methods, I found Cook's work to be much more helpful on the higher level of system design and Doel's work to be better at aiding in understanding of small details, such as the aforementioned implementation of physical equations into my code.

⁴ Foley is the name given the addition of sound effects to film.

⁵ For all web based examples see <http://www.cs.ubc.ca/~kvdoel/> accessed March 17, 2008.

2.2 Soundscape Studies

While the field of synthesis techniques was important for undertaking my work in synthesising sound, I found myself requiring an understanding of the how sounds of the real Japanese gardens were created. In an attempt to understand the acoustic space of the gardens, I chose to apply the analytical framework of soundscape studies, in particular the work that came out of the World Soundscape Project (WSP)⁶. The WSP was officially formed at Simon Fraser University in Vancouver, Canada in 1971. The WSP recorded documentation of soundscapes, this documentation started locally in Vancouver (collected on: Schafer, 1996) before moving further afield. It attempted to capture the feeling of chosen sites through their aural characteristics and this was similar to the way I was attempting to capture the feel of Japanese gardens through their own aural representation. The research into these soundscapes culminated in a number of written works by R. Murray Schafer and the WSP team, with Schafer's book The Soundscape: Our Sonic Environment and the Tuning of the World (Schafer, 1994) being most beneficial to my own studies by presenting methodologies for analysing soundscapes. The WSP also presented a 'dictionary' or 'lexicon' of the new field they were exploring in the form of the Handbook for Acoustic Ecology edited by Barry Truax (1999).

2.2.1 Soundscape Analysis

Reading R Murray Schafer's *The Soundscape* was my first attempt to understand the way soundscapes are composed, and what we can discover by analysing these compositions. I was hoping to focus on his work devoted to soundscape analysis as a way of categorising the Japanese garden soundscapes into a series of grouped sound sources.

⁶ See <http://www.sfu.ca/~truax/wsp.html> accessed March 17, 2008

While much of Schafer's book is aimed at promoting understanding of the changing state of the soundscapes around us and on the psychology of listening, it was the Analysis section of the text that held most relevance for my own work. In this section, Schafer provides the reader with a method of grading sounds based on a defined referenced system. Schafer particularly highlights the limits of notational methods capturing only two aspects of sound (an x/y mapping) at any one time, when in fact there are multiple elements of soundscapes (time, frequency, amplitude, etc) that require distinction if we are to truly understand any soundscape. Schafer also presents the reader with a classification system for capturing the elements a sound contains. Schafer describes sound using four physical characteristics: duration - the total time the event can be heard; frequency/mass - the frequency, or frequency band at which the event is heard and the frequency at which the bulk of the sound appears; fluctuations/grain - the movement of the event over frequency during its duration and a description of how the fluctuation take place; and dynamics - the perceived volume of the event. These characteristics can be used to provide a clearer understanding of where the sound event fits into the soundscape via a traditional two-dimensional map and are discussed in Garden Analysis. The combination of notation and classification became important in my understanding of the sound events that comprised the soundscape of the Japanese gardens.

2.2.2 A Lexicon For Soundscapes

Barry Truax was another member of the Simon Fraser team involved with the World Soundscape Project and, like Schafer, he has a compositional background. It was while researching synthesis techniques I was first introduced to Truax's work, through his use of granular synthesis (Truax, 1988). He was, along with Curtis Roads (Roads, 1988; Roads, 1991; Roads, 2001), one of the early creators of granular synthesis techniques, a technique that he used in many of his compositions⁷. I successfully employed the

⁷ Of Truax's granular compositions *Riverrun* is often cited as his greatest. He discusses this piece on his website, see <<u>http://www.sfu.ca/~truax/river.html></u>, accessed March 18, 2008.

granular technique in creating my modules, as will be discussed in 'Module Design'. However, perhaps his most important role in my work was as editor of the *Handbook for Acoustic Ecology*. It is quite common in the early stages of any movement for terms to be used differently by factions within the community; the *Handbook of Acoustic Ecology* is pivotal as a source of reference for the 'correct' interpretation of a word or phrase. It is important, for example, that when mentioning soundscape design we know that amongst other things, "Soundscape design may also include the composition of actual environments, and in this respect it is contiguous with contemporary musical composition." (*Handbook For Acoustic Ecology*, 1999, s.Soundscape Design). This 'lexicon' provided clarity in my early understandings of soundscape studies, providing abridged versions of many findings of the WSP, such as definitions of 'soundmarks' and 'noise pollution'.

2.3 Composition

My own background of composition has come from playing pop/rock music over the past ten years. As a result I have had limited training in formal compositional techniques and no experience except for writing or producing popular music. In undertaking the compositional aspect of this project I was hoping to research ways of composing soundscapes by methods of non-linear composition.

I found my inspiration for non-linear composition coming from two main areas, virtual worlds (such as those found in computer games) and installation art where the audience is expected to travel throughout the sound work composing as they go. Bernard Krause and Damian Kellar were the main inspiration for my soundscape compositions (along with aforementioned members of the World Soundscape Project). Krause was a composer and early adopter of the synthesiser as an instrument; his more recent work has been focussed on capturing and preserving the sounds of nature through his company

Wild Sanctury⁸. Damian Kellar (at one time a student of Barry Truax's) has been publishing research into his theory of ecological modelling (Keller, 1999; Keller, 2004), informing others of his experiences composing natural soundscapes.

2.3.1 Non-linear composition: composing for the virtual

Non-linear composition was one of the prime motivations for creating the sounds using synthesis techniques. Early forms of non-linear composition come from computer games, such as those created by David Thiel (Thiel, 2004). While computer memory expanded, synthesis lost favour to sound samples, but the concept of interactive compositions such as those made by Thiel remain. Today interactive compositions can be seen in games attempting to push the envelope for a new user experience. In procedurally produced games, the virtual world is never-ending, using algorithms to continually grow new lands. The promise shown by these procedurally produced graphics will not be realised without an ability to grow new sounds.

In the physical world events involving non-linear composition can be seen in the worlds of sound artists such as Christina Kubisch⁹. In her work Christina uses electromagnetic induction to carry sound over wires. The sound is picked up on headphones as the user walks through the space with each wire capable of carrying a different sound. Users can 'mix' these sounds together as they explore the area. Here users are given reign to compose their own soundtracks with elements such as duration the particular mix being at the user's own discretion. While these forms of non-linear composition were a large influence for the original undertaking of my research, they don't make an appearance until my final project where users are allowed to interact with the sounds by being free to move around the installation and compose their own soundscapes the way they might in a traditional garden.

⁸ See <http://www.wildsanctuary.com/> accessed March 30, 2008

⁹ See <http://www.christinakubisch.de/> accessed March 30, 2008.

2.3.2 A Niche Hypothesis

I knew of Bernard Krause through his work on film soundtracks and early electronic music (perhaps most famously for playing on the soundtrack to 1979's Apocalypse Now, or for his 1968 album with Paul Beaver The Nonesuch Guide to Electronic Music). Krause's more recent work is influenced by the sounds of the wilderness and it is in his book Wild Soundscapes: Discovering the Voice of the Natural World (Krause, 2004) that he provides instructional notes on how to get the most of listening to and recording nature. Amongst the instructional anecdotes contained in the book is an introduction to Krause's 'Niche Hypothesis' (Chapter 3, pp. 21 - 36). Krause hypothesises that ancient music is a way of transferring the sounds of nature, and that the sounds of a natural source can be heard to work in spectral bands. The calls of animals will fill a 'niche' only in the spectral ranges made available to them by the sounds they are surrounded by. If, for example, swarm of insects is heard to populate the 3 - 4,000 Hz spectrum, you won't find a bird in the local biophony¹⁰ to compete in this range, instead their call maybe in the 4K+ or sub 3K spectrum. Understanding this hypothesis, of how the natural world finds a place in frequency over time, was pivotal in both my understanding of creating modules, and later of composing soundscapes capable of containing sounds that didn't fight one another for temporal or spectral space. While I was familiar with similar techniques through my work with mixing pop music I cannot say for certain that I would have seen its relevance in the natural world without the explicit links Krause made.

2.3.3 Ecological Modelling

Damián Keller's work is primarily focussed on the composition of soundscapes using pre-recorded sound samples he had recorded from site-specific locations. Culminating in his Doctoral thesis (Keller, 2004), Keller continually built upon his concept of an

 $^{^{10}}$ The biophony is the term Krause uses to describe the combined sound of a natural location; a kind of choir of nature.

'ecological approach' to composition. Although seen throughout his work it is his Doctoral dissertation in which he explains the concept in greatest detail. In summary he distinguishes ecological modelling as a way of dealing with a listeners experiences spectrally, temporally and spatially. In order to compose ecologically Keller presents three stages of understanding. Firstly he discusses an ecological theory of sound, discussing key concepts such as the personal environment and events. These were key areas I used in my initial analysis of sounds. Secondly he proposes his ecological model as having five key requirements to allow the model to exhibit real-world behaviours. These five requirements: modularity - the development of an overall project containing many modules; stability - the ability of the project to capture many different states, and directly related to the need of the project to be modular; consistency - the model's ability to stay valid through various similar states, with particular reference to perceptual cues (in the example provided by Kellar (ibid p. 17), breaking of glass and spilling of water, the model used for breaking glass should be able to handle both glass breaking and water spilling); context dependence - where consistency is implied in perceptual cues context dependence should be applied to the time-based aspects of the model, allowing for the model to remain true to the context with which it is designed; and scalability - the benefit of a model to scale and hold many true states within its design; were captured in my module design. Finally Keller discusses how once these two steps have been understood composition can take place ecologically. Composing ecologically takes place within a framework of aforementioned spectral, temporal and spatial cues (ibid, p.25). Understanding Keller's notion enabled my composition to capture the elements of a natural soundscape rather than attempt to follow a more traditional musical compositional path.

2.4 Influential Works

I was interested in finding projects that covered all three of my fields of influence: synthesis, composition and soundscape studies. On top of just encapsulation all three fields I also required the projects to be relatively well documented. While there are

many works of art that attempt to sit over all three fields finding documentation on these was rare. As a result there were three projects that were key influences for my project, and which I will discuss below. The work of Daniel Dobler, undertaken at Hagenberg University (Dobler, 2003), the TAPESTREA project currently being undertaken at Princeton University (Misra, Wang et al., 2006) and the works of Nigel Frayne a Melbourne based soundscape artist who has undertaken soundscape works worldwide. Each of these three works had a specific relevance to the direction I took with my own work.

2.4.1 Real-Time Synthesis and Transformation of Ambient Sounds

Dobler focuses on the study of using synthesis to generate real world sounds, or ambient sounds as he refers to them. Yet despite these similar goals his work differs from mine in many ways. Primarily his thesis summarises the theory and history of synthesis techniques. It is not until the Appendix of his thesis that we see implementations of four examples of 'ambient' sounds using synthesis techniques; fire, lightning, ocean waves and birds. In this Appendix Dobler provides examples of how he created the modules using various synthesis techniques he had defined for the reader in the body of the document. Dobler makes no attempt to connect the modules in a work, instead treating them as separate entities (for example no soundscape is produced featuring birds in a thunderstorm). While we are able to learn an insight into the multiple synthesis techniques available in software based synthesisers and a brief history of the psychoacoustics and soundscape studies, I was let down by the lack of importance placed on the synthesis modules which were a result of the study. The style of Dobler's work as a collection of existing theories and techniques was strongly influential in driving me to focus my exegesis on design, so that people can gain insight into how I, as a designer, tackle such a project.

2.4.2 TAPESTREA

TAPESTREA is, like many Princeton music related projects, an acronym; it stands for: Techniques and Paradigms for Expressive Synthesis, Transformation and Rendering of Environmental Audio. TAPESTREA is the work of two PhD students (Ananya Misra and Ge Wang) and students and one professor (Perry Cook) and is quite an expansive TAPESTREA is a software application that allows for the analysis, undertaking. transformation and resynthesis of recorded sounds. It takes advantage of a lot of the best features from each field it is attempting to compile together (sound analysis, transformation and synthesis) to give the user a complete computer based environment for creating compositional soundscapes (or sound scenes as the TAPESTREA team like to call them). It contains most of the features I had to use multiple computer applications to obtain in one single package. It has a heavy focus on a spectrographic interface, using this spectrographic view the user has the ability to filter out sounds based on the spectral data (applying filters graphically). It also has the ability to adjust data with calls to a synthesis engine via the audio programming language Chuck (Wang, Misra, et al., 2005). With its focus on linear composition TAPESTREA provided me with impetus to continue on past my linear composition to the work on non-linear composition explored in my examination project.

2.4.3 Resonant Designs

Resonant Designs is the company formed by Nigel Frayne to implement designed soundscapes in site-specific locations. The soundscapes created by Nigel Frayne are the scale of work I would like to see myself working on in future projects. His work can be found in various locations throughout the world, including the San Diego, Singapore and Toranga Park (Sydney) Zoos, Aquariums in Genoa and Chicago as well as various

Museum and public spaces¹¹. His work focuses on extended duration soundscapes (often played continuously during opening hours of the locations he is designing for), are designed for an audience to move through, contain many influences of acoustic ecology and are often an attempt to give the listener an insight into a specific environment (Frayne, 2004). While on the surface my work shares similar outcomes to Nigel's (most obviously the ability to portray aspects of a particular soundscape to the listener), the main difference between his work and the project I undertook is that my project focusses on interactive sounds composed using synthesis techniques. I was not interested in the play back sampled recordings; I was interested in discovering how the sounds were made and recreating them before using these sounds to recreate a soundscape. The most appealing aspect of Nigel's work to me is that he is constantly referencing the natural soundscape in his compositions, something that was obviously a key aspect of my work.

2.5 Conclusion

In this chapter I have given a brief background on the people who were key to my understanding of my three main fields of research. The work of many more people will become apparent throughout this thesis, but it was the people mentioned in this chapter who really helped me to frame and understand my work. Looking back at them now it is obvious that I was most influenced by people who helped me by bringing a sense of clarity and understanding in the way I related to each of the fields. I feel I have been heavily influenced by each person by the way they ended up describing their own work, whether this be Cook's description of Physically Informed modelling, Krause's Niche theory or Keller's ecological modelling. It was the work's ability to enable me to gain clear insight into a particular idea through the description provided that made me focus on these works over the work of others that lay in similar areas.

¹¹ A more complete list of the Resonant Design work can be found on the companies website. See <<u>http://www.resonantdesigns.com/> accessed March 17, 2008</u>

3. Garden Analysis

3.1 Introduction

The first step in creating a synthesised soundscape of a Japanese garden was to use multiple techniques to analyse recordings of real sounds in two traditional gardens in Tokyo. The results of the analysis were then used to decide which sound events would be needed to resynthesise the garden soundscapes.

This chapter takes the reader through the various steps of the analysis of the gardens' soundscapes. It introduces the gardens where recording took place - Kyu Furukawa Teien and Koishikawa Korakuen – then describes the recording techniques used to capture the gardens' soundscapes. This is followed by a description of the analysis undertaken on these recordings. Finally other events that weren't captured by the recordings are mentioned. Together the sections in this chapter should inform the reader of the general feeling embodied in the gardens' soundscapes

3.2 Background

In June of 2006 two members of the Teimu team, Dr. Michael Fowler and Lawrence Harvey, travelled to Japan to undertake detailed sound recordings from two traditional Japanese gardens located in Tokyo. The gardens were Kyu Furukawa Teien, located in the Kita Ward and Koishikawa Korakuen located in the Bunkyo Ward

Kyu Furukawa Teien is located on the grounds of a former private residence and is quite a recent garden, having been built in the Taish period (1912 - 1926). Its primary features are a Western style house that sits upon a hill overlooking the garden, a western style rose garden next to the house, and at the bottom of the hill, a large Japanese garden. This Japanese garden is situated around a large lake, which appears in the shape of the Chinese character for 'heart'. As well as the lake, the garden features a single 10-meter waterfall, tea hut and waterway. Koishikawa Korakuen, in contrast to the relatively recent Kyu Furukawa Teien, was started in 1629, with an area of 63 acres, now diminished to 17.5 acres. It is located in a very busy part of the city with the Tokyo Dome and a large amusement park (with a very audible roller coaster) to its east. The garden features three very distinct waterfalls as well as large areas covered by water (lakes, ponds and streams). It was, and is, heavily influenced by Chinese garden design.

Kyu Furukawa Teien is shown via a satellite imagine in Figure 2 and a corresponding map in Figure 3. Koishikawa can be seen in Figure 4 as a satellite image and in Figure 5 as a map of its grounds¹².

There are two primary ways in which a Japanese garden is designed to be enjoyed; either in a contemplative or a stroll style¹³. As the description of each style suggests, the two styles create different experiences. While a contemplative garden is designed to be admired at its best from a particular viewing position, the stroll garden, as its name suggests, is designed to be walked through, allowing the observer to experience the changes in ambience as a path is taken on a specific journey. While a garden might be inclined to feature more of one style than the other, most gardens, in particular larger gardens, will have aspects of both styles. For example, taking a scenic stroll down a hill, finishing at a spot of contemplation, resting and regarding the path you have just traversed. Both gardens feature elements of both garden styles, traits that were captured in the recordings.

¹² Maps of Kyu Furukawa Teien and Koishikawa Korakuen were taken from the Tokyo Metropolitan Park Association website, see http://www.tokyo-park.or.jp/english/park/detail_05.html accessed March 12, 2008. Satellite images were made using the Google Earth application, also on March 12, 2008.

¹³ While the term 'stroll' seems to be used widely as a descriptive term for Japanese gardens, 'contemplative' gardens, as I describe them, may be referred to in other terms, such as 'viewing' gardens. A garden's style will regularly be used to describe them in guidebooks and on maps. A third garden type, the tea garden, can be used to describe gardens designed specifically for tea ceremonies. The level of detail used to describe the garden seems to be a decision left to the author of the particular work. In describing only the styles of stroll and contemplative, I have used a description of gardens at their simplest level.



Figure 2: Satellite image of Kyu Furukawa Teien



Figure 3: Map of Kyu Furukawa Teien.



Figure 4: Satellite image of Koishikawa Korakuen



Figure 5: Map of Koishikawa Korakuen.



Figure 6: Lawrence Harvey holding the five-microphone array This photo was taken at Koishikawa Korakuen by Dr. Michael Fowler.

3.3 Recording Notes

Recording took place on June 13 and 14, 2006 at Kyu Furukawa and on June 15, 16 and 17, 2006 at Koishikawa Korakuen. 23 recordings were made using two different methods, stationary and roving recordings. Stationary recordings were made using a five-microphone set-up seen in Figure 6 (one recording was made with a seven microphone array) and the roving recordings made using two microphones in a coincident pair configuration. These two formats were used in an attempt to capture the aural characteristics present in the parts of the garden designed as stroll and contemplative. Figure 7 shows the recording details.

In an attempt to capture the aural elements of both style of garden stationary and roving recordings were made in those parts of the garden that suited each technique. Stationary recordings were made with five Sanken CS-3 microphones on a multi microphone array

with microphones positioned at 0, 45, 135, 225 and 315 degrees. The 5 microphones ran into a Motu Traveler sound card and were recorded on an Apple PowerBook using Logic Pro 7. Roving recordings were made using two Schoeps microphones in a coincident pair configuration; a Sound Devices 722 was used to record the audio from these roving recordings. One recording was made using all seven microphones; the five Sankens were set up as they were in the standard stationary method and the two Schoeps were held pointing to the sky 45 degrees off centre, in an attempt to capture a greater level of detail in the height of the recording. In the final case the recording technique matched that of the other stationary recordings. The impact of the various techniques had significant influence when it came to composition and will be discussed further in Chapter 5.

Location	Duration	Tape ID dur.	Channels	Style
roving start point 1	9:27	1:10	2	Roving
stationary point 3	6:36	0:32	2	Stationary
roving start point 2	3:30	0:20	2	Roving
stationary point 2	6:12	0:56	2	Stationary
stationary point 1	10:12	1:04	4	Stationary
roving start point 2	7:18	0:40	2	Roving
roving start point 1	17:58	0:25	2	Roving
stationary point 2	23:10	2:04	5	Stationary
stationary point 2	5:31	0:28	2	Stationary
stationary point 1	21:59	2:17	5	Stationary
stationary point 1	1:27	0:23	2	Stationary
stationary point 5	5:36	0:16	2	Stationary
roving start point 3	11:22	1:03	2	Roving
stationary point 4	2:52	1:03	2	Stationary
stationary point 2	14:44	1:45	5	Stationary
stationary point 2	3:11	0:39	2	Stationary
roving start point 2	6:26	1:07	2	Roving
stationary point 3	10:54	1:09	2	Stationary
stationary point 1	16:07	1:53	5	Stationary
roving start point 2	11:26	1:43	2	Roving
stationary point 2	45:18	2:14	7	Stationary
stationary point 1	49:40	1:32	5	Stationary
roving start point 1	11:32	1:09	2	Roving
TOTALS	5:02:28	0:25:52		

Figure 7: Recording details, duration, channels and style.

3.4 Logging the recordings

Three levels of analysis were undertaken on the recordings with the aim of better understanding the aural characteristics of the gardens. The three levels will be referred to as macro, meso and micro level analysis and were influenced by Keller's work on ecological modelling discussed in the previous chapter. While the analysis undertaken does not focus directly on Kellar's work, it is the end goal of this analysis to prepare for an ecological composition. It was with this composition in mind that I focussed my analysis on an attempt to capture each of the key temporal states Kellar proposed, the macro, meso and mirco-temporal views. Analysis began with an attempt to capture the macro view of the gardens by undertaking event logging for each recording. It was hoped that the event logging would provide a clear view of what modules were required to simulate the acoustic properties of the gardens. An example of this event logging process can be viewed in Figure 8 and the recording corresponding to this event log can be heard on the accompanying CD on track 1. A complete version of the event logs can be read in Appendix A. After event logging was completed the meso-level view of the recordings was investigated by using temporal graphs to log the intensity of the sound levels of the events as they changed over time. It was hoped that by measuring the intensity of the events a greater understanding of their composition would be achieved. An example of a temporal log can be seen in Figure 11 (found on p.28). It corresponds to the event log and CD track mentioned above. Micro-level analysis of the garden was done in two phases. The initial phase (described in this chapter) was undertaken following techniques derived from R. Murray Schafer's work. The second phase consisting of more detailed event analysis (such as that previously defined by Cook) is described in the following chapter, Module Design, and was undertaken differently for each sound. It was expected that the macro and meso analysis results would combine to form the two major influences in module design and composition techniques in the completion of the project. Micro-level analysis is discussed in detail in Module Design.

Roving start point 2

Person doing tape ID: Michael Fowler Tape ID duration: 0:20 Channels: 2 (L&R) Duration: 3:30 Transcript: OK sound walk from the karetaki to our stationary recording point number 2. 0:20 initial state: high pitched hum on RHS 0:31 footsteps start 0:40 crows sounding a lot more reverberant than usual 0:59 traffic appears 1:09 crows sound as though they are in a cave somewhere behind us 1:27 waterfall appears (traffic has died off considerably) 1:57 crows sound almost as though they are outside and we are inside 2:20 footsteps have stopped being audible (this happened a while ago) 2:49 perfect example of what i mean by the reverberant crows 3:03 recording stops So far this would be the most interesting of the recordings as it has so much depth in the

sounds that occur. the traffic comes and goes, the waterfall does the same, the cawing of the crows is quite different.

Figure 8: An example of an event log.

3.4.1 Event Logging

As previously mentioned event logging was the first step in an attempt to understand the aural characteristics of the gardens at the macro level. I wasn't interested yet in the specific attributes of the sounds created, such analysis was to be undertaken at a much later stage. My initial interest was purely in the impressions made on my ears when listening to the recordings in a critical manner. The recordings were played back in the POD studio using a patch written by Dr Fowler using the programming language Pure Data. An example of the patch can be seen in Figure 9. Each patch shows the location of the recordings overlaid on a PDF map of the respective garden. A single spot is used in the case of the fixed recordings and the path followed is shown in the case of roving recordings. The patch contains visual information allowing for volume control and provides level meters for each channel used in the recording being played. The patch also has a small frequency graph showing output overall. An external timer was used to track times during playback.

As can be seen in the example in Figure 8 each file received a separate event log. Each event log started with a description of file: file name, recording type, number of channels and a transcript of the tape ID along with its duration and the name of the person who gave the identification. This was done so the recordings and logs could be matched at a later date should file names or other data change. Following these details is a brief description of the ambient characteristics of the particular recording. The log then follows. Once listening to the files had begun I started taking note of events that "jumped out" of the ambient field of the recording. Each entry in the event log is given a time and a brief description of the event. Occasionally the speaker location of the event is given when it was particularly relevant (usually it is only drastically noticeable in the surround recordings). Each recording was listened to a number of times; on the first listen I listed my immediate reaction to events and attempted to capture the most obvious events. The second listen was to confirm times and events and add anything that was missed in the first listen. Logs were considered complete when they could be listened through and no added events were apparent that had not already been listed.



Figure 9: A PD patch used for playback of the garden recordings.

The patches were created by Michael Fowler, they allow for play back of the garden recordings; a new patch was created for each day's recordings. The map of the garden indicates the location of the recording, or in the case of roving recordings the path travelled.

Of the five hours of recordings 607 events were listed in the logs, a graphical view of which can be seen in Figure 10. Surprisingly five of the most common six events occurred as a result of sounds generated due in some part to the garden itself (they were not an influence of the sounds outside the garden). This feature is discussed in the Sound Location section of this chapter.

The key result of the event analysis was that it formed the basis for five of the modules I would need to create in order to reproduce a soundscape with similar aural characteristics to those found in the gardens. What the event logging failed to show me

was how prevalent certain sounds were on the soundscape. It was hoped that by logging events temporally I would be able to capture this data.





3.4.2 Temporal Logging

With the macro world of the soundscape now better defined by way of the event logging it was necessary to move on to what I describe as the meso-scale. Event logging defined the characteristics of the scene and temporal logging was an attempt to view how those characteristics interacted with one another. What I hoped to achieve was the ability to view, via a graphical representation, how the scene's characteristics changed over the duration of each recording.


Figure 11: An example of a temporal log

This example shows three minutes of recordings. The name of the events appear down the left side while time moves across the bottom of each log in two second intervals.

In order to achieve my results I decided to use a piano-scroll type notation to display the data. I chose the piano scroll format for two main reasons: for the initial process of logging it was easy to produce and capture the data; for the later task of composition it was an easy format to follow. An A3 sheet of paper was used for each minute of recording time. Each page was laid out with a landscape orientation, the list of major events was located in a column on the left hand side of the page and time flowed from

left to right. Each of the major events in the event log for a particular file was given a separate row and one final row was used for any miscellaneous events,. The file was then played back once and general characteristics noted on a separate sheet of paper, for example where the loudest and quietest parts of the recording occurred. The events listed on the left of the temporal log were re-organised so the most dominating events were listed at the top of the list and the least dominating at the bottom. Once an order for the events had been set the recording was played back with attention being paid only to tracking the influence of the first event on the list. An arbitrary scale was used to measure the influence of that particular event on the soundscape at the time. By undertaking this method for each event in the list I was able to build an overall picture of the recording showing the weight of influence certain events had on the temporal make up of the recording.

Examples of temporal logging can be viewed in Figure 11. As a result of the temporal logging a much clearer understanding of patterns in the soundscape emerged and the way certain sounds interacted with one another became more apparent.

3.4.3 Sonogram Analysis

In an attempt to further understand the macro and meso-scale soundscape of the garden further analysis of the recordings was undertaken viewing their sonograms. This analysis was informed primarily by Krause and his 'Niche Hypothesis' and was an attempt to discover if there was a discernable 'biophony' present in the recordings. This analysis took place prior to my attempts to compose a garden soundscape and was much more influential in the compositional work than in the module design.

Mono versions of the recordings were viewed as sonograms. Viewing the sonogram's made it clearly visible how often events were occurring. For example if we look at the sonogram shown in Figure 12 it is clearly visible the number of times a crow can be heard in the 12 second duration of the recording, it is also visible that the caw of the crow is taking on two distinct call's, one that shows very little fluctuation and one that shows a fluctuation in pitch from 1300 Hz to 1100 Hz. While the sonogram analysis

was very handy for viewing major events I found that there was far to much noise on the recordings to really get a solid understanding of the entire biophony of the gardens by using such an analysis, it was very often too difficult to distinguish a bird call from random noise by simply looking at the sonogram.



Figure 12: A sonogram showing the caws of a crow

The sonogram displays two distinct types of caw, the first 9 are flat without fluctuations while the final five show fluctuations in the frequency of the caws. The caws sit primarily between 1100 and 1500 Hertz.

3.4.4 Event Analysis

Early on in the research an attempt was made to log events in a style influenced by the classification system used by R. Murray Schafer and described for the reader earlier on page 8. It was hoped that this system would allow me to analyse the gardens on a microscale and would sit within the gardens analysis section of the research and prepare me for the module design, where I would both utilise the results and conduct further microlevel analysis. A number of singular events were notated in a style based on the one Schafer described on page 136 of his work *The Soundscape* (1994). An example of such analysis can be seen in Figure 13. After completing a number of these charts I realised that I gained more insight by viewing a sonogram of the sound than the charts I had

created. I found the sonogram to give quicker reference to the same information contained in the event analysis charts. While I ceased with the creation of the charts I did keep the overall classifications Schafer described (duration, frequency/mass, fluctuations/grain and dynamics) as key parts of the events I was attempting to capture for use in the module design.



Figure 13: Examples of event analysis undertaken with reference to Schafer's classification system

Two examples of event analysis of the crow sounds seen in the sonogram represented in Figure 12. The changes in Frequency are cleary eveident along with changes in the dynamics of the sound. (On the Y-axis: D = Duration, F/M = Frequency/Mass, F/G = Fluctuations/Grain, Dy = Dynamics, while on the X-axis: A = Attack, B = Body and D = Decay)

3.5 Sound Location

In the final step of analysing the recordings I wanted to use the information I had produced from earlier analysis in an attempt to categorise the sounds. By categorising the sounds I was able to use the categories to build modules that were specific to the sounds heard in each garden. The grouping of the sounds was also used as a way to weight the importance of certain sounds in the overall properties of the garden's acoustic environment since my primary interest was to create sounds that were produced by the garden itself. By building modules capable of capturing the gardens' acoustic footprint, I hoped that, at a later date, work could be undertaken to study how sounds from the outside world impacted on the enjoyment of the garden

The event log provided me with an extensive list of sounds that were detected from the recordings. This list consisted of the events listed in Figure 10 which were categorised by their physical location (see Figure 14)- inside the garden, outside the garden or airborne. The events were then categorised again as having a 'garden influence' scaled from 0 - 5. Events that occurred as a direct result of the garden were given a 5 and sounds that occurred whether the garden was there or not were given a 0.

Event	Location	Garden Influence
Music	Inside	5
Water	Inside	5
Wood	Inside	5
Crows	Airborne	4
Other birds	Airborne	4
Footsteps	Inside	4
People	Inside	3
Machinery/works	Both	2
Metal	Both	2
Applause	Both	1
Genorator	Both	1
Animals	Outside	1
Bells	Outside	1
Planes/helicopters	Airborne	0
Mobile phones	Inside	0
Microphone noise	N/A	0
Motorcycle	Outside	0
Sirens/horns	Outside	0
Traffic	Outside	0
Trains/roller coaster	Outside	0
Other	Unknown	0

Figure 14: Influence of the garden on a sound event.

Essentially the task of grouping the sounds was a means of discarding certain events from module selection. I did not want or intend to create modules for sounds that existed without any "influence of the garden". By positioning the sounds into the three main groups of garden sounds, garden influenced sounds and external sounds, I created a schema that allowed me to quickly judge whether a sound was worth building a module or if it should be exempted because it fell into the group from external sources.

3.6 Seasonal Adjustments

In October of 2006 a conference call took place between the Teimu team members, located at RMIT, and Dr. Fowler, who was in Japan as a guest of Future University. Dr. Fowler had spent some time the previous week revisiting the gardens where he recorded in June (Kyu Furukawa Teien and Koishikawa Korakuen). During this conversation Dr. Fowler recounted his experience of returning to the gardens at a different time of year. For him the gardens had undergone an acoustic transformation with the change in seasons. This, as he informed us, was primarily due to the heavy influence of insects on the soundscape.

Sadly no recordings were made of the seasonal change that had taken place in the gardens aural properties. But the conversation did make me think about what was missing on the recordings and, as a result, in my analysis of them. The recordings themselves had been made during the opening hours of each garden. While there had been some recordings made after the garden's close, a time close to dusk, none of the original recordings had been made at dawn or during the night, times that typically see an increase in the sounds of nature. Weather conditions had been relatively clear on all days during recording times. There had been a brief shower on the first day of recording, and short recordings had been made while the team took shelter under the roof of a tea hut, but there had not been enough recording to influence the results of my event analysis.

I came to realise that, in order to fully capture all the possible conditions of the gardens, it would be necessary to go further than basing my module design on only the recordings we had accumulated as the result of one five day field trip. Other possible events were something I would have to place value on in my module design.

3.7 Conclusion

This chapter describes, for the reader, the real sounds that comprised the soundscapes of two Tokyo gardens, Kyu Furukawa Teien and Koishikawa Korakuen in June 2006. The

analysis provided in this chapter forms the basis for the next chapter, Module Design. It was undertaken at a macro and meso-level by using event and temporal logging. These results will be discussed again in relation to the composition of a garden soundscape, but before we do that we must look at the micro scale of the events logged and design modules to re-synthesise their sonic qualities.

4. Module Design

4.1 Introduction

The design of the modules was a lengthy procedure and took place in three phases: the selection of which modules would be required; the selection of the design tools; and finally the individual modules were designed and built. Module selection took place once the analysis of the garden recordings had been completed. Design tool selection was made while the garden analysis was still taking place, timed so I could start module design once the selection of modules was complete

Modules were designed so that their outputs could be combined to create a Japanese garden soundscape. The medium through which the composed soundscape could be played was undecided at the initial stage. It was important that the modules were designed in such a way that they could be used in multiple media. This meant their design had to take into account factors such as CPU performance, controls, and interaction, factors that could hinder possible performance at a later date. It was hoped that the modules could be used to build soundscapes in both a traditional linear format and in a non-linear interactive installation. Composition and installation-related work will be discussed in Design Outcomes but it is important to be reminded of the constraints of these future plans when designing the modules.

The real aim of the module design section was to master the art of synthesis techniques. As well as being a study of composition and sound interaction on a soundscape, I hoped to complete the study with a thorough knowledge of how to analyse sounds for resynthesis and how to best judge which techniques could be utilised to achieve a sound with certain characteristics.

4.2 Module Selection

The garden analysis described in the previous chapter was intended to have two main outcomes. The first was to get a full (macro-level) understanding of the elements contained in the soundscapes. The second was to use the recordings of the micro-level elements of the gardens to help the design of modules.

To select the precise sounds for the soundscapes I used the analogy of an orchestra: to synthesise an orchestra one would work on each instrument of the orchestra before combining them as one orchestral unit; so I needed to determine the sounds making up my composition as the 'instruments in my orchestra'. The most obvious way of discovering what made up my 'orchestra' was to look at the logs I had created and see what sounds were most prevalent. Figure 10, shown on p. 27, displays the total mentions of each sound made in the event logs. From this simple identification process it was clear that I would need to create modules for each of the following acoustic events: waterfalls, footsteps, crows and at least one other type of bird.

Having decided to make three modules for birds, five modules would form the basis of the sound of the garden. But what about specific identifying features? I knew I would want at least one of these. For this element of the garden I chose to make a module of the *suikinkutsu*. A *suikinkutsu* is a feature unique to Japanese gardens and a very distinguishable sound, usually found at the entrance to a garden it is a resonant cavity hidden under a water source and creates a bell-like sound when water droplets fall into it. In the Garden Analysis I spoke of elements that were missing from our recordings. To account for these elements I chose to make a module for insects.

With these seven modules I felt confident that I would be able to capture the essence of a Japanese garden. However, from early compositions, I realised I was missing something quite important; while I was capturing the garden I wasn't capturing the space surrounding the garden - the sounds that made up the rest of the event log list. Without these sounds the garden soundscapes I was composing came across as unfamiliar. To remedy this problem I used a concept of Japanese gardening known as *shakkei*, or the borrowed landscape (discussed in more length later in this chapter). Essentially this was the practice of making the garden fit into its external surrounds. The *shakkei* module

was an attempt to capture external sources and provide me with a way of changing the imaginary garden's surrounds, taking it from idyllic countryside to the rush of Tokyo

With these decisions in place I concluded that I would be creating eight modules in total: two water based modules; the *suikinkutsu* and a waterfall; three bird modules of a crow, a pigeon and a more general songbird; a module for footsteps; a module for insects; and a final module for the *shakkei*.

4.3 Design Tools

Before starting to build the modules I needed to choose a design environment capable of meeting all my requirements. Initially I perceived three broad options for my work. In terms of programming languages, either I could take advantage of sound and synthesis libraries within a language such as C, and use the Synthesis Tool Kit (STK) or Java and JASS or I could use a dedicated audio programming language such as Max/MSP, Pure Data (PD) or SuperCollider. The third option was to attempt to do all the work using tools designed more for musical applications such as Reaktor or AudioMulch¹⁴.

Each environment has its own pros and cons. Reaktor and AudioMulch are designed in ways with which I am familiar from my background of working with hardware synthesisers. But I knew I was trying to break away from musical form in designing my modules so I did not want to feel restricted in that way. STK and JASS are libraries designed to integrate with a programming language. Getting work up and running using these libraries would mean writing everything around either a C or Java code base and then a lot of extra effort would have to be spent debugging the non-sound side of things (user interfaces for example). I decided that to achieve my goals I was best using a dedicated audio programming language such as Max/MSP, SuperCollider or PD. These

¹⁴ For Max/MSP see <http://www.cycling74.com/products/maxmsp>, for Pure Data see <http://puredata.info/>, for SuperCollider see <http://supercollider.sourceforge.net/>, for Reaktor see <http://www.native-instruments.com/index.php?id=reaktor5>, for AudioMulch see <http://www.audiomulch.com>, all sites accessed March 18, 2008

languages carry the benefit of programmability, access to writing external applications should they be lacking in a specific requirement themselves, easily accessible features and good documentation. The question then came down to which of the languages I would use.

When it came to choosing a final environment I had limited my choices to the three languages mentioned above (Max/MSP, Pure Data or SuperCollider). I had not had any solid experience with any one environment so all were on equal footing. I tested all three languages for about a week each, by running through user guides and tutorials. Of the two graphical environments (Max/MSP and PD) I preferred Max/MSP. This was due primarily to the support that it came with. It seemed to be a bit more stable and after a week of using it I felt I was a bit more comfortable with it than with PD. However I felt that the text-based interface of SuperCollider suited my style more than the graphical nature of Max/MSP. I liked the text-based environment, as it was what I was familiar with from my own experiences in traditional software development. SuperCollider also seemed to draw on fewer resources (less CPU and RAM) than Max/MSP. I thought computer performance might be a concern later on in the project if I was to run my application as a stand alone piece and have all modules working at the same time. Most importantly I could see that everything I thought I would need was already included in the product. So with all these decisions in mind I chose to undertake the project using the current version of SuperCollider (McCartney, 2000).

4.4 Modules Design

4.4.1 Suikinkutsu

A *suikinkutsu* is a feature found in some Japanese gardens. It is essentially an upside down pot that sits buried in the ground and is usually found near a water source such as a *chozubachi* or *tsukubai*. Water from the source above the *suikinkutsu* falls through an entrance hole (located in the *suikinkutsu's* top) into a well of water located at the bottom of the *suikinkutsu*. The sound of the droplet that falls into the *suikinkutsu* then resonates

in the *suikinkutsu's* body creating a harmonically rich, bell-like sound. This process can be seen in Figure 15, and an audio sample can be found on track 2 of the accompanying CD, a more detailed explanation of the creation of the *suikinkutsu* module can be found in my paper *Creating a Virtual Suikinkutsu* (Brewer, 2007).



Figure 15: Cut-away image of a suikinkutsu

Representation of the *suikinkutsu* was the first activity in the entire project . It was started prior to the analysis of the recordings mentioned in Garden Analysis. While the *suikinkutsu's* sound does not appear in any of the recordings that were made in Japan by the Teimu team it was experienced by the author during his own travels in Japan, and enough information existed to study the sounds that they create. Watanabe discusses the sounds of the *suikinkutsu* in his paper *Analytical Study of Acoustic Mechanism of "Suikinkutsu"* (Watanabe, 2004), Adding to this information I was able to construct my own *suikinkutsu* following instruction taken from an article in Eiji Morozumi's *Japanese Garden E-news* (Morozumi, 2006).

Two key elements combined to form the *suikinkutsu* sound. First there was the sound of the initial droplet of water as it fell from the top of the *suikinkutsu* and hit the pool of water at the base (the source sound), quickly followed by the sound of the resonant chamber of the *suikinkutsu* body responding to the initial droplet sound (the resonant sound). To capture these two elements of the *suikinkutsu*, both sounds (source and resonance) were modelled separately and combined together for the overall module to produce a *suikinkutsu* sound. Creating the module involved a combination of simple sine wave modulation, to create the sound of the droplet, and modal synthesis, to model the resonance from the *suikinkutsu* body.

The synthesis of the droplet sound was informed by Kees van den Doel's *Physically-based models for liquid sounds* (Doel, 2004a). In his work he showed that the sound of a water droplet lies primarily in the bubble that is formed slightly under the surface of the water when a droplet hits the surface, and that formulae existed for calculating the properties of this bubble. In my initial attempts at synthesising this sound I was unsuccessful at generating a convincing bubble sound using the physical modelling techniques suggested by Doel; a problem I attributed to my lack of understanding of physical modelling synthesis at the time. Using the information provided by Doel in his summation of how a bubble sounds, I found that a sine-wave oscillator, which rises in frequency 2.5 times during its duration, could be used. For a 300 Hz bubble, a duration of 15 milliseconds was deemed best while, for a 2000 Hz bubble a duration of 4 ms was deemed appropriate. The duration was scaled to decay linearly between these frequencies.

The sound created by the resonance of the *suikinkutsu* body was informed heavily by Yoshio Watanabe's work. In his analysis of the *suikinkutsu* he concluded that the modes generated by the body of the *suikinkutsu* could be calculated by breaking down the *suikinkutsu* body to the sum of its parts, namely a cylinder and a hemisphere. The benefit of doing this is that modes can be calculated for these shapes using proven formulae. Watanabe combined the two formulae and included an 'empirical longitudinal

mode factor' to interpolate between them. Figure 16 shows all three formulae and a description of the 'empirical longitudinal mode factor'

Watanabe showed that by taking the function for calculating modes of a cylindrical space: $f_{NMS} = \frac{C}{2\pi} \sqrt{\left(\frac{\mu_{NM}}{R}\right)^2 + \left(\frac{\xi_S}{L}\right)^2}$ And the function for a hemispherical space: $f_{NS} = \frac{C}{2\pi} \left(\frac{\xi_{NS}}{L}\right)$ That the two functions could be combined to calculate the modes of a suikinkutsu: $f_{NMS} = \frac{C}{2\pi} \sqrt{\left(\frac{\mu_{NM}}{R}\right)^2 + \left(\frac{S\pi}{L}\right)^2}$ Watanabe uses an "empircal longitudinal mode factor" to interpolate the two equations in the form of $S\pi$ which must be within the range: $S\pi < \xi_S < \xi_{0S}.$ In all functions C = the speed of sound, R = radius, L = length and all other variables relate to the turning points of Bessel functions.

Figure 16: Watanabe's formulae for calculating the modes of a *suikinkutsu*. The cylindrical and spherical formulae from which it is derived appear as the first two equations in the figure.

Watanabe's formula was used to create my module, allowing for the calculation of modes for *suikinkutsu* of different sizes and shapes by providing it with the variable length and width of a *suikinkutsu* body. The formula calculated the first 12 modes of the *suikinkutsu*. These modes were then used to fill a resonant filter bank with the 12 calculated frequencies. When triggered this filter bank created an ideal sound of the *suikinkutsu's* resonant body.

The two sounds, the droplet and the resonant chamber, were then combined to form the overall sound of the *suikinkutsu*. A high pass filter was placed on the output of the resonant filter bank with a cutoff frequency that matched the droplet frequency; this

attempted to imitate the way the resonant sound is influenced by the bubble frequency in the real world examples.

In an attempt to test the results of the module, I compared the output of the module to the recordings of my homemade *suikinkutsu*. Through a comparison of recordings made on the virtual and real *suikinkutsu*, it was shown that Watanabe's formula, used to calculate the modes, was not 100% correct. Despite the variation of the "longitudinal mode factor" the same modes as heard in the real *suikinkutsu* recordings could not be calculated for the virtual model. Figure 17 shows a comparison between the frequencies output by the *suikinkutsu* module and the frequencies heard in the constructed *suikinkutsu*.

Mode	Real	Virtual
1	590	634
2	899	858
3	929	1060
4	960	1165
5	1012	1297
6	1094	1297
7	1179	1466
8	1264	1467
9	1297	1489
10	1352	1727
11	1705	1782
12	1874	1801
13	2121	1805
14	2492	2375

Figure 17 Mode frequencies of suikinkutsu.

The figure compares recorded and calculated frequencies (in Hertz) of a real *suikinkutsu* and the synthesised (virtual) *suikinkutsu*,.

The *suikinkutsu* is probably the most successful module in terms of coming closest to recreating the sound it intends to capture (in other words its sound is the most "life-like"). It had also received significant background research: physical equations had already been completed allowing for the calculation of bubble frequency and mode

frequencies. The source/resonance model occurs in so many situations that a lot of research had been conducted on the topic and was able to inform my model.



Figure 18: Bubble synthesis system

The bubble sound was generated by a single sine wave oscillator. The frequency of this oscillator rose in time from the base frequency to a frequency 2.5 times greater than that initial base frequency. The duration of this rise was calculated based on its frequency, with a bubble of 2 kHz having a duration of 3ms and a bubble of 300 Hz a duration of 15ms. The duration of the bubble was scaled linearly base on this two figures.



Figure 19: Suikinkutsu body synthesis system

The body of the suikinkutsu was a set of 14 resonant filters. The frequency of these filters was determined by Watanabe's formula using variables of length and radius of the suikinkutsu body. The duration of the filters was based on spectral analysis of suikinkutsu recordings and based on ideal durations. The strongest mode had a one second duration and all other weaker modes had shorter times. Once these filters were combined to form the sound of the suikinkutsu body they were placed within a high pass filter. The cutoff frequency of the HPF corresponded to the base frequency of the bubble generated to fall within the suikinkutsu chamber.

4.4.2 Waterfalls

Waterfalls are the most dominant sound created within a Japanese garden. They give each garden a focal point of sound and take place at levels capable of exceeding all of the other natural sounds in the garden. Sonically they work on two main levels: the sound of the waterfall as heard from standing directly in front of it; and the sound as heard from various points within the garden, for example occluded by hills or wide open to a spot of contemplation. Originally I wanted a module that was able to create sounds ranging from the smallest streams to those of the largest falls. Once this source sound of the waterfall had been created within the module it would then be filtered to take into account the effects of landscape, such as the previously mentioned effect of occlusion.

The Teimu team recorded four waterfalls while in Japan.¹⁵ A single waterfall can be heard in Kyu Furukawa Teien while three are located within Koishikawa Korakuen. Ten seconds of recordings made from standing in front of each waterfall were analysed in an attempt to understand the differences presented by each of the waterfalls. A spectrum analysis with these results overlaid can be seen in Figure 20. This analysis supports my initial assumptions that most of the variance in the waterfall sound takes place in the lower part of the spectrum (<3KHz), and that the higher frequency ranges all have a similar fall off. The sound level of a waterfall is obviously dependent on how much water is traversing over the waterfall's edge to its base. The sound of the waterfall is

¹⁵ Due to technical limitations, the field recordings in Japan were not calibrated. However as the recordings were for artistic & design use, not scientific recordings made were deemed adequate for the outcomes of this project.

partially dependent on what surface the water is falling on to; for example is it falling on to rocks or falling on to water and is that water still or is it turbulent?



Figure 20 Comparison of spectrums from recorded waterfalls The figure shows all four waterfalls with similar falloff frequencies but quite

different low frequencies.

Doel, in his previously mentioned "complex liquid sound simulator"¹⁶ shows some success in his bubble simulator at generating waterfall sounds using a physical modelling technique (Doel, 2005, p.9). The issue I had was that on my current machine (1 GHz PowerPC G4) the CPU was having a very difficult time generating sufficient bubbles with Doel's java applet to make a waterfall sound. I had already written code in SuperCollider for the *suikinkutsu* module which generated a bubble, but that was also too CPU-intensive to be deemed a justifiable solution. In order to make this module part of a system capable of generating an entire soundscape I would have to design the module with less of a demand on the CPU.

Initial testing involved attempting to minimise the number of bubbles required for the waterfall sound. This was done by using filtered noise for the sounds above 3KHz and

 $^{^{16}} See < http://www.cs.ubc.ca/\sim kvdoel/icad04/simulator/ > accessed March 17, 2008.$

using fewer bubbles in the <3KHz range. The assumption was that by adjusting the clustering of the bubble frequencies it would be possible to mimic the material at the base of the waterfall (stones, water, etc). The reality was that the sound still relied on too many bubbles to make the CPU use efficient. The module also lacked the natural sound heard in the recorded waterfalls, due in large part to the fact that even while using 100% of the CPU it was difficult to get 1000 bubbles generated while the real waterfall was generating bubbles on a scale much larger than this. This method still lacked the realistic mix of sounds in the natural waterfall. In particular the transient sounds of the synthesised bubbles were not capable of capturing the sounds of those heard in nature.

Finally a third attempt was made at generating the sounds of the waterfall using a less CPU-intensive granular synthesis technique (Roads, 1988; Truax, 1988). The drain on the CPU of the previous techniques had been due to the generation of an oscillator for each required bubble. The granular technique involves using a recording of a waterfall; samples of very short fragments (normally around 300 milliseconds) are taken at random positions within the recording. As the sound of the waterfall in nature is created by a technique very similar to the idea behind granular synthesis (the sound of the waterfall is made up of hundreds or thousands of concurrent bubbles bursting every second, in which each event occurs on a very short timescale), it seemed like a logical technique to use.

Filtering was used to adapt the sampled waterfall's characteristics enabling it a greater range of sounds. By running a band pass filter on the granulation in the low frequency spectrum (<3KHz) the characteristics of the output could be changed to set the low frequency spectrum of the waterfall. The result of this module was much more convincing than either of the two previous attempts. It kept all the natural characteristics of the waterfall and adds the ability to change the response; the granulation allowed the sample to be layered so that it could encompass sound akin to much larger waterfalls and the filtering gave the user the ability to alter the conditions of the waterfall's base.

Spatial characteristics of the waterfall heard by a listener walking around in the garden (adjusting volume and frequency) were added to the module externally, when mixing of the composition took place.

4.4.3 Footsteps

Sounds of footsteps are quite evident in many parts of the recordings. Obvious aspects of many Japanese gardens are the paths of pebbles that appear in many parts of the gardens. The sound of walking on these paths is something that, for the author at least, is heavily associated with his time spent in these gardens. The feeling of walking from one section of a garden into another section is heightened by having this visual moment matched with the audible qualities of walking on soft material changing to the crunching sound of walking on pebbles. In most gardens the walker makes very little sound when walking on the soft materials underfoot such as grass, contrasted with the much louder crunch heard when walking on pebbles. The design of the module was an attempt to replicate the sound made by one person walking on various grades of gravel (not grass or cement paths).

The formation of my module contained two main parts: firstly the controls for the sounds of the footsteps: and secondly some controls for the timing of the triggering of each step. I planned to develop a granular system capable of reproducing the 3 main aspects of a footstep; the heel of the foot landing in the pebbles, the rocking of the foot when it moves onto the ball of the foot and the toes as they leave the ground. The three stages can be seen in Figure 21. Each movement has a different amount of force acting upon the pebbles on the path, emitting a different sound from the contact. The general idea for this work was influenced by Cook's research into walking synthesis (Cook, 2002a, ch. 15; Cook, 2002b). Controlling the sound of the footfall using envelopes, giving the user control of the grains to determine the type of path that was being walked on were directly influenced by Cook. I did not however delve as greatly into the analysis undertaken by Cook in his work on walking synthesis and failed to deliver pre-

sets for men/women and age, something I will discuss towards this end of this section and in greater depth in Design Outcomes.



Figure 21: The three stages of a footstep: heel, ball and toe.

Each of the foot's three movements are triggered by a separate set of granular synthesis controls. Each movement of the foot has controls to adjust the overall frequency and duration. Subtractive synthesis was utilised for each grain by placing a band pass filter over white noise, creating a grain with a distinctive frequency. Sounds from each section of the foot combined three of these filtered grains to create the overall sound, the three grains having centre frequencies within one of three frequency ranges: 300 - 1000 Hz, 1000 - 2000 Hz and 2000 - 5000 Hz. The three frequency bands were designed to be used similarly to a parametric equaliser and blended to form the overall sound of the footstep sought. This was done to make the module able to allow for variable conditions such as weight of the walker or condition of the ground. The timing was then used to trigger the duration of each of the three stages; so a heavier person as well as having a lower frequency sound might also have a slightly longer sound for the heel of the foot than that of a small, less heavy, child. Having the three different foot positions works almost like an envelope. The heel of the foot can be seen as the attack, the ball moving across the pebbles is sustained and then finally the toes flicking up pebbles at the end can be viewed as the release.

Once the particular grain frequency and duration were set for each position of the foot the duration between footsteps could be set and the footsteps would then trigger in accordance to this setting. There is a factor allowing for the addition of a random amount of time so that the footsteps do not fall too precisely. These footsteps are only valuable in this sense as the footsteps of the viewer. Currently there are no controls allowing for the footsteps to appear and disappear or pan in any kind of direction, but it is assumed that such effects could be added either by an external object (such as in protools or logic at composition time) or, by adding another module to distinguish the location of the event from the location of the listener.

The footstep module ended up being the most confusing of the modules to operate. It contains 31 sliders controlling all aspects of the sound. It also has a range that extends from sounds that don't resemble anything like a footstep to some that sound like quite good approximations of feet walking on pebble paths. A lot more work is planned on the footstep module in order to make it more user friendly, details which will be discussed in Design Outcomes.



Figure 22: Footstep grain synthesis

Grains were generated for the footsteps by placing whitenoise within a band pass filter. The duration of the grain was controlled via the envelope with a sine-wave curve. Three of these grains combined to form the sound of each stage of the footstep, the heel, ball and toe movements. The three grains were given frequency ranges of 300 - 1000Hz; 1kHz - 2kHz and 2kHz - 5kHz.

4.4.4 Birds

Three modules for birds were designed. The two most prevalent birds, crows and pigeons, each received their own module; a third module offering a wider range of birdcalls was created for songbirds. Sounds for the crow and pigeon were both based on forms of additive synthesis, the crow with influences of formant synthesis while the pigeon's coo included a simple form of step sequencer in an attempt to convey a type of song. The songbird module eventually settled on using Frequency Modulation (FM) synthesis as its source.

Over 20% of the events listed in the event logs related to birds of some description so it was clear they were going to demand a lot of my attention. The initial listening of the recordings gave an impression of one being surrounded by crows so the module depicting them was going to be the first to make. The other clearly audible birds were pigeons but the background of the recordings also contained numerous small, barely audible songbirds. Audibly, these "background" birds only "appear" when one listens to the recordings with more scrutiny, as their place on the acoustic horizon is distant or they are drowned out by more apparent sounds (traffic or waterfalls).

4.4.4.1 Crows

Crows are one of the first things mentioned when I am asked about my experiences in Japanese gardens. Crows seem to appear everywhere and are found constantly sounding in the streets and gardens of modern Japan. The crow was always going to be the most prominent of the bird modules. As an example of their prominence, 39 crow calls can be heard in the 30 second sample heard on track nine on the accompanying CD.

Recordings made of crows were analysed to extract the spectral information of the caw. The formant frequencies and their duration were all noted and logged. This information provided the background for settings on the crow module. The module allows for formants to be set within the range of 600 to 2000 Hertz. The pulse width does not show up in the visual aspect of the spectrograph and has to be set by the user's ear. Finally the user will set an envelope for the duration of the caw.

By looking at spectrograms of the crow sounds contained in the garden recordings it can be seen that the sound emitted in a 'caw' (the crow's call) is located in three frequency bands. These frequencies represent the resonant frequencies of the crow's vocal tract and are known as formants. Formant synthesis uses a source/filter model to attempt to calculate the formants found in the vocal cavity. In his online resource for physical modelling Julius O. Smith informs us that: "Formant synthesis is an effective combination of physical and spectral modeling approaches".¹⁷ In his implementation Smith uses physical modelling to reproduce the vocal tract, while he uses spectral modelling to discover the frequency of the desired formants.

In my implementation of the crow module I used spectral modelling techniques to discover the formants of the caw but stopped short of physically modelling the crow's vocal tract. Sine wave oscillators were set at each formant frequency. A pulse wave was added to modulate the amplitude of each formant. This pulse wave acts almost like a tremolo effect. The sound of the crow is very rough and to achieve this sound we could modulate the amplitude of the formants. This amplitude modulation is attempted to capture the vibrating vocal folds of the bird when it caws in nature. These two components (the formants and the amplitude modulation) form the basic sound of the crow. The formants can be set to various frequencies and the depth of the vibrato can be altered to add a level of roughness to the sound of the crow. Finally an envelope has been added to allow for the control of the duration of the crow's caw.

 $^{^{17}} See < http://ccrma.stanford.edu/~jos/pasp/Formant_Synthesis_Models.html> accessed March 30, 2008.$



Figure 23: Formant synthesis system used for a Crow

The generation of each formant for the crow was used by adjusting a saw-tooth oscillator. The user set the frequency of each carrier oscillator in a frequency range of between 800 and 1500 Hz. A pulse-wave oscillator was used to modulate the amplitude of the carrier oscillator, the width of each pulse and the amplitude frequency of the wave could be adjusted. An envelope to control the duration of the call took the form of a triangle shape, with only overall duration available to the user. There were two formants available to the user to achieve the overall sound of the crow.

4.4.4.2 Pigeons

A similar technique of additive synthesis was used to create the coo of the pigeon. The name is used to suggest the 'coo' of the pigeon is a much softer sound than the 'caw' of the crow. The pigeon also holds quite a different place in the overall spectral position of the recordings to the crows. While the crow emits its caw with a base at around 800 Hz and a third formant of 1400 Hz, the pigeon's coo occupies the space around the 200 - 400 Hz range. While not quite a songbird the pigeon has definite beauty in its voice, especially when compared against the striking caw of the crow.

While the formants are quite visibly obvious in a crow's caw the formants that exist in a pigeon's coo are much less clear. Instead the pigeon's voice seems to have characteristics strongly focussed on a smooth vibrato.

The pigeons exhibited a number of different calls captured on the recordings. While the crows seemed to call without musical form the pigeons could offer coos of either a single call with a narrow spectrum, or a number of calls closely following one another, each with varying spectrum width.

The basis of the synthesised coo sits in a single sine wave oscillator with a second oscillator added to adjust the frequency, providing a vibrato effect. Envelopes were set up to control the duration of the coo and the change in pitch over the duration of the coo. A comb delay line was placed around the sound in an attempt to provide resonance to the coo.

The user has been given control over how many oscillators are added together to create each coo of the pigeon, with the option of having up to four oscillators at evenly spaced intervals of between 0 and 100 Hz. There is also the option to provide a simple 'song' for the pigeon by playing back up to three calls each with a different initial frequency and a space between the coos of between 0 and 2000 milliseconds.



Figure 24: Pigeon synthesis system

The sound of the pigeon was achieved by adding together multiple sine-wave oscillators. The user set the frequency of the initial oscillator between 250 and 500 Hz. The base oscillator's amplitude was modulated by a second oscillator and an envelope with attach, sustain and decay values was used to control the overall duration of the call. The user could not adjust these values. The user was able to add together up to four of these oscillators at increments of 50Hz from the original (base) frequency. The user could also play up to three calls in a row and adjust the base frequency and duration between each call.

4.4.4.3 Songbirds

The crow and pigeon modules were modelled based on very specific birdcalls. The spectral modelling techniques used were chosen in order to capture specific attributes of each call. In creating a module for songbirds, I was interested in a much broader range of sounds capable of mimicking a much larger percentage of the avian world. There were two options that I investigated in the design of this module. The first was to implement a physical modelling technique drawing heavily on work undertaken by Neville Fletcher (Fletcher, 1988; Fletcher and Tamoposky, 1999; Fletcher, Riede et al., 2005) and incorporating many of the traits of modern speech synthesis. This technique would be combined with a sequencer inspired by Olivier Messaien's work in transcribing

birdsong¹⁸. The second alternative, and the model I ended up making, was to use Frequency Modulation and create a generic module capable of creating sounds that have the essence of songbirds.

I have shied away from delving too deeply into the physical attributes of bird sounds. It should be noted that much work has been done in this field, particularly previously cited works by Neville Fletcher. While Fletcher's work has been cited by many in their own work synthesising birdsong to date there does not seem to be an integrated physical model capable of delivering birdsong. My initial thoughts on the matter were to attempt an implementation combining elements of vocal synthesis, particularly models for singing, for example (Cook, 1991), with a sequencer capable of playing birdsongs transcribed into musical notation, heavily inspired by the work undertaken by Olivier Messaien in which he transcribed many birdcalls and used these transcriptions as influences for musical compositions.

Another option for creating birdsong vocalization was one I had first read about at the start of my studies in David Cottle's introduction to SuperCollider manual in which he states: "It also sounds surprisingly similar to bird song. I believe I read somewhere that birds have two voice boxes that modulate one another in a similar fashion" (Cottle, 2002, p.83). I was able to find examples of various people who had created birdsong modules of their own in various synthesis languages, primarily Hans Mikelson in CSound and Andy Farnel in Pure Data¹⁹. Both Mikelson and Farnel combined the use of FM synthesis with AM synthesis to create their bird modules. I followed a similar tact and effectively built on top of the pigeon module I had already created.

The birdsong module was built using three oscillators and four envelopes. A carrier oscillator was created with a base frequency controlled by the user. A second oscillator modulates the frequency of this first, carrier, oscillator. Envelopes were created to

¹⁸ See <http:// www.oliviermessiaen.org/> accessed March 28, 2008.

¹⁹ For Mikelson's work see <<u>http://www.csounds.com/ezine/winter2000/realtime</u>>, accessed March 30, 2008. For Farnel's work see <<u>http://obiwannabe.co.uk/tutorials/html/tutorial_birds.html</u> > accessed March 30, 2008.

control the frequency and amplitude of the second, frequency modulating, oscillator. Control for the duration of the attack and sustain of the envelopes were pass to the user. A third oscillator was created with the same characteristics as the second. This third oscillator was used to control the amplitude of the carrier oscillator.

My decision to proceed with the FM synthesis technique lay squarely with the fact that it was easier. Songbirds did not dominate the soundscape to any great extent and while I feel strongly that more research is required on the physical modelling of birdsong, I believed that it would be too large an undertaking for this phase of the project



Figure 25: Songbird synthesis system

Songbird synthesis was based on frequency modulation. The user set the frequency of the carrier oscillator (a sine wave oscillator. Two additional sine wave oscillators then modulated the amplitude and frequency of this carrier oscillator. Each modulator had envelopes controlling its amplitude and frequency, the user set the attack and decay on these envelopes. To adjust the frequency of these modulating oscillators the output of the envelope adjusting frequency was multiplied by 3000. The output of the system is capable of achieving bird-like tones and simple song patterns.

4.4.4 Bird Module Conclusion

The bird modules were expected to play a large role in generating the soundscape. Birds seem to be almost always audible in the recordings made of the gardens. I attempted three different synthesis techniques to generate my bird modules trying to select the technique that best suited the desired outcomes. In undertaking this endeavour I became infatuated with the sounds produced by birds. While I am not entirely happy with any of the results of the current modules, I have great hopes for the future that I will be able to spend more time working on some of the ideas presented and create more robust and better sounding modules.

4.4.5 Insects

Insects were not something that appeared on the Teimu recordings made in Japan. Or at least they weren't noted in any of the analysis, nevertheless I did want a module capable of changing the scene of the garden from one season to another. I was initially uncertain how to undertake this module without the assistance of recordings to analyse. It was while reading the *Wild Soundscape: Discovering the Voice of the Natural World* by Bernie Krause (2004) that the design for the insect module made itself clear to me.

In his work Krause discusses the way smaller animals can use their sounds to collectively make them appear as larger 'objects', part of a collective, as a deterrent to predators, such as birds. This concept of creatures producing their sound in a choir sat nicely with the desire to put some insects into the garden modules set. In this sense the insect module was designed very differently from any of the previous modules. Instead of resynthesising a sampled sound I used the knowledge I had gained from designing the previous modules to make a sound I had only heard in my head. I was also going to use multiple modules, to create the effect of a larger ensemble than was possible from just a single module. All the previous modules had been designed to work in isolation; the insect module was designed to work as part of a collective unit.

The module itself was a very simple three-oscillator design. A base oscillator with a frequency set by the user could then have both frequency and amplitude modulated by separate oscillators at the user's discretion. The wave shape of the oscillators could be changed to adjust the effect produced. When using sine waves, the sound is smooth and harmonic but when square waves are used, the sound becomes a lot harsher. The module really owes as much of its design to my use of analogue synthesisers as it does to the world of analysis and resynthesis that has been described in this chapter.

The user is given a simple interface to control all aspects of the design and can then use their ears to make changes where they deem them to be necessary to get all insect modules to interact with one another. It is also hoped that in future installations these sounds could be diffused through a space similar to the way crickets sound in a summer's night.



Figure 26: Insect synthesis system

The insect module was a simplified version of the songbird module. Two oscillators (both sine wave oscillators) modulated the carrier oscillator (in this instance it could be either a sine wave or a saw-tooth wave). The user could control the frequency and amplitude of the modulators. There were no envelopes to control duration like in the songbird module, so the sound of the insect carried for as long as the user saw fit.

4.4.6 The Shakkei

The final module was built after initial compositions were made. It is discussed more in the next chapter, but it was decided that a module was needed for use as a background sound against which I could set my synthesised events.

In Japanese garden design there is an important design aspect called the *shakkei*, which can be translated as the "borrowed landscape". The basic concept is that gardens are not built in isolation but are designed to fit into their environment. So they take advantage of far off mountains or a tree that may be growing in a neighbour's yard. Designing the garden, without taking these features into account, would be a fruitless exercise, as the garden would always look out of place. While I was reflecting on my modules after using them to create a composition, I realised that I had not bothered to think about the sounds outside the garden. That the modules I had built did not have an environment to fit into. A full description of the *shakkei* principle in Japanese gardens appears in *Space and Illusion in the Japanese Garden* (Itoh, 1973).

To remedy this situation a very simple sample player was built. It allows the user to take sections of a recording and play them back and it will take a number of samples and play them in random order with envelopes so that they can blend into one another so that listeners do not focus on the fact that they are listening to looped recordings. By changing the samples the user is able to change the garden scene. Tracks 17 and 18 on the accompanying CD show an example of the same events track played back against two different *shakkei* tracks. In one, the garden is in a serene setting with little or no interference from the outside world. In the other the garden is engulfed by the sounds of traffic and is not as restful a place to be.

Technically making this module was not a very difficult task; in fact it was probably the easiest module to build, but its influence on the final composition was huge. It taught me a valuable lesson that by focussing too closely on the finer details of the garden, I was forgetting about the outside world and its influence on the garden, which is equally important.

4.5 Conclusion

As stated in the introduction to this chapter, the module design was the largest and most time-consuming section of my project. Through this chapter I have attempted to give an insight into my design methods, starting with the initial decisions about which modules I would create and also which design tools I would use. The bulk of this chapter however has been about the design of each of the modules. In discussing the design of each module I have attempted to disclose to the reader a number of thoughts:

- Why I chose each module
- Who or what informed my design of the module
- Which synthesis techniques I was able to use
- How successful I was with using each technique
- How happy I was with the final results of the module.

Capturing the essence of design is a difficult task. So many ideas, theories and accidents make their way into the final design that it is impossible to explain every single one of them. It is like asking a painter to describe each brushstroke on a particular artwork. What I have attempted to do in this chapter is explain the concept of the modules, on a level that should anyone see fit they could recreate the modules themselves using only my explanation of the design. What you have read is a snapshot of where the modules stood when they reached a preliminary stage. Each module was trialed many times before this preliminary design was chosen and it is my assumption that in many instances these designs will evolve further (as I will go on to explain in the next chapter) as I integrate new theories and understandings.

5. Design Outcomes

5.1 Introduction

One of the most important aspects of undertaking a project such as this is to be able to look back on the work and reflect upon it. As Peter Downton makes clear, both in his book *Design Research* (Downton, 2000) and through his teaching in a Research Methods class I undertook at the start of this degree, design is inherently a research activity. It is a way of working, reflecting and refining ideas and skills into a work that grows as a deeper understanding of a particular field is gained. This degree was a rather lengthier and much more in depth attempt to gain insight into how and why I design than I would usually undertake. Through to this point readers should have seen how I went about designing my work, hopefully they have gained an insight into my design practices and how I work. This final chapter should now give an insight into how I reflect upon my work, first for criticism of the work itself, and secondly as a way of obtaining lessons for my future design goals.

In order to capture these two insights, the chapter is divided into two sections: firstly, reflections upon the design and undertaking of the composition. In order to test the modules, I created a composition, which was performed at a SIAL concert in June 2007.²⁰ The first part of this chapter is dedicated to the creation of this composition and a reflection on the lessons learned by way of its undertaking. Secondly, I discuss the design techniques learnt for future designs. In this second section of the chapter I discuss more general design issues that were not a direct result of the composition. Particular attention is given to techniques that will be taken advantage of in future undertakings.

5.2 Evaluation of the modules through composition

In an attempt to assess the merit of the modules, I felt it necessary to use them in an artistic undertaking and reflect upon the process. From the beginning of my research I

²⁰ See <http://sound.sial.rmit.edu.au/Index/Projects+Spectrum03.php> accessed 18 March, 2008.

had been uncertain about how best to utilise the modules. One of the prime motivations of designing synthesis algorithms to create sounds is so that recurring events, such as footsteps or birdcalls, can be played back multiple times, each time with the subtle changes that occur in a real life environment. This means that the best place to take advantage of these benefits is in an interactive environment. My concern with leaping straight into an interactive environment was that if there were issues with the performance, it might be unclear if these issues lay in the module design or the interactive-environment design. I wanted to test just the modules and I thought that rather than creating an interactive work such as an installation or a computer game, it would be more beneficial to attempt a more linear composition. This composition would meet my criteria of an artistic representation of a Japanese garden, and it would attempt to utilise sounds from all the modules created so far.

A composition, discussed in detail below, was produced which lasted for 4:48 and can be heard as track 16 on the accompanying CD. The piece was performed on the SIAL diffusion system as part of the Spectrum 03 concert series, held on May 24, 2007 at the Meat Market in North Melbourne. The SIAL diffusion system consists of a 32-speaker system set up throughout the space in custom configurations. The composition was a stereo file which was played back through the SIAL diffusion matrix, a Max/MSP object used for routing input to numerous speaker banks. The output of these speaker banks were controlled in real time using four CM Labs Motor Mix consoles.

The composition was loosely based on what I felt while listening to the roving recordings analysed earlier in my study. The composition was created by drawing a simple map of an imaginary garden which can be seen in Figure 27. The composition is in the style of a sound walk through this garden, along a path from the entrance to the waterfall and back again and is conveyed to the audience through the ears of an imagined 'narrator'. The 'narrator' starts at a *suikinkutsu* before walking into the garden, past the garden walls, where a gravel path begins. The narrator then follows this path over a hill towards a waterfall, passing various species of bird life along the way. Once the narrator reaches the waterfall at the end of the path he stands still for a moment and

absorbs the sound of the waterfall's force before turning his back on it and walking back to the garden's entrance. Towards the end of the piece, before the arrival back at the *suikinkutsu*, insects invade the scene.





At many times during my study I have been asked what these modules are attempting to capture when they combine to form a scene. Would they attempt to capture a realistic soundscape of the garden, or would the output more of a more artistic merit? The piece I created was an attempt to do both. The start of the composition attempts to capture, realistically: the entrance to a garden; the sound of the *suikinkutsu*; the walking on the path; and the way the waterfall appears and is occluded by the hill. These are all attempts at a realistic sound walk experience. The arrival of insects was depicted in an exaggerated manner, partially as a way of working all modules into the piece and partially for artistic reasons. It was also a reflection on the diffusion system, which the piece was to be performed on. I wanted an ending to the piece that would be capable of
enveloping the audience with its intensity. This was an artistic decision and an attempt to test the modules for future artistic capabilities.



Figure 28: Notation of the composition in the style of a temporal log

The duration of the piece is five minutes. The composition starts with a *suikinkutsu*. Once inside the garden the sounds of footsteps on the path, a waterfall and various birds are heard. Towards the end of the piece the sound of insects increase. The journey through the garden is marked by a return to the sound of the *suikinkutsu*.

The temporal analysis techniques, discussed previously, were used to create a score for the piece based on the methods described in the previous two paragraphs, the score can be seen in Figure 28: Notation of the composition in the style of a temporal log. Each module was used to play its part and recorded into separate mono files. These files were then imported into Logic and mixed to a combined stereo track. Once the mono tracks had been moved into Logic, final touches were added to the composition: panning was added to certain features; time intervals were added between events if needed; and minor amounts of equalisation were added (mainly as a way of adapting the piece for the SIAL diffusion system). A number of versions were made of the final composition, which were then played on the diffusion system during rehearsals on the morning of the performance. As a result of these rehearsals one version was chosen to be the piece performed on the night.

5.3 Reflections on the composition

Once the composition had been created and performed it was necessary to complete this phase of the project by reflecting upon the outcomes. Reflection upon the piece produced three strong outcomes, which are discussed in the following three subsections. Firstly, silence and the *shakkei*. Digital silence is something we never face in real life; there is always some kind of pressure working on our ears so we avoid the nothingness of digital silence. In producing the composition I was made aware that by focussing the modules on event-based sounds I had forgotten to provide them with an 'atmosphere in which to breathe'. The *shakkei* module was a response to this issue. This is followed by a discussion of the module interaction. The composition was the first time I had attempted to have the modules interact with one another. I shifted my focus from isolated development of each module, where I was looking only at how they each compared with their real life inspiration, to combined output, where the modules worked directly with one another to create the composition. This enabled the sounds to work spectrally with one another. Finding the ideal spectral location for sounds so they could shine through was a compositional technique I had not taken into account when looking at the original analysis and a matter I needed to further investigate. The final section of the chapter is a debate about realism vs. art; I have already stated that my composition contained elements of both. Having composed with attention to both elements, I here investigate how I perceived the value of each.

5.3.1 Silence and the *Shakkei*

After reflecting on the composed piece, I believe the most obvious improvement to the sound was the treatment of silence within it. Any work that had been done in convincing the audience they were listening to a soundscape was quickly eroded by the appearance of a few seconds of lifeless silence. This was an issue that needed to be resolved for the

composition to have a more lifelike quality. This section discusses the reasons for the silence (a focus on events rather than ambience), the solution to the problem (the creation of the *shakkei* module) and the eventual results of the new combination of atmospheric modules (*shakkei*) and event based modules.

With the exception of the waterfall module, none of the modules dealt with sonic events that lasted longer than a second. By looking at the results of that analysis it can be seen that there are, on average, two events for each minute of audio. In creating my own composition I had filled in more events per minute of audio than I had noted during any point of my event analysis on the original Teimu recordings. I believe this happened because I was over inserting events in an attempt to cover up the silence that was otherwise filling the composition.

While the technical details of the *shakkei* module have already been discussed (see p.59), I now wish to discuss the design implications of the module. The thought behind the *shakkei* module is similar to the way a sound designer would record room ambience on a film set so that the soundtrack can later be set to the correct sound bed for the particular location. In creating my modules I was forgetting one of the main features of Japanese gardens - that of the *shakkei* (the borrowed landscape). I had not located my composition in any kind of relevant sphere; sounds existed in isolation. At no point in my design of the composition did I take into account where my imaginary garden was located. In drawing the map of the garden (originally seen in Figure 27 on p.63) I never inserted influence from outside of the garden's walls; the garden sits alone, untouched by the outside world - a state that can never exist.

The results of adding the *shakkei* module were immediate and impressive. No longer was I tied to filling up the soundscape with unnatural numbers of events in an attempt to hide the silence. I could use any backing track I liked as a bed to lay over the events generated by the module. I was also capable of altering the sense of the garden by changing the *shakkei* tracks. Figure 29 shows a map of the imaginary garden created in the initial composition with the influence of the *shakkei*. As can be seen it is now

possible to create a garden located in the midst of the city or a secluded part of the country.



Figure 29: Garden surrounded by aspects of the shakkei

The middle of the picture shows the image of the garden, imagined for the initial composition. The garden is surrounded by outside influences, the left a roller coaster, to the right a busy street and above it mountains. This is an attempt to show how the sound within the garden would be influenced by outside sounds, the *shakkei*, items I failed to include in my original composition.

5.3.2 Module Interaction (Spectral, Temporal and Spatial Elements)

The move from isolated development of the modules to a composition where the sounds were integrated with one another was the final step in testing the performance of the modules. In a way it was returning me to the start of my work; in the analysis steps I had started by spending time researching the macro-scale sounds of the environment as a means to discover the micro-scale sound of the modules, now I had to use the microscale environment to piece together a macro -scale world of composition. In doing this I had to look at the integration of the modules on levels I had not been consciously aware of when designing them on the micro-scale. I had to pay particular attention to the macro effects of spectral, temporal and spatial behavior of the modules' interactions with one another. Below I will discuss each of these elements, how they relate to the current state of the module project and also how they have influenced my thinking for future undertakings.

Particularly with the new *shakkei* module, it was important to have modules that would fit the spectral content of the surrounding environment. This would mean that while playing the *shakkei* in the background I would fine tune the spectral elements of the modules to find the most pleasing fits, the same way a musician might try many different sampled kick drum sounds in order to find the one that they deem best for their purpose. An example of such a change was adjusting the crow module to make caws that cut through holes left in the 800 to 1400 Hz range of the *shakkei* by adapting the crow formants correctly. In this way I became responsible for designing the sonic qualities of my garden soundscapes.

As illustrated in the spectral mix and the interaction between modules, it was also necessary to work on the temporal mix of the composition. The temporal aspects of the sounds appear in two primary ways: the micro-scale within each module, and the macro-scale that occurs when the modules interact with one another. In terms of the micro-scale, the temporal aspects of each module were something that was primarily dealt with within the design of the modules themselves (e.g. the use of envelopes for adjusting a birdcall duration). Working on the macro-scale was another way of finding the best fit for a particular sound contextualised in its surroundings. As mentioned previously, it was important not to overfill the scene with too many events. Getting the right temporal mix of space and events was achieved by making alterations in the timing of the composition, in conjunction with the spectral aspects described above. Once the modules had been recorded I used Logic to adjust the temporal aspects as needed.

Finally after completing the spectral and temporal elements of the composition I worked on the spatial mix. Spatiality was by far the most difficult aspect of the mix for me. I realised that in analysing my sounds and building my modules I had focussed heavily on temporal and spectral content of the recordings but in doing so I had dropped all spatial information. In creating my modules as mono sounds I had always expected that I would use an external spatial engine to generate spatial qualities in the work; qualities the sounds would require, making them come to life. By the time it came to creating the composition I realised that producing spatial quality was a much larger undertaking than I had initially anticipated. Working with the SIAL diffusion system made dealing with spatial issues a lot easier. Instead of having to use a spatial engine I was able to use the diffusion system to place events in particular speakers throughout the room. While it was not an ideal scenario, as I had already composed the piece in stereo, I was able to follow a score and move sounds around the room when certain events occurred. For example when I knew a series of bird calls was coming up I could increase the levels in certain speakers to move the sound to that part of the room.

In my initial undertaking of the project I was focussed on the task of analysing and resynthesising particular sounds. Despite my background, as a musician and performer, I got so lost in the analysis and resynthesis stages of the design that I never took the time to think of how these sounds would interact. I now had to think about how they would react with one another, in frequency, time and space. It is difficult to telescope the lessons I have learnt about spectral composition, temporal elements and spatial cues by building a composition and performing it on a spatial system into just one section of this thesis. These newly discovered skills of adjusting sounds in all three domains have worked their way into my musical work and are now primary goals of my focus when composing. This is something I feel I would not have understood as clearly as I do now, had it not been for the reflection upon my work and the time devoted to critical thinking about my particular work process.

5.3.3 Realism

Realism was a continuing topic of conversation during my study. It was something that seemed to confuse a lot of people and something I spent quite a lot of time having to defend. This was due partially to the way I phrased my research, but it was also due to the expectations listeners had placed on how realistic a piece should sound. Of primary importance to me, in this research, was the study of synthesis techniques; and

subsequently, by way of critiquing these modules, compositional techniques for soundscape work. By other peoples' standards success seemed to be based on how truly the synthesised sounds recreated their physical counterparts. When people were disappointed with the realism in particular modules, my devotion to realism was something I was either going to have to defend or justify.

Certain sounds possess characteristics that make them more suitable for re-creation using current synthesis techniques. The *suikinkutsu* is a good example of this. It produces a modal sound with modes that can be calculated using a known equation with a relatively respectable correction for error. These modes can then be created using synthesis techniques that make them sound quite similar to the real event. In terms of my modules I believe no other module imitated its real world counterpart as well as that of the *suikinkutsu*. Assuming people know what a *suikinkutsu* sounds like (which very few do), it is my belief that they would, upon hearing my synthesised sound, correctly state that it sounded like a *suikinkutsu*. Further research is needed on the sounds of other modules, these modules would probably benefit from better models being designed. I draw particular attention to the bird modules here. While I was happy with the sound I created of a pigeon, I would much preferred to have been able to implement a physical model of the bird vocal tract and compare all three styles of models used in creating birdcalls.

I was aware, when starting the research, that I would not be making perfect replicas of sounds. To achieve this, I would have been far better off just recomposing soundscapes using sampled sounds. Instead I used synthesis techniques in an attempt to understand their design capabilities. Instead of composing a better-synthesised trumpet sound, for example, I decided to focus on sounds found in nature by analysing soundscapes of Japanese gardens. The question always remained how could I utilise the modules I created? The creation of the composition goes some of the way to answering this question. The composition was specifically designed to test elements of realism and elements of artistic merit. I feel satisfied that the modules show the ability to produce

both outcomes to varying degrees²¹. My work has always been more of an artistic nature than purely technical, and that will continue to be the primary focus of my future works. If I want moments of super realism, I shall inevitably return to what I have done in the past and continue to use sampled sounds for those moments.

5.4 Future Plans

The previous sections of this chapter have been focussed primarily on results of reflection upon the composition I undertook to test the modules. Now that the work had been built and evaluated, it was important to plan for future endeavours. I was interested in seeing how lessons I had learned from undertaking the course of study would reflect themselves in my creative work. I have learnt many techniques over the course of this project and some of these I want to investigate further. The three key fields that I will be focussing on are synthesis techniques, user interaction and compositional content. The following three subsections discuss lessons I have learnt from all three fields and how I plan on implementing them in my future work.

5.4.1 Synthesis Techniques

The first of the fields for future development involves the use of synthesis techniques. As seen in Figure 1 presented on page 2, I weighted a lot of my work in the field of synthesis. Because of this and with the design of the modules occupying such a large percentage of this exegesis, it behoves me to discuss what I have learnt and how I plan on using this knowledge in the future.

Prior to undertaking this degree my experience with sound synthesis was primarily in playing the instrument form of the synthesiser. One of the things I hoped to achieve in studying synthesis techniques was to have a greater understanding of how the sounds in

²¹ Note that a full discussion on the concept of art vs reality in music and sound is beyond the scope of this document, this section is relating purely to the scale of realism contained the sounds of the modules themselves and how they work in a composition.

these instruments are created, and how these techniques can be applied to events other than the standard sounds found as presets on synthesisers (a topic I discuss in the next sub-section). I was interested in furthering my own understanding of digital sound, both in its creation and its use, by undertaking an in-depth study of how to use digital synthesis techniques to create a suite of tools capable of creating the specific aural atmosphere of a Japanese garden soundscape. As mentioned in the module design chapter, when I was creating the modules it was important for me to use as many different methods of synthesis as I could. By doing so I was able to learn when and where different techniques would be best suited.

There are many books and online tutorials devoted to synthesis techniques but reading about these techniques is really only the first step to mastering them.²² As with playing any instrument, to truly master these techniques much practice is needed. Bv undertaking this project I was able to get practical experience in a number of digital sound techniques, most particularly synthesis techniques. I was enamored of the idea of undertaking a large scale project using nothing but synthesis techniques - by the idea that by building in sounds generated with variables that would change fluidly I could create lifelike sounds; that I could create modules that could live on as though they were real events, rather than just a static sample playback. As mentioned in the conclusion to each module design, I was disappointed that some of my modules were not capable of capturing the same range of sounds found in the samples taken from the real world. Knowing the amount of work required for the creation of each module, I now realise that there is a lot of work still required in discovering algorithms and understanding the nature of an event's sonic qualities. The ability to use synthesis as a method for generating all sounds in a realistic manner still requires greater research and development.

²² There have been two examples previously mentioned in this document (Cook, 2002; Roads, 1999), for further examples see the bibliography.

What does this mean for my future? In the short term it means I will be continuing to utilise the techniques I have learnt to develop synthesised sounds with very specific outcomes in mind. My work will continue to focus on incorporating elements of nature, but probably not to the lengths of implementing a garden soundscape. Instead I will focus on using attributes of nature to reproduce more artistic work. For example I may create a work having sounds that will be influenced by the birdcalls we hear in a particular scene, but I will not be attempting to recreate these calls with the level of realism I required of the modules in this work. Instead I will take an approach similar to that taken for the insect sounds, where I incorporated more artistic goals into the synthesised output.

I will also be able to choose synthesis techniques to aid my desired sounds with greater ability than I ever could previously. I now hold a far greater knowledge about the qualities that each type of synthesis holds, whether it be granular or additive, subtractive or frequency modulated. I can use these qualities to my advantage in forming sounds that I build from the ground up. I have a far greater comprehension of the boundaries of each technique and can plan for these in advance. I will know when my work is calling for a granular bed or when it is calling for a frequency modulated harmony for example.

5.4.2 Interaction

One of my initial goals for the project was to create a suite of modules capable of generating real world sounds and then release them to the public, allowing them to be used by other people. While the modules are available as SuperCollider code as part of this thesis, I did not feel I achieved the second part of this goal in the way I would have liked which was to create stand-alone, easy-to-use applications. In order for the modules to be ready for releasing to a wider audience, there are a number of steps that I would want to undertake. In particular I would want to work on the user interface of the modules, the ability to create pre-set sounds and controls the user could access. The steps I would like to undertake are outlined in this section. For the examples of how this would relate to my work I have decided to use the footstep module for all examples.

The first review of the modules would involve re-working user-access to the controls. Improving the controls would allow the user to have access to change the sound, yet have the module still reflect the sound it is attempting to simulate. In the footstep module I created sliders enabling access to all valid variables. This left a large set of possible sounds, a range of which sounded nothing like footsteps. While access to all those controls might be valuable in an 'advanced' mode they are overly complicated for someone who wishes to open up the module and start making the sound of footsteps, and nothing else, right away. There should be ways I could simplify the controls to make it easier on the user, for example instead of having a separate slider for each frequency band used by the heel, ball and toe of the foot (a total of nine sliders for control of the frequencies plus another nine for amplitudes), I could perhaps attempt to use one slider for the initial frequency and have another slider control the way the other two frequencies are derived from the initial frequency.

Improving the interface aspect of the modules was only deemed necessary after preliminary testing had taken place. I had always assumed that user interface design would be one of the final stages of the module design, and that it would come about once I was satisfied with the sounds the modules were producing. I now realise that the modules, as they stand, are still very much in the development phase. I have worked with them in a standard compositional environment and have reflected and improved them upon completion of this phase. Now I would like to work with them and improve them in an interactive environment, whether this takes the form of a digital space or a physical interactive installation. Once I have done more of this testing I feel I will be better equipped to fully appreciate what a user might require from the modules.

My initial design strategy involved the audio output of the modules only. The layout of the user interface was designed with very little precision and with only myself as a user in mind. I am looking forward to the challenge of future interface developments. The examples given above show how I am starting to focus on how these modules can be better suited for public consumption, something I had always kept in mind but had continued to overlook in favour of focussing on the sonic quality of the modules output.

5.4.3 Deep Composition

Composition was not an initial aim of my Master's study, I undertook this study expecting to discover a greater understanding of synthesis techniques, digital sound and sonic environments. I did not have a prior focus on the compositional element of the work I was preparing to undertake, but was much more focused on creating the tool set and leaving the compositional work to others. At the conclusion of the project, the composition was the section of the project that really tied all of the work together and left me with a greater understanding of many aspects of sound, which I have incorporated into other aspects of my life as a musician and sound designer. This section will introduce the reader to my understanding of 'deep composition' and discuss how I plan on using the idea in my future work.

Awareness of the natural world has a great impact on me and on how I attempt to make sounds 'flow' in my own work. The delicate nuances of songbirds, the sounds that seem to only exist when close attention is paid - these are elements that are seeping into my work, particularly as a musician. Prior to undertaking this research I was only ever interested in the "big picture"; very seldom did I pay attention to the finishing touches or small details. By listening to multiple recordings of the natural soundscape and attempting to recreate these, I realised that a lot of the beauty of the soundscape was in the detail. Unlike when listening to a lot of musical recordings, I was not bored by the garden recordings. Instead I found myself continually more intrigued; with each listen I was discovering hidden moments in the soundscapes. I realised that to attempt to recreate these would take more than a quickly put together composition. Where I had previously understood the 'deep listening' technique put forward by Pauline Oliveros

(Oliveros, 2005) purely as a listening methodology, I found myself now required to create a 'deep composition' with my composition techniques.²³

5.5 Conclusion

This chapter has described two phases of the research undertaken. The first half of the chapter dealt with the reflection and evaluation of the work through creation of a composition. The second half dealt with future directions I aim to take, based on elements I have learnt from the study. As a whole, the chapter aimed to inform the reader of how I went about evaluating my work and where I plan to take my work in the future.

Evaluation of the work has been a difficult task. The work itself was a set of technical theories used to carry out an artistic goal. Does this mean that the work deserves a technical or an artistic evaluation? I chose to evaluate the work (the work referring to the modules) artistically, by testing the modules in an environment for which they were designed. By doing so I found weaknesses in my initial design (specifically the way I used or did not use silence) and was able to refine the work to take these newly discovered requirements and work them into my design process.

The second half of the chapter was written with the aim of demonstrating my continued commitment for future designs. Having learnt so much in this course of study, I aim not only to capitalise on those lessons (for example by continuing with my ideas of deep composition), but I also want to invest more research into areas such as user interaction.

Design is a continuing path of building, reflecting and improving. Where the previous chapter (Module Design) gave specific details of building, it is hoped that this chapter

²³ The idea of deep composition was expanded upon in my examination and is a concept I intend to take further. However, at the time of the original writing of this exegesis my thoughts on 'deep composition' were still at a very embryonic stage. I have left this section in place as a way to describe where my thoughts lay at the original time of writing.

demonstrates that not only am I able to design tools following technical specifications but I am also able to reflect and evaluate my own work, refine the design and move forward with clear goals for improving my design work.

6. Conclusion

The undertaking of this project affected me on a number of levels. Primarily I was made aware of the depth expected in scholarly projects. Prior to this project, my only accountability in my creative work had been to my self. Now with examination and explanation required on all levels, I have realised how my own designs have been heavily influenced by other's work. I believe that this realisation has improved the level with which I now research and plan my ongoing artistic works, in whatever field they may lie. I have also become much more aware of the importance of reflection on one's own work. In my life prior to this project I was always keen to move on, especially if something was not working out the way I had hoped it would. Perhaps most importantly, this project has provided me with design ideas. I now have a number of plans for pieces I wish to construct in the near future and as a designer that is something that is constantly important to a happy way of life.

To display many of the ideas discussed throughout this exegesis I have designed a new sound work, which is to be presented at examination. The piece will be a sound based representation of a Japanese garden. It will feature three distinct systems, which combine to give the overall feel of the work. The work is designed to show not only a reflection on my past, but is also designed to incorporate some of the aspects discussed in the previous chapter, with regards to future progression.

The three systems that combine to form the installation are: playback, real-time synthesized events and hardware synthesised events. Playback comprises a quadraphonic mix surrounding the installation space. This playback represents the *shakkei* and comprises sound events that take place outside of the garden boundaries such as traffic and building noise. This layer of the installation will be devoid of events likely to draw the attention of listeners, but provide subtle context setting sounds to the other layers. These computer synthesised layers will take the form of events that occur within the garden space and will be played back using the modules written in SuperCollider. The space will contain sounds of one waterfall, various birds (crows, pigeons and songbirds) and a *suikinkutsu*, which will mark the entrance to the garden.

Finally hardware synthesised sounds will be located within the garden space. These hardware units will use FM techniques, learnt from designing the insect module, to create insect like sounds. Taking inspiration from Sebastian Tomczak²⁴ and Ralph Schreiber,²⁵ these small units consist of one chip, three resistors, three capacitors, a battery and a small speaker. The intention with this layer is to create a soft intriguing bed of sound, inviting the listener to explore the space for the source objects. It is hoped that when these units are turned on they will not be initially noticeable over the more powerful soundscape that is being played back through visually obvious speakers.

Listeners will be free to move about the space, much the same way that they would move about in a garden. They can visit the waterfall or head to an area more dense with the sounds of birds and insects. The idea is to coax the user into exploring the site and appreciating subtle aspects of Japanese garden soundscape without the dominance of the visual aspects on which they would perhaps focus on more heavily if they were in a real garden.

The installation is a way of translating knowledge gained through my study into a physical form. It exhibits signs of all the aspects I have discussed in this paper; the early influences of synthesis design and soundscape studies through to my new understandings of ideas such as deep composition. The constant self-evaluation I have committed myself to throughout the course of this study has provided me with a number of fields with which I hope to continue exploring in the future. I see this new work as being not just a summation of my past lessons but also an early exploration of some of these new fields; such as creating a soundscape designed for spatial playback, for an audience that is not motionless during its performance and for a piece that invites the audience to interact with it.

²⁴ See <http://www.milkcrate.com.au/_other/sea-moss/> accessed March 17, 2008

²⁵ See <http://www.ralfschreiber.com/> accessed March 17, 2008

When I started this project I did not have the foresight to expect to uncover so much about myself, particularly the way I design. I did not expect to gain so much from each of the fields I was entering into; I learnt to appreciate the depths of study one has to go to in order to fully justify each decision. This study has been a great undertaking for me, and has shown me insights into my work I feel I would not have seen otherwise. Now I intend to use these insights in both my work as a designer and my broader life in general.

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Appendix A - Event Logs

Event Logs Kyu Furukawa Teien: June 13 Roving start point 1

Person doing tape ID: Lawrence Tape ID duration: 1:10 Channels: 2 (L & R) Duration: 9:27 Transcript:

This is a stereo recording from the kiosk. We are much closer to the road now; the time is 10 past five the garden is now closed. It is still overcast, no wind a few crows around. On the other recording you would have just heard some of the closing music of the garden from the day. This walk is going to go down a stone path; fountain on the left, waterfall on the left, you'll hear it as we go down. I'll just give it a couple of minutes so the traffic can establish itself and then we'll move off. Recording starts now.

Initial state: very audible traffic in FL

1:15 crows

2:05 traffic dies off

2:20 metallic sound

2:33 traffic picks back up

2:48 first steps heard

2:57 waterfall starts to appear

3:42 angry crow

4:13 more footsteps

4:20 traffic has died off again

4:44 waterfall becomes more apparent than distant hum, can make out splashes

5:00 some other bird appears with higher chirp

5:10 louder footsteps on stone

5:25 waterfall very apparent - characteristics of waterfall sounds as though there is a lot of water hitting stone and not hitting other water making a sharper sound with less sustain we are only hearing the impact of the water not the breaking of bubbles, the sound is more like that of a shower than that of a waterfall flowing into a pond 6:31 bird that sounds like goose but is probably a crow 7:44 possible bird in waterfall slightly different sound from usual

9:27 end

The recording seems very much focussed on the left channel, it is hard to say if this is due to greater volume of events occurring on that side without having been there. the waterfall isn't the most pleasant sounding waterfall i have ever heard but it make a nice change from the traffic sounds at the start of the recording. that being said the similarities between the two are quite interesting (dominant frequency noise interrupted by occasional short events (eg louder motorcycle and louder frequency in waterfall)), is a busy freeway the modern day waterfall?

Stationary point 3

Person doing tape ID: Lawrence Tape ID duration: 0:32 Channels: 2 (L&R) Duration: 6:36 Transcript:

OK this is stop point number 3; time is ten to five. The location is shinji-ike we are now half way between the real waterfall and the rock waterfall. Recording starts now.

Untitled Initial state: crows, waterfall on right 0:56: music starts playing (but not enough to drown out waterfall or crows) 2:16 crow sounds quite close 2:20 smaller chirping of birds
2:36 water splash
2:53 chirping bird gets closer
4:40 music stops
5:40 train
5:51 motorcycle?
5:56 more music starts
6:20 talking appears over the top of the music
6:36 recordings stops abruptly

While it is a nice recording of the music that is playing in the park there isn't much in the recording otherwise, the only other notable events would be the faint sound of the train which is a very interesting sound and the splash that is made in the pond.

Roving start point 2

Person doing tape ID: Lawrence Tape ID duration: 0:20 Channels: 2 (L&R) Duration: 3:30 Transcript:

OK sound walk from the karetaki to our stationary recording point number 2.

- 0:20 initial state: high pitched hum on RHS
- 0:31 footsteps start
- 0:40 crows sounding a lot more reverberant than usual
- 0:59 traffic appears
- 1:09 crows sound as though they are in a cave somewhere behind us
- 1:27 waterfall appears (traffic has died off considerably)
- 1:57 crows sound almost as though they are outside and we are inside

2:20 footsteps have stopped being audible (this happened a while ago)2:49 perfect example of what i mean by the reverberant crows3:03 recording stops

So far this would be the most interesting of the recordings as it has so much depth in the sounds that occur. the traffic comes and goes, the waterfall does the same, the cawing of the crows is quite different, however again making the analogy to music it while it is the most interesting of the recordings on initial listen it doesn't mean it is necessarily the richest of the 5

Stationary Point 2

Person doing tape ID: Lawrence Tape ID duration: 0:56 Channels: 2 (L&R) Duration: 6:12 Transcript:

This is a recording from the karetaki (dry waterfall) opposite the pond and opposite the main waterfall

Initial state: there is a lot of crow noise and the waterfall can be heard in the distance to the right

0:26 initial state
0:58 low level traffic hum evident
1:22 footsteps?
1:40 traffic intensifies
2:30 one crow flies closer
3:25 weird noise in distance
3:41 traffic rises again

4:22 splash

4:50 chirping bird (not crow)

5:00 lull in crows compared to the start

5:20 traffic

6:05 traffic picks up again

6:12 recording stops

Is 6 minutes long enough to convey the space? While it seems like a long period when listening to a pop song the time goes quite quickly in these recordings especially when events are so sparse. If we are looking for events and repetition I wonder how much of a sense we get for the environment from a 6 minute recording.

Stationary Point 1

Person doing tape ID: Lawrence Tate ID duration: 1:04 Channels: 4 (FL, FR, RR, RL) Duration:10:12 Transcript:

Tape ID channel 1 (FL), channel 2 (FR), channel 3 (RR) and channel 4 (RL). Back to channel 1. Date today is Tuesday the 12th it is about 3 in the afternoon, overcast probably about 20 degrees a bit muggy. This is the first location in front of the waterfall there are photos accompanying and Michael has done some sketches, not a lot of people around but we've had a few crows. Recording starts now.

Initial state: waterfall heavily in FL speaker

1:04 conversation in (RL)

1:49 distant motorcycle (RR)

- 2:08 faint footsteps LHS
- 2:13 loud footsteps RL

2:30 distant traffic RHS

2:55 distant car (RHS)

3:28 distant siren/traffic (RHS)

3:58 faint footsteps (RR)

5:00 crow (RL)

6:00 traffic rises

6:30 traffic intensifies

6:50 crow (RL)

7:20 crow (Rear/faint)

7:44 traffic (RL-RR)

8:00 people talking (RL, faint)

8:18 train? (RR)

8:50 crow (RHS) and faint (LHS)

9:00 laughing (faint rear)

9:16 crow (RHS)

9:30 crow (RHS)

9:35 crow (RL)

9:48 traffic intensifies (RR)

9:59 crow (RR)

10:12 stop

This was actually the first recording I listened to and I didn't make any comments on it.

Kyu Furukawa Teien: June 14 Roving start point 2

Person doing tape ID: Lawrence Tape ID duration: 0:40 Channels: 2 (L&R) Duration: 7:18 Transcript: OK here's sound walk number two. This time we're going to walk down the right hand side of the waterfall. It's a different path structure so we've just made a sketch and some measurements for the previous path. This one starts off with some large rocks which we took photos of earlier this morning they look like a waterfall moving into a stone path. The time is 5:30 weather conditions haven't changed much still muggy temperature is 20 degrees maybe a bit higher. Recording starts now.

0:40 initial state: waterfall can be heard in background siren in back ground bird (not crows) chirping

- 0:57 siren of ambulance can be heard approaching and tyres on roadway, ambulance
- 1:30 ambulance disappears
- 1:35 lots of high pitched noise enters
- 1:49 crows
- 1:55 footsteps on small pebbles
- 2:11 car horn in background
- 2:17 train
- 2:27 murder of crow in background
- 2:38 waterfall starts to appear, very high-pitched, quite distant still
- 3:12 more crows
- 3:17 other bird calls
- 3:44 lower frequencies of the waterfall can be heard
- 3:57 new bird noise (one I haven't heard yet)
- 4:05 footsteps stone path/pebbles
- 4:35 waterfall becomes more evident
- 4:53 waterfall starts to take over the sound scape

5:10 possibly another new bird in the background (sound is being drowned out by waterfall)

- 5:43 traffic is still very evident here motorcycle or truck?
- 6:55 something that sounds like static on the right channel
- 7:18 recording stops

Again after listening to more of these it becomes apparent that what i want to hear in the recordings is variety. this one appeals because of the numerous birds (at least 3 different types of bird as opposed to the usual one or two crows) and we can hear a waterfall approach and change over time which replaces the traffic at the start of the recording. this could just be a result of my logging of the recordings though, i'm looking for change so i can make note of it.

Roving start point 1

Person doing tape ID: Lawrence Tape ID duration: 0:25 Channels: 2 (L&R) Duration: 17:58 Transcript:

OK, this is tape identification, we've started recording at the garden it's late afternoon; traffic, a few people around. Recording starts now.

0:25 initial state: lots of traffic noise and people chattering, we are obviously on a street

- 0:50 lull in traffic (5 secs or so)
- 1:15 lull in traffic (10 seconds)
- 1:30 bike moves past; idles in front of listener

1:54 footsteps

- 2:00 traffic gets really loud
- 2:17 bike takes off from idle

2:28 footsteps on stone, traffic noise dies down a lot we have obviously just entered the garden

2:51 first crow appears

- 2:59 loud motorcycle
- 3:09 more footsteps on pebbles

3:09 people talking

3:29 crow

3:42 lots of footsteps passing a crowd of people on the right

3:57 someone is running

4:03 another crowd of people

4:21 more crowd, this time they pass us laughing

4:56 possible start of waterfall in background

5:02 mobile phone rings

5:08 garbage bin

5:41 distant crows vs. distant conversation interesting effect

6:00 waterfall becoming more prominent the voices that were drowning out the traffic

have stopped and it too has picked up as a feature

6: 38 what I assume is a mic lead hitting a case when steps are taken

6:50 waterfall moves up another level

7:00 waterfall drops a bit in prevalence

7:14 waterfall appears in full moves in and takes up a position in the RHS

7:59 traffic can still be heard

8:52 motorbike

9:20 sounds like music coming in the very distant background

9:49 the waterfall produces a lot of high frequency noise that isn't too appealing

10:10 waterfall moves across speakers and drops off, listener must be walking away from it

10:30 louder footsteps

10:42 traffic starts to pick up again (as does hanging mic cord)

11:02 people re-appear in conversation

11:14 crow reappears

11:22 people become louder

11:50 footsteps stop for while

11:57 crows argue with each other

12:45 more water in distance, slightly deeper sound to previous waterfall

13:49 sounds as though one mic drops out for a bit

13:59 change in ambience of the sounds high end drops out sounds like a void have we stepped inside a building?

14:42 weird animal like sound in background

15:23 crow

16:00 traffic reappears

16:35 different bird in background: chirping, sparrow?

17:35 train very dominant against the sparse backdrop

17:52 a lot of mic noise

17:58 end of recording

By far the greatest range of the recordings so far, but also 3 times as long as most of them and probably a much greater distance covered. The main thought running through my head as I listen to this recording is that perhaps it would have been nice to have multiple recording stations set up around the garden recording at the same time, it would be nice to get a sense of what is going on outside of the garden as a reference to how much of that carries over into the garden. as an example in this recording the traffic noise is very evident at the start but as we turn away it drops off, how much of this is due to the position of the mics and our body being between them and the source of the traffic noise? This one would possibly make some for some interesting notation.

Stationary point 2 (multi-channel)

Person doing tape ID: Lawrence Tape ID duration: 2:04 Channels: 5 (FL, FR, RL, RR, C) Duration: 23:10 Transcript:

OK this is tape identification we have now moved to location number 2 for day 2. I'll take some photos of this but spatially its like a mound up about 2 or 3 meters above the area around us. Although it is sloping territory around us there are people walking

around at 360 degrees so we're completely surrounded by paths. I'm going to record at this level here for 20 minutes and then we'll stop and do another 20 minutes at a much higher level.

Crows above us, trees above us so it feels very contained you can hear the traffic off in the distance sometimes. I'll leave the rest up to the recording.

OK for tape identification: this is channel 1 (FL), tape identification channel 2 (FR), this is channel 4 (RL) and this is channel 5 (C) which is the centre please note day 2 recordings 5 is the centre, I think on day one we might have had 3 as the centre.

- 2:04 initial state: loud people, crows and traffic, footsteps
- 2:43 applause
- 2:54 another smaller bird can be heard in distance (not crow)
- 3:23 crow prevalent
- 3:28 car horn?
- 4:31 more applause
- 4:46 loud crow
- 4:55 car horn
- 5:11 more strange animal noises in background (continuing)
- 5:23 laughter
- 5:47 localised laughter (RL)
- 6:00 laughing group approaches from front C/RHS
- 6:36 multiple birds calling to one another
- 6:46 low frequency truck dominates sound
- 7:31 bird call
- 8:10 high pitch oscillating noise
- 10:18 traffic
- 10:50 keys jingling

12:22 the birds that have been talking to each other in the distance come quite a lot closer

- 12:40 loud group approaches
- 12:53 the talking birds go further away (to the right)
- 14:20 crows become the dominant bird again
- 15:11 footsteps (light)
- 15:17 traffic seems to have picked up
- 16:49 truck or bus appears
- 17:08 duck? faint in distance first one I have heard
- 17:50 motorbike
- 18:24 some kind of siren appears in distance (police, ambulance?)
- 18:47 motorcycle really takes off
- 19:08 child laughs
- 19:20 'singing' birds have returned
- 19:27 child's laughter turns to crying
- 20:17 playing child (older than the one who laughed then cried)
- 20:43 crow appears on RL and flies towards us
- 21:16 footsteps on stone path
- 21:44 duck has returned (faintly)
- 21:52 another crying child
- 22:53 tyre squeal
- 23:10 recording ends

Rear channels appear to be quite separated not much appears in both the speakers, the overall image isn't enveloping me into the space, the center speaker is VERY dominant. Despite Lawrence's initial comments about the traffic if i was to listen to these i probably wouldn't guess that I was in a garden it sounds more like a cafe on a side street to me the traffic noise is very obvious. This one might do well with analysis of the recordings separated rather than listened to as a whole. I think I have mentioned this is one of my previous impressions but it is difficult to listen to these recordings without some kind of bias towards events that occur (as I'm listening for them to make notations) does this skew my impression of the recording? probably.
Stationary point 2 (stereo)

Person doing tape ID: Lawrence Tape ID duration: 0:28 Channels: 2 (L&R) Duration: 5:31 Transcript:

OK this is stop point recording number one at the *keikoku*, the ravine, and we'll record for about 5 minutes. It's almost closing time so you'll probably hear some music soon. It's about 4:30 the recording starts now.

0:28 initial state: quiet no people low hum in background bird life.

0:30 siren in background (faint)

0:45 crow

- 0:58 (faint) people approaching
- 1:10 peak of approaching people
- 1:16 car horn
- 1:20 crow
- 1:27 chirping bird
- 1:35 people chattering
- 1:41 far off crow
- 1:46 music starts
- 2:26 watch beeps
- 2:58 dog bark
- 3:14 static on RHS
- 3:57 whistle or squeal in background
- 4:20 mechanical sound
- 4:30 music stops
- 4:43 footsteps in RHS
- 4:58 remarkably quiet

5:22 dog bark5:31 recordings stops

I think it was the first time I have heard a dog bark in any of the recordings which i find interesting, it's funny that when the music starts up my listening shifts to searching harder in the background for events than it does when the music is off. The most interesting thing about this recording is that it was apparently taken at the same point as the multi channel recording yet the difference between the two is huge, in that respect it is a shame the music is on this recording as it would have been nice to have a 10 minute recording to judge the difference between the MC and stereo recordings of the location.

Stationary point 1 (multi-channel)

Person doing tape ID: Lawrence Tape ID duration: 2:17 Channels: 5 (FL, FR, RR, RL, C) Duration: 21:59 Transcript:

OK this is tape recording on day two tape identification: channel one (FL), this is tape identification channel 2 (FR) and this is tape identification channel 3 (RL) and this is tape identification channel 4 (RR) and this is tape identification channel 5 (C). The time is 10:37, June the 14th, today we've moved down to the *karetaki*, dry waterfall; and a few more people here today still a very pleasant day. Slightly overcast, breeze is slightly up, temperature in the low 20s not so humid when the wind's around. We'll probably just do a series of 20-minute recordings and this will be the first one there'll be a bit of shuffling around and then we'll start ok recording starts now.

Initial state: quite a bit of crowd noise, loud crows.

Final id recording starts now. (1:46)

1:46 - crowds, traffic, crows Absolute id recording starts now (2:17)

2:27 chirping bird

2:34 angry crow

2:40 giggling and laughter

2:51 dominant truck

3:15 nice split of female in RL and male in FR

3:38 someone walks past creating movement across the recording field

3:58 the separation of the people talking is quite distinct in these recordings you really can here where they are standing or walking

4:20 lots of pebbles being crunched only really strongly audible in FR

4:30 someone whispers as though they are telling their friend they are recording

5:07 some slow claps or hammering of nails

5:36 i believe there might be some water in front of us that can be heard but i have only just perceived of it being there

5:45 more of the nailing

6:24 rear channels are much quieter than the front channels

6:56 loud car horn

7:36 again interesting separation of conversations in various speakers

7:57 loud truck

8:09 someone walks in front quite close but interestingly isn't picked up in center channel all that much was it really a center channel?

8:58 some bird calls

9:15 bird crow flies front to rear

9:41 hammering which creates a fantastic effect with the hammer being heard first RL and then the echo being strongly perceived FR

10:21 more of the hammering with echo

10:35 more hammering

10:44 hammering

11:47 truck

11:52 different hammering, hitting nail then sometimes hitting wood

12:22 strange sounding bird, probably not a crow don't know if i have heard one of these before

13:20 some loud females in FL

13:38 a music of some description can be heard in background possibly from a car radio

13:58 our females move off to the FR

14:20 bird tweets

14:50 some interesting footsteps not on gravel perhaps someone jumping from rock to rock on the path avoiding the gravel?

15:57 light footsteps in the pebbles

16:18 multiple types of bird all calling at once

16:48 more pebbles in FR

17:19 someone sneezes LHS

17:59 helicopter appears

18:05 car horn in background

18:19 helicopter starts circling appearing in various speakers great example of how well we can pinpoint directions

19:01 ducks

19:07 someone coughs

19:16 wood breaking

19:21 someone speaks what appears to be directly into FR speaker

19:40 more nailing again different sound to the other two

19:55 helicopter still hanging around

20:00 maybe a jet going overhead didn't really sound like cars very distant sound though

21:01 someone digging a whole with a shovel?

21:19 gate closing

21:59 recording stop

This recording has a lot of interesting effects going on in it particularly to do with spatial sound, the strongest of which would be the hammering which can be heard with the echo giving as an indication of obstacles on the other side of the scene (which would have

been needed to produce the effect). Also the helicopter flying around overhead, and conversations people were having while moving through the recorded field. Of all the recordings listened to so far this one may contain the most events that transpire during its course but the question remains are these events the ones we are really after?

Stationary point 1 (stereo)

Person doing tape ID: Lawrence Tape ID duration: 0:23 Channels: 2 (L&R) Duration: 1:27 Transcript:

OK as we fade in a beautiful afternoon of afternoon music, this is the second stop point it's the dry waterfall; got a few ducks out and a few people, recording starts now.

0:26 initial state: ducks water, people0:40 bird in FR0:53 some footsteps1:15 music starts up again1:27 recording stops

Nothing much happens in this recording, I don't know if it was the one Michael intended it to be 1:27 seems awfully short

Koishikawa Korakuen June 15-16 Stationary point 5

Person doing tape ID: Lawrence Tape ID duration: 0:16 Channels: 2 (L&R) Duration: 5:36 Transcript:

OK tape identification; we found the *shishiodoshi* at the front of the visitor centre and we're just going to record that now.

- 0:27 water
- 0:39 wood hitting stone
- 0:48 hum of traffic in background
- 1:00 water
- 1:04 wood hitting stone
- 1:12 people talking
- 1:34 water
- 1:36 wood hitting stone

1:44 Lawrence: we're just going to try and second perspective getting the water dribbles on the left and people on the right giving some more background noise

- 2:08 water
- 2:10 wood
- 2:39 some interesting background noises
- 2:40 water
- 2:42 wood
- 2:55 banging in background
- 3:11 more banging
- 3:15 water and loud engine in background
- 3:17 wood
- 3:29 people approach
- 3:37 person walks off
- 3:49 water
- 3:51 wood
- 4:10 could be a bird faintly in the background
- 4:21 water

4:23 wood
4:45 phone in background
4:53 notice crows
4:54 water - loud engine once again
4:56 wood
5:28 water
5:30 wood
5:35 end recording

If the architects are after patterns this could be the recording for them, sadly again it is a bit short for my liking, 5 minutes and you only really get started on these things. The sound of the *shishi-odoshi* is very nicely recorded though I don't get a lot of sense of stereo which I thought I would

Roving start point 3

Person doing tape ID: Lawrence Tape ID duration: 1:03 Channels: 2 (L&R) Duration: 11:22 Transcript:

OK this is the left channel and this is the right channel this is the tape identification for a sound walk from the entrance to Koshikawa Korakuen garden. It is now about 3 o'clock and the rain has held off for a while. What we want to show is the transition from what looks like not a very busy road, but we did notice it the other day, quite a dramatic change. So I'll start off facing the road at the front of the garden turn and walk up the Japanese garden path. Recording starts now. OK recording starts now.

1:06 initial state lots of traffic, cars can be pin pointed not as much of a wash as the previous garden much more of a stereo effect on these recordings most cars coming from right to left.

1:33 siren starts in background

- 1:59 ambulance approaches from right goes to left talking comes out of speakers
- 2:26 siren changes slightly
- 2:31 siren no longer clearly audible
- 2:37 first crow
- 3:14 some people speaking
- 3:30 someone walking past with change in their pockets perhaps?
- 3:50 some footsteps on rock start
- 4:11 traffic noise has died off a lot
- 4:27 change in sound of footsteps
- 4:38 footsteps return to original sound
- 4:48 something audible only on left channel
- 5:14 footsteps stop / crow sounds
- 5:25 footsteps start back up
- 5:42 bird tweeting
- 5:54 faint sound of water? more present on right channel
- 6:17 water getting louder

6:38 water appears more prominent on left channel sounds very different to water from previous garden this one the water is definitely falling into water not onto rocks as much 7:19 there is a lot of stereo movement on these with the water going from left speaker to

right speaker

- 7:47 different water source, quieter than waterfall (secondary?)
- 8:03 water no longer audible

8:16 crow

- 8:30 clang in background
- 8:58 single water bubble?
- 9:12 louder bubble, deeper sound

9:21 is someone throwing rocks into the pond?

9:36 must be fish swimming around

10:10 bubbles but further away have we moved off that spot?

10:29 traffic seems to be picking up again

10:33 fish is back

10:47 Lawrence: ok end of recording i don't know what that was when i got down to the end on the point the carp came out to have a look and they make great splashing sounds 11:22 end

This recording has a lot more going on in the water than the previous garden. The sound of the previous garden was one of water hitting stone and very high pitched this one was a lot lower and the carp were making much more noise than at the previous garden (although i did hear them at the previous garden it wasn't nearly as pronounced). The stereo separation that takes place when we approach the waterfall is a bit annoying the waterfall moves from one speaker to the other and doesn't fill up the space in between the speakers. I don't know if this is the fault of the microphones or of the speakers here but I'm guess it is the mics.

Stationary point 4

Person doing tape ID: Lawrence Tape ID duration: 1:03 Channels: 2 (L&R) Duration: 2:52 Transcript:

This is the left channel...OK we'll start again, this is the left channel, this is the right channel. Tape identification, ah it's the *chu hosen* [??] Friday 17th of June it's about 1 o'clock, hang on ...13:35; 13:135, um, 1:35. So we're at a small stone bridge. Due to the rain the small river-lets around the garden are now flowing so we'll just take a couple of

minutes of this one. Recording starts now, ok field note one let's commence with a pair and then we'll do a crossed. Recording starts now.

1:03 initial state lots of water sounds particularly in RHS

1:06 some people appear in conversation

1:43 traffic can be heard in the background as a constant hum, it doesn't sound very nice

2:27 birds

2:33 crows

2:52 end recording

Too short to a recording in my opinion. The water sound is nice, the traffic in this one was horrible though, I don't know why it stood out more than others, it might be the new garden the other recordings from this garden I have listened to so far have had more going on in them so the traffic hasn't been as apparent but in this recording it just sounds like you are completely unprotected from the sound of the city.

Stationary point 2 (multi-channel)

Person doing tape ID: Lawrence Tape id duration: 1:45 Channels (5 (FL, FR, RR, RL, C) Duration: 14:44 Transcript:

OK here comes the tape identification. Here is the tape identification for the afternoon recordings this is channel one (FL), this is channel two (FR), this is channel 3 (RR), this is channel 4 (RL) and this is channel 5 (C). We're currently set up on a path underneath quite a bit of foliage, which is quite good because it has started to rain quite lightly. The wind is quite strong; we're trying to record for about 20 minutes. We're about 7 meters from the waterfall on a path. You might hear some people come along the path. There'll be some images accompanying. Do you have the time Michael? 14:37, 2:30 or there

about. Oh a bit of bird life, the other thing you'll be able to hear is we're a couple of hundred meters from a really huge building but again I'll take an image of that. Recording starts now.

1:45 waterfall present in FR

- 2:20 drumming in background (very faint)
- 2:30 footsteps
- 2:56 chanting in background? (RL)
- 3:24 chirping bird very present
- 3:57 squealing of brakes
- 4:04 siren on ambulance
- 4:13 crow
- 5:07 building work going on in background
- 5:19 duck/crow on right
- 5:37 generator/train starting up
- 5:50 more hammering
- 6:07 some people talking
- 6:21 crow in FL
- 7:02 generator/train again
- 7:40 different bird in FR and FL speakers
- 8:31 generator thing again
- 9:40 footsteps
- 10:40 car reversing?
- 11:04 generator again
- 11:15 train passing? Something picks up the volume that hasn't been heard before
- 11:40 hammering
- 12:36 more building noises
- 12:55 hammering on metal
- 13:03 footsteps start on L move to R
- 13:20 drilling or jack hammering
- 14:44 recording ends

This recording doesn't sound like we are in a garden. There is so much city noise here, building sites, traffic, generators, and yet we were only 7 meters away from a waterfall. As I'm still not 100% sure on what we'll end up looking for this recording is dominated by sounds which occur outside of the garden, although I guess that it what you would expect as inside the garden there isn't much making noise, could be something worth looking into, I think Michael was suggesting some kind of topographic map of the garden in terms of the noises it creates, it would be interesting. Also Lawrence said in the ID that there was a lot of wind about but I didn't hear any of it on this recording something I found interesting.

Stationary point 2 (stereo)

Person doing tape ID: Lawrence Tape ID duration: 0:39 Channels: 2 (L&R) Duration: 3:11 Transcript:

This is the left channel, this is the right channel; this is the second waterfall. The cranes gone off so we'll start recording straight away I'm just going to check the levels first: one, two. Recording starts now.

0:39 initial state: waterfall in right channel0:55 some machinery starts up in background1:58 crow LHS2:20 car in background3:11 recording stops

waterfall has an interesting sound quite high pitched hard to tell on initial listen but it sounds like it is falling into a pond although not from that great a height. This recording

is, according to the map, from the same place as the multi channel recording and the different between the two is incredible, this does only go for 3 minutes but it no longer sounds like you are in the middle of the city it sounds like you are in the garden. Perhaps it is the Sanken mic's that make all the different as i believe the stereo recordings were done with the Schoeps.

Roving start point 2

Person doing tape ID: Lawrence Tape ID duration: 1:07 Channels: 2 (L&R) Duration: 6:26 Transcript:

OK this is the sound walk between two water sources we're calling this one here waterfall 3 we're going to loop back over to the one we just recorded which we're calling waterfall 2. I'm just gong to change some headphones over hang on. Just getting some cables sorted now this one is waterfall 3 and there's a loop which is called kiso river the inner garden and its a loop so this will be from 3 to 2 and back again it's a circle. OK the recording starts now.

1:07 initial state: waterfall prominent (lower frequency that previous one) crows active

- 1:54 waterfall starts to move into right speaker
- 2:202 waterfall now completely gone
- 2:10 traffic appears, car horn
- 2:20 perhaps fain waterfall in left channel
- 2:40 chirping birds
- 2:46 traffic picked up

2:55 footsteps are on an interesting surface (not pebbles)

- 3:16 waterfall appears in right channel?
- 3:39 waterfall seems to have some horrible phase issues

3:54 waterfall prominent

4:10 waterfall has dropped off

4:22 crows

4:26 cable noise

4:34 footsteps now sound like they are on concrete path

4:43 path changes?

4:50 waterfall 2 reappears

5:19 crow

5:39 chirping birds sound higher

5:54 Lawrence: ok that's the end of the recording what you would have heard is that the crane has started up in the interim be interesting to hear how much masking of the sound the waterfall has the second waterfall was only 20 meters or so away over a small hill. 6:26 end

Wouldn't have known the crane started up if Lawrence hadn't made a comment about it at the end of the recording. Nice contrast between the two waterfalls also interesting how quickly the first one dies away when you start walking away from it, I'm assuming this has to do entirely with mic direction. Would perhaps be interesting to do these recordings in ambisonic to attempt to capture what we here when we are in the garden as i can't imagine that the sound of the waterfall drops off that quickly.

Stationary point 3

Tape ID duration: 1:09 Person doing tape ID: Lawrence Channels: 2 (L&R) Duration: 10:54 Transcript:

OK here we go tape id left channel right channel. It's about 20 to 4 we've been stopped now for about 3/4 of an hour for rain. We're waiting under a little pavilion hoping that it

will stop but it looks like it's settled in. Now they've just been making announcements in both Japanese and English about being careful because the pavements and rocks get wet and we've just noticed that the audio quality of the announcements in amazing for a public outdoor system. So I'm just going to start this recording and hopefully we'll catch the next cycle. We're just standing under the pavilion where it's dry, should hear a bit of rain and the announcements. Thursday the 15th I've been getting the date wrong. OK recording starts now.

1:09 initial state: water; birds chirping

117 footsteps

1:31 Lawrence: just going to move position

1:39 more rain coming up on levels now

2:00 crows

3:01 crow

3:43 some footsteps

4:49 birdcall

4:56 rain seems to pick up a bit

5:06 truck

5:26 footsteps (faint)

5:45 people in conversation

6:00 rain really picks up

6:13 rain starts falling really heavily

6:38 rain has interesting aspect as it is hitting so many surfaces, some sounds like umbrella and others sounds like it is hitting open stone, etc

7:20 rain starts to die down a bit

8:29 conversation (LHS)

9:42 footsteps

10:54 end of recording

Interesting due to the fact that it is the first recording with rain on it and the sound of the rain is very rich in terms of objects it is hitting and rate at which it falls, volume etc. But

other than that not a lot else, i keep coming back to the fact that i would like recordings to compare, for example it would be nice if there was a recording taken at roughly the same time on a day without rain, or even with slightly different rain, although then the differences probably wouldn't be as stark.

Stationary point 1

Person doing tape ID: Lawrence Tape ID duration: 1:53 Channels: 5 (FL, FR, RR, RL and C) Duration: 16:07 Transcript:

OK this is test number one I need to talk at about this volume level here, if I talk at this volume level here its alright. Can you see channel one on the volume meters down there? This is channel 1, this is morning recordings, um, version one. We've just set up near the waterfall at the moment I'm going to go straight into it as there's a good chance of rain this morning. A bit cooler, overcast, a few people around, we've also got a bit of a window with workmen and what not, they've just stopped using chainsaws, etc. We've just stopped using...this is channel one (FL), this is channel two (FR), this is channel 3 (RR), this is channel 4 (RL), this is channel 5 (C). There are also images accompanying these recordings and they start now.

1:53 initial state: waterfall is very present in FL, C, FR, and RR speakers 1:53

- 2:03 some people in RR
- 2:11 crows on RHS
- 2:24 crows seem to get closer
- 2:57 slight background traffic

3:08 crow on RL

- 3:23 traffic or perhaps overhead jet
- 3:37 traffic noise sounds like heavy truck

- 4:00 truck noise has moved to LHS
- 4:39 on RR sounds like lower frequency bubbles, possibly carp?
- 5:02 chirping bird on LHS
- 5:45 some kind of motor on RR
- 6:04 crows still on RR in distance
- 6:57 RR has a lot of machinery noise on it
- 7:29 children playing or brakes squealing perhaps on RR
- 9:27 plane flying overhead perhaps helicopter
- 9:51 helicopter becomes very apparent flies from RR to FR
- 11:08 click on RL
- 11:41 helicopter returns on RHS
- 12:58 helicopter must be doing some kind of loops as it has returned again
- 13:58 on cue helicopter back on RHS
- 14:33 some high pitched noise from RR
- 16:02 footsteps
- 16:07 end of recording

This recording is totally dominated by the waterfall, while there is plenty going on in the waterfall other events have to be very loud to be heard. Traffic noise is audible on the rear speakers but it is more of a hiss that the usual rumble. Listening to this recording is quite tiring due to the amount of noise coming into your head from the waterfall in front, the helicopter that returns on the RHS and the traffic that appears in the rear speakers.

Koishikawa Korakuen June 17 Roving start point 2

Person doing tape ID: Lawrence Tape ID duration: 1:43 Channels: 2 (L&R) Duration: 11:26 Transcript: I'll just do a tape identification here, left channel, right channel. OK this is a sound walk on a very wet Friday the 16th of June. What's the time? 15:55. Right now we've got a couple of hours in the garden it is very wet today. What I've done different with this recording that is different from other recordings is I've put 40 or 80 khZ 12 db per octave, which is a step up from yesterday, in. We'll mark on the map what the route of this is. We're going up on a small hill and into a valley. You'll hear water sounds etc not many people around recording start now. (1:09)

Just pausing for one moment ok recording starts now (1:43)

1:43 initial state: some chirping birds some distant water and what sounds like occasional water droplets.

- 2:14 crows in background chirping bird in foreground
- 2:33 water gets a bit louder
- 2:47 footsteps become apparent quite distinct left on LC right on RC
- 3:22 bird sound almost electronic
- 3:36 droplets
- 3:57 traffic sound increases water has dropped off
- 4:15 car horn
- 4:20 footsteps start on different surface
- 4:31 bells? chiming of clock?

4:51 background noise hard to distinguish between traffic or waterfall at this stage could be either

- 5:27 car reversing
- 5:33 possible different surface for feet again
- 5:41 traffic noise increases
- 6:30 traffic/machinery has become very prominent
- 7:00 sound kind of public announcement can be heard in background
- 7:41 can hear a little stream in FR
- 7:59 water movements and what sounds like birds wings flapping
- 8:23 crow in background

8:50 again footsteps have changed surfaces

10:06 car horn

- 10:19 applause? very distant
- 11:05 birdlife seems to have dropped off
- 11:15 velcro sound, bag noises
- 11:26 recording ends

The roving recordings seem to hold a lot more interest for me than the stationary recordings, I don't know if this is because there is more going on or that they have greater changes in their makeup but they are definitely more interesting to listen to. This one has quite a lot going on in it. at the end of the recording the birds you have heard throughout the entirety of the recording seem to drop out which poses some questions. the rise and fall of the intensity of the traffic is also quite interesting it would be interesting to see a 3d visualisation of the garden as you walk through it to see what is impacting on that sound making it onto the recording.

Stationary point 2

Person doing tape ID: Lawrence Tape ID duration: 2:14 Channels: 7 (FL, FR, RR, RL, UL, UR, C) Duration: 45:18 Transcript:

OK here we go, alright, tape identification this is channel one (FL), this is channel two (FR), this is channel three (RR), this is channel four (RL), this is channel left its going to be high (UL), this is the right channel that's going to high (UR) and this is channel five (C). OK it's now three minutes past one on Saturday June 17. We've moved to the final location *otawa-no taki* and what we're going to do here is a 5-channel recording with another two channels on the stereo system pointing up. So I'll stand kind of behind Michael for as long as I can so there might be some breaks in the recording due to arm

fatigue and we'll take it from there. Sun's out and the traffic seems to have picked up a bit since we've moved location, but given the time, people are just out and about as well. OK we're now doing the many armed god so I can clap here comes the synch; one more not so loud, and again. OK here we go; OK recording starts now.

- 2:14 initial state quite a lot of traffic some bird life
- 2:17 crowd noises children playing perhaps quite reverberant
- 2:39 loud car
- 3:20 siren (ambulance)
- 3:30 a whistle of some kind
- 3:39 bird on RHS prominent
- 4:00 ambulance rises to loudest peak around now
- 4:59 some interesting bird chirps that are very directional
- 5:17 another siren different to the first starts up
- 5:40 some construction type sounds in the background
- 6:13 car takes over the front of the recording
- 7:10 some people seem to approach in conversation from LHS
- 7:40 an interesting bird call
- 8:00 car in C and FL
- 8:13 not much seems to be happening in the RR or UR
- 9:03 what sounds like a pair of birds communicating in FL and C speakers
- 10:00 some children playing become apparent on LHS
- 10:05 a loud car again from C to FL
- 10:20 conversation appears in C
- 10:39 a duck on LHS
- 11:11 some water sounds? C
- 12:17 some construction FL
- 12:25 conversation moving about the speakers

12:58 sounds like a jet first instance of hearing something that sounds like it is physically above you probably due to the heightened mic

13:33 mechanical ringing sound like phone but louder

13:50 car moves from left to right

14:30 a bird has been making noise and moving about the front speakers

14:40 a car moves around the front speakers

15:49 nice bird trill sound on C

16:02 duck UL

16:07 phone sound has returned

16:16 loud truck sounds like it is heading straight for us

16:47 some footsteps

17:15 the duck has moved from UL to C

17:30 some more water sounds

17:35 construction noise of something faling

17:48 a motorcycle takes off

18:08 sounds like a crowd cheering in distance

18:20 a train on FR/C

18:38 some footsteps

19:14 some hissing appears on RHS somewhere

19:50 bird loud in C

20:30 sounds like a heard of geese in FL

21:11 some footsteps on RR

21:33 some prominent music and an announcement prominent on C

21:16 music again end of announcement

22:36 plane or helicopter can be heard overhead doesn't have the same feeling of height

as the earlier plane did (jet plane)

23:08 someone coughs on FR

23:39 sound of bottle collection

24:11 loud bird starts on LHS moves to RHS

24:30 adult voice seems to have joined the children previously heard in FR (they have been there the entire time)

25:05 someone whistles on FR

25:18 bird flaps wings as though in bath also some water noise FL

26:15 train again in FR

26:25 siren once more

26:34 more whistling

27:07 bird bathing seems to have moved from FL to C

27:35 loudest car yet started in FL moved to C

28:40 loud hissing on RR

29:27 phone sound has returned

29:44 car horns

30:18 more bird washing, crows have also been active in last minute or so

32:10 more ringing type sounds on LHS

32:24 loud car on C appears to come towards us

32:58 bird on RR with sound i don't think has been heard before

33:22 crows on rampage mainly FL/C

34:06 train on FR?

34:27 bird washing sound appears again this time on FR

36:33 truck

37:25 footsteps

37:33 truck

37:51 something that sounds like a low flying propeller type plane, could be a strange sounding car though as it doesn't seem to be constant like a plane would be

38:40 loud motorcycle

39:13 people seem to be yelling in FR

39:30 birds interacting

39:40 yelling man can be heard echoing through speakers on other side

40:26 chimes followed by another announcement

40:49 announcement in English

41:27 faint conversation on LHS

41:44 hissing on FR could this be wind related?

42:44 some construction sounds/rubbish being dumped?

43:00 hissing on RR

43:06 laughter on FL conversation has been continuing

43:26 high pitched motorcycle or scooter on C moves to FR

44:16 a whistle sounds like a spot might be being played

44:56 footsteps and conversation sounds like they might be some synching issues has this been happening the entire time?

45:18 end of recording

This has been by far the longest of the recordings so far, yet it wasn't all that interesting to me. The majority of the sounds came from children playing and traffic, which I assume were outside the garden. It makes me wonder if sounds from outside the garden are of interest to us? The have nothing to do with the garden; this recording didn't give me any sense of feeling that I was in a garden. There was a lot of bird life on the recording but I couldn't really hear them in trees, there wasn't much local conversation either most noise made by people came from the distance. The height did make this a very enveloping. I keep on thinking about the fact that Alex and Peter have said that they are after patterns in the recordings and I don't know that a recording like this gives us patters that are a result of the garden and its design. The only sounds here that could be related to that would be those of the birds bathing but i don't know that they happened enough over the course of 40 minutes for us to really see a pattern forming.

Stationary point 1

Person doing tape ID: Lawrence Tape ID duration: 1:32 Channels: 5 (FL, FR, RR, RL, C) Duration: 49:40 Transcript:

OK, day 2, three, day three, June 17 this is channel one (FL), this is channel 2 (FR), this is channel 3 (RR), this is channel 4 (RL) and this is channel 5 (C). it is currently 11:04 on June 17 and we've set up on a small hillock not far from the entrance but overlooking the lake, city. You'll see in the images there is a very dramatic view of the city is a Saturday morning and traffic is quite quiet this morning. The plans are, weather

permitting, is that we're going to do an hour recording. This is the first of two locations, there is a theme park that backs onto the garden and it is quite a ways off. 1:32

1:32 some bird life, quite a lot of background noise

2:25 some clicking occurring, possibly a person walking by carrying something

2:52 majority of the sound coming from FL, C, FR and RR not much coming from RL

3:18 some people laughing

3:27 clicking sound might be a gardener working? sounds like they are pruning trees

4:18 some kind of motor in FL either distant bike or perhaps chainsaw/lawnmower

4:52 some footsteps

5:00 a jet plane? Distant. C

5:43 previously i thought they were construction sounds but might be sound of roller coaster

6:54 chirping bird

7:09 events pick up on RR

7:54 screaming probably from roller coaster

8:26 footsteps starting in FR leading to RR small pebbles

9:22 some conversation on RHS

10:45 again sounds like a jet plane

11:26 some kind of construction/theme park noise

11:43 the juxtaposition of the clipping and the distant theme park/city noises in quite interesting

12:20 very low frequency sound no idea what it would be, possibly from shaking the mic

12:46 quite a few ducks or geese

13:59 ringing bell in far distance?

14:14 squealing from theme park again

15:08 bird noise

15:17 second clipper/chainsaw seems to have started up

15:30 helicopter appears it could have been that which i thought was second clipper

16:46 something starts up on RHS possibly truck of some kind

17:36 clipper fluctuates a bit starts up/stops starts up/stops

17:56 distant siren

18:39 strong click in sound playback was a setting changed on the sound devices?

20:12 another helicopter

20:38 some conversing birds

20:45 more squeals from theme park

20:51 a car horn

21:05 some people talking RR

21:21 clipper has definitely changed sounds seems further off, perhaps obscured by something

23:45 truck on RR

24:23 some hammering

24:33 the slipper changes its sound again

24:58 another plane passing overhead

25:35 some clapping

26:48 more squeals

27:05 sounds like another plane passing overhead

27:28 louder screams

28:42 some different birds seem to have arrived

28:53 the clipper stops

29:07 clipper starts back up again

29:25 some ducks/trilling birds

30:45 another break from the hedge machine allows for a very different view of what is

going on in the recording

31:43 some more birds very distinctive locations on each

33:00 more birds

33:25 more squeals from roller coaster

34:29 someone calling out in RR

35:20 some hammering is going on C

36:44 again the hedge machine/slipper has changed its sound quite dramatically

37:00 some kind of sound in RL that sounds like a phone

37:25 motorcycle

- 37:42 hedge machine seems to have disappeared
- 38:38 some slight conversation on LHS
- 39:15 sounds like a jet again could this be from the theme park?
- 39:51 some cheering
- 39:58 some more squeals
- 41:14 hedge machine has started back up
- 41:33 conversation on FR moving to RR?

42:37 bird on C

- 42:48 hedger seems to either hit something or be breaking
- 44:53 some birds on RR
- 45:08 conversation on C sounds muffled
- 46:22 siren
- 47:10 sounds like metal poles clanging together
- 48:13 hedger stops or at least slows down a bit
- 48:38 hedger has started back up
- 48:43 siren on RR/FR maybe even moves to C and across to FL
- 49:18 footsteps
- 49:40 end of recording

This recording was dominated by the hedging machine that constantly hummed on the FL channel, in the few gaps that were on the recording from when it wasn't working there was an interesting difference in the characteristics of the recording. Again not a lot of sound made by the garden, not many footsteps on surfaces or tree noises or water. This one did have a bit of bird life but probably not as much as the previous one. There wasn't as much traffic on this recording as on previous recordings which was interesting as I think we were on a hill so I would have expected there to be a bit more. Again I think the recording time is a perhaps a bit too long, i seem to like the 20 minute recordings the best.

Thoughts made during listening:

Interesting how my thoughts on sounds change knowing that there is a theme park near by

Roving start point 1

Person doing tape ID: Lawrence Tape ID duration: 1:09 Channels: 2 (L&R) Duration: 11:32 Transcript:

OK this is tape identification, this is the left channel this is the right channel. It's a bit after two we've just finished a 50 minute recording, sore legs, what we're going to do now is a sound walk from the position of this morning's original recordings, which we're calling the hillock, through the area of the red bridge over and around the water concourse area where we've just done the 50 minute recording. Very nice afternoon sunny and a few people around so we may even get some people sounds. Recording starts now.

- 1:09 traffic noise, construction noise now much garden noise (birds/water)
- 1:41 squeals from the theme park
- 2:00 construction type noises in R
- 2:18 bird tweeting
- 2:31 slight water sounds?
- 2:45 footsteps slightly audible very small pebbles
- 3:03 twig snaps
- 3:14 the footsteps sound almost like a chicken shake
- 3:24 sound of jet? Probably is actually roller coaster
- 4:06 some people conversing
- 4:18 bell in distance (very quiet)
- 4:37 footsteps have changed surface

4:44 significant drop in traffic noise

4:53 v.loud footsteps

5:20 loud footsteps on R people talking

5:37 very loud child moves from R to L

6:42 loud bird followed by crow

7:11 loud and angry crows moves from R to L

7:34 truck shifting gears

7:46 lots of little birds can be heard

7:54 a helicopter appears

8:36 footsteps

8:50 people conversing on R

8:54 roller coaster again?

9:43 again sounds like a church bell in the distance (very quiet)

10:03 footsteps

10:13 workman like sounds

10:37 truck reversing

11:00 bird noises

11:16 Lawrence: ok that's the end of the recording, that was a stroll for the most part had to accelerate to make it past a small kid on the bridge so that will come through hopefully the footsteps hitting the bridge they were either French or Spanish.

end of recording (11:30)

11:32 end

Perhaps not as interesting a sound walk as some of the others to listen to. The garden didn't generate much of its own sounds in this recording. The path didn't have surfaces that made loud footsteps and there weren't any waterfalls so you couldn't really where you were in relation to the garden. It would be interesting to compare these recordings now against their scenery, this walk visually could be very appealing as you cross a bridge and I'm assuming due to the dramatic drop in traffic noise that you go in some overhanging trees or perhaps a valley of some kind but aurally it doesn't hold as many items of interest as many of the other walks.

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Appendix B - SuperCollider code

Suikinkutsu

$\bigcirc \bigcirc \bigcirc$		Suikinkutsu		
Print	Play			
Length	n		20	
Radius	3		20	
Roundness			0	11.

```
(
SynthDef(\Droplet,
      arg out=0, freq, end, pan = 0, riseCutoff = 2.5, riseDuration, temp, ampAdjust;
      var amp;
      // bubbles of freq 300 have duration of 15 ms, bubbles of 2kHz have duration 3 ms
      temp = freq - 300;
      temp = temp / 1700; // % of scale
      end = 0.15 - (temp * 0.12);
                                         // max duration - % of sliding duration scale
      // similary to above main 300 Hz = 1, 2 kHz = 0.3
      amp = 1 - (temp * 0.7);
      amp = amp / ampAdjust;
      riseDuration = end;
      Out.ar(out,
           Pan2.ar(
                 SinOsc.ar(
                       XLine.kr(freq, freq*riseCutoff,riseDuration),
                       0,
                       Decay2.ar(Impulse.ar(1), 0.001, end)
                 ),
           pan, 1)
           Line.kr(amp/2, amp/2, end+0.1, doneAction:2) // adjust overall volume based
on frequency
}).load(s)
)
(
// window variables
var w, lControl, rControl, sControl, resultButton, playButton;
// suiknikutsu variables
var length, radius, es, eos, percAdj = 0, esAdj, unm, c, natFreqs;
var ringTimes, ringAmp, bubFreqAmp, freqModulo;
// routine
```

```
var r;
// initialise length and radius
length = 0.20;
radius = 0.20;
// set speed of sound in kms
c = 340.29;
// initialise es figures and bessel function turning points
// these follow a multi-dimensional array set up as follows
// [ 0, 1, 1, 0, 2, 2, 2, 1, 2, 3, 2, 3, 3, 3 ]
// [ 1, 0, 1, 2, 0, 1, 0, 2, 0, 0, 2, 1, 0, 0 ]
unm = [ 0, 1.872, 1.872, 0, 3.132, 3.132, 3.832, 1.872, 3.832, 4.399, 3.132, 4.339,
5.332, 7.016 ];
es = [ 1, 0, 1, 2, 0, 1, 0, 2, 0, 0, 2, 1, 0, 0 ];
eos = [ 0, 4.4934, 7.7253, 10.904 ];
// init bubFreqAmp, ringAmp to 0
bubFreqAmp = \{0\}.dup(14);
ringAmp = {0}.dup(14);
// set ring times of modes, this could be improved to react to the bubble frequency
ringTimes = [ 1, 0.6, 0.6, 0.4, 0.4, 0.4, 0.4, 0.2, 0.2, 0.2, 0.2, 0.2, 0.1, 0.1 ];
// initialise esAdjust
esAdj = { arg index;
   es[index] * pi + ( ( eos[ es[index] ] - ( es[index] * pi ) ) * percAdj );
}.dup(14);
// initialise natFreqs
natFreqs = {arg index;
   (c / (2 * pi)) * (sqrt(pow(unm[index] / radius, 2) + pow(esAdj[index] /
length, 2 ) ) );
}.dup(14);
// start routine
r = Routine.new({
   // for testing purposes run with only 5, change to inf for performances
   5.do({ var bubbleFreq, duration;
          // calculate a bubble frequency, currently set up for height = 0.24
       bubbleFreq = 900; // base frequency for height of 0.24 m
       duration = 1 + 5.0.rand;
       if (duration > 3,
           { bubbleFreq = bubbleFreq + ( [1,-1].choose * 50.rand ); },
           {if (duration > 2,
               {bubbleFreq = bubbleFreq + ( [1,-1].choose * 100.rand ); },
               {bubbleFreq = bubbleFreq + 400 + ([1, -1].choose * 400.rand); }
           )}
       );
       // to discover bubFreqAmp the bubble frequency is compared to the natural
freuencies
       // of the suikinkutsu body. if they are close the amp is 0.5 if they are distant
       // the amp drops to 0
       14.do({arg index;
           if (natFreqs[index] > bubbleFreq,
```

```
{freqModulo = natFreqs[index] % bubbleFreq},
```

```
{freqModulo = bubbleFreq % natFreqs[index]}
           );
           freqModulo = freqModulo / natFreqs[index];
           bubFreqAmp[index] = (1 - freqModulo);
           ringAmp[index] = ( ringAmp[index] + bubFreqAmp[index]);
                      // kill resonance if bubble freq is far away from natFreq
           if ( bubbleFreq / natFreqs[index] > 1 ,
               {bubFreqAmp[index] = 0 }
           );
       });
      // this is the sound of the suikinkutsu
        duration.wait;
       Synth(\Droplet, [\freq, bubbleFreq, \ampAdjust, 2]);
       //play suikinkutsu body based on bubble freq
       {Pan2.ar(HPF.ar(Klank.ar(`[natFreqs, ringAmp, ringTimes],
       Impulse.ar(1,0,0.1)), bubbleFreq - 100) * Line.kr(1,1,1, doneAction:2), 0,
1)}.play;
       bubbleFreq.value.postln;
   });
});
// make the window
w = SCWindow( "Suikinkutsu", Rect( 20, 400, 440, 120 ) );
w.front;
w.view.decorator = FlowLayout( w.view.bounds );
// the result button is used for printing the mosdal values of the suikinkutsu
resultButton = SCButton( w, 75 @ 24 );
resultButton.states = [
   [ "Print", Color.black, Color.green ]
];
resultButton.action = {
   natFreqs.value.postln;
};
playButton = SCButton( w, 75 @ 24 );
playButton.states = [
   [ "Play", Color.black, Color.green ],
   [ "Stop", Color.green, Color.black ]
];
playButton.action = { |view|
   if( view.value == 1 ){
       // start suikinkutsu
       r.reset;
       r.play;
   };
   if( view.value == 0 ){
       // stop loop
       r.stop;
   };
};
// create the controllers
w.view.decorator.nextLine;
lControl = EZSlider( w, 400 @ 24, "Length", ControlSpec( 10, 30, \lin, 1 ),
   {lez! length = ez.value/100;
                                      natFreqs = {arg index;
       (c / (2 * pi )) * (sqrt(pow(unm[index] / radius, 2) + pow(esAdj[index] /
```

```
length, 2 ) ) );
   }.dup(14); }, 20 );
w.view.decorator.nextLine;
rControl = EZSlider( w, 400 @ 24, "Radius", ControlSpec( 10, 30, \lin, 1 ),
   {lez! radius = ez.value/100;
   natFreqs = {arg index;
       ( c / ( 2 * pi ) ) * ( sqrt( pow( unm[index] / radius, 2 ) + pow( esAdj[index] /
length, 2 ) ) );
   }.dup(14); }, 20 );
w.view.decorator.nextLine;
sControl = EZSlider( w, 400 @ 24, "Roundness", ControlSpec( 0, 100, \lin, 0.1 ),
   { |ez| percAdj = ez.value / 100;
   esAdj = { arg index;
       es[index] * pi + ( ( eos[ es[index] ] - ( es[index] * pi ) ) * percAdj );
   }.dup(14);
   natFreqs = {arg index;
       ( c / ( 2 * pi ) ) * ( sqrt( pow( unm[index] / radius, 2 ) + pow( esAdj[index] /
length, 2 ) ) );
   }.dup(14);}, 0 );
)
```

Waterfall

$\Theta \Theta \Theta$	waterfall		
start			
trigger rate		100	
freq val		500	
filter_freq		500	
filter q		1	
			///

// allocate sample to buffer. buffer number must be refered to in SynthDef (eg. 10)
s.sendMsg(\b_allocRead, 10, "sounds/waterfall/waterfall3.wav");

```
(
SynthDef(\Waterfall, {
    arg out, trate = 100, freq = 10, filter_freq = 500, filter_q = 1, gate = 1, b = 10;
    var dur, system;
    dur = 1000 / trate / 1000;
```

```
// granulator plays back buffer, the position in the buffer can be adjusted by
altering the
    // frequency of the LFSaw wave, while the number of triggers can be adjusted using
trate
    system = BPF.ar(TGrains.ar(2, Impulse.ar(trate * 3), b,
1,LFSaw.ar((freq/BufDur.kr(b)) * 3,0,0.5,0.5), dur, 0, 0.3, 4), filter_freq,
filter_q);
    system = system * EnvGen.kr(Env.cutoff, gate, doneAction: 2);
    Out.ar (out, system);
```

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```
}).send(s);
)
(
// window variables
var w, startButton;
// granulation control variables
var trig_rate, freq_rate, filter_freq, filter_q, id;
// create node
id = s.nextNodeID;
// create window
w = SCWindow("waterfall", Rect(10, 100, 440, 150));
w.front;
w.view.decorator = FlowLayout(w.view.bounds);
// start button
startButton = SCButton(w, 75 @ 24);
startButton.states = [
      ["start", Color.black, Color.red],
      ["stop", Color.red, Color.black]
];
// action attaced to start button
startButton.action = { |view|
      if (view.value == 1) {
      s.sendMsg("/s_new", "Waterfall", id, 0, 0,
            "trate", trig_rate.value,
            "freq", freq_rate.value,
            "filter_freq", filter_freq.value,
            "filter_q", filter_q.value);
      };
      if (view.value == 0) {
            // change gate
            s.sendMsg("n_set", id, "gate", 0);
      };
};
// create sliders
w.view.decorator.nextLine;
trig_rate = EZSlider(w, 400 @ 20, "trigger rate", ControlSpec(2, 300, \lin),
      {lez! s.sendMsg("/n_set", id, "trate", ez.value);}, 100);
w.view.decorator.nextLine;
freq_rate = EZSlider(w, 400 @ 20, "freq val", ControlSpec(1, 5000, \lin),
      {lez! s.sendMsg("/n_set", id, "freq", ez.value);}, 500);
w.view.decorator.nextLine;
filter_freq = EZSlider(w, 400 @ 20, "filter_freq", ControlSpec(100, 3000, \lin),
      {lez! s.sendMsg("/n_set", id, "filter_freq", ez.value);}, 500);
w.view.decorator.nextLine;
filter_q = EZSlider(w, 400 @ 20, "filter q", ControlSpec(0.1, 10, \lin),
      {lezl s.sendMsg("/n_set", id, "filter_q", ez.value);}, 1);
)
```

Footsteps

$\Theta \Theta \Theta$	foot steps		
Start			
Heel Low Freq		700	
Heel Mid Freq		1700	
Heel High Freq		5300	
Heel Low dur		0.03	
Heel Mid dur		0.03	
Heel High dur		0.03	
Heel Low level		0.5	
Heel Mid level		0.5	
Heel High level		0.5	
ball Low Freq		700	
ball Mid Freq		1700	
ball High Freq		5300	
ball Low dur		0.03	
ball Mid dur		0.03	
ball High dur		0.03	
ball Low level		0.5	
ball Mid level		0.5	
ball High level		0.5	
toe Low Freq		700	
toe Mid Freq		1700	
toe High Freq		5300	
toe Low dur		0.03	
toe Mid dur		0.03	
toe High dur		0.03	
toe Low level		0.5	
toe Mid level		0.5	
toe High level		0.5	
heelSpace		0.03	
ballSpace		0.03	
toeSpace		0.03	
footfall space		1	
			11.

```
// grains used in the footstep are band pass filtered, white noise
(
SynthDef(\myGrain,
      {arg out=0, freq = 1700, recQ = 0.2, dur = 0.05, maxLev = 0.5;
            Out.ar(0,
                 BPF.ar(
                       WhiteNoise.ar(maxLev), freq, 0.2
                  ) * EnvGen.kr(Env.sine(dur, 1), doneAction: 2)
           )
).load(s);
(
// window variables
var w, startButton;
// each foot movement is made up of three grains hi, lo and mid
// each grain has a duration and a level
// heel variables
var heel_low_freq, heel_mid_freq, heel_high_freq;
var heel_low_dur, heel_mid_dur, heel_high_dur;
var heel_low_level, heel_mid_level, heel_high_level;
// ball variables
var ball_low_freq, ball_mid_freq, ball_high_freq;
var ball_low_dur, ball_mid_dur, ball_high_dur;
var ball_low_level, ball_mid_level, ball_high_level;
// toe variables
var toe_low_freq, toe_mid_freq, toe_high_freq;
var toe_low_dur, toe_mid_dur, toe_high_dur;
var toe_low_level, toe_mid_level, toe_high_level;
// timing variables
var heelSpace, ballSpace, toeSpace, footSpace;
// create the window
w = SCWindow("foot steps", Rect(10,10,500, 800));
w.front;
w.view.decorator = FlowLayout(w.view.bounds);
// the sound of the footstep is held within a routine
r = Routine.new({
      inf.do{
      var temp;
            2.do{
                 // randomness is added to the base freqs and durs in order to change
the sound of
                 // each footstep
                 Synth(\myGrain, [\freq, heel_low_freq + 100.rand, \dur, heel_low_dur +
0.02.rand, \maxLev, heel_low_level]);
                 Synth(\myGrain, [\freq, heel_mid_freq + 250.rand, \dur, heel_mid_dur +
0.02.rand, \maxLev, heel_mid_level]);
                 Synth(\myGrain, [\freq, heel_high_freq + 1000.rand, \dur, heel_high_dur
+ 0.02.rand, \maxLev, heel_high_level]);
                 heelSpace.wait;
```

```
};
2.do{
                  Synth(\myGrain, [\freq, ball_low_freq + 100.rand, \dur, ball_low_dur +
0.02.rand, \maxLev, ball_low_level]);
                  Synth(\myGrain, [\freq, ball_mid_freq + 250.rand, \dur, ball_mid_dur +
0.02.rand, \maxLev, ball_mid_level]);
                  Synth(\myGrain, [\freq, ball_high_freq + 1000.rand, \dur, ball_high_dur
+ 0.02.rand, \maxLev, ball_high_level]);
                 ballSpace.wait;
           };
           1.do{
                  Synth(\myGrain, [\freq, toe_low_freq + 100.rand, \dur, toe_low_dur +
0.02.rand, \maxLev, toe_low_level]);
                  Synth(\myGrain, [\freq, toe_mid_freq + 250.rand, \dur, toe_mid_dur +
0.02.rand, \maxLev, toe_mid_level]);
                  Synth(\myGrain, [\freq, toe_high_freq + 1000.rand, \dur, toe_high_dur +
0.02.rand, \maxLev, toe_high_level]);
                  toeSpace.wait;
           };
       temp = footSpace + 0.3.rand;
       temp.wait;
      };
});
// play button
startButton = SCButton(w, 75 @ 24);
startButton.states = [
      ["Start", Color.black, Color.red],
      ["Stop", Color.red, Color.black]
];
startButton.action = { |view|
      if (view.value == 1) {
           r.reset;
            r.play;
           heel_low_dur.value.postln;
      };
      if (view.value == 0) {
            r.stop;
      };
};
// sliders
w.view.decorator.nextLine;
heel_low_freq = EZSlider(w, 490 @ 20, "Heel Low Freq", ControlSpec(200, 1000, \lin),
      {lez! heel_low_freq = ez.value}, 700, labelWidth: 100);
w.view.decorator.nextLine;
heel_mid_freq = EZSlider(w, 490 @ 20, "Heel Mid Freq", ControlSpec(1000, 5000, \lin),
      {lez! heel_mid_freq = ez.value}, 1700, labelWidth: 100);
w.view.decorator.nextLine;
heel_high_freq = EZSlider(w, 490 @ 20, "Heel High Freq", ControlSpec(5000, 10000, \lin),
      {lez! heel_high_freq = ez.value}, 5300, labelWidth: 100);
w.view.decorator.nextLine;
heel_low_dur = EZSlider(w, 490 @ 20, "Heel Low dur", ControlSpec(0, 0.05, \lin),
      {lez! heel_low_dur = ez.value}, 0.03, labelWidth: 100);
```

```
w.view.decorator.nextLine;
```
```
heel_mid_dur = EZSlider(w, 490 @ 20, "Heel Mid dur", ControlSpec(0, 0.05, \lin),
     {lez| heel_mid_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
heel_high_dur = EZSlider(w, 490 @ 20, "Heel High dur", ControlSpec(0, 0.05, \lin),
      {lez! heel_high_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
heel_low_level = EZSlider(w, 490 @ 20, "Heel Low level", \amp,
      {|ez| heel_low_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
heel_mid_level = EZSlider(w, 490 @ 20, "Heel Mid level", \amp,
     {lez| heel_mid_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
heel_high_level = EZSlider(w, 490 @ 20, "Heel High level", \amp,
     {lez! heel_high_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
ball_low_freq = EZSlider(w, 490 @ 20, "ball Low Freq", ControlSpec(200, 1000, \lin),
      {lez! ball_low_freq = ez.value}, 700, labelWidth: 100);
w.view.decorator.nextLine;
ball_mid_freq = EZSlider(w, 490 @ 20, "ball Mid Freq", ControlSpec(1000, 5000, \lin),
     {lez| ball_mid_freq = ez.value}, 1700, labelWidth: 100);
w.view.decorator.nextLine;
ball_high_freq = EZSlider(w, 490 @ 20, "ball High Freq", ControlSpec(5000, 10000, \lin),
     {lez| ball_high_freq = ez.value}, 5300, labelWidth: 100);
w.view.decorator.nextLine;
ball_low_dur = EZSlider(w, 490 @ 20, "ball Low dur", ControlSpec(0, 0.05, \lin),
      {lez! ball_low_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
ball_mid_dur = EZSlider(w, 490 @ 20, "ball Mid dur", ControlSpec(0, 0.05, \lin),
      {lez! ball_mid_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
ball_high_dur = EZSLider(w, 490 @ 20, "ball High dur", ControlSpec(0, 0.05, \lin),
     {lez! ball_high_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine:
ball_low_level = EZSlider(w, 490 @ 20, "ball Low level", \amp,
      {lez! ball_low_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
ball_mid_level = EZSlider(w, 490 @ 20, "ball Mid level", \amp,
     {lez! ball_mid_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
ball_high_level = EZSlider(w, 490 @ 20, "ball High level", \amp,
      {lez| ball_high_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
toe_low_freq = EZSlider(w, 490 @ 20, "toe Low Freq", ControlSpec(200, 1000, \lin),
      {lez! toe_low_freq = ez.value}, 700, labelWidth: 100);
w.view.decorator.nextLine;
```

```
toe_mid_freq = EZSlider(w, 490 @ 20, "toe Mid Freq", ControlSpec(1000, 5000, \lin),
      {lez! toe_mid_freq = ez.value}, 1700, labelWidth: 100);
w.view.decorator.nextLine;
toe_high_freq = EZSlider(w, 490 @ 20, "toe High Freq", ControlSpec(5000, 10000, \lin),
      {lez| toe_high_freq = ez.value}, 5300, labelWidth: 100);
w.view.decorator.nextLine;
toe_low_dur = EZSlider(w, 490 @ 20, "toe Low dur", ControlSpec(0, 0.05, \lin),
      {lez| toe_low_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
toe_mid_dur = EZSlider(w, 490 @ 20, "toe Mid dur", ControlSpec(0, 0.05, \lin),
      {lez| toe_mid_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
toe_high_dur = EZSlider(w, 490 @ 20, "toe High dur", ControlSpec(0, 0.05, \lin),
      {lez! toe_high_dur = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
toe_low_level = EZSlider(w, 490 @ 20, "toe Low level", \amp,
      {lez! toe_low_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
toe_mid_level = EZSlider(w, 490 @ 20, "toe Mid level", \amp,
      {lez| toe_mid_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
toe_high_level = EZSlider(w, 490 @ 20, "toe High level", \amp,
      {lez! toe_high_level = ez.value}, 0.5, labelWidth: 100);
w.view.decorator.nextLine;
heelSpace = EZSlider(w, 490 @ 20, "heelSpace", ControlSpec(0, 0.05, \lin),
      {lez! heelSpace = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
ballSpace = EZSlider(w, 490 @ 20, "ballSpace", ControlSpec(0, 0.05, \lin),
      {lez! ballSpace = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine;
toeSpace = EZSlider(w, 490 @ 20, "toeSpace", ControlSpec(0, 0.05, \lin),
      {lez! toeSpace = ez.value}, 0.03, labelWidth: 100);
w.view.decorator.nextLine:
footSpace = EZSlider(w, 490 @ 20, "footfall space", ControlSpec(0, 2, \lin),
      {lez! footSpace = ez.value}, 1, labelWidth: 100);
)
```

Crows

000	crow		
Play Caw			
Formant1		1330	
Formant2		1506	
Pulse1		100	
Pulse2		100	
Width1		0.5	
Width2		0.5	
Amp1		0	
Amp2		0	
Dur1		0	
Dur2		0	
			11.

```
(
```

```
SynthDef(\crow, {
      arg out = 0, formant1 = 1335, formant2 = 1506, pulse1 = 70, pulse2 = 70,
                 width1 = 0.1, width2 = 0.1, dur1 = 0.6, dur2 = 0.6, amp1 = 1, amp2 = 1;
      var osc1, osc2, env1, env2;
      // the crow works on the basis of two formants
      osc1 = SinOsc.ar(formant1, mul: LFPulse.kr(pulse1, width: width1, mul: amp1));
      osc2 = SinOsc.ar(formant2, mul: LFPulse.kr(pulse2, width: width2, mul: amp2));
      // envelopes control the duration of each formant
      env1 = EnvGen.kr(Env.triangle(dur1), doneAction: 2);
      env2 = EnvGen.kr(Env.triangle(dur2), doneAction: 2);
      Out.ar( out, osc1 * env1 + osc2 * env2);
}).send(s);
)
(
// window variables
var w, startButton;
// variables to modify the synthDef args
var mod_formant1, mod_formant2, mod_pulse1, mod_pulse2, mod_width1, mod_width2;
var mod_dur1, mod_dur2, mod_amp1, mod_amp2;
// synth ID
var id;
id = s.nextNodeID;
// create the window
w = SCWindow("crow", Rect(10,10,440, 300));
w.front;
w.view.decorator = FlowLayout(w.view.bounds);
```

```
// play button
startButton = SCButton(w, 75 @ 24);
startButton.states = [
      ["Play Caw", Color.black, Color.red],
      ["Reset", Color.red, Color.black]
];
// the crow plays when the startButton is pressed
startButton.action = { |view|
      if (view.value == 1) {
             s.sendMsg("/s_new", "crow", id, 0, 0,
                   "formant1", mod_formant1.value,
"formant2", mod_formant2.value,
                   "pulse1", mod_pulse1.value,
                   "pulse2", mod_pulse2.value,
"width1", mod_width1.value,
"width2", mod_width2.value,
                   "amp1", mod_amp1.value,
                   "amp2", mod_amp2.value,
                   "dur1", mod_dur1.value,
"dur2", mod_dur2.value);
      };
      if (view.value == 0) {
             // change gate
             id = id + 1;
      };
};
w.view.decorator.nextLine;
mod_formant1 = EZSlider(w, 400 @ 20, "Formant1", ControlSpec(800, 2000, \lin),
      \{\}, 1330\};
w.view.decorator.nextLine;
mod_formant2 = EZSlider(w, 400 @ 20, "Formant2", ControlSpec(800, 2000, \lin),
      {}, 1506);
w.view.decorator.nextLine;
mod_pulse1 = EZSlider(w, 400 @ 20, "Pulse1", ControlSpec(0, 400, \lin),
      {}, 100);
w.view.decorator.nextLine;
mod_pulse2 = EZSlider(w, 400 @ 20, "Pulse2", ControlSpec(0, 400, \lin),
      {}, 100);
w.view.decorator.nextLine;
mod_width1 = EZSlider(w, 400 @ 20, "Width1", \amp,
      {}, 0.5);
w.view.decorator.nextLine;
mod_width2 = EZSlider(w, 400 @ 20, "Width2", \amp,
      {}, 0.5);
w.view.decorator.nextLine;
mod_amp1 = EZSlider(w, 400 @ 20, "Amp1", \amp,
      {}, 0);
w.view.decorator.nextLine;
mod_amp2 = EZSlider(w, 400 @ 20, "Amp2", \amp,
      {}, 0);
```

Pigeon

000	pigeon		
Start			
Initial Pitch		350	
# of coos		1	
Coo Depth		4	
Second Pitch		425	
First Pause		0.5	
Third Pitch		425	
Second Pause		0.5	11.

```
(
```

```
(
// unlike most other modules the pigeon doesn't use a SyntheDef
// variables for window
var w, startButton;
// variables for controlling the sound of the pigeon
var initial = 375, third = 300, second = 450, increment = 50, thickness = 4, streak = 1,
pitch, count = 1, firstPause = 0.5, secondPause = 1;
// the sound of the pigeon is held within a routine.
r = Routine.new({
streak.do({
if ( count == 1, {pitch = initial;}, if (count == 2, {pitch = second;}, {pitch =
third;}));
thickness.do({
{CombN.ar(SinOsc.ar(LFPar.ar(50, 45, mul: 12.5, add: XLine.kr(pitch, 350, 0.4)), mul:0.2)
* EnvGen.kr(Env.linen(0.05,0.3,0.1), 0.5), 0.2, 0.2, 0.5) * EnvGen.kr(Env.linen(0.1, 1,
0.1), 1, doneAction:2) }.play;
pitch = pitch + increment;
});
0.3.wait;
if(count == 1, {firstPause.wait;}, {secondPause.wait;});
count = count + 1;
});
count = 1;
});
// create the window
w = SCWindow("pigeon", Rect(400,100,440, 200));
```

```
w.front;
w.view.decorator = FlowLayout(w.view.bounds);
// play button
startButton = SCButton(w, 75 @ 24);
startButton.states = [
      ["Start",Color.black, Color.red],
["Reset",Color.red,Color.black]
];
startButton.action = { |view|
   if( view.value == 1 ){
       r.reset;
       r.play;
   };
   if( view.value == 0 ){
       // stop loop
       r.stop;
   };
};
// sliders
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "Initial Pitch", ControlSpec(250, 500, \lin), {lez| initial =
ez.value}, 350);
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "# of coos", ControlSpec(1, 3, \lin, 1), {|ez| streak = ez.value},
1);
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "Coo Depth", ControlSpec(1, 4, \lin, 1), {|ez| thickness =
ez.value}, 4);
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "Second Pitch", ControlSpec(250, 500, \lin), {|ez| second =
ez.value}, 425);
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "First Pause", ControlSpec(0, 2, \lin), {|ez| firstPause =
ez.value}, 0.5);
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "Third Pitch", ControlSpec(250, 500, \lin), {lez| third =
ez.value}, 425);
w.view.decorator.nextLine;
EZSlider(w, 400 @ 20, "Second Pause", ControlSpec(0, 2, \lin), {lez| secondPause =
ez.value}, 0.5);
```

```
)
```

Songbird

000	Song B	ird	
Start			
ffAttack		1	
ffDecay		1	
faAttack		1	
faDecay		1	
afAttack		1	
afDecay		1	
aaAttack		1	
aaDecay		1	
baseFreq		4000	

```
(
// songbird SynthDef, three oscillators are used a carrier which is frequency and
amplitude modulated
SynthDef(\bird2,
      { arg out = 0, baseFreq = 2000, fmFreq = 4000, fmAmp = 0.2, amFreq = 200, amAmp =
0.2, gate = 1,
            ffAttack = 1, ffDecay = 1, faAttack = 1, faDecay = 1, afAttack = 1, afDecay =
1,
            aaAttack = 1, aaDecay = 1;
      fmFreq = 3000 * EnvGen.kr(Env.perc(ffAttack, ffDecay, 1, -4), 1 );
      amFreq = 3000 * EnvGen.kr(Env.perc(afAttack, afDecay, 1, -4), 1);
      fmAmp = EnvGen.kr(Env.perc(faAttack, faDecay, 1, -4), 1);
      amAmp = EnvGen.kr(Env.perc(aaAttack, aaDecay, 1, -4), 1);
      Out.ar(0,
            SinOsc.ar(baseFreq + SinOsc.ar(fmFreq, mul: fmAmp), mul:SinOsc.kr(amFreq,
mul: amAmp))
                  * EnvGen.kr(Env.cutoff, gate, doneAction:2)
           );
      3
).send(s);
)
// window variables
var w, startButton;
// variables to control the SynthDef
var ffa_ctrl, ffd_ctrl, faa_ctrl, fad_ctrl, afa_ctrl, afd_ctrl, aaa_ctrl, aad_ctrl,
baseFreq_ctrl, id;
// set the node ID
id = s.nextNodeID;
// create the window
w = SCWindow("Song Bird", Rect(300,400,440, 250));
```

```
w.front;
w.view.decorator = FlowLayout(w.view.bounds);
// play button
startButton = SCButton(w, 75 @ 24);
startButton.states = [
      ["Start", Color.black, Color.red],
      ["Stop", Color.red, Color.black]
];
//button action
startButton.action = { |view|
      if (view.value == 1) {
            s.sendMsg("/s_new", "bird2", id, 0, 0,
                  "ffAttack", ffa_ctrl.value,
                  "ffDecay", ffd_ctrl.value,
"faAttack", faa_ctrl.value,
                  "faDecay", fad_ctrl.value,
"afAttack", afa_ctrl.value,
                  "afDecay", afd_ctrl.value,
                  "aaAttack", aaa_ctrl.value,
                  "aaDecay", aad_ctrl.value,
                  "baseFreq", baseFreq_ctrl.value);
      };
      if (view.value == 0) {
            // change gate
            s.sendMsg("n_set", id, "gate", 0);
      };
};
//sliders
w.view.decorator.nextLine;
ffa_ctrl = EZSlider(w, 400 @ 20, "ffAttack", ControlSpec(0, 5, \lin),
      {lez! s.sendMsg("/n_set", id, "ffAttack", ez.value);}, 1);
w.view.decorator.nextLine;
ffd_ctrl = EZSlider(w, 400 @ 20, "ffDecay", ControlSpec(0, 5, \lin),
      {lez! s.sendMsg("/n_set", id, "ffDecay", ez.value);}, 1);
w.view.decorator.nextLine;
faa_ctrl = EZSlider(w, 400 @ 20, "faAttack", ControlSpec(0, 5, \lin),
      {lez! s.sendMsg("/n_set", id, "faAttack", ez.value);}, 1);
w.view.decorator.nextLine;
fad_ctrl = EZSlider(w, 400 @ 20, "faDecay", ControlSpec(0, 5, \lin),
      {lez! s.sendMsg("/n_set", id, "faDecay", ez.value);}, 1);
w.view.decorator.nextLine;
afa_ctrl = EZSlider(w, 400 @ 20, "afAttack", ControlSpec(0, 5, \lin),
      {lez! s.sendMsg("/n_set", id, "afAttack", ez.value);}, 1);
w.view.decorator.nextLine;
afd_ctrl = EZSlider(w, 400 @ 20, "afDecay", ControlSpec(0, 5, \lin),
      {lez! s.sendMsg("/n_set", id, "afDecay", ez.value);}, 1);
w.view.decorator.nextLine;
aaa_ctrl = EZSlider(w, 400 @ 20, "aaAttack", ControlSpec(0, 5, \lin),
      {lezl s.sendMsg("/n_set", id, "aaAttack", ez.value);}, 1);
```

```
w.view.decorator.nextLine;
aad_ctrl = EZSlider(w, 400 @ 20, "aaDecay", ControlSpec(0, 5, \lin),
        {lez1 s.sendMsg("/n_set", id, "aaDecay", ez.value);}, 1);
w.view.decorator.nextLine;
baseFreq_ctrl = EZSlider(w, 400 @ 20, "baseFreq", ControlSpec(300, 7000, \lin),
        {lez1 s.sendMsg("/n_set", id, "baseFreq", ez.value);}, 4000);
```

```
)
```

Insect

000		insect		
Sine	Saw			
FM freq			0	
FM Amp			0	
FM Add			0	
AM freq			0	
AM mul			0	
duration			0	
Width			0	//.

 $\prime\prime$ there are two SynthDefs. One for sine wave based insect sounds and the other for saw wave

```
(
SynthDef(\Insect, {
    arg out, modulator_freq, modulator_amp, modulator_add, am_mod_freq, am_mod_amp,
gate = 1;
    var modulator, carrier, am;
```

```
// set up the modulator wave
modulator = SinOsc.ar(modulator_freq, mul: modulator_amp, add: modulator_add);
```

```
// wave for amplitude modulation
am = LFPar.ar(am_mod_freq, mul:am_mod_amp, add:am_mod_amp);
```

```
// the carrier wave
carrier = SinOsc.ar(modulator, mul: am);
```

```
// add a gate to stop the sound
carrier = carrier * EnvGen.kr(Env.cutoff, gate, doneAction: 2);
```

```
Out.ar(out, carrier);
```

```
}).send(s);
)
```

```
(
SynthDef(\Insect_saw, {
```

```
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```

```
// set up the modulator
      modulator = SinOsc.ar(modulator_freq, mul: modulator_amp, add: modulator_add);
      // amplitude modulation
      am = LFPar.ar(am_mod_freq, mul:am_mod_amp, add:am_mod_amp);
      // carrier wave
      carrier = Saw.ar(modulator, mul: am);
      // gated to stop the sound
      carrier = carrier * LFPulse.kr(dur, width: width) * EnvGen.kr(Env.cutoff, gate,
doneAction: 2);
      Out.ar(out, carrier);
}).send(s);
)
// window to control the SynthDefs
(
// window variables
var w, startButton, sawButton;
// sliders, etc to control the SynthDef
var mod_freq_ctrl, mod_amp_ctrl, mod_add_ctrl, am_freq_ctrl, am_amp_ctrl, id, mod_dur,
mod_width;
// create and ID for the synth
id = s.nextNodeID;
// creeate the window
w = SCWindow("insect", Rect(10,10,440, 200));
w.front;
w.view.decorator = FlowLayout(w.view.bounds);
// play button for sine wave based insect
startButton = SCButton(w, 75 @ 24);
startButton.states = [
      ["Sine", Color.black, Color.red],
      ["Stop", Color.red, Color.black]
];
// the action plays the SynthDef
startButton.action = { |view|
      if (view.value == 1) {
            s.sendMsg("/s_new", "Insect", id, 0, 0,
                  "modulator_freq", mod_freq_ctrl.value,
                  "modulator_amp", mod_amp_ctrl.value,
"modulator_add", mod_add_ctrl.value,
                  "am_mod_freq", am_freq_ctrl.value,
                  "am_mod_amp", am_amp_ctrl.value,
                  "dur", mod_dur.value,
                  "width", mod_width.value);
      };
      if (view.value == 0) {
            // change gate
            s.sendMsg("n_set", id, "gate", 0);
      };
};
```

```
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```

```
// play button for saw wave based insect
sawButton = SCButton(w, 75 @ 24);
sawButton.states = [
      ["Saw", Color.black, Color.red],
      ["Stop", Color.red, Color.black]
];
sawButton.action = { |view|
      if (view.value == 1) {
            s.sendMsg("/s_new", "Insect_saw", id, 0, 0,
                  "modulator_freq", mod_freq_ctrl.value,
                  "modulator_amp", mod_amp_ctrl.value,
"modulator_add", mod_add_ctrl.value,
                  "am_mod_freq", am_freq_ctrl.value,
                  "am_mod_amp", am_amp_ctrl.value,
                  "dur", mod_dur.value,
                  "width", mod_width.value);
      };
      if (view.value == 0) {
            s.sendMsg("n_set", id, "gate", 0);
      };
};
// sliders
w.view.decorator.nextLine;
mod_freq_ctrl = EZSlider(w, 400 @ 20, "FM freq", ControlSpec(0, 20000, \lin),
      {lezl s.sendMsg("/n_set", id, "modulator_freq", ez.value);}, 0);
w.view.decorator.nextLine;
mod_amp_ctrl = EZSlider(w, 400 @ 20, "FM Amp", ControlSpec(0, 20000, \lin),
      {lez! s.sendMsg("/n_set", id, "modulator_amp", ez.value);}, 0);
w.view.decorator.nextLine;
mod_add_ctrl = EZSlider(w, 400 @ 20, "FM Add", ControlSpec(0, 20000, \lin),
      {lez! s.sendMsg("/n_set", id, "modulator_add", ez.value);}, 0);
w.view.decorator.nextLine;
am_freq_ctrl = EZSlider(w, 400 @ 20, "AM freq", ControlSpec(0, 20, \lin),
      {lez! s.sendMsg("/n_set", id, "am_mod_freq", ez.value);}, 0);
w.view.decorator.nextLine;
am_amp_ctrl = EZSlider(w, 400 @ 20, "AM mul", ControlSpec(0, 0.5, \lin, 0.01),
      {lez! s.sendMsg("/n_set", id, "am_mod_amp", ez.value);}, 0);
w.view.decorator.nextLine;
mod_dur = EZSlider(w, 400 @ 20, "duration", ControlSpec(0, 1, \lin),
      {lez! s.sendMsg("/n_set", id, "dur", ez.value);}, 0);
w.view.decorator.nextLine;
mod_width = EZSlider(w, 400 @ 20, "Width", ControlSpec(0, 1, \lin),
      {lez! s.sendMsg("/n_set", id, "width", ez.value);}, 0);
)
```

The Shakkei

```
//load sounds into buffers.
//begin routine
// pick one sounds play it
//wait until it has finished
// repeat until finished.
// there is no gui for the shakkei
SynthDef("playBuf", { arg out=0,bufnum=0;
       Out.ar(out,
              PlayBuf.ar(1, bufnum, BufRateScale.kr(bufnum))
       )
}).load(s)
(
b = Buffer.read(s, "sounds/beds/bed1.wav");
c = Buffer.read(s, "sounds/beds/bed2.wav");
f = Buffer.read(s, "sounds/beds/bed3.wav");
g = Buffer.read(s, "sounds/beds/bed4.wav");
a = Routine.new({
       inf.do({ d = [1,2,3,4].choose;
              if ( d > 3,
                     {Synth(\playBuf, [\bufnum, b.bufnum]);
                     z = b.numFrames / b.sampleRate;
                     z.wait;
                     },
                     if(d > 2,
                            {Synth(\playBuf, [\bufnum, c.bufnum]);
                            z = c.numFrames / c.sampleRate;
                            z.wait;
                            },
                            if ( d > 1,
                                   {Synth(\playBuf, [\bufnum, f.bufnum]);
                                   z = f.numFrames / f.sampleRate;
                                   z.wait;
                                   },
                     {Synth(\playBuf, [\bufnum, g.bufnum]);
                     z = g.numFrames / g.sampleRate;
                     z.wait;
                     };);););
       d.value.postln;});
       b.free;
       c.free;
       f.free;
       g.free;
       });
)
a.play;
a.stop;
```