AMERGENT MUSIC:
BEHAVIOR AND BECOMING IN TECHNOETIC & MEDIA ARTS

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PhD

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AMERGENT MUSIC:
BEHAVIOR AND BECOMING IN TECHNOETIC & MEDIA ARTS

by

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Abstract

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Amergent Music: behavior and becoming in technoetic & media arts

Technoetic and media arts are environments of mediated interaction and emergence, where meaning is negotiated by individuals through a personal examination and experience—or becoming—within the mediated space. This thesis examines these environments from a musical perspective and considers how sound functions as an analog to this becoming. Five distinct, original musical works explore the possibilities as to how the emergent dynamics of mediated, interactive exchange can be leveraged towards the construction of musical sound.

In the context of this research, becoming can be understood relative to Henri Bergson's description of the appearance of reality—something that is making or unmaking but is never made. Music conceived of a linear model is essentially fixed in time. It is unable to recognize or respond to the becoming of interactive exchange, which is marked by frequent and unpredictable transformation. This research abandons linear musical approaches and looks to generative music as a way to reconcile the dynamics of mediated interaction with a musical listening experience.

The specifics of this relationship are conceptualized in the structaural coupling model, which borrows from Maturana & Varela's "structural coupling." The person interacting and the generative musical system are compared to autopoietic unities, with each responding to mutual perturbations while maintaining independence and autonomy. Musical autonomy is sustained through generative techniques and organized within a psychogeographical framework. In the way that cities invite use and communicate boundaries, the individual sounds of a musical work create an aural context that is legible to the listener, rendering the consequences or implications of any choice audible.

This arrangement of sound, as it relates to human presence in a technoetic environment, challenges many existing assumptions, including the idea "the sound changes." Change can be viewed as a movement predicated by behavior. Amergent music is brought forth through kinds of change or sonic movement more robustly explored as a dimension of musical behavior. Listeners hear change, but it is the result of behavior that arises from within an autonomous musical system relative to the perturbations sensed within its environment. Amergence propagates through the effects of emergent dynamics coupled to the affective experience of continuous sonic transformation.

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DVD Disc

The supporting DVD contains documentation for all projects discussed in this thesis. The disc will play on any computer running Mac OS or Windows, or NTSC-capable DVD players.

It will not run on players that require PAL-formatted media.

All examples feature music, so be sure you are wearing headphones or have your speakers switched on.

DVD-ROM

A few of the featured projects are capable of running on your desktop or laptop computer. Insert the disc and find the DVD disc icon labeled NORBERT_HERBER_PHD_THESIS. Then double-click (Mac) or right-click and choose Open (Win) to reveal the ROM Content folder. The following table shows the location of the files within ROM Content that launch these projects.

Project	Location (ROM Content/)	File Name
PSO[1]	PSO[1]/	PSO[1] (Mac) pso-1.exe (Win)
PSO[2]	PSO[2]/	PSO[2] (Mac) pso-2.exe (Win)
AUTOMATICBODY	AUTOMATICBODY/	AUTOMATICBODY (Mac) AUTOMATICBODY.exe (Win)
Composition-Instrument Study I	Composition-Instrument Studies I & II/	Study I.app (Mac) Study I.exe (Win)
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Londontown Journalism quest	Londontown/	Journalism Quest.app (Mac) Journalism Quest.exe (Win)

Double-click the file's icon and the project will play. Depending on your computer's OS, the icon will look like either of the following:

All projects except for *Composition-Instrument Study I* & *II* fill the entire screen (fullscreen mode). To exit this mode and see a project in a single window, press the Escape key.

To quit a project, press the Escape key (to exit fullscreen mode), then:

- in Mac OS choose Flash Player > Quit Flash Player (Command-Q)
- in Windows choose File > Exit (Control-Q)

Many of these projects are also available online at www.x-tet.com/phdtod

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I must first thank my immediate and extended family for their emotional and intellectual support throughout my time as a PhD student and candidate. Jenny, Nadia, and Benno so helpfully provided distractions (or lack of them) as needed while I was writing. Jenny—my lovely wife—deserves special thanks for her assistance with the typography, design, and layout of the final thesis document.

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Finally I owe a sincere thank you to Brian Eno who, in spite of his perpetually exhausting schedule, always replied to my questions with candor and humor, and had nothing but superb advice. Now that my candidacy has come to an end I hope that we can find a project to do together, even if it involves hanging Christmas lights.

Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

A programme of advanced study was undertaken, which included the course I590 *Artificial Life as an approach to Artificial Intelligence* with Larry Yaeger in the spring semester of 2005. This course was offered through the School of Informatics at Indiana University, Bloomington. In addition, several projects were produced to experiment with many of the ideas explored in the course of this research. These are discussed in detail throughout the body of the thesis and thoroughly documented both in the appendix and on the supporting DVD. Many projects are also documented online: www.x-tet.com/phdtod.

A small portion of this study involved work on the collaborative project *Londontown*, a virtual world set in Victorian-era London, initiated by Lee Sheldon at Indiana University, Bloomington in 2007. This project involved students and faculty from across campus as there was much work to be done including modeling the environment in 3D, the creation of visual assets (people, objects, vehicles, etc.), writing story seeds, designing political and economic systems, and recording sounds to fill the world. The project relates to this thesis in that it provided a superb vehicle for employing and testing many of the musical ideas generated throughout this research process. *Londontown* quest scripts were used to generate possible scenarios of interaction and serve as a recipe for the kind of emergent dynamics that are leveraged to create Amergent music. Beyond this, the musical work involved in *Londontown* that relates to this thesis was conducted on an independent basis by the candidate with occasional feedback from the lead designer and helpful suggestions provided by others involved with the project.

As a student in the Planetary Collegium, 10-day composite sessions were attended three times per year between August 2004 and April 2007 in locations such as Beijing, Istanbul, São Paulo, and Montreal. At each composite session, every candidate presented their current research and creative work. In addition our group always attended a public conference which provided the opportunity to give talks, prepare papers for publication, to visit external institutions for consultation, and to discuss research and art work with colleagues from around the world.

The research for this thesis produced two publications, led to two grant awards, and generated work for seven gallery shows and public art installations. See appendix sections A.1, A.2 and A.3 for full details. Copies of published works appear at the end of the bound thesis document.

Conferences were attended; in most cases to make presentations on the research or projects related to this thesis. See appendix section A.4 for a full listing of conference titles, locations, and presentation titles.

In addition to the University of Plymouth supervisors who advised throughout the research process there were several external contacts that were consulted for guidance in various forms. This includes:

Brian Eno, Musician, London, UK

Larry Yaeger, Professor of Informatics, Indiana University, Bloomington, USA

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Introduction

"The behaviour does not specify the connexions uniquely."

– W. Ross Ashby, *An Introduction to Cybernetics* (1956: 93)

Considering Ashby's thorough introduction to control systems, their underlying logic, and the variety of their functioning, this statement is both curious and exciting. It communicates the idea that a technical system may be capable of more than what its internal wiring or programming suggests is possible. The functioning and output of a system is not necessarily defined by a specific set of connections. General, specific, and unpredictable behavior may be elicited from a variety of different links and configurations. Change and transformation (both internal and external) are not a teleology of finite correspondences, but a synergy of possible states mobilized as adaptive behavior. The emergence that gives rise to such behavior is indicative of the systems that generate it and the overall environment to which they belong. When trying to understand the behavior of a system it is necessary not only to look at its physical composition but at the local interactions of sub-systems and the behaviors they cultivate and sustain.

Concerning This Inquiry

Amergent music is the result of an ontological inquiry into the technoetic arts and mediated environments of entertainment and communications. The focus of this research was to know and better understand these environments so as to gain additional perspectives concerning their ability to integrate and sustain sound and music. Environments of connectivity and mediated interaction are environments of emergence, where meaning is negotiated through personal awareness and experience of continuous transformation and shifting relations—the becoming of the mediated space.

In such an environment, how does sound function as an analog to this becoming? In what ways can music operate as an integral part of the environment rather than as a sympathetic, parallel channel? How might the emergent dynamics of mediated, interactive exchange be leveraged in the construction of musical sound? These are the questions that drive this research process and lead to the production of ideas and projects discussed throughout this document. There is no single, definitive answer. There is however, a useful set of conclusions that speak to the initial question. In addition, this work reveals an emerging relationship between people and technology, created through a mode of interaction made possible by the projects presented here.

Territory of This Inquiry

Though many terms will be used throughout this thesis to discuss the various kinds of works related to Amergent music, the environments most conducive to the musical approach presented here are known as *technoetic*. Roy Ascott described this term in this essay, *When The Jaguar Lies Down With The Lamb: speculations on the post-biological culture*:

> …a fusion of what we know and may yet discover about consciousness (noetikos) with what we can do and will eventually achieve with technology [techne]. It will make consciousness both the subject and object of art. (2001)

This thesis makes no attempt to define consciousness but it does take the position that music can shape and transform consciousness; it can give rise to a new consciousness as it is experienced. As one transitions to an alternate or mixed reality using tools of mediation like the Internet, personal com-

puter, mobile phone, or other telematic device, consciousness is altered. Music that operates in congruence with (rather than in parallel to) this reality becomes a more substantial ingredient in forming that new consciousness. As such, the artworks, projects, and systems of mediation to be discussed in this thesis will be referred to as *technoetic*, or as *technoetic environments*.

Technoetic arts and computer games are the fields that share the greatest resonance with the work of this thesis. In all of these, the lowest common denominator is emergence. Jesper Juul notes two relevant categories of emergence in games: *combination*, "the variety of possible states and game sessions that a game's rules allow," and *emergent strategies*, "…the actually emergent properties that are not immediately deductible from the game rules," which includes any kind of play strategy and team play (2002: 3). Amergent music seeks to leverage the behavior produced through "combination" and "emergent strategies." By coordinating generative systems and sounds with the various aspects of the environment's design, the multitude of possible states in the game world leads to a congruent variety of possible states in the music. Similarly, as strategies for navigating the world emerge, choices are linked to sounds and simple rules of the generative system that interact to produce a complementary emergence in the aural aspects of the environment.

Roy Ascott makes a similar case for the inherent emergence of technoetic arts:

> Just as the 'artist' is fast becoming a complex and widely distributed system, in which both human and artificial cognition and perception play their part, so art is no longer primarily a matter of representation but of emergence, ordering itself from a multiplicity of chaotic interactions in telematic data space, within the structural coupling of what we know as human evolution. The key to our understanding of this evolution lies within the domain of consciousness. (2003: 275)

What is experienced as art is more a matter of process, a becoming in the space created or sustained by the artwork, that gives rise to affect and new experiences of consciousness. The artwork is not "out there" to be discovered, but something to be experienced through direct engagement and a negotiation of relations with what constitutes such a work. Scientist and scholar Andrew Pickering finds it useful to look at our physical reality as though it were a cellular automata:

> One might indeed understand these mathematical systems as a kind of ontological theatre: they stage emergence for us and dramatize it. Think of the world as built of cellular automata, say, instead of static entities like quarks and you start to get the hang of emergence ontologically, as a fact about the world. (2008: 129)

The research presented here sees emergence as a fact of technoetic arts and other environments of mediated interaction. It is a primary feature of their ontology and as such is the driving force behind the sound and music created within, and coupled to, these environments.

Where emergence can be said to characterize the behavior of music in these environments, *ambience* is the defining character of its sound. Amergent music focuses on the sound of an environment; in particular, the way in which the events or actions that transpire in such an environment can be used to create and sustain this sound. Amergent music extends from the tradition of Ambient music, which was a thoughtful intervention to the presence of MUZAK (programmed music) that came to permeate commercial and public spaces. Brian Eno writes about his initial intentions behind Ambient music:

> Whereas the extant canned music companies proceed from the basis of regularizing environments by blanketing their acoustic and atmospheric idiosyncracies, Ambient Music is intended to enhance these. Whereas conventional background music is produced by stripping away all sense of doubt and uncertainty (and thus all genuine interest) from the

> music, Ambient Music retains these qualities. And whereas their intention is to 'brighten' the environment by adding stimulus to it (thus supposedly alleviating the tedium of routine tasks and levelling out the natural ups and downs of the body rhythms) Ambient Music is intended to induce calm and a space to think. (1996: 296)

Compared to the arguably insidious quality of MUZAK, Ambient music was created with an empowering aesthetic. It did not seek to control the environment but rather serve as a sonic catalyst to thought and imagination. However, like "conventional background music" the first Ambient recordings were passive, sounding the same every time they were played. Generative music (a genre title coined in 1996, also by Brian Eno) alleviates this homogeneity. It is a music defined by its ability to create itself anew every time it is played. Drawing on Experimental music practices started in the 1960s, Generative music unfolds procedurally from a known origin but with an uncertain destination. The mixture of these characteristics defines Amergent music. Like Ambient it will sonically color its environment, and like Generative it will transform across the span of time in which it is heard. But this transformation is tied directly to the environment and modulated by the actions that occur within it. Amergent music further empowers listeners so that what is heard is a direct reflection of their choices and their participation in the mediated reality that surrounds them.

In this conception, music is coupled with interaction in ways that are most clearly explained through comparisons to various biological phenomena. Humberto Maturana and Francisco Varela's system of structural coupling is an excellent model for such a description. When unities are linked in this fashion, interactions between them are sent and received as perturbations. There is no deliberate instruction, but a simple message to be handled within the domain of the receiving unity's functioning order. As such, perturbations do not direct or control anything in particular, but act to trigger structural changes within a unity in general. Each unity retains its autonomy while simultaneously participating in what its structurally-coupled neighbors refer to as their environment. Such an arrangement demonstrates how systems can be viewed as a collection of autonomous unities that, as a whole, constitute their own environment, and as such, can be viewed as an autonomous system that is likewise coupled to additional, complementary systems at a higher order (Maturana & Varela 1980).

This perspective is cybernetic as much as it is biological. It is a useful way of thinking about many different kinds of interrelated systems because it values emergence above all. The idea of control is decentralized. There is no single functioning order, but a confluence of small, individual orders that interact and give way to an emergence that characterizes the behavior of the overall system. Amergent music has little relation to traditional notions of music composition. Nothing is defined or written out in detail in advance. Through the local interactions of individual systems, music emerges as a behavior of sound. Unlike a film score written to match the emotional contours of a scene, or a broad ambient statement that establishes a mood over a period of time, Amergent music behaves in ways congruous to the events of the environment in which it is heard.

Methods of This Inquiry

This thesis was produced through a combination of academic research and artistic practice. The connection between them varied throughout the process, but while writing this document it became abundantly clear that the two were situated in a relationship akin to the opposing sides of a Möbius strip. It has been nearly impossible to think or write about one without needing to consult the other.

This research sought to discover techniques and approaches for creating a system of music able to acknowledge and manifest the potential of becoming experienced in the course of mediated interaction. This was conducted in part by examining scores and other musical documents, and by reading about musicians' methods in original texts and interviews. Listening was also employed extensively to generate ideas for orchestrations and arrangements, explore new sound palettes, consult performance

style, and maintain a general awareness of the contemporary work that complements or can help to extend my artistic practice. See the Discography for a list of musical recordings that were consulted.

The experience of technoetic and media art works was also vital to this work. In a research context, the mode of experience goes beyond simply taking something in. To truly understand the relationship between mediated environments and the music that exists within them, a deconstructive approach was necessary. This meant using or exploring a system in ways that ran contrary to its design, which often revealed the technical character and inner-workings of the system.

In the earliest phases of this research process there was a lot to be gained through keeping a research journal. This initially served as a useful means of monitoring personal milestones and introducing supervisors to the various directions of research. Later it became far more useful to write conference papers and journal articles, and to engage in projects within my artistic practice. Project journals were maintained throughout, but became especially important while working on *Dérive Entre Mille Sons* and *Londontown*, two projects discussed throughout this document. Work on these continued over a period of months and it became necessary to document the technical and conceptual progress of each. These journals turned out to be one of the most valuable assets in writing this thesis, as they documented every step in the process and made it possible to uncover the origins of both technical and musical directions.

Musical works were treated as experiments as much as they were projects within an artistic practice. The projects presented in this document served as a creative testing ground to explore the musical techniques derived from the other facets of research. Each project is discussed in the context of the chapters with the most relevant content. Sound and video examples are cross-referenced from each chapter of this written document to sections of the supporting DVD.

Academic writing was an important means of clarifying many of these ideas when they were still in development or at some stage of completion. Conference papers and presentations, book chapters, journal articles, grant awards, and juried gallery shows that helped to further facilitate this research process are documented in appendix sections 1–4.

Results of This Inquiry

The process and outcome of this research has yielded the term *Amergent music*. It is a play on the word *emergent* that calls deliberate attention to the essence of phenomena that have dimensions of both *effect* and *affect*. *Effect*, when used as a noun, is a consequence or result. As a verb it means "to bring about." *Affect* is an emotion or desire that influences behavior when used as a noun, but adds emotional nuance to the idea "produce an effect upon" when used as a verb. Amergent combines the idea of action—those processes which produce results—with emotion and feeling. Emergence is action, manifest through local interactions; affect is the impact of such an action on consciousness. Taken together, the term *Amergent* speaks to a music brought about by emergence that shapes the consciousness of those who engage it. Like the experience of reality described by William James, Amergent music consists of a flow of sonic events that:

> …run[s] by cognitive transition into the next one… We live, as it were, upon the front edge of an advancing wave-crest, and our sense of a determinate direction in falling forward is all we cover of the future of our path. (1922: 69)

Philosophies of process are important to this research because they present an understanding of reality that never *is* but rather *becomes*. Like emergent behavior, the becoming of process philosophy is characterized by a continuous flow of novelty. Nicholas Rescher observes an essential point in James' philosophy, in that he:

> …emphasized that one characteristic mode in which we humans participate in nature's processes is through choice, and in choosing—in free action—we both make ourselves and change the world into something that would otherwise be different. Even truth and knowledge come within the realm of the Jamesean dynamism: They are not things we find but things we make. (1996: 16)

In the flow of becoming there remains agency. We may be falling forward on the crest of a wave but still retain the ability to turn to the left or right. Reality is constantly in the making but it is *our* making. Amergent music, and its relationship to technoetic and media arts, makes this phenomenon a defining element in our experience of consciousness as shaped through processes of mediation. The fluidity and transmutability of technoetic environments amplifies our ability to make new realities and distill the essence of a place or situation.

Martin Heidegger discusses technology as a tool for the discovery of truth and a means of *poiesis*, or bringing-forth (1977: 330). In works of Amergent music (or projects in which Amergent music comprises part of the overall experience) the person engaged in the work—frequently known as the participant, user, or player—is more accurately called the *poiesist*. They are engaged in a bringing-forth. Their actions constitute a process of making within the flow of becoming; a bringing-forth of sounds into music. The term *poiesist* will be used throughout this thesis to identify the person engaged in the projects that are presented because it most accurately characterizes the kind of experience Amergent music can facilitate. Music brought-forth is the result of interaction in a technoetic art work, as a result of the perturbations that trigger shifts and transformations of consciousness. Bringing-forth is not characteristic of a music that *is* or *exists* but of music that *becomes* from moment to moment as it is drawn out in the course of mediated experience.

CHAPTER 1

Research Context

NEO

Whoa, déjà vu.

TRINITY

What did you just say?

NEO

Nothing, just had a little déjà vu.

TRINITY

What did you see?

NEO

A black cat went past us, and then another that looked just like it.

TRINITY

How much like it? Was it the same cat?

NEO

Might have been; I'm not sure.

NEO

What is it?

TRINITY

A déjà vu is usually a glitch in the Matrix. It happens when they change something.

– Wachowski & Wachowski (1999)

The dialogue excerpted above is from the 1999 movie, *The Matrix*. The characters are discussing the mechanics of reality, or rather "reality," as both are fully aware that the world they experience is no more than an elaborate computer program that has overtaken the consciousness of the human race. With the exception of Neo, Trinity, and a few other characters in the story, every human is unknowingly and permanently connected to a vast network of machines know as the Matrix. Terms like "suspension of disbelief," "immersion," or "absorption" do not apply to those under its control. It is completely mediated and it is the only reality they know. Neo and Trinity have a different connection to the Matrix. They are aware of its mediating process and enter into it freely. When they experience something like a déjà vu, they are more keenly aware of the system's operation than ever. Such a "glitch in the Matrix" reveals its own functioning from within.

Those of us who experience technoetic art works and mediated environments are in a position similar to that of Neo and Trinity. We enter into various mediated realities to experience a shift of consciousness—a new reality facilitated by the art work. And like Neo's déjà vu, those events that repeat in uncanny ways call our attention to the processes of mediation. Brian Massumi, drawing on the work

of William James, makes a useful comparison to our un-mediated reality:

> But there is no general event. There is only *this* event, and *this* one, and *this* other one—none of them exactly alike. Each event is unique. It only stands to reason, then, that the event's general conditions do not fully account for its repetition, as it happens: different at each iteration. (Massumi 2002: 222)

An event repeats, but it is never the same, *exact* event. An ingredient is always slightly different so as to change the interactions of all elements in that very moment and render it fresh and new, apart from all those that preceded or will follow it. When reality is experienced as a becoming, anything working against the production of continuous novelty draws attention to those very processes of production. As mediation is exposed, the experience of a new or alternate consciousness is diminished.

The research that produced this thesis began with a survey of the field, identifying the music produced for digital interfaces, multimedia web sites, communications applications, computer games, and other applications involving personal computers and mobile devices. More broadly this includes technoetic and telematic arts, and related applications for mediated entertainment and communications. Internet and satellite radio, podcasts, media player software such as iTunes, and related networks of social and commercial distribution do not count significantly in this inquiry. Software and media such as these—those that use music in ways reiterative of earlier technologies—are part of the overall landscape but comprise a different territory. This critical examination was conducted with the intention of identifying the potential for creative music making in relation to these various technologies. The objective of this research was to understand relevant software and devices, to weigh the actual and potential uses of each, and to experiment with different techniques for making music that suited the use of contemporary technology and leveraged its unique capabilities.

1.1 Critique of Linearity

Movies, opera, radio, television, theater—forms of media, art and music invented in the past—are dominated by linearity. There is a beginning, a middle, an end—and, with the exception of those forms that require live performance—little variation between those points. Of course there were forms that sought to undo this for various reasons. Experimental music, Free improv, and a-life art are all forms that abandon all traces of an "A-to-B" structure out of technical, performative, or aesthetic necessity. Although the experience of these works is still linear and they progress with the passage of time, their construction leads to a novel or unpredictable unfolding within the duration of the work or the interval one chooses to spend with(in) it.

In the contemporary landscape of media, art, and technology there are many examples in which the overall visual, narrative, or play experience is assembled on-the-fly as a result of unique circumstances and choices, but the accompanying audio is static. It is aurally incongruous to the emergent dynamics that characterize the rest of the experience. Contemporary computer games provide some of the best examples of this phenomenon.

1.1.1 Music in Computer Games

In contemporary games, the relationship that couples musical and visual elements has been predominantly forged using dated models based on linear thinking. Results of these procedures can be compared to fitting round pegs into square holes—they almost fit. It's not a question of creating "good" or "bad" music, but of creating music that is appropriate to the dynamics of the medium in which it will be heard. The difficulty lies in what Kurt Harland refers to as "conceptual problems of interactive game scores," where listener expectations of "good" music do not necessarily match the sounds and structures best suited to these kinds of works (Harland 2000). He observes that the vast majority of this music is composed to match the western musical traditions of a fixed form that leads listeners on

an ideal musical journey. The linearity embedded in this approach presents a distinct disadvantage because "…most of the things that one can do to a track to make it interactive are the things that take it a step away from being a well arranged song" (Harland 2000). The music complementary to an interactive, non-linear environment is not the kind of music that sounds best when separated from this environment. However, as the music is often evaluated separately, it is often discarded in favor of music that "sounds better," but is less appropriate in the environment of the game.

Initiatives to undo this problem have been launched by the Interactive Audio Special Interest Group (www.iasig.org) and Sonify.org (www.sonify.org). These groups support writing and discussion surrounding the improvement of sound practice in digital media and online environments. Unfortunately, their stance is prescriptive. The majority of articles and working group discussions focus on new technologies that enable the playback of linear sound compositions. This route only addresses modes of delivery and negates the actual content to be delivered. Drawing on Harland's critique, the conclusions of this doctoral research suggest that additional technological platforms are not the only part of a sustainable solution for the future.

A prime example of this in contemporary practice is a method of music production known as Adaptive Audio (AA). Thomas Dolby Robertson initially defined AA in 1987 as "…a dynamic audio soundtrack which adapts to a variety of emotional and dramatic states resulting, perhaps, from choices the user makes" (Sanger 2004: 202-3; Brandon 2005: 85; Collins 2008: 183). The idea of AA is a step in the right direction, but unfortunately the implementation of this technique has thus far been too closely connected to linear techniques. Guy Whitmore, one of the advocates of AA who has successfully implemented it into his projects, discusses the difference of the approach. He writes, "linear music…follows a singular path created by the composer, while non-linear or adaptive music chooses one of many potential paths. This does not mean that adaptive music is formless. Its form lies within the boundaries set for the music" (Whitmore 2003). The shortcoming of this approach is in the notion of "potential paths." In the compositional scheme outlined by Whitmore, a variety of in-game conditions are posited and short pieces ("music cells") are composed for each. These cells are then organized within a spreadsheet-like grid to create a map of possible musical permutations relative to potential game states. While the results of this compositional process produce interesting music, the focus is on a recombinant technological system. The composer is bound by the system map, which ultimately negates some possibilities and demands that others are fulfilled.

In the contemporary game world there are many tools available for working sound designers and musicians. These applications are called *middleware* because they are literally the middle step in the overall development process. In a typical game project, the first step in developing music would be considered the creation, or composition step. Music is written. Next it is either performed and recorded or sequenced in software such as ProTools or Logic, and then rendered into complete pieces or songs. The final step is audio programming, which involves writing lines of computer code that tell the game program which sound files to play and when. Middleware simplifies many of the tasks that connect these steps by allowing audio assets to be connected to game parameters. Musicians and sound designers use middleware to audition the game as if it were being played, and to hear how the various audio elements would sound in the context of the game world. The middleware application directly associates sound resources with in-game behaviors, and consolidates and stores these as computer code and resource files for an audio programmer to later integrate. Programmers can focus on optimization and efficiency, while musicians and sound designers can focus on developing sounds.

Currently there are several middleware packages available to musicians and sound designers:

- *Miles* by RAD Game Tools (The Miles Sound System 2010)
- *XAct* part of Microsoft's XNA game development tools (XACT Overview 2010)

- *FMod* by Firelight Technologies (FMod 2010)
- *Wwise* by Audiokinetic (Wwise 2010)

As part of this research, both *FMod* and *Wwise* were tested for possible integration into the *Londontown* project (see chapter 5). Both of these tools have features that allow the creation of "non-linear music" (FMod 2010) or "interactive music" (Wwise 2010). In short, this amounts to a song that is assembled in real-time, following a branching musical structure that is dictated by the events of the game. While this is not specifically Adaptive Audio as discussed earlier, it works similarly and has all of the same limitations. After a few minutes of investigation is was clear that this feature of the software would not be able to sustain the music planned for the project. However, the tools that were written for sound design tasks proved to be considerably more flexible. For instance, in *Wwise* there is a set of "Sound Playback Behaviors":

> Random—plays a series of objects in a random order to avoid repetition.
>
> Sequence—plays a series of sounds in a particular order using playlists.
>
> Switch—determines which sounds to play based on a series of options or alternatives that exist in the game.
>
> Blend—plays a series of sounds simultaneously. Sounds and containers can be grouped into blend tracks where sound properties are mapped to game parameters using RTPCs [real time parameter controls]. Cross-fades between sounds can also be applied based on the value of a game parameter (Wwise 2010).

These behaviors are all very similar to those of the generative instruments (see chapter 2) that were developed in the course of working on *Londontown* and the other projects involved in this research. This was an interesting discovery, but after some reflection, one that did not prove to be a great surprise. In games, sound effects need to be incredibly responsive. Answers to questions regarding whether a target was hit, how fast a vehicle is traveling, and so forth, can be answered by watching *and listening* to what is happening in the game world. And because these worlds are entirely digital, the sound must be created from the ground up by the software that controls the world itself. A collection of environmental ambiences, object, and event sounds (impacts, steps, etc.) can be made to play autonomously and in response to specific actions. Together these audio playback behaviors construct the overall sound of the game world. This approach is very similar to what happens with Amergent music, where collections of musically-oriented sound files are played according to various behaviors as a result of the events in a mediated environment. The specifics will be explored later, but what is most pertinent for the time being is the dominance of linear musical thinking in contemporary game projects and development tools. Music will always be experienced as a linear sonic progression across time, but that does not dictate that it should be created along those same lines.

1.1.2 Linear Musical Behaviors

In a critique of linear musical thinking, it is impossible to draw lines and make divisions within the enormous variety of media and art works in the landscape of contemporary technology. To say that the music of ALL computer games suffers from overly-linear approaches is untrue; it is equally untrue to make the equivalent statement for web site audio, user interfaces, installation and gallery art works, and so on. While much of this research led to examples and artistic approaches that were ultimately unproductive and musically off-base, there are excellent examples (as will be discussed later) that point in encouraging directions for future work in this field. Those pieces that are not viewed as part of a sustainable future for music in mediated environments all possess ingredients or behaviors that ultimately limit their potential for cultivating musical interest. These are the qualities, characteristics, and technical or artistic approaches that Amergent music seeks to undo in the music of mediated environments.

1.1.2.1 Looping Sounds

Melodic phrases, rhythmic patterns, or generic sonic passages that can be repeated to create an extended musical statement are known in the context of this field as *loops*. In music the use of loops can be traced back to Pierre Schaeffer and musique concrète, through Edgard Varèse, Karlheinz Stockhausen, and the Beatles (Pouncey 2002). Terry Riley, Brian Eno, and nearly all contemporary artists working in hip-hop and electronic music can be included in this group as well. With musical instruments and devices, one finds precedent for this in the Chamberlin and the Mellotron, two "…pre-digital 'sampler[s]'…" that produced sound by playing the audio information recorded onto short tape loops (Roads 1996; Yelton 2010). In computer software, loops are particularly advantageous for two primary reasons: they do not require as much memory as an entire song or piece of music and they have no set duration. A loop, once started playing, can continue endlessly. This is especially effective in computer games, interfaces, and other mediated environments in which the span of time one spends is unknown. A loop set on continuous repeat will insure that music plays throughout the time spent in such an environment.

Musical loops used in this way seem to engender a love-hate relationship. Music by Minimalist composers such as Philip Glass, Steve Reich, Terry Riley, and LaMonte Young uses extreme processes of repetition as an essential compositional device. It is also a feature in some works of Experimental music. According to Cornelius Cardew, there is a performance priority for uniformity, but ultimately "…the variation that is desired is that which results from the human (not superhuman) attempt at uniformity" (Nyman 1999: 17). An example of this human-imposed, inadvertent variation can be found in Brian Eno's account of performing *X For Henry Flynt* (1960) by LaMonte Young. The piece calls on the performer to repeat a heavy sound such as a dense chord cluster as loudly as possible, *X* (preferably very, very many) times (Nyman 1999). Eno writes that this process deceives the ear:

> …with each repetition it [the ear] pays less and less attention to all the common information and more and more the singularities. Thus one becomes crucially aware of the accidental addition or omission of a note to the chord cluster; differences in the amplitude of one chord to the next come to assume major proportions, and the ear begins to 'hallucinate.' (Eno 1978: 10)

Gavin Bryars and Christopher Hobbs report similar phenomena in playing *Vexations*, an 18+ hour piece by Erik Satie that consists of a 52-beat musical passage to be repeated very softly and slowly 840 times (Nyman 1999). In 1971 Hobbs and Bryars performed *Vexations* in shifts, taking time in-between turns at the piano to report feelings "like falling asleep while driving on the motorway" (Nyman 1999: 37; Toop 1995: 200). Lapses of concentration, judgement, and general fatigue are expected and introduce the inconsistencies and variations that make the experience of listening and performing this music unique. David Toop observes that:

> By composing a work which few humans would feel capable of undertaking, Satie gazed one hundred years ahead of himself to a time when music of all kinds could not be played by humans without assistance of machines. (1995: 200)

If the affects of repetition in the music of Satie, Young, and others constitute "love," Toop's conclusions reveal the source of "hate." Machines that run programs for computer games and web browsers for viewing Adobe Flash-based web sites are capable of precise repetition. Down to the sample level, they play a digital audio file identically over and over and over and… Often, this is to the detriment of the application to which it belongs or the musician or designer responsible for creating it. Contemporary computers are too precise, and digital audio loops often too "perfect" to stand up to this kind of treatment. It's not that the music is poorly written or produced, it's that it does not sound good when played in an extremely repetitious fashion. This concern translates to any medium in which music is part of mediated interaction, but is especially relevant to—and most often articulated by—those who

work with music and audio in computer games. Scott B. Morton writes:

> Not only have you eliminated the emotional effectiveness of the music by generalizing it and not applying it to a context, but by looping it over and over, you've completely detached the player from even registering it altogether. And what's worse, it usually becomes annoying after a time. Now we've moved down from 'why should we even have music playing here' to 'why shouldn't we turn off the music altogether and listen to MP3s?' Let's be honest. Why even hire a composer in the first place if the music isn't going to play a functional part in the gaming experience? (Collins 2008: 140)

In this statement, Morton addresses all of the important issues related to audio looping in mediated environments. In terms of "emotional effectiveness," if music is meant to convey something that enhances the visual components and interactions, a musical loop is unidimensional and can only support a narrow range of emotion. It is possible to use longer loops with a mixture of musical styles, but then synchronization becomes a problem. There is no guarantee that the correct style of music will be heard at the appropriate time, nor that it will match the duration of the events that happen in the game. Musical "annoyance" is primarily the result of digital precision, and avoidance by turning the sound off and playing something else as an alternative is a logical conclusion. Music can be "a functional part in the gaming experience" as Morton advocates if and when the behaviors that lead to unproductive and unpalatable repetition are overcome. Sound and music that are part of many other digitally mediated experiences can benefit from these considerations as well.

1.1.2.2 One Action One Sound

In the design of digital musical instruments David Wessel subscribes to what he calls the "…no action no sound principle" (2006: 96). This approach makes a laptop computer more like an acoustic musical instrument in that every sound must be produced through the direct control of the musician. However, this statement is deceivingly complex, because like an acoustic instrument, the same action never produces *exactly* the same sound. First, it is extremely difficult for a human performer, even with years of training, to execute identical gestures. There will always be minute variations in speed, pressure, and the other aspects of the movement(s) that contribute to producing a musical sound. If you add to that all of the environmental variables that can lead to subtle differences in the sound of an acoustic instrument, the range for sonic variation in any musical gesture becomes much more broad.

Wessel's digital instruments use "generative mapping algorithms" (2006: 93) to account for these kinds of variations. Part of the software that comprises the instrument has the ability to change and shift relationships over time so that an input action will not be mapped to an identical sonic output every time it occurs. In other kinds of software the opposite is true. A gesture or input action (or an entire range of actions) is often mapped to a single, identical sound output. An action, no matter how differently it is performed, produces the same sound every time it is executed. This kind of behavior is a departure from what we as humans have come to expect in the physical world. It is an unnatural acoustic phenomenon that draws attention to the act or process of mediation.

In the case of some software, this is helpful. Computer operating systems need to communicate messages such as, "the file was deleted," "you can't put that here," "the system is shutting down," and so on. Auditory icons (natural sounding aural representations), Earcons (conceptual aural representations), and Spearcons (vocal representations) are all different examples from the auditory display and sonification community that can serve to alert or inform the user about relevant changes in their computer system or software (Davison & Walker 2009). Depending on task and overall software design, a variety of sounds can be used to communicate these kinds of messages. Through the experience of this research it has become clear that consistent sounds are highly functional. When they are delivered in identical fashion every time, playback consistency strengthens their message. Just as the

repetitive precision of a melodic or rhythmic loop tires ones ears, so do these kinds of sounds. The main difference is that interface sounds are not looped back-to-back, but cued when an event occurs. A specific sound recalls a specific action and provides confirmation that a task is in progress or has been completed. However, in mediated environments where sound is used to construct an overall experience, this kind of functional consistency is detrimental. It calls attention to the processes of mediation and creates a greater awareness of the artificiality of the environment. Potential remedies can be simple and complex. Various forms of randomization, procedural sound design and generative algorithms as advocated by Wessel all work to increase the potential sonic variety produced through the use of a computer interface.

1.1.2.3 Melodies and Songs

Another linear musical behavior that is exposed most acutely in the realm of game audio is melody. It is rare for melody to be discussed as problematic. Often it is a *lack* of melody that is the focus of a critique, but as Kurt Harland reveals, the critique itself is often misguided. His article *Composing for Interactive Music* (2000) is now ten years old, and while the technical details are expectedly dated, his foundational argument rings true. Harland refers to "conceptual problems of interactive game scores," where listener expectations of "good" music do not necessarily match the sounds and structures best suited to these kinds of works (2000). He observes that the vast majority of this music is composed to match the western musical traditions of a fixed, narrative form that leads listeners on an ideal musical journey. The linearity embedded in this approach presents a distinct disadvantage because "…most of the things that one can do to a track to make it interactive are the things that take it a step away from being a well arranged song" (Harland 2000) The music congruent to an interactive, mediated environment is not necessarily the kind of music that sounds best when separated from such an environment. However, practice within the game industry will often dictate that the music be evaluated separately. As a result, it can be discarded in favor of music that "sounds better," but is less appropriate in the emergent dynamics and overall environment of the game.

Melodies that create musical identity to make a tune memorable, even sing-able contribute to this problem. Arrangements that build tension or create surprise are also unsuccessful simply because they operate independently. The most well-crafted melody or clever song arrangement will sound out of place if its dramatic or emotional contours do not fall in line with the events that are happening in the game world or any other mediated environment. It is not to say that the music will have no impact. The audio-visual bond that is formed between sound and images is profoundly strong. Michel Chion's "simultaneous vertical relationship" and the "Forced Marriage exercise" (see chapter 4) reveal it to be multifaceted and nearly unbreakable. The most pertinent question concerns the nature of the bond—primarily, how it will form. If what is heard and what is seen are incongruous, the connection between these elements will be awkward or confusing, the processes of mediation will be exposed, and the overall experience will be ultimately unfulfilling.

1.1.3 Why Games

The efforts behind this research sought to explore the ways in which music could be employed in mediated environments so as to complement their unique dynamics. The outcome was to coin the term *Amergent music* which characterizes a new approach to musical thinking and production for all kinds of projects that involve digitally mediated interaction. Computer games are just one of many genres that could be discussed and mined for examples—so why such an emphasis on games in this research? In spite of their often infantile content, the technical research and aesthetic concerns of computer game audio most aptly and robustly address the role of music and sound in mediated environments.

The community concerned with sonification and auditory display deals primarily with issues surrounding aural usability. There are many productive discussions but the focus frequently drifts away

from the primary concerns of this research project. In the field of music, conversations are almost entirely aurally-focused and any discussion of interaction typically revolves around issues of performance. Artistic and musical concerns that expose the similarities of composition and instrument relate crucially to this research and will be discussed in chapter 3. Digital art, a-life art, generative art are all related but very inclusive. With a few exceptions to be noted later in this chapter, discussions in these fields that deal with sound and music are relevant, instructive, but ultimately not thorough enough to go beyond the surface of the questions of audio raised here. Other areas that would at first seem to have no connection whatsoever have often proven to be the most enlightening. Biology, urban planning, cognitive science, and process philosophy have all proven to be as useful (if not more so) than "obvious" fields like art and music. But games, particularly game audio, has always been there to offer examples of what *not* to do and to provide a general framework with all of the most prescient concerns. Ultimately an investigation of game audio has led to many productive conclusions that help in the development of game and non-game projects alike.

1.2 Computer as Processor

In her book, *Hamlet on the Holodeck* (1997), Janet Murray discusses the bardic tradition in relation to storytelling and narrative in cyberspace. Oral storytelling was based on various devices such as redundancy and cliché which made it easier for the bards to memorize and recall their stories (Murray). However, these language patterns only served as signposts. They would help construct a tale *in general*, with the specifics left to the storyteller to decide in the moment. This created a situation that was ripe for narrative variation. From telling to telling, a story would have a uniformity and overall general consistency, but with room to vary the details so that each version was unique. Murray sees this as a model for storytelling in mediated environments:

> What the computer would provide would be a means for using formulaic patterning, in much the same way the oral bards did, as a system for assembling multiform plots. The electronic system might be able to generate more variants than the author could ever read in a lifetime (let along write individually), but since she would have specified all the important details and all the rules of variation, the computer would be merely the instrument of the author, an extension of her memory and narrating voice. (1997: 212)

Murray, writing in the early days of the world wide web, expresses frustration with current narrative trends in hypermedia, CD-ROMs, and MUDs. She sees opportunity for rich and varied stories that leverage the processing capabilities of the computer. By encoding creative writing processes into machine-executable systems, a digital bard has the potential to spin tales with unprecedented novelty and variation. Such an approach is not a panacea. The process and results of my research revealed inherent challenges and limitations in the ideas conveyed by Murray. These will be discussed in the context of musical works employing similar ideas, or music meant to function in support of such narratives. However, the potential for the computer to process information and assets in the realtime construction of new art works and mediated experiences remains a powerful and emerging trend in the contemporary landscape of art and media.

1.2.1 Processing Mediated Reality

Chris Crawford has also written on the artistic potential of creative and technical synergy. In *The Art of Computer Game Design* (1982) he discusses six precepts to help game designers perfect their art by understanding the strengths and weaknesses of their medium. Crawford asserts that computers are far more useful for processing information than for simply storing it. Consequently, his fifth precept is "store less and process more" (43). Computer games derive much of their artistic merit from responsiveness and interactivity, and information processing is essential in facilitating these behaviors.

Because computers are natural number-crunchers, game programs can be written to exploit this fun-

damental strength, which makes computer games different from the kinds of games that preceded them. The computer can be told to respond to a choice made by the player and offer a new set of choices. As those choices multiply and begin to represent consequences from myriad prior interactions, the player is confronted with a spectrum of possibilities, each with its own unique outcome and potential for further exploration. This kind of interactivity is only sustainable through processing. A computer program that is limited to re-presentation of canned assets will be, by comparison, very limited in its output.

Crawford's observations and lessons should not be limited to game design. Generative and other forms of computer music, artificial life (a-life) systems and a-life art all belong to the landscape of this research project because they leverage a computer's processing capabilities. Much (if not all) of the digital technology used by contemporary artists and musicians has the ability to process and facilitate interaction between computer systems, individuals, and entire networks of online participants. Once processing has enabled robust interaction, emergence comes to characterize the overall behavior of the system.

Some of the best examples of "processing over storage" can be found in the work of Will Wright, designer of the popular games *SimCity* (1989), *The Sims* (2000), and most recently *Spore* (2008) (Maxis 2010; Maxis Top Games n.d.). Wright has stated that he thinks of his projects as software toys. In a 2007 talk at the TED conference, he expressed his fascination as a young Montessori student learning through toys and coming to understand the world through discovery and play (TED Conferences 2007). He recalls that the Montessori toys included possibilities for failure, which enriched the scope of learning through trial and error. With his "toys," Wright wants to encourage children and other players to explore and discover principles of the world on their own terms.

One way this is done is through computer-driven simulations. In a game like *SimCity* various characteristics of an urban environment can be captured in time as statistics, or modulated through time as trends and dynamics. Crime, population, pollution, traffic, and so on all relate to each other, and the relationships change over the passage of time. To mobilize such a system for a simulation toy, Wright and his team use computer algorithms to model naturally-occurring urban dynamics:

> It's more like we're building algorithms and playing with those algorithms a lot until we get something that looks reasonable.…But, for the most part, we're basically exploring an emergent system. And because it's emergent, by its very nature, you can't sit there and engineer it top-down. What we have to do is we have to sit there and kind of play with a wide variety of algorithms and structures. Turn them on. Observe the behavior. Then when it doesn't quite do what we want, we go back to the drawing board. (Cagle 2009)

These dynamic systems "simmer" beneath the surface of the simulated world, controlling various aspects that bring it to life. When a player engages in the simulation, choices they make are later effected by a complex network of circumstances rather than a database of pre-configured outcomes. The ensuing experience does not match the precise dynamics of the physical world, but has many of the same fissures and developments that characterize a non-mediated reality. Wright states that one benefit of such a toy is to help people engage in long-term thinking (TED Conferences 2007). It is difficult to forecast the outcome of today's choices 50-100+ years in the future, but with simulation toys to generate possible scenarios, one gets a glimpse of what *could* happen as a result of a few seemingly harmless decisions. Processing affords a view of possible futures and, as an essential ingredient of this research, leads to the generation of possible music.

1.2.2 Procedural Audio & Sound Design

Procedural techniques are not only useful when running "behind the scenes," but also for creating the more "tangible" or immediately discernible elements of a mediated reality. In Wright's evolution-

based toy *Spore*, creatures are textured and animated through procedural techniques (TED Conferences 2007) allowing players to experiment with evolutionary advantages by picking and choosing options rather than building something in every last detail from the ground up. Procedural techniques are also used in many other areas of game design to create environments (Ebert et al. 2002), control character AI (Wardrip-Fruin & Harrigan 2004), facilitate level design (Compton & Mateas 2006), and serve in a variety of other tasks. These techniques are most useful in situations that have limited computer memory, an excess of required content, a need for variation within a set or class of assets, and when assets are required to change frequently (Fournel 2010). These circumstances characterize—in one way or another—nearly every project discussed here. Most relevant to the research of this thesis is the use of procedural techniques to create sound.

In many contemporary works of art and media, sound assets are incorporated as pre-recorded digital files. These are fixed in their final form, and while some variation and modification can be applied as these files play in the context of the work, there is a limited range in which to maintain acceptable fidelity. Procedural audio seeks to overcome this limitation. Sound is approached as a process to be executed rather than data to be read, which means that any sound is possible, with greater flexibility and fewer limitations when compared to traditional techniques involving recording (Farnell 2008). A procedural sound designer thinks about a sound as a system or production, or in the words of Lonce Wyse, a "generative sound model" (Wyse 2005: 370). He notes that such a system is "…an algorithm for synthesizing a class of sounds under parameterized control…" and that "…they can function as [a] description of the sounds they generate" (Wyse 2005: 370). In contemporary practice many computer games use procedurally generated content, but early games did as well—especially when it came to audio. For instance, Texas Instruments SN76489, the sound chip in ColecoVision (1982) and Sega Genesis (1989) game systems had 3 square oscillators and a white noise generator. Additionally the MOS Technology SID (Sound Interface Device) of the Commodore 64 (1982) had 3 oscillators with 4 waveforms, a filter, 3 ADSR envelopes, 3 ring modulators, and more (Fournel 2010). These tiny synthesizers were controlled by the game program. The music and sound effects these created were rudimentary by contemporary standards, but they were nonetheless procedural and created in real time as a response to the events of the game.

A few early projects from my research experimented with procedural audio. The focus emphasized music over sound design, but the basic concepts discussed in these examples remained true. The creative impetus followed the line of thinking that:

- mediated environments are a profound source of emergent dynamics
- similar dynamics are also found in a-life systems
- all of these dynamics can be tracked numerically in real time

I then asked: if the data stream produced through the dynamics of an a-life system is connected to a synthesizer, what sort of music might be produced and what would it reflect of the environment to which it belongs? For more on the projects (*A(rt)Life 1.0*, *A(rt)Life 2.0*, and *A(rt)Life 2.5*) see chapter 2. Ultimately I believe that procedural techniques for sound creation and synthesis have an incredibly promising potential for the future. In the context of my research, the amount of work involved to implement these techniques was simply too much. In addition to exploring questions of music, interaction, emergence, and becoming in mediated environments, I would have had the additional task of designing a battery of custom synthesizers and samplers. Nicolas Fournel cited similar reservations in his talk on procedural audio at the 2010 Game Developer's Conference. While it is tremendously powerful and flexible in a variety of real time applications, he noted that it is not an across-the-board solution, it is still more difficult to implement than pre-recorded audio assets, and that additional training, tools, and ready-to-use models are still needed before it becomes a sustainable option (Fournel 2010). While he is likely to agree that there are currently some drawbacks, Andy Farnell summa-

rizes a hopeful future:

> Procedural sound is a living sound effect that can run as computer code and be changed in real time according to unpredictable events. The advantage of this for video games is enormous, though it has equally exciting applications for animations and other modern media. (Farnell 2008)

The outcome of the research that went into producing this thesis concurs with Farnell's statement. Though media devices are growing smaller and on-board storage larger, and ubiquitous Internet access makes additional assets available as never before, the ability to create the components of a work as it is experienced leaves artists in a position of unprecedented flexibility and their audience in a position to have experiences that are rich and novel, time and time again.

1.2.3 Procedural Music

The research and musical works that produced this thesis finds much resonance with process philosophy. Henri Bergson wrote that reality is never made but in a continuous process of making and unmaking (Bergson 1998). This idea applies equally to organic and mediated reality alike. But whereas the impetus that comprises the flow of becoming in our physical world is still definitively unknown, the processing of algorithms and their transformations to the raw materials of sound, image, text, and so on provide tangible evidence of the "stuff" that comprises mediated reality.

The specific focus of this research is music, which makes up one part of that reality. Scored or "narrative" music—as has already been discussed—is indifferent to this becoming. It is fixed along a linear path and unable to transform in ways that are congruent with mediated reality. Procedural techniques like those used for sound design, visual asset generation, urban dynamics, and so forth can also be effectively employed to musical ends. In the way that the parameters of a simulated city can construct dynamic traffic and weather patterns, they can similarly be used to produce music. And, in the way that these parameters both create and respond to the reality of the mediated world, music created through this same approach will be similarly bonded to this world and the interactions that happen within it.

Specific cases and various forms of procedural music will be discussed throughout this thesis in a variety of contexts. In particular, *Generative music* is discussed at length. Brian Eno, who coined the term, compares this musical approach to making a seed, while the composition of a symphony is like engineering an entire forest (Toop 2001). The musical work is not determined at the outset; rather it is allowed to unfold on its own accord in different ways at different times. Generative music has been used in computer games such as *Creatures* (1996), *Spore* (2008), and others to be discussed later in this chapter. While generative techniques signal a much-needed departure from the linearity heard in other forms of game music, they have thus far not been used to their full potential. Generative music that is not substantially connected to interaction and events within the game world represents a sort of sympathetic reality—one that has an independent rather than integrated becoming. It runs in parallel, but is not meaningfully connected to the other aspects that comprise the mediated experience. Scored, narrative and sympathetic generative approaches produce a similar or nearly identical affect: a disconnect between the mediated reality one makes/unmakes with the mediating system and the mediated reality of an autonomous musical composition or soundscape that plays with little to no regard of the environment to which it belongs. Through a closer examination of other contemporary game, art, and media projects, the nuances of this position will become clearer, as will the advantages of Amergent music as a means of creating music that comprises part of a mediated reality.

1.3 Relevant Works of Music, Games & Technoetic Art

The projects and art works listed here do not comprise an exhaustive list. These are, rather, pieces

that are historically, technically, or conceptually relevant to Amergent music and the research that produced this thesis. As a methodological component of this research, the author has played the games, listened to the examples, and watched the videos for every project in this section. Though projects done in the past often only have sparse online documentation, every attempt was made to see and hear these, and to reach an understanding of the advantages and disadvantages of the musical techniques employed in each.

Ballblazer (1984) was a futuristic, one-on-one soccer game originally developed for the Atari 800 and 5200 game systems (AtariAge 2010). Players could match up against the computer or their friends while attempting to move "…a floating ball called a Plasmorb…" towards the opponent's goal (Fox 2010). Peter Langston, who single-handedly started game development in 1982 within the Computer Division of Lucasfilm Ltd. (now LucasArts), was responsible for the music of *Ballblazer*. According to Langston:

> Among our innovations in game design is an increased focus on sound and music. One example is the music score for BALLBLAZER which not only responds to game-play and provides vital status cues, but is also constantly improvised by an algorithmic composition scheme. This use of music that never repeats itself, responds to game-play, and carries information is a first in the industry (and even now is only challenged by Microsoft on the hugely more-powerful Xbox). (2005)

The music of *Ballblazer* was algorithmically generated using an approach Langston called "riffology" (Langston 1989). Langston writes that this technique plays a continuously varying melody over a rhythmic and harmonic accompaniment (see figure 1.1). The accompaniment is also generated in real time, but with variation heard within larger increments of time. Langston's evaluation of this technique is that it passes the "is it music?" test by constituting an acceptable background audio accompaniment, but that its inability to have more structural variation cause it to fail the "is it interesting music?" test (Langston 1986). Regardless of this critique, the algorithmic music of *Ballblazer* is one of the earliest known examples of procedural music in computer games.

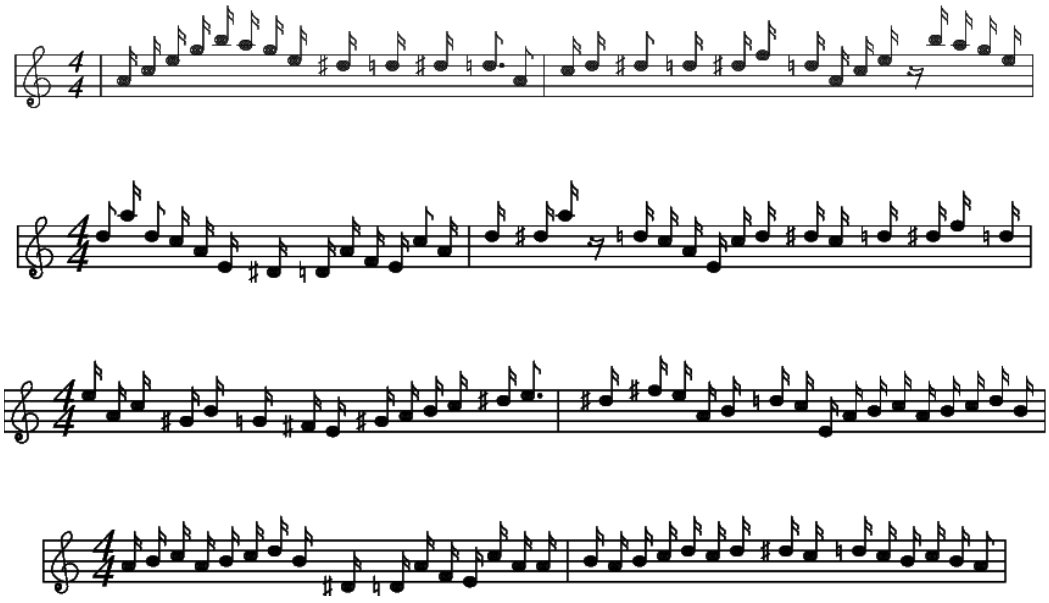

Figure 1.1: A reproduction of "Figure II - Riffology from 'Song of the Grid'" by Peter Langston (Langston 1986: 5).

Creatures (1996; see figure 1.2) by Steve Grand was created to be a synthetic environment for virtual pets (Grand, Cliff & Malhotra 2004). Each creature is an autonomous agent with the ability to move, metabolize, reproduce, play, eat, and generally thrive in its digital environment. Peter Chilvers has been working with Generative music since his involvement with *Creatures*. In writing about his music

for *Creatures*, he discusses opting for a generative compositional approach. Each piece of music in *Creatures* is tied to a set of "players" in a sort of virtual band. A player has its own set of instructions that will respond, for example, to the emotional state(s) of the character(s) on screen or to any threats present in a character's environment. Chilvers notes that his music builds the mood and atmosphere, and that it compensates "…for the lack of information to other senses such as smell and touch. It can also impart information about thoughts and characters that is not otherwise evident" (*The Music Behind Creatures* 2004).

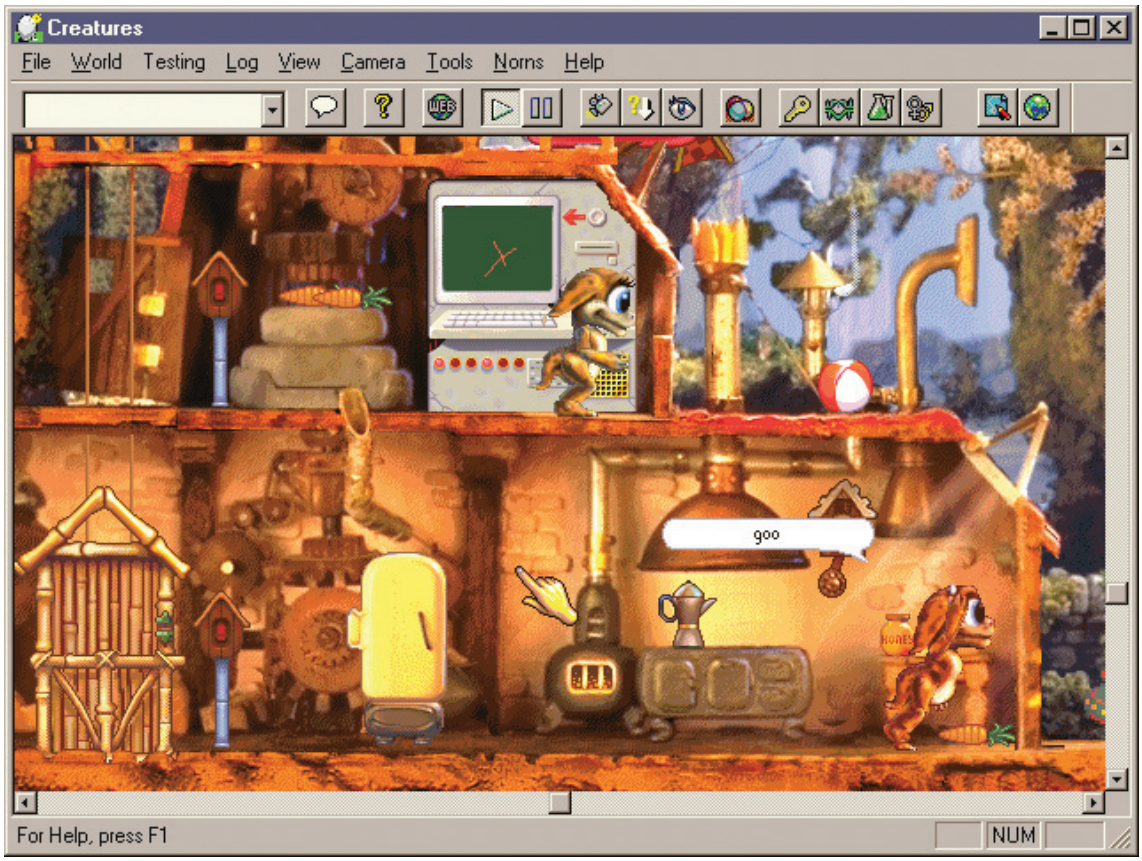

Figure 1.2: A screenshot of *Creatures* from "Creatures: Artificial Life Autonomous Software Agents for Home Entertainment" by Stephen Grand, Dave Cliff, and Anil Malhotra from their talk at Agents '97, Marina Del Ray, California (Grand, Cliff & Malhotra 2004).

Intelligent Street (2003) was a telematic sound installation where users could compose their sound environment through SMS messages sent via mobile phone (Lörstad, d'Inverno & Eacott 2004). The piece was developed in 2003 by Henrik Lörstad, Mark d'Inverno, and John Eacott, with help from the Ambigence Group. *Intelligent Street* was situated simultaneously at the University of Westminster, London and the Interactive Institute, Piteå, Sweden via live video connection. Users at either end of the connection were able to see and hear the results of their interactions. Using freely-associated, non-musical terms such as 'air' or 'mellow', participants sent an SMS message to *Intelligent Street*, and were able to hear how their contribution impacted the overall composition (Lörstad, d'Inverno & Eacott 2004). Simultaneously, all received messages were superimposed over the video feed to create a graphic representation of the audible sounds at any given time. *Intelligent Street* showed how music could be used to set the mood of a physical space through processes of cooperation and composition across groups of people in distributed environments (Jo-Anne Green, Riel & Thorington 2004).

Further information about *Intelligent Street* is available at John Eacott's web site (Eacott 2008), and the Interactive Institute of Sweden (The Interactive Institute n.d.). This project was one of the pieces investigated before beginning work on *Sound Garden* (2007). As a work that included generative processes and algorithms, as well as real time interaction both through physical presence and telematic

connectivity, *Intelligent Street* was very helpful in my preparations for my own piece.

Eden (2000) by Jon McCormack (see figure 1.3), is described as an "interactive, self-generating, artificial ecosystem" (McCormack 2000). In more general terms, it is a generative installation artwork of sound, light and animation, driven by artificial life systems and environmental sensors (McCormack 2002). *Eden* situates visitors in a room, standing outside the virtual ecosystem that is represented by a projected, cellular lattice in the room's center. A visitor's presence in the room can favorably impact the ecosystem. Someone standing in a particular location either makes the adjacent space within the work more inviting, or provides opportunities for the creatures, known as "sonic agents," that inhabit *Eden*. The lives of these creatures involve eating, mating, fighting, moving about the environment, and—central to the musical character of the piece—singing. In various ways, all of these activities lead to both the visual and aural events that comprise the work.

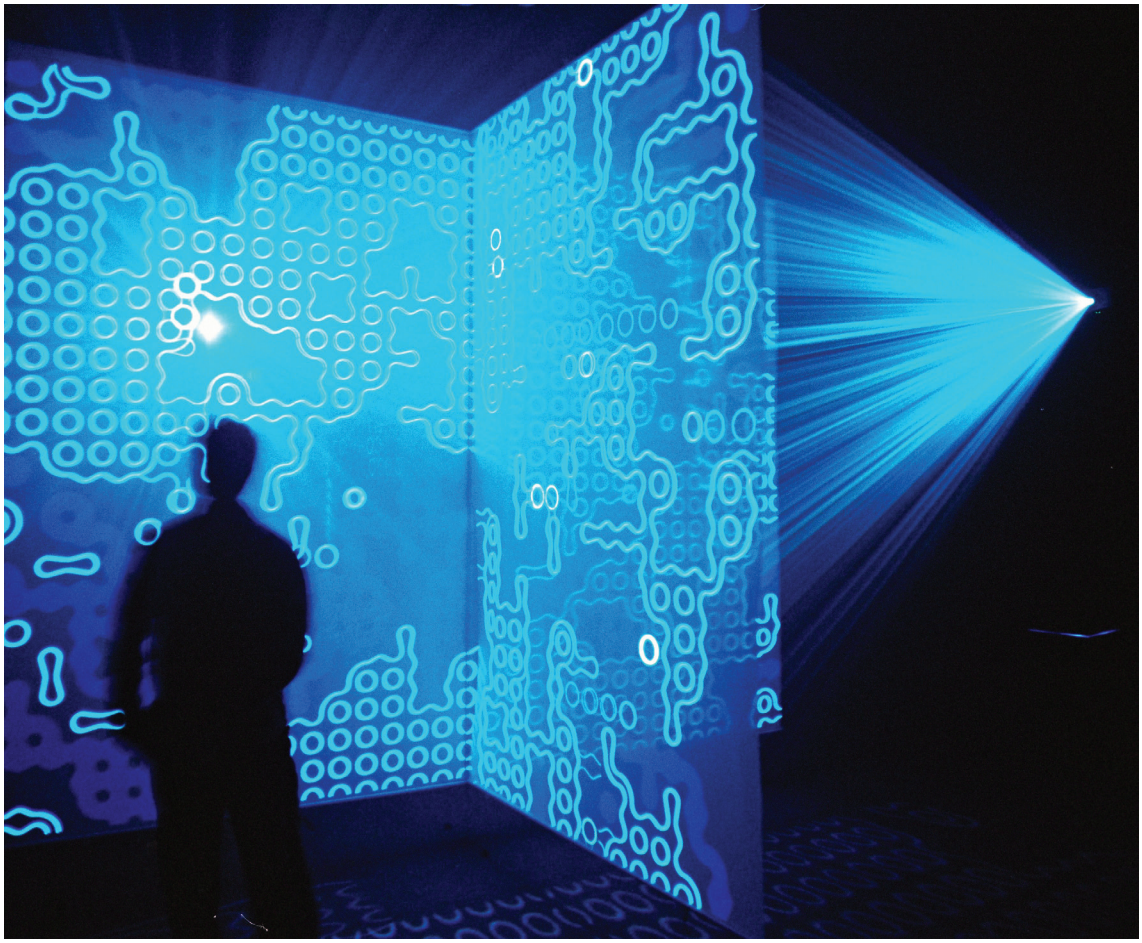

Figure 1.3: In exhibition, the *Eden* environment is projected onto two large, translucent screens arranged to form an 'X'. The audio speakers and environmental sensors required for the work are not pictured here.

The use or leverage of emergent dynamics in *Eden* was incredibly encouraging to this research. Unlike other art works in which the self-organization of a synthetic organism or ecosystem was used to generate material that would later comprise the final work, McCormack allows the behavior of his agents to generate the entirety of the experience. More information about *Eden* and McCormack's publications are available at his web site *(McCormack 2000)*.

Electroplankton (figure 1.4) was created for the Nintendo DS game system by Toshio Iwai. It was initially released in Japan in 2005, and later in Europe and North America in 2006. Iwai writes that the idea draws on his fascination with different objects across the course of his life—a microscope, a tape recorder, a synthesizer, and the Nintendo Entertainment System (NES) (Nintendo of America

2006). Some consider it a game; others a musical toy. Either way, *Electroplankton* captivates player and audience alike with its engaging use of sound and animation controlled via the touch-sensitive screen of the Nintendo DS device. Using a stylus, players are able to draw, twirl, tap, and sweep an array of animated plankton characters on the screen. There are ten different plankton "species," each with its own sounds and sound-producing characteristics. Plankton and their behavior are linked to a pitched sound or a short recording made by the player using the device's built-in microphone. Manipulating an individual plankton (or its environment) initiates a change in the sound(s) associated with it—a different pitch, timbre, rhythm, phrase length, and so on. As multiple plankton are manipulated, a shift in the overall sonic output of the system is apparent, causing the music of *Electroplankton* to produce an enormous variety of musical textures and gestures.

Figure 1.4: Using the stylus to perturb the Hanenbow species of Toshio Iwai's *Electroplankton*.

Interactions with the plankton turn the Nintendo DS into an instrument that can be played purposely through the manipulation of the onscreen animations. Simultaneously, the software programming that links sounds to the plankton and their environment represents a musical ordering, or composition, that is implicit in *Electroplankton*. The coupling of these attributes perfectly illustrates how the combination or blurring of composition and instrument (to be explored later) can lead to an interactive work with profound musical potential.

Spore (2008) was designed by Will Wright and features generative music developed by Brian Eno and Peter Chilvers. This software toy (to use Wright's term) allows players to model the evolution of a civilization from its microscopic beginnings in a primordial soup through tribal, civilization, and space exploration phases. Generative music is a perfect complement to an environment such as this because it has the ability to adapt, change, and evolve, much like the creatures themselves.

Spore Audio Director Kent Jolly and contracted audio programmer Aaron McLeran spoke at the 2008 Game Developer's Conference about their involvement in the technical development of the project. They used the terms "procedural music" rather than generative music, and "game" rather than software toy as they described in detail many of the systems they designed and their reasons for using this

unique approach. Procedural music was used throughout the entire game, but its connection with player interaction was not always uniform. Because the overall focus of the game is on making customized content—creatures, dwellings, and vehicles, for example—the editing tools that allow players to create these things had a more substantial connection to the music than other sections of the game (McLaren 2008). For instance, in the creature creation tool (see figure 1.5) players can design a creature with features that make them better suited to either aggressive or social behavior. As body parts such as claws and sharp beaks are added to an attack-oriented creature, the music shifts to take on a darker character (McLaren 2008).

Figure 1.5: The creature editor in *Spore*.

In an effort to develop music that specifically supported the creativity of the game, McLaren (2008) said that they followed four rules:

- the music should not be distracting
- there should be no looping or repetition
- the music should be playful
- music should respond to the player in ways that make sense in the immediate context

Jolly, McLeran, and the audio team at Electronic Arts were responsible for the overall system design and software development of the project. This included developing a customized version of the graphic programming environment Pure Data (Pd), called EAPd (Kosak 2008). As a programming environment, EAPd worked much like many of the audio middleware tools discussed earlier in this chapter, but with far greater flexibility for coding and listening to procedural music. Eno is credited with the "Spore Compositions" and "Generative Music Design," while Chilvers is listed as a "Generative Music Consultant" (Wright 2008). Jolly described Eno's role as "inspiring," and that in addition to making great sounds for the game he was instrumental in getting everyone behind the idea of using

procedural music in the game, and that he helped direct the music overall (McLaren 2008). The computing power allotted to music was not sufficient for the *Spore* audio team to do everything they had hoped to. Nevertheless, in the end the project is an impressive feat and demonstrates how procedural and generative music can be effectively integrated into digital worlds with constant levels of change, and can deliver an organic mix of music to support them.

Bloom (2008), ***Trope*** (2009), and ***Air*** (2009) are all applications for the Apple iPhone and iPod Touch produced by Brian Eno's company, Opal, Ltd. (see figure 1.6). Though they are all different in their particulars, they are all works of Generative music that can play autonomously, be played through input on the touch sensitive screen of these devices, or a combination of both. These applications reveal a hopeful future for Generative music. In the past, this music was typically bound to another work, such as the music within *Spore* or *Creatures*. Similarly, when Brian Eno released the first Generative "album," *Generative I* (1996) it was distributed as software with very specific requirements:

> Windows PC and Creative Labs AWE64 /AWE32 / SB32 Soundcard (100% compatible) or SBLive! + LiveWire 2 / Audigy soundcard (90% compatible with standard SBLive! GM Soundfont bank, or 100% compatible with additional AWE GM SoundFont Bank). Without the right soundcard this title will *not sound as intended***.** (Eno & SSEYO 2006, author's emphasis)

Without this specific software and hardware configuration, the samples and sounds heard in the music would not be those originally planned, hence the "…not sound as intended" warning. While this deliberate kind of control seems inconsistent with the experimental nature of Generative music, the reality in 1996 was that any other sound sources would be so different as to constitute a new work altogether rather than some radical version of *Generative I*. *Bloom*, *Trope*, and *Air* all represent a positive step forward because every element required to make the music is included in the application. Getting this music for your device requires no additional expertise or technical hoop-jumping. Listeners simply download, sync to their device, and play.

Figure 1.6: *Bloom* (left), *Trope* (center), and *Air* (right).

Bloom by Brian Eno and Peter Chilvers is the result of leftover ideas that were never incorporated into *Spore*. Eno relayed via e-mail (10 February 2008) that he thought of this arrangement like a painting:

> My picture was of a field composed like a traditional Chinese painting: Sky at the top, then mountains and forests, then people in distant fields working, then some closer details, then a stream and earth at the bottom. And then I imagined the piece being a day within such a

> landscape, so that it was time sensitive: for example, as dusk fell a new set of nodes - night insects, if you like, or shooting stars, would become active. And various 'daytime' ones would fall quiet: sounds of people working, for example.

Musically speaking there is a background drone track that sets a mood, and a foreground track that plays sounds complementary to the drone. When *Bloom* is set to play in "Listen" mode, the foreground sounds play autonomously; when it is in "Create" mode, listeners can touch the screen to add foreground sounds, each of which is accompanied by a colored dot that expands and contracts with the envelope of the sound. Frequent interactions lead to dense sonic clusters while less busy fingers make subtle melodies. It is also possible to change moods (deliberately or randomly) which transposes the drone track to a new key and changes the overall character of the listening experience.

Trope, also by Eno and Chilvers, is similar to *Bloom* with some modifications and extensions. Eno describes the musical experience of *Trope* as "…a different emotional experience from Bloom - more introspective, more atmospheric" (Opal Ltd. 2009b). The overall arrangement is the same with a background ambience, but it is less of a drone and more of a slowly unfolding, generative melody. The foreground sounds can be heard with or without listener intervention via "Listen" and "Create" modes. As opposed to the clear, droplet-like tones of *Bloom*, *Trope*'s foreground sounds are more like that of a tambura—a soft, textural pad with a complementary visual analog that appears like airplane contrails traced by fingers on the screen.

Air by Sandra O'Neill and Peter Chilvers is based on many of the concepts used by Brian Eno in his first Ambient record, *Music for Airports* (1978). And like *Airports*, it features female voice and piano, with long reverberations that Chilvers says were inspired by the 900-year-old Ely Cathedral near his home *(Opal Ltd. 2009a)*. *Air* will play autonomously, respond to interaction, and has the ability to be spread across up to eight devices, turning each into a "performer" in a small choir.

Concerning *Bloom*, Eno says, "You can play it, and you can watch it play itself" *(Opal Ltd. 2008)*. This statement, which is equally true of *Trope* and *Air*, resonates with some of the more important conclusions of this research. The terms *composition*—a musical work that plays, and *instrument*—a device used to make music, become less clear in contemporary musical works that afford both listening and performance experiences via interaction. These ideas will be explored in greater depth throughout this thesis.

RjDj (2009) is a platform for reactive music that runs on the Apple iPhone, iPod Touch, and iPad (Reality Jockey Ltd. 2010c). RjDj uses physical and sonic input from these devices to make music that is directly the result of one's actions and acoustic environment. Pieces, or "scenes" for RjDj are written in Pure Data, a graphical programming environment for real-time sound, video, and graphics processing. In addition, software called RJC1000 (produced by Reality Jockey Ltd., the designers of RjDj) provides a graphical user interface for artists who want to make work for the RjDj platform but do not want to get involved with Pure Data (Reality Jockey Ltd. 2010b). RjDj does not behave exactly like other standalone iPhone apps. It acts as a host for individual scenes, so to experience music in RjDj, it's necessary to launch the RjDj application and load a specific scene. Collections of RjDj scenes are called an album.

While working on the prototype for *Dérive Entre Mille Sons*, I spent some time looking into this platform. The RjDj album *Shake* included two scenes by artists Matt Robertson and Mike Reed, aka Moodbungalow (Robertson & Reed 2010), called *Meno* and *Satseauxmann*. Both of these involve tilting interaction, revealing RjDj as capable of realizing the interaction mechanism for *Dérive Entre Mille Sons*. While the RjDj platform supported all of the proposed functionality for the project and provided a straightforward means of production, its attachment to the genre "reactive music" poses a troubling limitation as it concerns this research. With Pure Data at its core, RjDj is completely ca-

pable of allowing listeners to enter into a more sophisticated relationship with sound. *Reactive* is but one of several means of characterizing such an experience. If this research has revealed anything it is the potential to forge a meaningful and ongoing dialogue between a listener, a musical system, and the overall environment created by the music (and art) work through the kinds of interaction afforded by a device like the iPhone. Such a relationship involves more than the ability to react to input, and RjDj as a platform is capable of more if the discourse around it can become more robust. Statements such as, "RjDj is a music network where music is produced, distributed and listened to in a whole new format: S O F T W A R E" (Reality Jockey Ltd. 2010a) are encouraging, but not the entirety of a future musical experience.

AGATE (2010) is an acronym of Adaptive, Generative Audio Tonal Environment developed by Kurt Larson (cited earlier in this chapter as *Kurt Harland*) with the help of composer Jim Hedges and programmer Christopher Mayer (Larson 2010). At the 2010 Game Developer's Conference (GDC) Larson and his colleagues were not able to disclose the specifics that launched the project other than it was to be part of a Massively Multiplayer Online virtual world (MMO) that was abandoned during development. Unlike the "cinematic" and tightly composed music heard in other MMOs, AGATE was designed to create loosely-structured music with a static mood that could be responsive to changes in the game world. Larson noted that such events provoking musical changes would include combat (fighting or not fighting), time of day, weather, and location; and that the music would be modulated in terms of its density, pitch, tempo, and sound selection (Larson 2010).

During their talk at the 2010 GDC, Hedges explained some of the aspects of this system that make it different from other forms of adaptive music (discussed earlier in this chapter as adaptive audio) that are more commonly used in the game industry. These differences can be loosely characterized as granularity and randomization. AGATE uses pre-recorded assets but does not combine them in the prescriptive, branching fashion usually found in adaptive music. Sound assets are shorter overall and can be combined or sequenced with greater variety than extended musical gestures or phrases. In addition they are weighted with different probabilities and randomized to provide varying degrees of organic structure (Larson 2010). In its final implementation the AGATE system used the middleware tool FMod. Hedges also noted that the sound design features of the tool were the only ones required, which is consistent with the conclusions of the research of this thesis for the *Londontown* project (coincidently, also an MMO). In virtual worlds and other mediated environments, linear music cannot adapt and respond to the dynamics generated within the world. Myriad interactions create an experience that is distinguished by novelty and change. The music that comprises an important part of these worlds must have the capability to be congruent with this emergence.

Conclusion

> Thus it is a misconception to suppose that process philosophy, siding with becoming, rejects being. Rather, it is a doctrine of being in becoming, permanence in the novel; by contrast, philosophies of being are doctrines of becoming in being, novelty in the permanent. (Browning 1965: xix)

These thoughts on philosophies of process and philosophies of being resonate with the comparisons between bottom-up versus top-down methodologies. Is reality in a constant state of creative flux, spinning forth through myriad interactions of tiny autonomous systems and processes? Or is it an elaborate and meticulously engineered construct, existing "out there?" This research favors the former, especially when one is at the intersection of metaphysics and technoetic arts. To create a mediated reality is to create an alternate consciousness—a new reality for those who engage in the art work.

This research is focused on music that creates and/or contributes to the creation of mediated reality. Linear music—songs, scores, and other narrative forms—are indifferent to this becoming. They are

fixed along a path and unable to transform to be congruous with the becoming of mediated reality. Many of the obstacles that have hampered the development of music in these environments are due to an inability or unwillingness to let go of forms from music of the past. It is not so much a question of sound (though sound certainly matters) but of behavior. Sound and music that is unable to behave in ways that complement the dynamics of becoming cannot create a shift of consciousness, but is instead exposed as mere accompaniment or in the worst cases, artifice.

Unvaried looping, teleologic sound mapping, and a general unawareness of the relationship between audio and visual elements diminish the ability of technoetic art works to re-shape consciousness. In digital entertainment and communications media, connections between audience and mediated environment are similarly weakened. Computers that give rise to and sustain these kinds of works are often valued more for their hard drive than their CPU. Storing media assets is essential to these works, but controlling and shaping them in real time is even more necessary. Through processing and the transformation of stored assets, a mediated reality can be brought into being through processes that leverage emergence and becoming. Reality is not made and re-played, but created anew every time it is experienced. This is not simply clever design but the result of the unique circumstances that come to define this reality as a user, player, or poiesist makes it.

Procedural techniques that use algorithms to produce or transform digital assets are a crucial step in this creative process. As it concerns the specifics of this research, procedural techniques for sound and music are especially relevant. The instructions that produce and transform the sounds of a mediated reality can create something specific as well as something that is the unique result of the environment in which it exists. Generative music, autonomous systems, and the forms of art and music that pave the way for self-making are important predecessors to works of Amergent music.

CHAPTER 2

Generative Systems

"…the responsibility of the artist becomes inventing a system that produces his work, rather than just producing the work."

– Brian Eno, on the nature of generative processes for art & music (Darko 2009)

In the Middle Ages the above statement may have been received with some confusion (at best). But sharing an actual, self-producing artwork would most likely have lead to accusations of witchcraft and burning at the stake. It is difficult to separate truth from legend, but in a story related by improviser, sound artist, and sculptor Max Eastley (Toop 2001), this is the fate that nearly befell St. Dunstan when nearby listeners heard his harp play on its own accord. Stories about first experiences with music and technology get even more cloudy going back to Hermes and King David, both of whom experienced the curious relationship between the wind and string instruments (Hankins & Silverman 1999).

How can strings vibrate and resonate a wooden cavity with no one in command of them? Such an instrument, known as the Aeolian Harp, was eventually seen as less diabolically threatening and gained popularity in the 1700s (Hankins & Silverman 1999). The harp is not played in the conventional sense, but rather "excited" by the wind. Air in motion causes the strings to vibrate and to produce individually tuned pitches and overtones, creating an enormous variety of melodic and harmonic texture.

The artistic process surrounding the Aeolian harp shares a great deal with the musical philosophies and techniques discussed in this chapter. *Composition*, understood as an act of creating a musical work, is no longer a matter of specifying directions to be followed. The harp is constructed with materials and a tuning that will produce the kinds of sound desired by its maker. At that point control is relinquished. The location of the harp and local wind conditions determine what happens next—loud or soft; harmonically sparse or dense. The harp "plays" on its own, or is perhaps "played" by the wind. Either way, this represents a particular view of making music where the focus is on possibility, potential, and surprise in the course of a listening experience. Composition has more to do with a field of relations than with prescriptive instructions.

2.1 Musical Machines

The aural-kinetic sculptures of Max Eastley, Ray Lee's whirling speakers, and the electronic Rube Goldberg experiments of Kanta Horio (see figure 2.1) are all excellent examples of musical machines. These are proper-looking machines with moving parts: arms, levers, and pendulums made of metal. Some (though not pictured here) could even be considered very simple, sonic robots. The sounds produced by the machines of these artists are incredibly compelling, but not the kind to be discussed here.

Figure 2.1: Sound art works of (L-R) Max Eastley (Eastley 2008), Ray Lee (Lee 2010), and Kanta Horio (Horio 2010).

All of these machines, including the Aeolian harp and wind chimes, share the idea of process—the result of setting something up and then letting it go. The crucial difference is that the machines of Amergent music exist as code and sound resources inside a computer. Their operation is audible. The working parts of a physical machine are simply replaced by instructions telling the computer to reconfigure the relations of objects in its domain. In many cases these machines grant a degree of control or influence to the listener. But this is an indirect kind of control that seeks to find balance between their personal interests and intentions, the artistic focus of the work, and the dynamics of the environment in which all these ingredients are brought together.

2.1.1 Personal History & Perspective

The interest in musical machines came as a result of my personal fascination with systems. Of course for years this was in embryo. I had heard of another, much older Norbert who had something to do with something called *cybernetics*. But, at the time, I first remember thinking about Lego building blocks as a system, I was more interested in building new toys than in communications and control. Systems and music have long been separate, personal preoccupations. It was not until my post-college years that these parallel streams merged. In the end (which is really the beginning as it concerns this research) a book opened this new world to me. *Complexity* by M. Mitchell Waldrop (1992) was captivating. I had never excelled in the sciences, but the story of Brian Arthur and his colleagues, and the way they approached problems was beyond compelling. In part it was *how* they worked, but mainly it was the nature of the problems they confronted. Order, just on the edge of disintegration. How could that not be compelling? Every fulfilling musical experience I'd had up to that point in time could be characterized in the same terms.

As a young musician I gravitated towards jazz music. This was due to the fact that I wanted to have a role in which contributions were equal to that of other musicians. The choice was based more on issues of participation than anything else. In most other playing opportunities I had at the time, the saxophone was used for cameo solo appearances or journeyman supporting roles. Neither was particularly compelling. To play, to interact, and to develop music as a group were my primary concerns. Within the world of jazz I was most interested to play in a modal style, where the harmonic structure of a piece is based on scaler modes rather than a progression of chord changes. Pieces like *Impressions* by John Coltrane and *Footprints* by Wayne Shorter were explored frequently in practice sessions and at performances. Likewise, the albums *Kind of Blue* by Miles Davis and *A Love Supreme* (also by John Coltrane) were tremendous influences. All of these works used modes almost exclusively, and frequently employed the double-bass to set the musical foundation through the use of ostinato figures. These often simple, repeated phrases established both a rhythmic and harmonic foundation that served as the group's point-of-departure.

In modal playing I found a resonance with systems thinking. At the most basic level, a mode (or scale) can be played to fit within the harmonic structure of the piece. This constitutes a simple, one scale to one chord system. Effectively, this means playing in the same key to maintain an overall consonance. With something simple like *Impressions*, the AABA form alternates between D-7 in the A sections and Eb-7 in the B section. In a 1:1 modal system, musicians use the D and Eb Dorian modes as they play in the corresponding section of the piece. On a more interesting level, modes from other keys can be explored. This opens possibilities for introducing dissonance and harmonic tension to the modal structure. In figure 2.2 a more complex system for modal playing shows two ways that a ii-V-I chord progression can be modally interpreted.

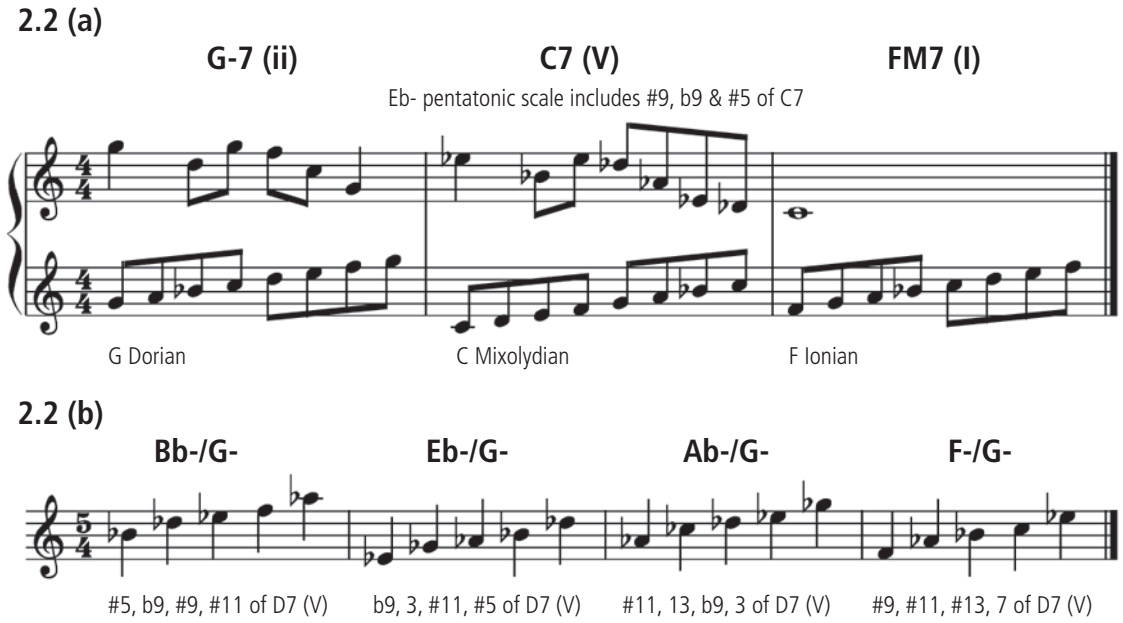

Figure 2.2: (a) ii-V-I uses identical notes but different modes given the first pitch of each scale: Dorian, Mixolydian, and Ionian respectively. Here, an Eb minor pentatonic scale is used over V (C7) to introduce harmonic tension and tonal color. (b) Several different Dorian scales can be played over G-7 to suggest dominant sounds (D7, D7b9, D7#9#5, etc.) that pull towards resolution at the harmonic foundation of a modal piece. The four scales shown here represent a 4:1 system of modes that can be transposed and used in all 12 keys of the even-tempered scale.

The modal approach discussed here only represents a few ways an improvising musician might engage a modal piece of music in a jazz context. The example is not meant to be exhaustive but rather to provide an example of a systemic approach used by the author. It was not uncommon to think about improvisation as a matter of "available notes within sets of scales" as opposed to anything else. The sound of these modes provided a set of constraints within which I would seek interesting new harmonic and melodic possibilities, while exploring tonal color both inside and outside the key. To this day, this basic harmonic approach remains a small foundational component in the process for much of the music I create. This approach to improvisation also translates well to other musical genres. However, most of the projects discussed in this thesis are meant to be experienced on personal media devices, usually over long periods of time, and in some cases to include the interactions of listeners. Of course, a human performer can't be permanently included in these works, but systems like the one just described can be written in computer code and set into motion with musical machines. Generative techniques provide a means of extending musical ideas endlessly in time through the use of systems.

2.1.2 Machines for Music: a condensed history of Generative music

When asked "What is Generative music?" a comparison with the music of wind chimes can be a helpful answer. Given the potential complexity of some Generative music systems this could seem

dumbed down but it is in no way a glib response. Wind chimes have an elegant simplicity that captures the essence of Generative music and allows one to extrapolate and imagine how such a system might work at larger scales. Alan Dorin writes that wind chimes represent something unique within this musical style:

> Hence it deserves a special place in the history of Generative music. Note that the wind-chime's structure dictates the timbres and pitches that it is capable of creating. Although it is capable of producing an infinite variety of sound-events, it may not produce *any* timbre or sound-event. (Dorin 2001: 50)

The "infinite" that is so often discussed in Generative music is not endless in every sense of the term. In these works, infinite may characterize the potential length of performance or the perceived variety of melodic and textural development in the piece, to name a few. It does not suggest that comprehensive musical knowledge has been encoded as a simple computer program that will spin out tune after tune. Music like all of the arts benefits from constraints. They have the counterintuitive capability to increase creative potential and variety. While wind chimes are perhaps an extreme case of creative economy, they show that there can be a seemingly infinite variety of beauty and interest produced through very simple means. Other musical precursors reveal this in different ways as a result of their strengths and productive limitations.

Cybernetician Stafford Beer's definition of an algorithm is "a comprehensive set of instructions for reaching a known goal" (Beer 1972: 305). The idea of an algorithm was first introduced in the ninth century by Abu Ja'far Mohammed ibn Musa al-Khowarizmi (Cope 2000). Composers have been employing algorithms since the 1026. Guido d'Arezzo (995-after 1033) developed a systematic means to pair pitches with the vowel sounds in the words of a liturgical text (Toop 2001; Roads 1996). Years later, Philippe de Vitry (1291-1361) (Cope 2000), Guillaume de Machaut (1300-1377), and Guillaume Dufay (1400-1474) (Roads 1996), are all known to have used algorithmic techniques in various ways to combine the rhythmic, pitched, and textual material of motets. In 1660 Giovanni Andrea Bontempi wrote *New Method of Composing Four Voices, by means of which one thoroughly ignorant of the art of music can begin to compose,* in which he proposed various systematic means of composition for, as the title suggests, uninitiated musicians (Cope 2000). In the eighteenth century Mozart is often the most-recognized for composing *Musikalisches Würfelspiele* (musical dice games), but Haydn, C.P.E. Bach, and Johann Philipp Kirnberger (Cope 2000) were also involved in composing these chance-based, musical parlor games.

David Cope, a composer and expert on Algorithmic music, continues his historical discussion of algorithmic precedents in western art music to include Johann Joseph Fux, whose rules regarding counterpoint were influential to Bach, Mozart, and Beethoven, among others (Cope 2000). He cites many other musical situations where an algorithm or some system of constraints has been employed in nearly all forms of composition leading up to the modernist serial approach of Pierre Boulez and the aleatoric techniques of John Cage. Cope considers indeterminate techniques, compositions created on performance instruments, and the rules of music theory all to be a kind of algorithm. This enormously inclusive claim, he believes, "…helps diffuse the usually destructive segregation…" (Cope 2000: 15) between composers who do and composers who do not use algorithms in their compositions. While his intentions to find common ground between composers with different methodological views are noble, the argument is frail and misleading.

Beer's definition of an algorithm includes, "…a known goal," which means the destination or result of a process is specified in some detail at the outset of the operation. This definition speaks to the written musical work itself. It reflects the historical context of these techniques within western art music, and situates algorithmic composition as one "musical species" evolved from the seminal pieces identified here. In his book, *The Brain of the Firm*, Stafford Beer makes a clear distinction between algorithm

and *heuristic*, which is defined as "a set of instructions for searching out an **unknown goal** by exploration, which continuously or repeatedly evaluates progress according to some known criterion" (Beer 1972: 306 emphasis added). He provides the example that if you were to help someone reach the top of a mountain covered by clouds, the heuristic "keep going up" (Beer 1972: 69) will get them there. The differences between algorithm and heuristic were outlined by Brian Eno in his essay *Generating and Organizing Variety in the Arts* as a means to help distinguish the differences of approach between traditional western art music and Experimental music. His statements serve as an excellent pivot-point in the history of Generative music.

Experimental music emerged from New York in the 1950s as "Sound come into its own" (Cage 1973: 68). In this movement, musicians John Cage, Morton Feldman, Earle Brown, and Christian Wolff shared a common determination:

> …for a music which should be allowed to grow freely from sound at its very grass roots, for methods of discovering how to 'let sounds be themselves rather than vehicles for man-made theories, or expression of human sentiments.' (Cage 1957 cited in Nyman 1999: 50-1)

Cage and those listed above were significant in getting the ideas behind Experimental music started. Others working in England, such as Cornelius Cardew, Gavin Bryars, and John Tilbury, were able to move some of these ideas out of traditional "music" performance venues and into art schools, galleries, and other accessible public places (Nyman 1999). Brian Eno, then an aspiring art student who experienced this dissolution of austerity first-hand, comments that this music was "…explicitly anti-academic…" in order to counter the more cerebral serial music of Stockhausen and Boulez that was currently the rage with other students from the nearby music college (Nyman 1999: xi). In some cases these works were admittedly written for non-musicians (Nyman 1999), but this music was in no way overly simple or childlike. Rather, as Cage expressed, it granted sound, performers, and listeners a great deal of freedom. The process of creation and the process musicians and audiences experienced during a performance was far more important than any sort of artifact or product.

Terry Riley's *In C* (1964) is a seminal work in both the Experimental and Minimalist music traditions. The piece consists of 53 melodic phrases (or patterns) and can be performed by any number of players. The piece is notated, but was conceived with an improvisatory spirit that demands careful listening by all involved in the performance. Players are asked to perform each of the 53 phrases in order, but may advance at their own pace, repeating a phrase or a resting between phrases as they see fit. Performers are asked to try to stay within two or three phrases of each other and should not fall too far behind or rush ahead of the rest of the group. An eighth note pulse played on the high C notes of a piano or mallet instrument helps regulate the tempo, as it is essential to play each phrase in strict rhythm (Riley 1964).

The musical outcome of *In C* is a seething texture of melodic patterns in which phrases emerge, transform, and dissolve in a continuous organic process. Though the 53 patterns are prescribed, the choices made by individual musicians will inevitably vary, leading to an inimitable version of the piece every time it is performed. Riley's composition reflects one of John Cage's thoughts on Experimental music, when he writes that the "experiment" is essentially a piece of music: "the outcome of which is unknown" (Cage 1973: 13). When performed, *In C* has indefinite outcomes and yet—like wind chimes—is always recognizable as *In C* due to the character of the musical material and directions that comprise the work.

Free and non-idiomatic improvisation (Bailey 1992), games-based improvisation (Zorn 2004), and other forms where personnel choices are enough to constitute a loose set of rules or organization (Warburton 2005) also share some common ideas with Experimental music. But in these forms the machines are human, and far more complex than anything discussed here. While algorithms can be

a part of Generative music, there is often more involved in the process. Strict algorithmic techniques certainly set the foundation for some of the qualities that make Generative music what it is, but the trial and error of a heuristic approach also has great value while the seed of a new work is being created.

The overall aesthetic of Generative music is much more consistent with the casual, open, and more restless attitude of Experimental music. As with most histories, the past of Generative music is fragmented—an amalgam of technologic possibilities and musical aesthetics. Like the music itself, once these ideas have been blended together, the process of unfolding continues. Of particular interest to this thesis is how this history has affected the career of Brian Eno and the contributions he has made that allow this work to go forward in new directions.

2.1.3 Brian Eno & His Contemporary Musical Machines

Through his recording studio interventions and *Oblique Strategy* cards, Brian Eno can be credited with transplanting Experimental techniques into Art Rock and popular music (Sheppard 2008). His tape delay experiments with Robert Fripp (1973-1974) and later solo project *Discreet Music* (1975) furthered an ongoing musical investigation into processes and systems, and among other circumstances, led Eno to pioneer Ambient music. Eno's first "official" Ambient album, *Music for Airports* (1978) makes use of tape phase techniques similar to those of Steve Reich in his pieces *It's Gonna' Rain* and *Come Out*. Eno commented that *It's Gonna' Rain* is:

> …probably the most important piece that I heard, in that it gave me an idea I've never ceased being fascinated with – how variety can be generated by very, very simple systems. (Tamm 1995: 23)

The idea of a music-making machine has fascinated Eno throughout his career (Eno 1996; Darko 2009). Tape delay and phase systems mark the beginning of this ongoing process in his body of work. In the years that followed, while working in a more conventional art setting with video and light installations, he used looping cassette tapes to create a continuous, ambient sound world that could be heard throughout the environment where his work was experienced. With the standards set by contemporary computers this seems primitive, but it echoes the incredible "variety through simplicity" idea in Reich's work that was so initially inspiring.

The term *generative* is most closely connected to Eno's work with SSEYO Koan, a software application for composing Generative music. Eno's only Koan-based album was titled *Generative 1* (Eno & SSEYO 2006). Koan (and Noatikl, its successor), have not gained much popular momentum as music production tools, but the techniques and aesthetics these applications enabled has come to be known broadly as Generative music. In the way that the name *Experimental music* contains a raison d'être, so does Generative music:

The concepts of process and algorithm are closely linked with those of dynamism and change, with *becoming*. When a process creates a new entity or brings about novel circumstances, it is a *generative* process with respect to the change(s) it brings about. Why not explore this concept of change through algorithmic means? (Dorin 2001: 49)

Generative music uses algorithms, but it is not Algorithmic music. For instance, an algorithm used by Eno in *Music for Airports* follows the instruction: play the note C every 21 seconds. The term *generative* communicates the idea of a computer processor (or other machine) doing the work to compute the iterative sequences, shifting permutations, and random routines that can also be used in this music. Unlike much Algorithmic music that focuses on producing a final, notated output or a music that can authentically match a predetermined style (Cope 2000), Generative music can be compared

more aptly to a seed. Brian Eno has made this metaphor in talks and interviews, (Eno & Wright 2006; Toop 2001) saying that like a seed, something unique will grow out of this music. Neither the listener nor musician knows *exactly* what it will be, but just as one would not expect a daisy to sprout from tomato seeds, each has a general idea or range of expectations. A tomato plant will sprout, but it won't look exactly like the one next to it or like any others in the row. The generative musical experience, like Beer's destination at the misty mountain top, is there, but the details are uncertain and the ensuing journey rich in possibility.

2.2 Artificial Life & "Music as It Could Be"

In music, traditional, linear compositional approaches leave little to no room for the potential of becoming and novel moments in the listening experience. Once a piece has been written it is expected to unfold along prescribed lines. In the early stages of my research, with an interest to explore becoming and generativity, I investigated the field of artificial life and the science of self-organizing systems. The motivating question asked how it could be possible to harness the emergent dynamics of an a-life system and use these as a framework or "engine" for music with the potential of nearly unlimited development and variation. The "life as it could be" credo of a-life (Langton 1988) was used to explore "music as it could be."

2.2.1 Particle Swarms in Early Research Projects

My first investigations into the possibilities of artificial life were done with Particle Swarm Optimization (PSO), an algorithm originally developed by scientists James Kennedy and Russell Eberhart (Kennedy & Eberhart 1995; Kennedy, Eberhart & Shi 2001) for optimizing nonlinear functions. It is related to artificial life, flocking behavior, and evolutionary computation. PSO, like other self-organizing systems, is rooted in the idea that the social sharing of information among individuals can be beneficial to an entire group. Swarm behavior was considered not only as a reflection on the nature of mediated interaction; it was used sonically to demarcate specific events within an interaction, transforming each into a fabric of sonic events within a continuous musical becoming. The pieces I created with PSO were done purely with an experimental mindset. "What would it sound like if…?" was the question sustaining this early work. I was curious to know the ways in which the emergent behavior of swarm agents could produce or manipulate sound to make music. What *could* this sound like? Would the visible emergence of the swarm manifest sonically in some way? Audio examples of the finished pieces—*PSO[1]*, *PSO[2]*, and *AUTOMATICBODY*—are in section 1 of the supporting DVD, and each project is available to play on your PC. See the DVD Instructions for details.

In these early projects, emergent dynamics were used as the point-of-departure for a musical work. These first three particle swarm-driven works have no provision for interaction. Rather, they are loosely structured with an underlying collection of sonic material that is arranged and re-arranged to create a framework of musical possibilities. The various musical components coalesce to realize an ever-changing composition that has the flexibility to adapt itself to the twists and turns of an interactive exchange between networked individuals, user and system, performer and performance space, or audience and composer. The PSO algorithm proved to be incredibly robust and has served as the generating force for most of the other projects discussed in this thesis.

To use this algorithm musically, it was necessary to draw directly from the data that produced the swarm's behavior. I was not interested in interpreting or representing actual swarm dynamics, but capturing the *affect* of swarm dynamics. An essential aspect of Kennedy and Eberhart's algorithm is the sharing of information between agents. When the swarm is initialized a space is defined. Within it, swarm agents are randomly distributed and a point is established as the target that each agent is meant to find. When the search begins, each agent computes a new trajectory based on A) a personal best (*pbest*): the point it, individually, has found nearest the target and B) a group best (*gbest*): the nearest

pbest in the entire swarm, which is frequently updates and simultaneously shared among all agents. Each agent then randomly selects a point between A and B and moves to it (see figure 2.3). This process repeats very quickly (24-30 times/second) to create an elegant, elliptical movement that appears like the swarming of insects. Distance from an agent to the target is called *fitness*. Over time, through individual work and social sharing of "bests," agents seek greater fitness (a value approaching 0), and the swarm coalesces at the target. With the original, intended use of PSO, the search would be considered complete and the problem solved once the target is found. With my use of the algorithm, this first success is only the beginning. I use PSO to construct continuous music and therefore, the swarm must keep going. When any agent's fitness is below a predefined threshold (usually between 1-5), the target is moved to a new, randomly selected position within the search space and each agent's search begins anew. Books and papers that discussed PSO (Kennedy & Eberhart 1995; Kennedy, Eberhart & Shi 2001) led me to the conclusion that the *pbest* variable was the most significant event at the core of particle swarm behavior. In my PSO system an agent plays a sound at every new *pbest*. If you were to anthropomorphize an agent, you could say that it "sings" when a new location nearer its goal is found.

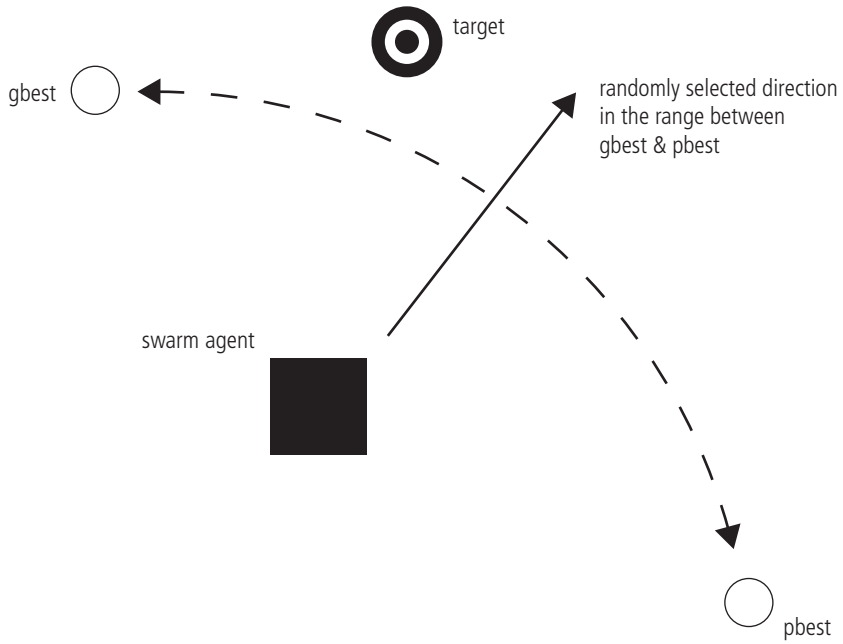

Figure 2.3: Agents randomly choose a new direction within the available range between *gbest* and *pbest*. Each then moves in that direction seeking a new, "best" location.

Agents draw from lists of pre-rendered sound files: environmental textures, pitched instrumental notes, synthesized washes, short melodies, and field recordings. The preparation of sound files was by far the most challenging aspect of this work because I had to imagine each sound as a tiny part of a much larger system. All processing and equalization had to be completed before the sounds were made available to the swarm system. After some trial and error, I adopted a layered approach where I would complete one set of sounds, load it, and then let the swarm play. Then I would work on the next set of sounds while the first set played in the background. It was a somewhat arduous, iterative process, but it enabled me to hear how the various sound components might fit together and gradually build the music layer by layer.

The first PSO experiments had between seven and nine agents, each with five to twenty-one sound files available to it. The agents were organized according to voice: high, middle, low; lead, accompaniment, bass; and so on. A specific organization was not set for all works, but pragmatically suggested by the musical direction of the work. Voices allowed the music to retain a balanced texture to comple-

ment the emergent behavior of the swarm.

After completing the initial three particle swarm works, the question arose as to whether the use of pre-recorded sound files masked the dynamics of the swarm as an artificial layer that concealed even greater musical potential. *max.s.o* (later re-named *A(rt)Life 1.0*) sought to continue exploring the possibilities of particle swarm optimization. Swarming arises through the collective, social behavior of swarm agents. Personal bests, group bests, and measures of fitness are evaluated throughout. In addition to these parameters, the velocity of an agent is representative of the minute adjustments made as the agent swarms, seeking greater fitness. This information, and the dynamic organization it represents, provides the framework for a non-interactive, generative musical work. By tracking the horizontal and vertical velocities of each agent at moments of optimization (new *pbest*s), the swarm's order can be captured numerically. Max/MSP is used to transform this numeric output into sound using sine wave generators. The specific organization is documented in table 2.1. Each agent was designed to send its current velocity and a list of other swarm-derived values to a simple sine wave generator. The sound module then plays a tone drawing on these incoming values. With 20 agents and nine sound modules, the project is a kind of experiment in real-time additive synthesis. However, this ratio proved to produce the most clear and varied texture, as emerging trends in an agent's velocity would produce everything from pointillistic, rhythmic pings to sweeping, dramatic washes of sound.

Table 2.1: Compositional organization for *max.s.o*.

sound parameter	swarm parameter at the moment of new pbest
volume	Average horizontal and vertical velocity (xVelocity+yYelocity/2) sets the level of each agent's tone. High velocities produce louder tones and vice-versa. The PSO algorithm has maximum and minimum velocity levels, which is interpolated within 12.5–100% of the audio system's playback capabilities.
pan	The position of an agent relative to the target determined the placement of a tone within a two or four speaker field.
pitch (sine wave frequency)	An agent's distance from the target along the y-axis is interpolated in the range 80-8,000 Hz. Agents finding new personal bests when far from the target produce low tones; those nearer produce high tones. This frequency range was determined as a result of technical restraints across different playback systems and personal musical aesthetics.
envelope (pitch duration)	An agent's distance from the target along the x-axis is interpolated in the range of current and maximum velocity. Agents finding new personal bests when far from the target produce long tones; those nearer produce short tones. These effects are further modulated by velocity, as faster agents have a more narrow range of high-velocity/long-envelope values. This allows for textural diversity. For example, agents near to the target can produce long tones even if they are moving slowly.

The intention of this piece was not to uncover the "definitive" sound of the swarm system. I thought of this piece as a musical sonification where the swarm could be considered from multiple points-of-view and expressed in sound. This approach allowed me to expose the inner workings of the swarm as though viewed through different light gels. One organizational scheme sends swarm variables in such a way as to show "how it looks in blue." Additional interventions could reveal the same dynamics in red, green, yellow, and so on.

2.2.2 Flocking & Immersive Music Installations

A(rt)Life is an installation series done in collaboration with a-life scientist Larry Yaeger that reveals the emergent dynamics of artificial life systems through digital animation and music. Emergence creates structure in the relationship between agents, one that is in a constant state of refinement and revision. Extending the work that had started with Particle Swarm Optimization in *max.s.o* the *A(rt)Life* pieces examined the relationship of music and emergence by exploring the self-organizing behavior of flocks

as part of a generative system that can extend music endlessly in time.

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A(rt)Life was based on the boids flocking concept by Craig Reynolds (Reynolds 1995). His work was based on three steering behaviors: separation, alignment, and cohesion. With separation, a boid steers to avoid crowding. Alignment is used to keep all boids moving in the same general direction. Cohesion keeps groups of boids together. Boids are aware of their flockmates' position. With this knowledge and adherence to the three flocking rules, hundreds of boids can be randomly initialized and then quickly fall into tidy clusters that fly elegantly throughout a digitally rendered environment. Where progress towards greater fitness is the imperative in a particle swarm, separation, alignment, and cohesion are the most significant factors behind the behavior of a flock. These became the organizational elements from which the music was developed, with cohesion taking precedence over the other two behaviors.

An early challenge came in finding a way to cope with the influx of data sent from the flock of 200 boids to Max/MSP and the unique sound-generating software developed for this project. We simplified this by breaking the flock into groups, or bands, based on their level of cohesion. The bands were labeled Min, Mid, and Max, for boids that exhibited the least, moderate, and most cohesive behavior. Each band was then assigned a number of voices to filter the amount of data that was actually heard in the final work.

Max/MSP hosts four instruments: a sine wave generator, a custom FM synthesizer, a variable pitch sine wave generator, and a basic FM synthesizer. All of these offer enough input parameters that flocking data from a boid can be used to craft unique tones as a result of their flight. Due to the amount of data, it is important to work with fairly simple synthesis schemes. These rather basic, individual waves act as components in a more complex sonic texture constructed through a kind of additive synthesis. The result is satisfying both musically and conceptually, as it reflects the idea of complexity from simplicity, which was one of the qualities that initially drew me to work with a-life systems.

Boid cohesion bands are distributed across the available instruments. This step was completed through a process of trial and error, balancing personal aesthetics and flock dynamics. table 2.2 lists the distribution of bands, voices within bands, and voices to instruments.

Table 2.2: Flock bands, voices, and instruments

cohesion bands	available voices	sine wave generator	custom FM synthesizer	variable pitch sine wave generator	basic FM synthesizer
min-band	12	5	3	1	3
mid-band	16	4	4	4	4
max-band	10	5	2	1	2

Boids send tone generating data on a continuous basis. But only when a voice is available (not already playing a tone) is an instrument able to receive the flocking data that produces a tone. table 2.3 lists the parameters that connect flocking behavior to sound-generation.

Table 2.3: Musical organization for A(rt)Life 2.0

sound parameter	flocking parameter
amplitude (volume)	Speed. Fast boids are loud; slow boids are quiet.
pan (position of sound in available playback channels)	A boid's position within the spherical flocking space determines placement of its sound in the quadraphonic field.
pitch (sine wave frequency)	Overall pitch range is determined by a boid's cohesion. The least cohesive are limited to the range 82.407 Hz–164.814 Hz (pitches E1–E2), while the most cohesive boids have the greatest range, from 82.407 Hz–7040 Hz (pitches E1–A8). Other boids make up a mid-cohesive unit and play pitches from 110 Hz–329.628 Hz (pitches A2–E3). Within a specified range, the exact pitch is determined by a boid's horizontal velocity. Left to right or right to left direction determines a starting pitch in the range and speed determines whether the pitch ascends or descends from the initial frequency. The logic behind this organization was to allow the greatest range of pitches possible for those boids with the tightest pattern, a wide range for medium-level pattern boids, and a moderate range for the loner boids.
envelope (tone duration)	The neighbor count and curvature (angular degrees a boid turns per unit of arc length) parameters are used in combination to determine envelope, or how long a tone sounds. Boids with fewer neighbors produce longer tones, while those in a tight cluster play with shorter, even staccato, articulations. Similarly, a tight turn yields shorter tones; a gradual turn longer tones. A boid's neighborhood does not directly contribute to flocking behavior but is ultimately determined by cohesion and the cohesion of other boids near it. Large neighborhoods must have sufficient cohesion to keep lots of boids together, otherwise they break apart to become small neighborhoods or loners. The curvature parameter reflects more of an aesthetic choice in this work. It is related to Reynolds' alignment behavior, but does not contribute directly to flocking.
envelope attack	The larger a boid's neighborhood, the longer the attack, or initial portion of an overall tone duration. For example, long attacks are brought to full volume slowly, creating a fade-in effect.
envelope decay and FM mod frequency	Separation—the distance between a boid and its nearest neighbor—sets the slope from full volume to silence (decay) or alters an FM modulation frequency in real time. When neighbors are near, tones fade-out more quickly and modulation is more exaggerated; distant neighbors create the opposite effects.
reverb distance	As with the envelope parameter, curvature was used out of aesthetic concerns. Tight turns sound less distant, while long, swooping turns sound spacious and diffuse.
envelope attack inversion (NOTE: This and other inversions work to lend synthesized sounds a more organic quality. When the usual parameters are flipped there is greater variation across all tones produced through flocking.)	Boid x-velocity flips the envelope attack parameter lending all boids the occasional chance to play with a variety of attack lengths.
envelope decay inversion	Boid y-velocity flips the envelope decay parameter lending all boids the occasional chance to play with a variety of decay lengths.
pan adjust time	Speed controls pan adjustment. Fast boids pan quickly; slow boids pan gradually.

The *A(rt)Life* pieces unfold organically to yield a unique experience where the act of listening involves both reflection and discovery. Both versions of the work were exhibited in a small room with dimensions that were close to forming a perfect cube. The walls were covered with black fabric and the floor was covered with black carpet. A projection screen was mounted on the ceiling and the projector secured to the floor so that it could point upwards. Four speakers were mounted in the corners of the room and angled downwards. Visitors were encouraged to sit or recline while meditating on the flock and the sound it produced. The gallery placard read as a kind of invitation:

> Dear visitors,
> Welcome. Please enter through the curtain and proceed into the room. Allow some time for your eyes to adjust to the darkness. Inside you will find pillows (and people!) on the floor. Kindly remove your shoes and make yourself comfortable. Feel free to stretch out and rest on your back. If you're tired, have a nap. There are chairs in the corners for those who prefer to sit. What you will see and hear is unique in each moment, so relax, enjoy, and remain as long as you like. (Herber & Yaeger 2006)

The *A(rt)Life* installations provided an environment for immersive listening. Due to the dynamics of the flock the musical experience was more textural and less melodic when compared to the works done with PSO. The differences between swarming and flocking are immediately apparent when one sees each system in motion. These projects succeeded to make them aurally different as well. Audio and video examples are in section 3 of the supporting DVD. The software synthesizers used for each project were more-or-less identical, but the variety of parameters that could be extracted from the flock was more rich and varied. This was reflected in the musical output. *A(rt)Life* was not better or more successful as an artistic endeavor, but noticeably different due to the uniqueness of the dynamics generated by its flocking agents.

These projects were interesting and instructive. As an artist who had always performed music in a live setting or recorded in studios, the experience of planning and following through on a gallery installation was challenging. But apart from making a new work, or pursuing new venues for future creative work, the motivation behind all of this was to conduct musical experiments with self-organizing systems, and to see and hear what possibilities and potentials each afforded.

After doing a few casual experiments with a cellular automata running Conway's *Game of Life* rules, I felt that this course of research had brought me to a point of divergence. There is clearly infinite potential in using a-life systems to make Generative music. The experiments discussed above were a small introduction to a very promising field of continued study and musical investigation. But there was cause for concern that it would be a rabbit hole from which I would never return. Learning to fully understand the nuances of a-life as a field, and pursuing the design and use of these systems for future projects had an allure that could hold my attention for some years to come. It could also prevent me from ever returning to my initial research questions involving emergence, Generative music, and interaction within mediated environments.

2.2.3 A-Life Conclusions & the Way Forward

As it concerns Amergent music, a-life based music (Evolutionary Computer or EC music) has much to offer in its use of algorithms and mapping techniques. However, there are marked differences in the artistic intentions of the two. After completing projects with swarms and flocks, and reading papers and articles with a wide variety of alternate systems and approaches (Biles 1999; Waschka 1999; Dahlstedt & Nordahl 2001; Berry & Dahlstedt 2003; Miranda 2003; Blackwell & Young 2004; Miranda 2004), I reached a point of clarity. There was a difference of aesthetic priority between most of the music coming from the EC community and what I was seeking to do. Where EC music values *permanence* I emphasize *evanescence*. In much of the EC work there are many discussions about the

elegance of the evolutionary process. At the same time there is a persistent reminder that this music is working towards some sort of musical ideal—a "goal" that will make their music acceptable (Waschka 1999; Dahlstedt & Nordahl 2001; Biles 1999). EC papers always have a compelling discussion about systems and software, but frequently conclude with penitence, admitting that the system is still not capable of making "vital concert music" (Waschka 1999: 201). This is a curious position. Evolutionary forces (natural or simulated) are some of the most powerful and transformative processes known to humankind. Pursuing a sonic agenda with nearly limitless potential, and then strictly reining that in to pre-existing traditions is contradictory and counterproductive. John Cage, when asked by a European musician if it was difficult to write music in America being so far from the "…centers of tradition" (Cage 1973: 73), replied in the converse, saying he thought that the difficulty was in being so close to these traditions. There are relevant and very interesting projects in the EC community (Miranda 2003; Blackwell & Young 2004; Berry & Dahlstedt 2003), but most of what was discovered was motivated by a different set of artistic intentions and concerned with very different research questions. The objective of this thesis is not to robustly critique the music and methods of the EC community. This body of work did have an influence on my research and it is important to state where its usefulness both begins and ends.

A-life systems are worthwhile and interesting precisely because their behavior is unpredictable, varied, and ongoing—tendencies that are characterized by many EC musicians as subversive intrusions to the final musical output of their work. This contradiction was initially confusing, but eventually made clear after reading about Harold Cohen. Cohen has been involved in a long-term project called AARON, an artificial-intelligence program that makes original, museum-quality images (Cohen 1999). In an essay on AARON and machine creativity, Cohen discusses "painting-as-verb" and "painting-as-object" (Cohen 1999: 14). His distinction between "artwork as a thing" and "artwork as a process" struck me as the difference in musical approach that separated my interests from those in the EC community—music-as-noun vs. music-as-verb. As stated in other terms throughout this chapter, music is not something that exists but something that happens. Amergent music emphasizes *process* in the artwork, where affect is found in the development and unfolding of the work over time.

The emergent, bottom-up nature of a-life processes and a systems approach to music are very compatible. Eno's comparisons of western art music composition and Experimental music from *Generating and Organizing Variety in the Arts,* borrows another quote from Stafford Beer and *Brain of the Firm*, saying:

> Instead of trying to specify [organize] it in full detail, you specify [organize] it only somewhat. You then ride on the dynamics of the system in the direction you want to go. (Beer 1972: 69; Eno 1976)

Beer's thoughts on systems-based management of organizations are an uncanny characterization of the creative process behind Experimental and Generative music. If the intrinsic order of a system can be understood, variables can be stacked so as to take best advantage of the system when it is set in motion. The specific outcome is unknown, but it is limited to an acceptable range ("the direction you want to go") defined by initial conditions and overall behavior of the system. In terms of Amergent music, sounds and their organization are "somewhat specified" and then set to ride the dynamics of their own operation and those of the environment in which they exist.

In the early phases of this research, artificial life was thought to be significant to its outcomes, and in terms of the generative potential of these systems, it has been. But in mediated environments there is interaction. This presented a number of challenges; the greatest of which was the issue of scope. Designing an artificial-life based system that was musically interesting, receptive to interaction in a wide variety of mediated environments, and portable to a variety of technology platforms was too much to

manage. It was possible to conceptualize individual works that relied upon a-life algorithms and other simulated evolutionary processes, but not to also find a way that makes such an approach robust.

The question driving this research was based on the relationship between people and music in environments of mediated interaction. An attempt to broaden this and include a-life systems in a more substantial way proved to be unsustainable. On a personal level, it demanded technical skills and savvy beyond the capabilities of this author. Conceptually it was very interesting but not the only answer up for consideration. Pragmatically it was not the most promising path forward.

The research question behind this thesis considered all environments of mediated interaction: present and future. A-life systems had the probability to overly complicate the technical aspects of this work, making it laborious to grow with technology, as well as the potential to complicate future collaboration with other artists. The approach that was used as an alternative met this challenge with success. Ongoing research led to the development of a set of generative instruments, each of which has proven to be functional in different mediated environments and on a variety of computing platforms.

2.3 Generative Instruments

The historical perspective of Experimental, Algorithmic, EC, Ambient, and Generative music has presented a useful mix of strategies and techniques for the development of Amergent music. By borrowing (and taking) ideas from these other genres, it became possible to develop a framework that could support future prospects for collaboration and the flexibility to create music in a variety of technoetic environments. All of these systems have unique behaviors that make them suited to particular kinds of "musical jobs" that were identified throughout the course of this research. This is not to say that each is only capable of a single task. Like acoustic and electronic instruments, these generative instruments have strengths, weaknesses, and enough plasticity for rule-breaking.

2.3.1 Instrument Types

A **Shuffler()** is an instrument based on the tape phase system used by Brian Eno in *Music For Airports*. It borrows its name from a talk Eno gave at the University of Arts in Berlin in January of 2007 (Pohflepp 2007), in which he discussed how he and Peter Chilvers had been working on using this same approach for the upcoming evolution-based computer game *Spore*. In Eno's system, a piece of audio tape is mostly silent except for one section where there is a recording. The ends are spliced together to create a loop, and then played in tape machine. Every time the playback head reaches the recording, sound is produced; otherwise it is silent. With multiple tape machines and loops of different lengths you have a system like the one shown in figure 2.4. In computer terms, this constitutes a very simple algorithm that tells the software to play *x* sound every *y* seconds.

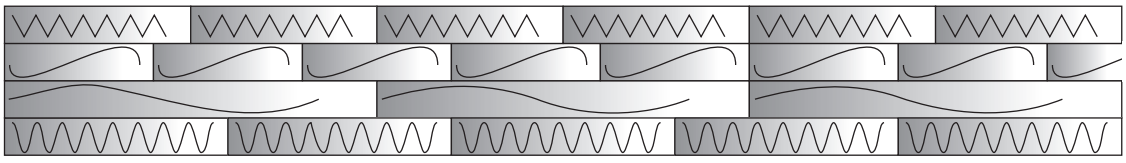

Figure 2.4: A hypothetical tape phase system. When loops of different lengths are played against each other sounds get out of phase. Like Reich's *It's Gonna' Rain* and *Come Out*, a Shuffler() instrument establishes these basic relationships and then lets the individual loops drift independently over time.

The generative possibilities of the Shuffler() are multiplied when you think in two dimensions. Time on the y-axis stretches into the future and sounds fall in and out of phase with one another. On the x-axis there is pitch, which creates harmony and tonal color. In *Music For Airports* the harmonic content for track *2/1* is as follows:

Ab'

F'

Eb'

Db'

C'

Ab

F

(Tamm 1995: 136)

Taken as a whole, these pitches suggest a DbM9 chord. However, Db is in the middle of the orchestration and does not function as a tonal root in the overall harmonic scheme. As these pitches are played out in time, they phase at the following intervals (" = seconds):

C'	Eb'	F	Ab'	Db'	F'	Ab
21"	17"	25"	18"	31"	20"	22"

The sequence listed above is based on Eric Tamm's transcription (Tamm 1995: 137), and shows each pitch in the order which it is heard on the recording of *2/1*. When Eno made this piece he set up the tape machines and started them, recorded the ensuing process, and then excerpted a shorter section for the final album. Given enough time to run through its permutations, this system has the capability to produce harmonies that suggest Fm7, AbM13, Ab sus4, Eb sus4, Cm, and so on. The music is not set in any particular key, nor does it sound based around a tonal center. As the pitches in this system drift in and out of phase, they produce tonal colors when heard in groups of two or more, and melodies when heard in succession.

The Shuffler() instrument duplicates this entire process as computer code in such a way that each instrument is like a tape machine in the original system. Different projects require a different number of Shuffler()s—there could be as few as four or as many as many as eight to twelve set to play. Each instrument is assigned a sound file and a timed interval. When started, each performs a modulo calculation with a global, random interval and its assigned interval. This simulates a situation in which the instruments have already been playing over a period of time. When an Shuffler()'s interval expires it plays its associated sound file, and resumes counting from the beginning.

DeckOfCards() is an instrument that plays sound files randomly. As the name suggests, it "shuffles the deck" (re-orders a list of sound files) to create a newly-ordered sound file sequence. When the instrument is cued it picks the "top card in the deck" and plays that sound file. This instrument is monophonic, meaning that a new sound cannot be cued until the previous one has completed playing. After all sound files have been played, the deck is re-shuffled and the process begins again. Shuffling is done so that no sound is ever heard back-to-back. If the bottom card of the deck becomes the top card after a shuffle operation, the cards are re-sorted in retrograde.

Seq() or a sequence instrument is exactly like DeckOfCards() with two exceptions: there is no shuffling in order to preserve the original order of the sounds provided, and sound files are allowed to overlap. Because Seq() and DeckOfCards() are such opposites it is helpful to discuss their applica-

tions in tandem. Seq() is the instrument to use if you have a series of sounds that, when repeated, can produce interesting melodic permutations. The ability to overlap successive sound files makes this instrument behave like a Shuffler() that is not bound by a timer. DeckOfCards() is more of a true randomizer and is best used for sounds that need to be heard sparsely. In situations with long lists of sound files, and a low probability for the events that will cue them, the DeckOfCards() instrument works well to introduce behavior with greater reserve and variation than that of its fellows.

Scaler() instruments are thus named because they were designed to be an arbitrary randomizer limited to a scale of notes within a set range. Its behavior combines qualities from each of the three instruments discussed so far. Like Seq() instruments, Scaler() allows overlaps. Like DeckOfCards() all sounds are random following no particular order, but repeats or multiple iterations of the same sound are allowed. And like Shuffler() it will continue to play until explicitly stopped. Scaler() is cued in a completely different fashion than any of the other instruments by using two event generators (EG) and a random gate (RG) to determine when sounds can be played (see figure 2.5). The first EG determines the length of the phrase that will be played and is connected to the RG. When the EG cues a phrase the RG gives it a 50% chance that the phrase will play. If RG is closed, nothing happens; if it is open, the phrase plays. The density of note events is controlled by the numeric value of the second EG. Other parameters include *range*, which determines the number of notes available within a phrase, and *root*, which sets the lowest possible note of any phrase.

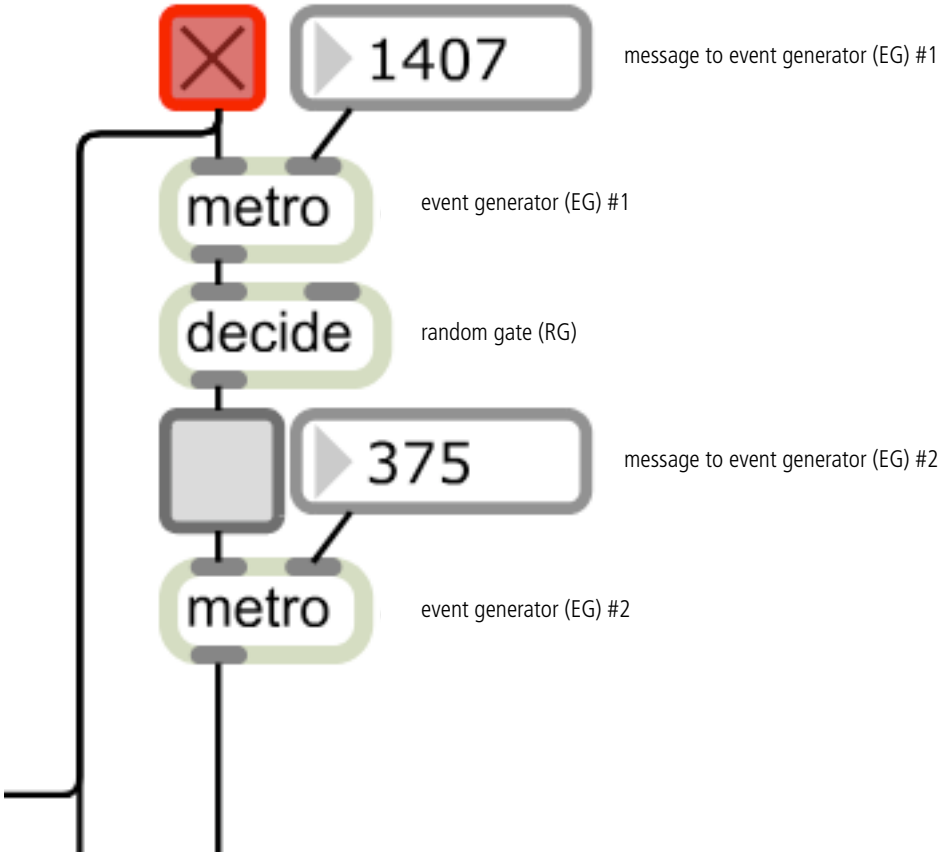

Figure 2.5: The Scaler() instrument was made in Max/MSP. A *metro* object with a definable interval is used to make each event generator, while the *decide* object serves as the random gate.

Scaler() was made specifically for experimenting with different sound palettes while developing the music for *Londontown*. Max/MSP was an ideal environment because all note events generated by the instrument could be sent via MIDI to a synthesizer or sampler running in Apple's Logic Studio audio software. In practice, the kinds of sounds used dictate how the other parameters are to be set. For example, to introduce sudden changes of mood, sparse, single note phrases with a small range and a

low-pitched root work well with bass-like instruments. In the discussion of work that went into the music for *Londontown*, this thesis will describe how two Scaler() instruments were used to simulate a specific kind of performance using sounds from an acoustic piano.

The End2End() instrument creates continuous textures or drones by cross-fading a series of audio files. This procedure can be thought of as "stitching together" audio files in succession to create the effect of a single, never-ending audio track. The files to be used are provided to this instrument as a list. Like the DeckOfCards() instrument, the files are "shuffled" before being played to re-order the list. After the first file is cued, it plays as the instrument monitors its current playback position. When it is at or over 80% (or another specified interval) of its total duration, the next file at the top of the list is cued to play. The crossfade routine, depending on the version of the instrument, is handled either by the code of the instrument or pre-rendered fades in the audio files. Either way, the duration of the crossfade can be edited to best match the character of the sounds the instrument will play.

End2End() is the instrument to use when there is a need to establish a continuous drone or sonic foundation. While its operation may at first seem to lead to monotony, it is actually capable of producing a good deal of variation. For example, to play an ongoing drone that establishes a key center and has some modulation of timbre over time, several short sound files that match pitch but have different timbral colors will create the required effect. When these are allowed to play in a randomized sequence the length of the crossfades can be increased so as to create fluid transitions across the timbrally unique audio files. This effect can be further enhanced when two or more End2End() instruments play different sets of sound files that mix when they are heard concurrently. It is also possible to vary the lengths of the sounds provided for each instrument. This technique creates phasing patterns similar to that of the Shuffler() instrument.

Phraserizer() combines behaviors in DeckOfCards() or Seq() and End2End(). While it could be used to play the kinds of sounds discussed in the context of the other instruments, its primary use is for rhythms and percussive patterns. As the name implies, it is a kind of "phrase processor." The available phrases can be set to play in a set order or randomized, and like End2End(), each successive phrase is connected one after the other. However, because these are rhythmic, there is no crossfading. The instrument preserves the tempo of the phrases to maintain a consistent pulse.

While this description may at first sound generatively limiting, it is actually quite powerful. A phrase is often understood within the convention of four beats that make a bar. With the Phraserizer() instrument there are no such restrictions. Phrases of any length can be used, and there is no need for consistency. Short and long phrases can be combined to create shifting metric permutations: 4+2+3, 2+3+4, 3+4+2, etc.

The Phraserizer() can also function like a REX file (Propellerhead Software 2010) player. Extremely short phrases or samples can create a "granular" kind of rhythm that has a consistent but ungrounded pulse. Rhythms are some of the most challenging musical gestures to create in a generative context because of their repetition. After an extended period of listening, the repetitions can become apparent and their musical affect can dissolve. With the kind of variation the Phraserizer() is able to introduce, the tedium of rhythmic repetition can be minimized or avoided altogether.

2.3.2 Generative Instruments & Projects

All of the instruments discussed here have been used in the projects that support the research of this thesis. Specific uses are a function of individual projects and the artistic or technical concerns of the work involved. The following list pairs the musical works that will be discussed throughout this thesis with the generative instruments that were used in each.

PSO Series & *AUTOMATICBODY*: DeckOfCards(), End2End(). For examples, see section 1 in the supporting DVD and the discussion of these projects earlier in this chapter.

Perturb: DeckOfCards(). For examples, see section 3 in the supporting DVD and thesis chapter 3.

Sound Garden: DeckOfCards(). For examples, see section 4 in the supporting DVD and thesis chapter 3.

Dérive Entre Mille Sons: Shuffler(), DeckOfCards(), Seq(), End2End(). For examples, see section 5 in the supporting DVD and thesis chapter 4.

Londontown: Shuffler(), Seq(), Scaler(), Phraserizer(). For examples, see section 6 in the supporting DVD and thesis chapter 5.

In each of these projects the use of various instruments is not as transparent as the earlier example given from *Music for Airports*. This is either due to their behavior, the sounds assigned to each instrument, or the combination of both. This collection of generative instruments was a crucial part of realizing the music of each project, and the specific sounds to be played by each instrument were equally vital, if not more so. Together, instruments and sound palettes served to constitute a generative system that could be made to behave in ways that were responsive to the various modes of interaction experienced within each project.

2.3.3 Instruments, Sounds, and a Generative System

Generative music extends stylistically from Ambient music. It takes with it both the temporal function to "exist" continuously in an environment, and the sonic function to act on that environment as an aural tint or hue. Amergent Music seeks to extend both of these traditions through the relationship it forges between listener and mediated environment. The sound of Amergent music is not strictly Ambient, but draws many of its sonic qualities from the style. As Ambient music endeavors to create in the listener "…space to think" (Eno 1996: 296), Amergent music seeks to create a sonic space to experience the becoming of a technoetic environment.

As will be discussed in later chapters, linear or *narrative* music does not allow a listener the degree of freedom appropriate to these environments. All are capable of imparting feeling and affect—a symphony or rock band can be emotionally transportative but neither is capable of sustaining that kind of listening experience over long spans of time nor adapting and behaving in ways that are congruous to the mediated environment and the events that transpire within it. Sound exists to establish a mood, but it also works as a synergizing agent to intensify the bond between person and technology, drawing them more deeply and profoundly into a technoetic experience. There is no single doctrine of sound in Amergent music. The specific ways in which sound is used relates more to individual projects than it does to a generalized aesthetic.

The connection between sound and instruments is a very important aspect of this music, however. Individual sound files and resources are coupled to instruments and are moveable. The ability to swap and switch the sounds of any instrument is the most important function in establishing a relationship between Amergent music and a listener (see figure 2.6). An instrument, and the sounds made available to it, constitute a generative system that is "…not a thing, but a list of variables" (Ashby 1956: 40). As the variables change, so does the output of the system. A person in the technoetic environment does not treat the generative system as a machine, feeding it input and waiting for output. Their actions and presence in the environment lead to developments that: are initiated by them; are the result of changes to system variables; and manifest as an overall sonic behavior. The specifics of this behavior and the ways in which sound files relate to one another within the generative system

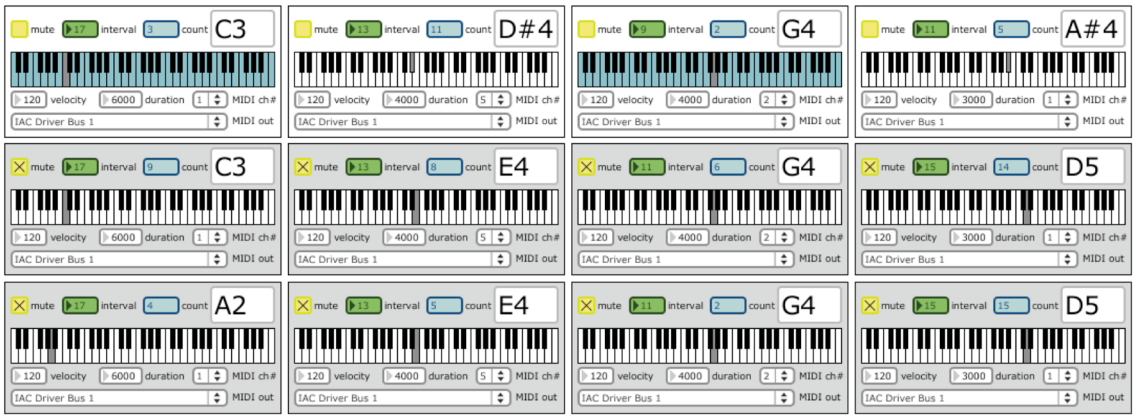

Figure 2.6: In this generative system there are three Shuffler() instruments. In the first interaction each Shuffler() has the notes of Cm7 (C, Eb, G Bb). A second interaction will trigger a change that retains the first and third notes but changes the other two to produce C9 (C, E, G, D'). The third interaction keeps all but the first note creating an Asus7 sound (A, E, G, D').

will be discussed throughout this thesis, especially as it regards the projects *Perturb*, *Sound Garden*, and *Londontown*.

Conclusion

Amergent music—similar to the music of wind chimes and the Aeolian Harp—is generative, and comes about as the result of systems and musical machines written in computer code. Many musical machines use algorithms—instructions that lead to the production of a sound or sounds. While their use is very diverse, algorithms have been used in music since the early part of the second millennium. Liturgic, concert, and early popular forms have all employed algorithms for various reasons including convenience, high concept, and amusement. Algorithmic music is an important predecessor to Amergent music, as is Free and non-idiomatic improvisation, Experimental, Evolutionary Computer, and Ambient music.

In the earliest stages of this research, artificial life systems were thought to be an important means of generating behaviors and data that could be leveraged to produce interesting musical gestures. Some techniques, including particle swarms and flocking, were successful, while others led to results too far afield to be sustainable for future research.

Amergent music approaches music as a verb, not a noun. Like Experimental music before it, there is an aesthetic priority of process over product. In the course of this research a battery of generative instruments was designed to create the musical works discussed in this thesis. The design of each is simple: they iterate, re-order, or sequence musical material to produce continuous variations of sound over time. Taken together, these instruments and the sounds assigned to them constitute a generative system that exists within each work of Amergent music. Interactions within a mediated, technoetic environment "perturb" this system in ways that produce unique sonic behaviors additional to the novelty produced by the generative instruments. Biologists Humberto Maturana and Francisco Varela write, "Behavior is not something that the living being does in itself (for in it there are only internal structural changes) but something that we [as observers] point to" (Maturana & Varela 1992: 138). The musical behaviors produced by a generative system are not prompted deliberately, but through one's presence and relations in the technoetic environment.

CHAPTER 3

Generative Systems & Interaction

"It's clear that saying 'you may interact with the work' is not enough. More and more things in our lives are saying that, and we don't call them art."

– Brian Massumi, *The Thinking-Feeling of What Happens* (2008: 2)

This thesis takes a unique view of interaction in mediated environments. That these kinds of environments afford interaction at all is of course, in 2010, a given. As noted above by Brian Massumi, interaction alone is not enough to constitute a work of art. Certainly, a work of art can involve interaction, but so do computer games, mobile phone applications, web-based media, digital training, children's toys, and so on. Concerning the work at hand, sound and music also have roles to play that can enhance or accompany interactions in these various media platforms. The specific nature of that relationship—whether it substantially *enhances* or superficially *accompanies*—raises some very interesting technical and theoretical questions. Many of these have been explored in the course of the research that formed this thesis.

Some of the most productive outcomes concerning interaction have come from looking at biology. In a garden it is not uncommon to see that two plants of the same species may grow differently after their seeds have been sown at different ends of the plot. It is easy to think of numerous other examples in which biological processes produce simultaneous uniqueness within individuals and similarities across groups. Similar behavior can be found in synthetic biological processes. In artificial life, a cellular automata will develop differently for each unique set of initial conditions. Flocks, swarms, and other kinds of a-life systems exhibit a general behavior that provides a particular character—that which makes it look and behave as a flock or swarm. But on every occasion that the flock or swarm is initiated, the specific details of its behavior are unique.

The experience of mediated interaction has organic qualities as well. Unique circumstances can create very different experiences for someone visiting the same mediated environment on separate occasions. Unpredictable change on a variety of time scales—from moment to moment or day to day within a mediated space—is what differentiates the mediated environments discussed here from static media such as film, television, and musical recordings. If music is to operate in these environments it must also assume the same kind of organic tendency towards regular change and transformation.

3.1 Interactions as Perturbations

> Ongoing structural change of living beings with conservation of their autopoiesis is occurring at every moment, continuously, in many ways at the same time. It is the throbbing of all life. (Maturana & Varela 1992: 100)

Lifelike tendencies and behaviors are essential characteristics of technoetic arts. Mediated environments are marked by their emergent properties—the art, play or information experience to be had is one of emergent relations between images, sounds, ideas and so on. To think about music with an organic congruity to these dynamics it is helpful to look for biological paradigms that can be translated into musical paradigms. Artificial life helps bridge the gap between Generative music and biological life: like generative music it can produce continuous variety and like biological organisms it appears to be "alive." All of these things can be viewed as systems, where organic behavior is simply the result of a system's own operation.

3.1.1 Biological Autonomy & Autopoiesis

Discussions of life as a systemic process or the characterization of living things as "machines" can certainly call to question the quality and nature of life being espoused. This could be viewed as especially suspicious in an art practice that claims to celebrate the wonder and diversity experienced in the natural world. This language reveals an important distinction, however. For the work discussed in this thesis (and for many of the sources consulted) biological processes are celebrated for their unfolding rather than their final state. Or more broadly, this could be characterized as a greater interest in their becoming than in their being. Understanding the processes that give way to life is a complicated endeavor. Scientific reductionism would advocate the examination of individual components in a living thing. Once the constituent parts are understood the entire subject can be understood, which is true in cases where "…the whole can be treated as a *sum* of its parts…" (Holland 1998: 14). But for living things this approach is not always successful. As an alternative to "top-down" reductionism, artificial life advocates a "bottom-up" approach where the process of inquiry to understand life stems from an attempt to model it (Langton 1988). Organisms and living systems are modeled in computers and run to sustain themselves and/or the larger system to which they belong. Following Chris Langton's assertions about a-life (1988), the substrate is artificial but the processes of life are genuine, so while they are built like machines they act as if they are organisms. These ideas resonate in traditional biology as well.

Cybernetically-inclined biologists Humberto Maturana and Francisco Varela write that the defining element of all living things is their autonomy. Much of their work is based on their theory of *autopoiesis*. Autopoiesis, simply put, states that the product of any living thing is itself; there is no separation between the producer and the produced (Maturana & Varela 1992). In *Autopoiesis: organization of the living*, they define this functioning order in no uncertain terms:

> An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network. (Maturana & Varela 1980: 78-9)

The language that explains autopoiesis makes the connection between organic life and generative systems clear. Generative music systems have a sustaining order defined by their own processes. A "network of processes of production" can be compared to various generative instruments, particle swarms, and sound resources as components that comprise a system. A generative system is also a unity in the space that it exists. Whether it is part of a standalone work such as the *PSO-* series (discussed earlier) or a component to a larger work such as *Perturb* or *Sound Garden* (to be discussed later in this chapter), generative music systems have a discrete identity. To the listener it is a series of processes (sometimes visible as in the case of *PSO*) and collection of sounds that exists with them in a mediated environment. To the musician a generative music system is visible and editable as computer code.

Where these connections become less clear is in the regeneration of processes of production. For the works discussed in this thesis, there are many examples of novel generation but no specific instances of regeneration. A musical system that can, to use Maturana & Varela's words, "…regenerate and realize the network of processes (relations) that produced [it] …" (1980: 79) would be able to write additional rules that are added to the generative procedures, or be able to record itself and integrate those recordings into the body of sound material at its disposal. It is at this point where a direct comparison of autonomous systems and biological organisms that depend upon autopoiesis starts to fray. The theory of autopoiesis applies to individual biological cells but not to entire organisms. Maturana

and Varela make this distinction clear in *The Tree of Knowledge*:

> We know in great detail how a cell comes about as a molecular autopoietic unity, but how can we possibly describe in an organism the components and relations that make it a molecular autopoietic system? In the case of metacellulars, we are still ignorant of the molecular processes that would constitute those metacellulars as autopoietic unities comparable to cells. (1992: 88-9)

The complexity of the interactions between the cells that comprise a metacellular organism (a human for instance) is too great to simply transpose this theory in a scientifically sound manner. Autopoiesis, however, remains a powerful artistic concept.

Following his training involving cybernetics within art practice, Brian Eno has used many different processes to encourage creative autonomy. In the book *More Dark Than Shark* there is a reproduction of a schematic drawing for a work specifically titled "Autopoietic Music" (Eno & Mills 1986: 74). In 1978 Eno also wrote an essay entitled *Self-Regulation and Autopoiesis in Contemporary Music* for the (ultimately unpublished) volume *Challenge to Paradigm* commissioned by Stafford Beer (Eno & Mills 1986: 74). In the essay Eno discusses, amongst other works, "Paragraph 7" from *The Great Learning* by Cornelius Cardew. As it concerns autopoiesis, Eno emphasizes how factors surrounding the abilities of the performers and the acoustic resonance of the room in which the piece is performed can effect Cardew's instruction to, "Sing a note that you can hear" (Eno 1978: 6). In this case, what the work produces is taken back *into the work* and involved in the continued processes of production. Of course this situation becomes complicated when you consider that the mechanisms behind these processes of production are people, which constitute a kind of social group. This situation has its own set of difficulties making it hard to argue for genuine autopoiesis (Maturana & Varela 1992). However, there are definite similarities between Cardew's "Paragraph 7" as a musical machine and an autopoietic machine.

Cognitive scientist Randall Beer, writing on the autopoietic quality of cellular automata gliders in Conway's *Game of Life*, asserts that it can be productive to study self-organizing systems through the lens of autopoiesis (2004). From a scientific perspective this allows "…us to directly study the behavioral and cognitive implications of autopoiesis without first developing a complete theory of it" (Beer 2004: 312). Beer explained that the specific case of autopoiesis is too complicated to generalize the term in paradigms beyond its initial scope. Therefore, as it concerns Amergent music, *autopoietic* will be replaced by another term of Varela's:

> Autonomous systems are mechanistic (dynamic) systems defined as a unity by their organization. *We shall say that autonomous systems are organizationally closed. That is, their organization is characterized by processes that (1) are related as a network, so that they recursively depend on each other in the generation and realization of the processes themselves, and (2) they constitute the system as a unity recognizable in the space (domain) in which the processes exist.* (1979: 55)

The idea of organizational closure, or a system that is "organizationally closed" is related to autopoiesis. This term includes some of the qualities and characteristics required in autopoiesis—a network of self-producing processes; the unity solely defined within its environment—but excludes the idea of regenerating these processes. Varela's "Closure Thesis" states, "Every autonomous system is organizationally closed" (1979: 58). A generative music system like those discussed in this thesis cannot be compared directly to a biological cell because it lacks the recursive ability to regenerate the very processes that sustain it. However, because it is discrete in its environment, and has the ability to continuously produce itself out of the network of components that comprise it, the generative system is both autonomous and organizationally closed. It is not autopoietically alive but it is "livinglike" (Varela 1979: 59) in its operation.

Maturana & Varela's theories of biology and cognition are extremely helpful in explaining the technical workings of Amergent music. In both, autonomy is an essential quality. In Amergent music autonomy enables a continuous flow of music over indefinite periods of time within a mediated environment. However, this is not the most important reason to look at these systems. Varela reminds us:

> But what we should never forget is that one of the central intentions of the study of autopoiesis and organizational closure is to describe a system with no input or outputs (which embody their control or constraints) and to emphasize their autonomous constitutions… (1979: 56)

These systems are autonomous and *closed*. With no inputs and outputs, their functioning order is all that is available to them. Communication between these systems is therefore not a matter of sending and receiving messages, but of perturbation. Maturana & Varela define perturbation as "all those interactions that trigger changes of state" (1992: 98). In its autonomy, the organizationally closed system will undergo internal changes of state relative to external sources (the environment, other systems), but these entities on the periphery can in no way "…specify or direct them" (Maturana & Varela 1992: 75). All changes that an observer sees occurring *to* an organizationally closed system are actually changes *of* that system. In its autonomy, the organizationally closed system will only change in ways that support the continuation of its autonomy:

> …every structural change occurs in a living being necessarily limited by conservation of its autopoiesis; and those interactions that trigger in it structural changes compatible with that conservation are perturbations… (Maturana & Varela 1992: 100)

What Maturana & Varela state here as it concerns living beings is just as applicable to other systems that exhibit closure, as clarified by Varela:

> …no matter what our description of the system's purpose is, its behavior will be such that all perturbations and changes will be subordinated to the maintenance of the system's identity. (1979: 59)

Living things are subject to disturbances in their environment, or perturbations, that present a threat or challenge, or simply new set of circumstances that must be handled or overcome. Perturbation, and the idea that systems can both maintain and convey their autonomy, was crucial to this research. This behavior connects everything concerning musical generativity (as discussed in the previous chapter) and interaction (the focus of this chapter). Perturbations can be obstacles in the functional order of a unity and they can allow organizationally closed systems to interact, though their interactions are never tightly coordinated or specified between discrete unities. All interactions take place within an environment, which has an additional role to play in this mutual exchange.

3.1.2 Structural Coupling

When multiple unities coexist in an environment there can be a relationship of *structural coupling*. This is a biological phenomena described by Humberto Maturana and Francisco Varela as a history of "reciprocal perturbations" (1992: 75) between two or more living things, and these living things and their environment. The basic relationship is illustrated in figure 3.1.

Structural coupling exists, "…whenever there is a history of recurrent interactions leading to the structural congruence between two (or more) systems" (Maturana & Varela 1992: 75). This relationship of reciprocal perturbations triggers structural changes. These are never directed or specified, but they remain consistent within the autopoiesis of the individual unities involved.

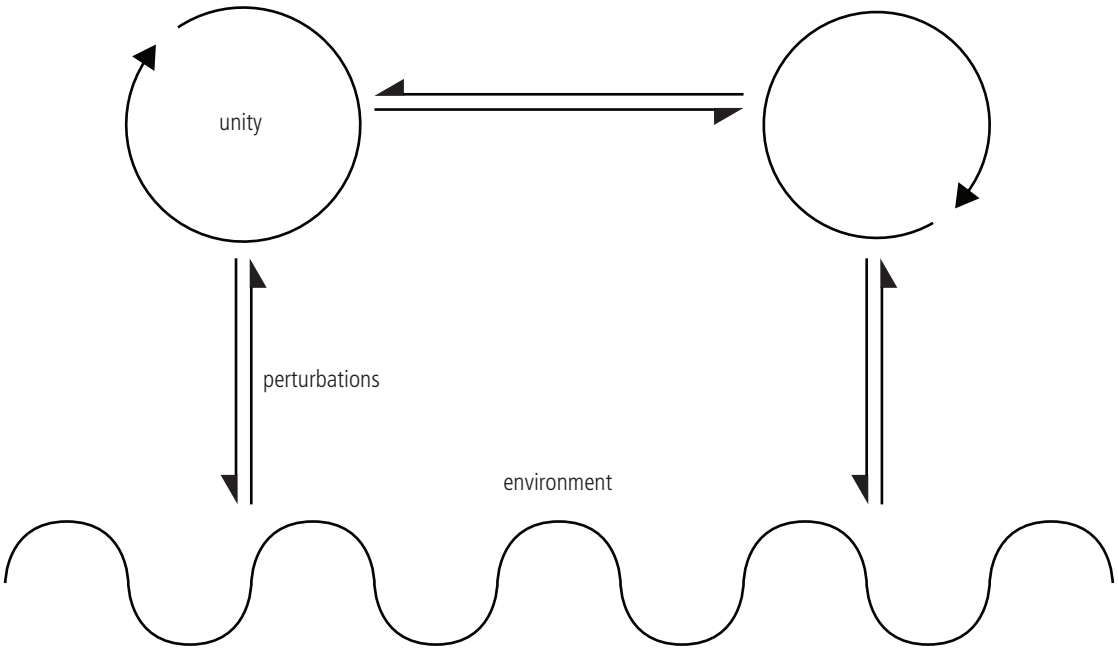

Figure 3.1: In Maturana & Varela's structural coupling (1992: 74), each unity is autonomous in its autopoiesis, and through its autopoiesis will make perturbations that are felt by adjacent unities and the environment in which they exist.

This idea is very useful for characterizing the dynamics of a mediated, interactive environment for Amergent music. To think biologically about music within a mediated environment is to think about events within that environment as perturbations to a generative musical system. In a biological structural coupling, any internal changes to a unity are always subordinate to the continuous functioning of it as a "machine": "Thus any relation between these changes and the course of perturbations to which we may point to, pertains to the domain in which the machine is observed, but not its organization" (Maturana & Varela 1980: 80-1). This is also like the relation of shifting sonic textures triggered by interactions in a mediated environment. Though I (as artist/creator) *do* know that these are linked to the machine's organization, the affect on the listener is more like the experience of observing a living system. To the observer, the machine persists and thrives in its environment while its organization is unchanged by "handling" the perturbations it encounters. Similarly listeners are affected by sonic changes as a result of their perturbations but are unaware of the mechanics responsible for what it is they hear. With a few semantic modifications, structural coupling is an excellent way to frame the relationship between a person and generative music system in works of Amergent music.

3.1.3 Struct*aural* Coupling

Structural coupling belongs specifically to the domain of biological systems. It is a relationship that requires autopoiesis, and as such, should only be discussed as a mechanism of organic life. As Maturana & Varela have noted, autopoiesis applies to individual cells and should not be scaled or transposed to include higher levels of organization in an organism (1992). However, the concept is very powerful in the realm of academic study and artistic creation, and can be simplified in ways that preserve its creative potential but remain consistent with Maturana & Varela's theory:

> Autopoiesis is a case of, and not synonymous with, organizational closure, and the autonomy of living systems is a case of, and not synonymous with, autonomy in general. However, because of the kind of detail we have in our knowledge of living systems, and because there are some particularly minimal cases such as the cell, the basis of autonomy is clearer in living systems… (Varela 1979: 57)

All autonomous systems are organizationally closed, particularly the generative systems employed in Amergent music. Therefore, to maintain the unique distinction that places autopoiesis firmly in

the realm of the biological, I will say that the relationship between an autonomous, organizationally closed human listener and an autonomous, organizationally closed generative music system is struct*aurally* coupled (see figure 3.2). This relationship forms the basis of Amergent music.

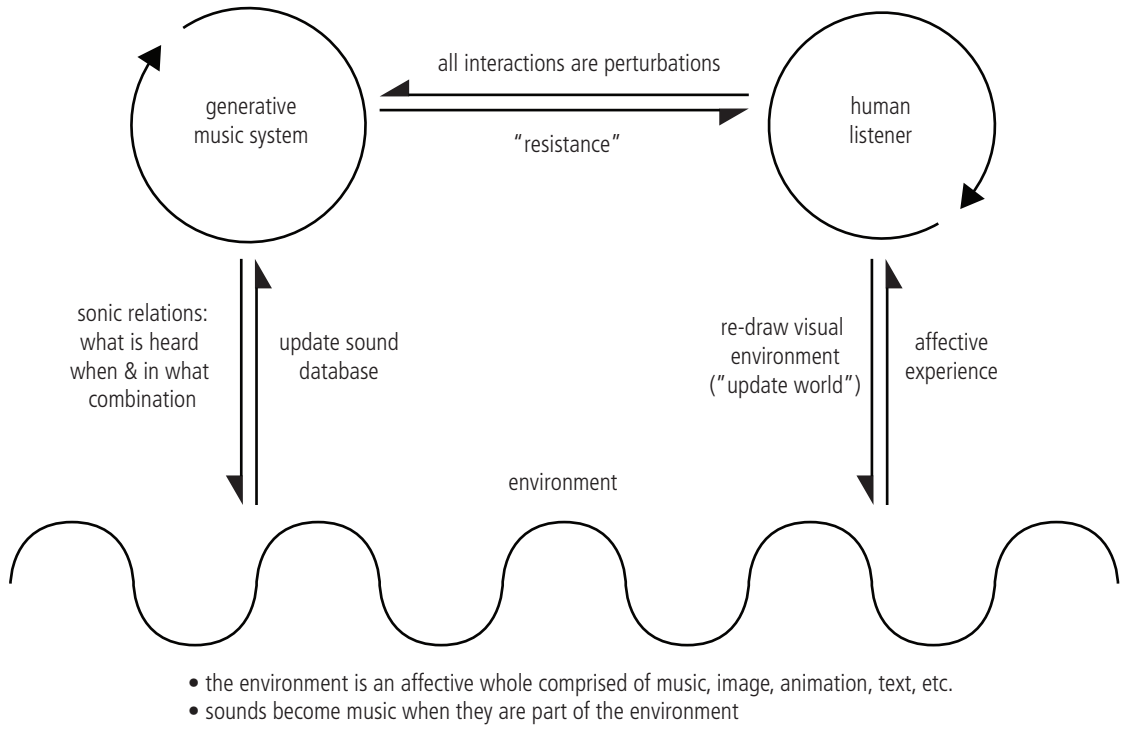

Figure 3.2: Struct*aural* coupling is the relationship of mutual perturbations between organizationally closed unities: a generative music system and a listener. The model (when in use/in context) creates a fluid stream of musical experience. Though it is often unclear how or where the perturbations that establish coupling begin, the listener develops a sense of congruence with the world through the music that comprises (a part of) it.

Struct*aural* coupling takes the same overall form as structural coupling in biological systems. There are mutual perturbations between organizationally closed—not autopoietic—unities. These perturbations characterize the kinds of interactions that take place between a generative music system, the listener within the mediated environment, and the environment itself. All interactions are recurring, which leads to continuous structural changes that are triggered, yet never specified. All changes remain compatible with the preservation of each unity's organizational closure. To borrow a phrase from Maturana & Varela, this is the "throbbing" of Amergent music.

A generative music system as a unity in this coupled arrangement consists of one or more generative instruments, a collection of sound file resources, and the rules or organization that defines the relationship between instruments and their audio assets. These rules are also the processes that comprise the organizational closure of this unity. Whether it is a timer, randomizer, or a-life algorithm, these processes run continuously. As it concerns the theoretical side of the model discussed here, continuous processes define the unity within its environment; as it concerns the artistic side, they generate novel data streams leveraged towards the production of music.

The listener is also an organizationally closed unity in a struct*aurally* coupled arrangement. Their biology defines them as such, but so does the process of mediation. Their unique abilities in the mediated world (as enabled by software) separate them from their environment. The environment is the mediated world that unifies an experience binding listener to music. In addition to music it can be comprised of images, video, animation, text, seeds of a narrative, and in some cases, other unities. Any perturbations made by the listener resonate both to the generative system and the environment. Similarly, the generative system perturbs the listener and environment, and the environment can per-

turb the listener and the generative system. The specific natures of these perturbations are unique to individual works of Amergent music and will be detailed in the projects discussed later in this thesis.

Other unities may be struct*aurally* coupled in this relationship as well, but for the sake of simplicity, this introductory description will be kept consistent with Maturana & Varela's original design of two unities in their environment. A single perturbation can originate from any of the three components and resonate throughout the entire struct*aurally* coupled system. There is no teleologic connection that specifies or directs individual changes. Rather, the perturbed components each adjust their structure while maintaining organizational closure:

> Despite the perturbations a unity receives, it is no mere puppet of its environment. Rather, a unity actively determines its own domain of interaction. At any point in time, a unity's structure specifies both the subset of environmental states that can influence it and the interactions with those states in which it can engage without disintegration. (Beer 2004: 316)

In this arrangement perturbations initiated by a listener are the easiest to understand. When such a perturbation occurs, it triggers structural changes in the generative system, which could call for an alteration of the behavior of a generative instrument or an update to the list of available sound files. Whatever the case may be, these changes are dependent on the dynamics and closure of the generative system. This same perturbation could also trigger changes in the environment that lead to cueing an animation or opening the possibilities of a new narrative thread.

The generative music system is a source of continuous perturbations. As the various generative instruments play they act on the available sound files to create a continuous stream of sonic relations that perturb the environment as they become music. Maturana & Varela refer to the environment as "… the ambience in which it [a living being] emerges and in which it interacts" (1992: 95). Sounds flow into the environment and become music. This affects the qualitative experience of the environment, which is in turn one dimension of the perturbations resonating from the environment to the listener. As it regards the environment, listeners take in music and images and are perturbed in the course of their affective experience. The environment also perturbs the generative music system. Transformations in its overall makeup trigger changes that can cause the addition or subtraction of available sounds. Finally, to complete the cycle of mutual perturbations, the generative system perturbs the listener.

This is one of the most complex and important perturbations in the struct*aurally* coupled interaction model. Part of what it triggers in the listener is due to the affect of music—the perturbation that resonates from environment to listener. While the listener does not have direct or immediate control over what happens in the music, after a few reciprocal perturbations have passed, it becomes apparent to listeners that their actions have a congruence with the music. The arrangement of struct*aurally* coupled interaction makes it impossible to control anything directly, but a relationship becomes audible over time. It also becomes "tangible" in a sense. There is no direct contact, but through the same structural changes in the generative system that lead to new musical directions, there is a perturbation that pushes back, *against* the listener. This is a quality of musical instruments, something that Aden Evens refers to as "resistance." He explains:

> Defined by its resistance, the instrument does not just yield passively to the desire of the musician. It is not a blank slate waiting for an inscription.…The instrument itself has a potential, a matter to-be-determined, and its use is always in relation to its own character as well as to the desire of the musician.…Neither music nor instrument is predetermined, set in a specified direction from the beginning.…The instrument's resistance holds within it its creative potential… (2005: 160-1)

The generative system pushes back to let the listener know its bounds and the possibilities it affords.

The kinds of sounds that can be heard, overall texture and density, emergent melodies and placid spaciousness—these are all sonic qualities under the control of the generative music system. The management of incoming perturbations causes this system to undergo structural changes that maintain organizational closure within its own "structural determination" (Maturana & Varela 1992: 96). This means that the system of a biological cell will change but only within the range of possibilities afforded by its structure. This is similar to the structural determination of a musical instrument. An FM synthesizer cannot behave like a sampler; a trumpet cannot sound like an accordion. There is a wide range of sonic possibilities in synthesizers and brass instruments but there are also limits set by their structure and materials.

Within the range of possibilities these instruments possess there is resistance. The buzz of the reed on the saxophonist's lips or the pinching strings at the guitarist's fingertips offers resistance. "The musician applies force to the instrument, and the instrument conveys this force, pushing sound out and pushing back against the musician" (Evens 2005: 159). In biology, Humberto Maturana sees this same kind of relationship in structural coupling and calls it a *consensual domain*. He says:

> If the two plastic systems are organisms, the result of the ontogenic structural coupling is a consensual domain, that is, a domain of behaviour in which the structurally determined changes of state of the coupled organisms correspond to each other in interlocked sequences. (1975: 326)

A consensual domain, like resistance, is found in the mutual perturbations that exist between person and generative music system. A person interacts in their mediated environment and perturbs the generative system; the system reciprocates with its own perturbations. Struct*aurally* coupled interaction is not tangible and has no kind of physicality. It is aural changes of timbre, tonality, and sonic density that all act to provide resistance and create a consensual domain. As the listener negotiates the environment of mediated interaction, what they do and what they hear are closely related in the course of their experience. Audible changes "push back" to let them know what is and is not possible, musically and otherwise.

This kind of resistance is unique because it allows the environment of struct*aurally* coupled interaction to behave like an instrument. However, because there is musical autonomy in the organizational closure of the generative system, there is also an element of composition. Like a composed work of music, it is possible to listen to the environment for what it is and what it becomes. And like an instrument, it is possible to "play" the environment by engaging in different kinds of interactions. Thus, works can *play* and *be played* simultaneously. The technique of combining elements of composition and instrument is familiar to other musical endeavors. There is much to be learned from these approaches that can enhance the further practice of Amergent music.

3.2 Composers, Instruments, & Composed Instruments

As contemporary technology develops new devices or packs more power and capabilities into smaller and smaller containers, "software and gadgets for music" grow and diversify quickly. Along the continuum between *composition* and *instrument* there is an enormous variety of projects and art works. Concerning the research at hand, projects nearest the center of the continuum—those with the most even blend or tightest integration of the two—are most relevant to the discussion. Others, while technologically interesting and artistically viable, just don't have enough in common with Amergent music to be included here. Such an example situated too far down on the instrument end of the continuum is Tod Machover's *Toy Symphony* (Machover 2010). This work, like the *Music Toys* instruments designed by Machover and his team at the MIT Media Lab, is highly interactive and sonically rich. But the overall focus favors musical performance; Amergent music is more listening- and listener-centered.

At the other end of the continuum are works like *I am sitting in a room* by Alvin Lucier (Lucier 1990) or *4 ROOMS* by Jacob Kirkegaard (Kirkegaard 2006). In each, a room or enclosed space is used as a kind of instrument. A recording is played into the space and is transformed by its acoustics. This process is recorded and becomes the next generation to be played when the process is repeated. After several iterations (32 for Lucier; ≤10 for Kirkegaard) the densely-packed layers of filtering and resonance create the final musical work. Composition and instrument are clearly linked as a process and the environment in which it unfolds, but the works account entirely for listening and have no provisions for interaction or perturbation. Amergent music and the kinds of interaction supported through struct*aural* coupling require a more delicate balance of composition and instrument.

3.2.1 Michael Hamman's Open Episteme

In discussing the use of computers in musical composition, Michael Hamman recognizes a synergy in the creative efforts behind realizing the musical work (composition) and developing the tools that facilitate this process (instruments). He writes of the mutual determination between technological instruments and the works they create:

> These efforts reinforced the notion that just as one might compose musical and acoustical materials per se, one might also compose aspects of the very task environment in which those materials are composed. (1999: 96)

Michael Hamman emphasizes that these kinds of "task environments" are more creatively productive when they are designed around an "open episteme" (Hamman 1999: 95). *Episteme* is borrowed from Michel Foucault. Used in this context, it refers to the process by which the description of a mechanism is revealed, and how that description forecasts an output by the mechanism. Hamman describes a "closed episteme" as one bound to cultural, technical, or historical expectations. These leave little room for innovation because their use is assumed based on prior exposure or understanding. An open episteme is one in which the frame for understanding is emergent. The mental model of its use changes relative to the particularities of an interaction with the mechanism at the time of interaction.

The open episteme offers a porous understanding, "open to input from a particularized situation" (Hamman 1999: 95). A struct*aurally* coupled relationship leads to such an understanding because the mediated environments that facilitate this approach are themselves open, and produce unique outputs relative to the myriad interactions conducted within them. This makes the frame for understanding a struct*aurally* coupled system emergent—its dynamics will always be specific to an interaction at a certain time, in a certain place, and under certain conditions. As the circumstances of the interactions shift, the system's outputs shift. Most significantly, the person engaged in interaction experiences an emergent shift in their reception of that output and in their mental model of the system and its possibilities. This is, to use Evens' term, another form of *resistance*. When compositional and instrumental activities are blurred, the instrument pushes back to reveal the unique potentialities of the situation.

3.2.2 Encoding the Musically Possible

Computer-aided composition reveals much about the creation and experience of real time music. Software is able to capture and recreate the creative process of a composer and preserve it as a sort of artifact or algorithmic process. A composer can use software to formalize processes into rules and let these determine the direction of a new work. Otto Laske writes:

> In contrast to model-based thinking, **rule-based compositional thinking is not based on the analysis of existing music, but *on an awareness, if not an analysis, of compositional processes.*** (1989: 48)

Laske emphasizes that composers are highly attuned to the difference between the "possible" and

the "pre-existing" in a musical work (1989: 54). Whether they are planning for a piece or putting instructions down for a performer, they have to correlate their imagined experience (inner-ear listening & imagination) with the mental experience of the player who will interpret the instructions and audience member who bears witness to this realization. While Laske's specific approach differs greatly from that used to create Amergent music, there is a common resonance in the idea of imagining the musically possible. Efforts to create music stem from modes of thinking than ask "what if?" rather than express "because." David Rokeby discusses this as a confluence of intentions between the composer and the one playing the composer's instrument:

> The music becomes a function of both the inner world of the creator's personal vision and the outer world of physical reality. Each are drawn into a creative relationship with the other through the mechanism of the instrument/composition. (Rokeby 1996)

From the perspective of this research, generative systems create music based on a set of processes or rules designed around this author's musical sensibilities. These are then set into motion and perturbed in the course of interaction within a mediated environment. With Amergent music, interaction and music-making are concomitant.

3.2.3 Composing Instruments: David Wessel & Ali Momeni

Musical interaction in mediated environments and with electronic devices can carry with it a "fun" factor, which can prompt the question as to whether the experience is a game or a toy. As discussed earlier, works such as Toshio Iwai's *Electroplankton* is a fine example of the blurriness that is created when compositional processes are brought to the fore in the design of a device or activity. David Wessel comments on this as an essential consideration of instrument design. Ideally he calls for computer-based instruments with a "low entry fee with no ceiling on virtuosity" (Wessel & Wright 2002: 11) which means the instrument has a gradual learning curve and can sustain a lifetime of musical curiosity and development. A solution he proposes for this is that the instrument be "composed" (Wessel 2006: 94).

The most lucid definition of a composed instrument comes from Wessel's student, Ali Momeni, who writes:

> The compositional work is in the ergonomic and mechanical design of the instrument, the representation and organization of the material, the generative real-time software at its heart and the interaction between the performer, software and instrument. Design decisions in the physical form of the instrument as well as its virtual inners are made based on the artistic constraints imposed by each project. (2005: 41)

This makes the process very clear and reveals similarities between their notion of composing instruments and the ideas discussed in this thesis surrounding struct*aurally* coupled interaction in Amergent music. While ergonomics are not always a part of the creative process, the organization of material, the coordination of generative software with interaction, and an overall aesthetic that works within a project's artistic constraints are certainly crucial to the development of Amergent music. All of these will be addressed throughout this thesis, but as it concerns struct*aurally* coupled interaction, the relationship with generative software is especially pertinent.

For Wessel & Momeni "generative real-time software" is the aspect of a digital instrument that introduces elements of 'the organic'—a generative algorithm ensures a sonic output that has variation within a range. When Wessel writes about a computer-based instrument that engages the senses of the performer, he specifically calls upon "generative algorithms worthy of extensive exploration" (2006: 93). These are crucial in making the instrument capable of sonically rich outputs; more than a binary on/off sort of controller. Amergent music similarly employs generative processes to produce unex-

pected and novel combinations of sonic material. Composed instruments have their algorithms working to expand the variety of sound produced through human-directed, physical gestures. But in the end, variety and an expansion of sonic possibilities show that both approaches have similar objectives.

The struct*aurally* coupled interaction of Amergent music and that of composed instruments are different in the relationship that is created between the art work and one's use or experience of the work. Composed instruments are used or performed. They are created for musicians to use in *a particular* performance or as a general performance instrument (Wessel 2006; Momeni 2005). Struct*aural* coupled interaction in Amergent music is a more general musical technique that can be employed in a variety of mediated environments. The research conducted to support the ideas in this thesis is about affect within a mediated experience of music. This work is primarily focused on the relationship between people (listeners) and sound within mediated environments. Choices and actions in a mediated space reveal new melodies, harmonies, timbres, and textures that speak directly to one's situation.

However, there is an element of "instrument" throughout this discussion. The connection between listeners and sound in an environment with struct*aurally* coupled interaction has profound similarities to the relationship established between musician and instrument. In writing about the emerging potential for instruments that behave as compositions and vice-versa, David Rokeby writes:

> An instrument contains a large number of simultaneous sound possibilities. Music is conventionally, an established sequence of these possibilities strung out through time. Somewhere between music and instrument there exists the possibility for a kind of labyrinth of sound, where there are many possible paths through one composition… (1996)

While Amergent music takes a more expansive view of "possibilities" than would be suggested by a labyrinth, it resonates with Rokeby's statement. Unlike a musical instrument that can be explored as an individual object, a work of Amergent music is coupled to interactions within a mediated environment. Musical possibilities lie dormant within; only through an engagement of the environment and perturbations to the various systems that comprise it will the music be fully realized.

3.3 Music & Structaurally Coupled Interaction

Two projects, *Perturb* and *Sound Garden*, were initiated to experiment with the ideas of struct*aural* coupling in a musical work and explore what happens when those who participate have an audible role in shaping the music. These pieces were created through the confluence of artistic priorities and funding opportunities. The grants that funded these works demanded that the final piece be shown in a public space. For *Perturb* this meant an art gallery; for *Sound Garden* the project had to be installed somewhere on the Bloomington campus of Indiana University. These public settings somewhat change the diagram for struct*aural* coupling that was presented earlier as shown in figure 3.3.

Randall Beer describes this situation as a unique case of structural coupling:

> An especially interesting and important special case of structural coupling occurs when multiple unities share the same environment. Not only do such unities interact with their environment, they also serve as mutual sources of perturbation to one another. Indeed, to any particular unity, other unities literally are a part of their environment. (2004: 318)

In biological systems where there is structural coupling, and in mediated environments where there is struct*aural* coupling, multiple unities can exist. For biological systems this means additional cells; for *Perturb* and *Sound Garden* this meant additional people. While this did constitute an additional amount of perturbations that had to be handled by a single system, it did not necessarily complicate the situation. Each system is autonomous in its organizational closure, which means that all perturbations are handled similarly and subordinated to the ongoing maintenance of this closure. The source

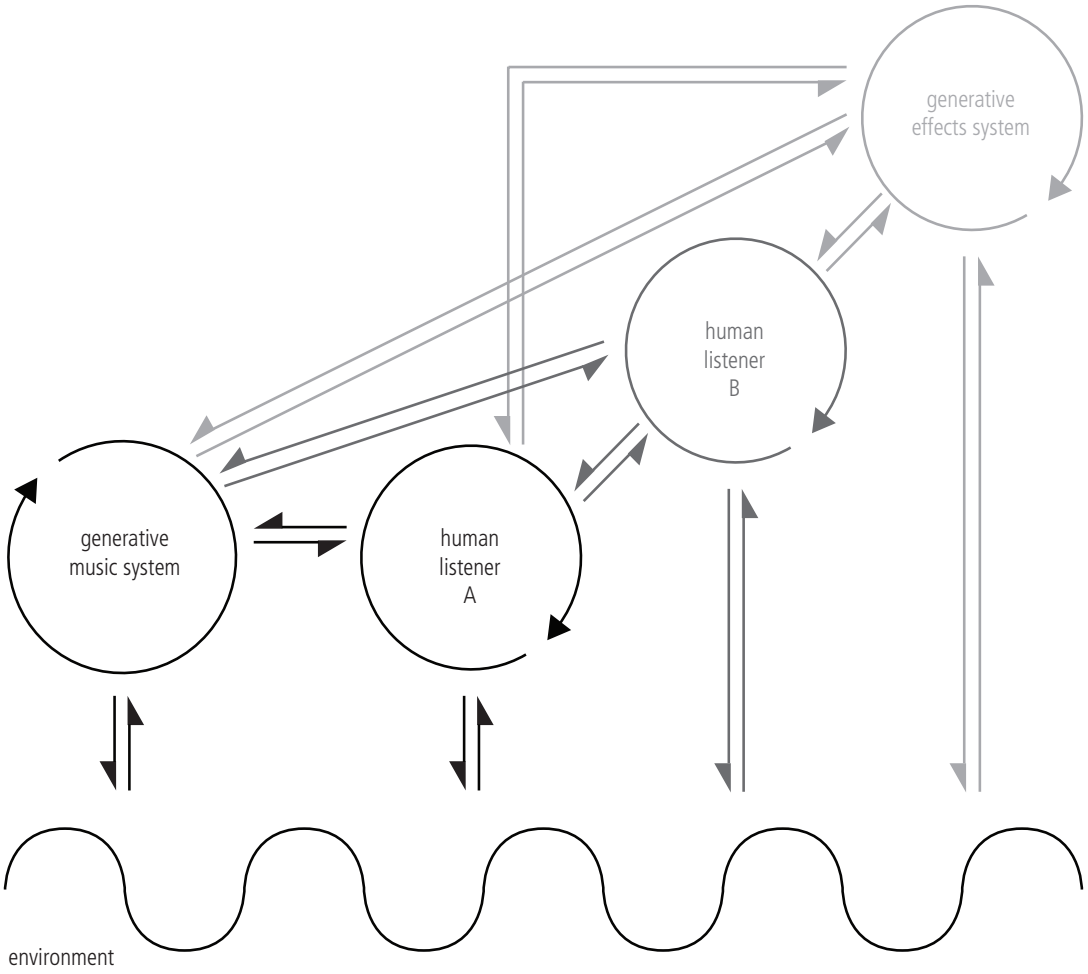

Figure 3.3: Struct*aural* coupling can support multiple unities. In the case of *Perturb* and *Sound Garden* this meant additional people, but it could just as easily include additional generative music systems.

of a perturbation is less significant than the fact that there *is* a perturbation to be handled. In Maturana & Varela's words, the perturbations of one organizationally closed system are "indistinguishable" (1992: 75) from those of another or from the surrounding environment. Autonomy and closure lead to coupling, and are the most important aspects of maintaining a congruence between adjacent systems as they undergo reciprocal interactions and perturbations.

3.3.1 Perturb: triggering structural changes in the generative system

Perturb is an open work of distributed musical authorship. This was the first piece that implemented struct*aurally* coupled interaction. As discussed earlier in this chapter it put gallery visitors into the simultaneous roles of listener, performer, and composer. *Perturb* (see figure 3.4) is offered on a single personal computer with attached monitor, keyboard, and mouse. These components are situated in a physical environment and surrounded by four loudspeakers to spatialize the sound of the piece. For additional images and sounds of *Perturb*, see appendix section 4, and section 3 in the supporting DVD.

When it is first installed, *Perturb* generates a very simple sound—a kind of primer for an aural canvas. Visitors are encouraged to construct or join in the performance with their own short recordings, samples, soundscapes, and found sonic objects. Apart from the primer sounds, additional audio material is provided entirely by gallery visitors in either of the following ways: visitors may add their own sounds to the piece by copying them to the *Perturb* computer from a personal recorder, hard drive, iPod, or USB flash memory drive. Or, they can borrow from their collaborators and choose among the sound files already copied to *Perturb* by others.

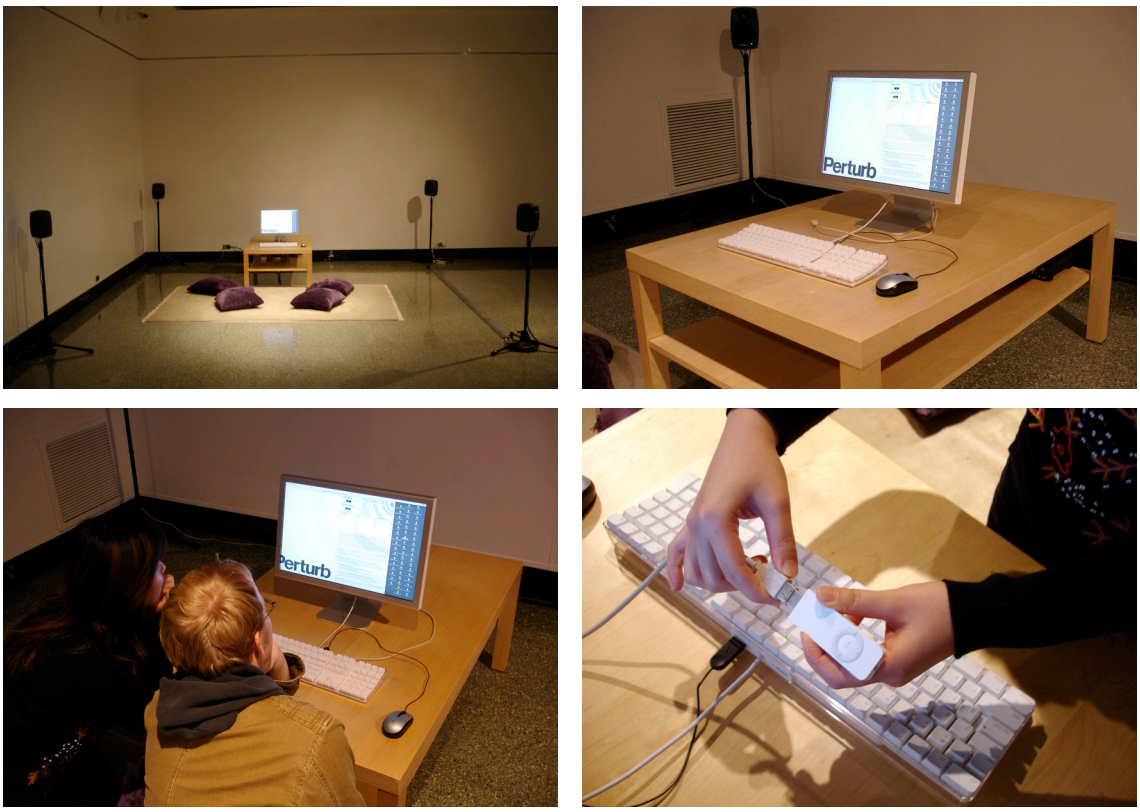

Figure 3.4: *Perturb* was exhibited at *Perform.Media: Transdsiciplinary festival and symposium of creativity, research, theory and technoculture*. September 29-October 14, 2006 at the SoFA Gallery, Indiana University, Bloomington, Indiana, USA.

Pertub uses the particle swarm system (Kennedy & Eberhart's PSO algorithm) that was the foundation of my earlier PSO works. However, in this case the particle swarm is used primarily as a triggering mechanism. The *Perturb* interface sends messages to software written in Max/MSP. Each message communicates which audio file to play, at what volume, at what position in the quadrophonic field, the reverb parameters to apply, and the envelope to shape a sound's playback. For details, see table 3.1. Data from the swarm works to mix the loaded sounds with each other and the primer sounds to create a continuous musical flow from disparate and seemingly incompatible sources.

Table 3.1: Swarm data and sound generation for *Perturb*

sound parameter	swarm parameter at the moment of new pbest
sound file	Sound files are triggered at random. This technique creates repetitions but enables the playback system to be more responsive, as there is no lag between the time that a sound is added as an input and the time when it may be heard playing through the system.
volume	Volume for each sound file is set randomly within 12.5–100% of the audio system's playback capabilities. To ensure consistency within a body of sounds of an unpredictable dynamic range, this parameter value does not draw from swarm dynamics.
pan	The position of an agent relative to the target determines the placement of a tone within the quadrophonic (four speaker) field.
reverb distance	The difference between horizontal and vertical velocity (Math.abs(xVelocity–yYelocity)) sets the distance parameter for a reverb effect. This processing is applied to each sound as it is played.
pan adjust time	Overall fitness for the entire swarm determines how quickly pan values are updated. A swarm that is very near the target updates pan values quickly and vice versa.
envelope	An agent's personal fitness determines how quickly a sound will fade in and out on playback. High fitness (an agent is nearer to the target) creates quick, clean fade durations, while low fitness leads to long, gradual slopes to or from a sound's determined volume level.

The main motivation behind *Perturb* was to provide public access to the sound resources of a generative music system, and to create a situation in which gallery visitors directly participated in the musical work. In most generative music works, the rules (generative instruments) and sounds that comprise a system are in a black box. Listeners are usually able to start and stop a system, or enter and leave if the music is playing in a specific location. But what happens within that frame is largely outside of their control. *Perturb* intended to break open the black box and explore a more hands-on experience of generative music.

The sonic material that makes up part of a generative music system has enormous influence on the output and character of the system. In most cases of generative music, it is probably customary to think about sonic material as the input of a system. But in the case of Amergent music, sound samples, digital synthesizers, and virtual instrument patches are all crucial components *of* a system. These sound resources, plus the generative instruments that play them, are organizationally closed and constitute a discrete unity in a struct*aurally* coupled relationship. As discussed earlier, there is no input; no way to direct the operation of the system. It can only be perturbed. The system will function autonomously in its handling of external forces.

Perturbations that can affect the operation of the generative system come from people and the overall environment that constitutes the work. In this piece, an interaction (or perturbation) is introduced by making a sound file available to the generative system. This seems like the very definition of *input* because the sound file is literally *put into* the system for processing. However, in the conception of struct*aural* coupling behind Amergent music, this is viewed differently. Providing a sound file does not direct a generative instrument to play it instantly. It does add to the body of available sound resources, but the manner in which the generative instruments work through these is dictated by their own operation. What sounds are played and when is beyond the control of a person in this interaction scenario, which makes providing a sound file less an act of input and more of a perturbation. Conversely, removing a sound from the queue constitutes a perturbation because this act has no control over what the generative instruments do. Adding and subtracting sounds simply demands that the instrument(s) update their functioning order to reflect the change introduced by the perturbation.

As different sonic combinations are realized through the operation of generative instruments and the sounds available to them, the music can drift from bright to dark, optimistic to uncanny. With *Perturb*, the transparency of this behavior is its *raison d'être*. Generative music can change and develop in myriad ways, but largely this is out of one's control. The musician creates a generative system, turns it loose, and listens to what happens. Within environments of mediated interaction this kind of behavior is ideal to accommodate situations in which the duration of someone's experience is unknown. When possibilities for interaction are included, the situation becomes additionally ambiguous. Not only is time or duration in question but the events that constitute the experience are unknown. Amergent music was developed in the course of this research to address this incompatibility between linear music and nonlinear mediated experience. A generative approach provides a good means of extending musical sound indefinitely in time, and to further accommodate the unpredictable twists and turns that happen within that frame, it became necessary to perturb the generative system in ways that were congruent with the other events in the mediated environment. Early attempts to experiment with these ideas and demonstrate them proved to be too confusing. There were too many variables involved to create a situation that could effectively question aesthetic issues and provide a lucid solution that was technically and artistically viable. *Perturb* was the project that finally brought all of these concerns together in a single work.

The earliest versions of the work provided a "library" of sounds to choose from. While this achieved (to this author's ears) satisfactory results, I did not believe that others would find it to be as interesting. The problem was that it was "my stuff" that was made available to them. Someone unfamiliar with

my music and perhaps unfamiliar with how sounds can blend and mix when played simultaneously would not be able to clearly hear the results of their perturbation. They could read the names of the available sounds and the names of those playing, but it was difficult to make a meaningful connection between these labels and what they heard. This deficiency undermined the entire project and thus it had to be re-visited.

There were several possible directions that provided a solution. The one that preserved the integrity of my initial inquiry involved allowing visitors to supply and remove their own sounds from the generative music system. This was successful because it was immediately easier for people to relate to the structural change triggered by their perturbation. The sounds with which they *perturbed* were their own; this substantially strengthened their connection to the music.

Of course this arrangement also opened the door to the possibility of noise: too many incompatible sounds, excessively loud sounds, and so on. In my view, however, these were minor concerns. The overall situation *Perturb* creates is much like a collective, free improvisation. In the way that musicians who play in this style have a shared or common vocabulary (Prévost 1982; Warburton 2005), and use listening as a primary strategy in their performance (Bailey 1992; Borgo 2005), the musical situation creates an expectation for people to demonstrate sensitivity and creativity in their perturbations. And in cases where the range of perturbations is stretched further than expected, the work potentially opens ears to different and even opposing sets of musical sensibilities. The interface of the system requires that people enter their name when they made their perturbation. In the way that social networking sites and online discussion forums require an identity, so does *Perturb*. There is no way to guarantee that people submit their real name, but it does accord a degree of responsibility and ownership in the generative performance. All audible sounds are listed alongside the name of the person responsible for adding them to the piece.

The links between this work and free improvisation will be explored in greater detail in discussions of the project *Sound Garden*. More importantly to the immediate concerns of this piece, *Perturb* clearly demonstrates that the shifts occurring naturally in a generative musical work can be leveraged towards creating greater musical depth in technoetic and media arts. In a struct*aurally* coupled relationship, perturbations that trigger structural changes in the generative system forge a more substantial connection between listener and music. The perturbing listener is partly responsible for what they hear. In the case of *Perturb*, they have an especially close relationship because they may have taken the time to record and edit a sound file for the piece, and may have removed others' sounds from the mix to make room for their own. While *Perturb* does not address all artistic and musical concerns prevalent to Amergent music, it was a crucial step in the process of refining the relationship between people and music in mediated environments.

3.3.2 Sound Garden

Sound Garden is a musical installation that explores the relationship of people, location, and music relative to technology. The practice of gardening and the concept of music growing from a seed is a favorite metaphor used by Brian Eno when discussing generative music (Darko 2009; Eno & Wright 2006; Toop 2001). *Sound Garden* (see figures 3.5 & 3.6) was created to explore this metaphor in a more direct way and to extend the concepts of *Perturb* through telematic collaboration and environmental sensors. Additional images and sounds of *Sound Garden* are in section 4 of the supporting DVD.

Sound Garden is a continuous work—a persistent musical environment—meaning it is not defined by a performance of any particular duration. Listeners situate themselves in the garden at the installation site or listen to the web stream and remain indefinitely. The music of *Sound Garden* is characterized by unique sonic events heard in the moment—both sounds that nurture the garden and environmental perturbations that affect its development and transformation.

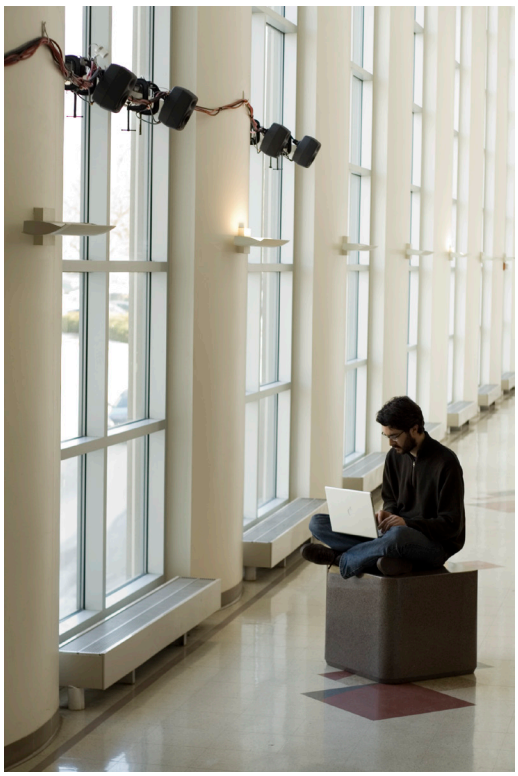

Figure 3.5: *Sound Garden* was originally completed for Arts Week 2007 at Indiana University, Bloomington (USA). The project was installed in the atrium of the Radio-TV Center from February 21–March 7, 2007.

Figure 3.6: *Sound Garden* was selected for the 2009 SPARK Festival of Electronic Music and Arts at the University of Minnesota (USA), and was installed in the skyway at the Regis Center for Art, February 17–22, 2009.

Like *Perturb*, *Sound Garden* provides an interface that complements the physical activities of organic gardening by allowing listeners to tend a continuous sonic environment and take an active role in its organization and care. One important difference, however, is that the *Sound Garden* interface is online, which means listeners do not need to be at the site of the installation. In keeping with the physical work associated with organic gardens (planting, watering, fertilizing, weeding, pruning, etc.) listeners use this interface to "plant" their own digital audio files (musical material, voice and environmental recordings, etc.) in *Sound Garden* and become "gardeners" that form the overall sonic landscape of the environment.

Each uploaded sound is unique, allowing the "seeds" that are planted to significantly affect the primary characteristics of the garden. Again, following the model of *Perturb*, generative musical instruments in the system "grow" these seeds and create the overall musical experience of the garden. The piece is also largely shaped by events that occur at the site of the physical installation. Environmental sensors tracking ambient light levels, temperature, motion, and vibration act on individual sounds that make up the garden (see table 3.2). These sensors serve as additional sources of perturbation to the generative music system, and trigger a variety of signal processors that can further transform the music. As environmental conditions shift and change, the sensors reflect that change in the garden's continuous musical growth and development.

Table 3.2: Sensor data and digital signal processing parameters for *Sound Garden*

sensor type (#)	location	signal processors driven by sensor values	discussion
light (2)	#1: facing the exterior of the installation space through glass	reverb: early reflections vocoder: pulse period, pulse width, filter Q	As the amount of light (from natural and artificial sources) shifted throughout the day, the ambience of the installation space would shift in kind. Reverb was used to complement these transitions such that when the room was bright, sounds were very immediate and present. When the room was dark, sounds became more distant and enveloping. Similarly, pitch shift was used to raise the pitch with increased light and lower it as light diminished. Vocoder parameters were sensitive to gradual shifts in the light and processed signals accordingly.
	#2: facing into the installation space	reverb: decay time, high-frequency dampening and bandwidth vocoder: filter Q pitch shift: pitch and low-pass filter	
temper-ature (2)	inside computer cabinet	envelope generator: speed, grain reverb: tail level vocoder: pulse amplitude	The temperature inside the computer cabinet was usually high (70º-80ºF), while the temperature at the window frame tended to be rather cold (40º-50ºF), as this project was installed in the winter months. Reverb tail level was set by tracking the difference between these levels. At night, when the outside temperature dropped consid-erably, greater differences produced long, reflective reverberating decays. Vocoder parameters were sensitive to subtle temperature shifts and processed signals accordingly.
	attached to window frame	envelope generator: speed reverb: tail level vocoder: noise threshold	
vibration (1)	above entry to public hallway	envelope generator: enve-lope shape	The envelope generator was used to transform long, sweeping washes of sound into punchy, rhythmically an-gular bursts. As much as I would have liked to generate envelopes based on sensor data, no data sources were suitable to produce the desired effect. Instead, the proj-ect used preset envelopes that were triggered to change every time there was enough air movement through the installation space to send the vibration sensor over its threshold.
motion (1)	facing floor or public "walking path" of installation space	matrix controller: mix settings	Sound signals routed to Max/MSP were further routed to various digital signal processors. Processors could be chained together and fed back in a variety of configu-rations. For instance, a droning sound routed to the envelope generator could become rhythmic, and then be patched into the reverb processor to take on a new, wave-like quality as the rhythmic bursts ring out with reverberation. Mix configurations were set in advance to prevent accidental feedback loops and potential damage to the audio equipment. When someone walked through the installation space a new mix was triggered and one set of parameters gradually morphed to another over a period of about 5.5 seconds.

Sound Garden was designed to be more capable of mutual perturbations in a struct*aurally* coupled relationship. When exhibited, it is situated in a physical environment where environmental factors including natural and artificial light levels, temperature, air flow, and human presence are monitored by electronic sensors (see figure 3.7). These perturb the generative music system by triggering changes in the sound processing and signal flow. Audio signals (both those permanent to the garden and those "planted") are routed through a variety of signal processors and effects. This includes a vocoder, inputs for cross-synthesis, a comb filter, a pitch shifter, and others detailed in table 3.2. These processors continuously modulate the sounds played by the generative music system relative to the environment in which *Sound Garden* is situated.

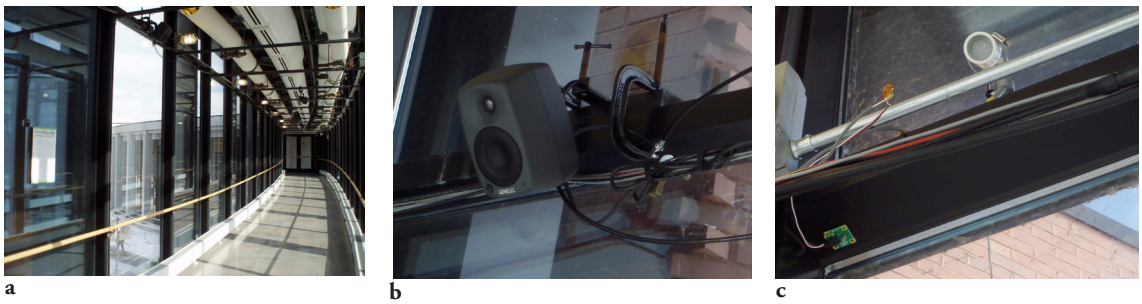

Figure 3.7: a) *Sound Garden* in the skyway between the East and West buildings of the Regis Center for Art at the University of Minnesota, Minneapolis, USA. b) *Sound Garden* speakers were mounted to the frame of the skyway. c) A motion sensor sat on top of the frame, while one of the two light sensors was affixed to the frame bottom to capture the ambient light of the space.

The swarm system was used generatively to play a sound file for every agent's new *pbest*. Agents were divided into channel groups, with seven agents playing system sounds (channel 1) and two agents playing user sounds (channel 2). System sounds served as the general tone of *Sound Garden*, and was meant to act as a sort of aural primer or sonic invitation to encourage interaction. These, plus sounds "planted" (uploaded via web interface) by participants in the work were internally routed from the generative system via Soundflower (www.cycling74.com/products/soundflower) to an audio processing patch developed in Max/MSP. This Max/MSP patch also served as the hub for incoming sensor data. All environmental data could be used to immediately act on the sounds coming from the swarm and produce the music of *Sound Garden*. See figure 3.8 for complete details on the various systems that comprised *Sound Garden* and their interconnectivity.

Sound Garden advanced the musical concerns of *Perturb* because it expanded the potential for interaction by moving the interface to "plant" and "prune" sounds to the Internet. The subtitle of the piece is "asynchronous improvisation by Norbert Herber + others." Just as in *Perturb*, interaction is struct*aurally* coupled, but it is also telematic. The asynchrony created through an online interface introduced subtle changes to the coupled relationships of interaction, and fit in well with the gardening metaphor. Organic plants grow slowly and so does this music due to the arrangement of online interaction. Unlike *Perturb*, all perturbations must to travel across the network, affecting every aspect of the work. When a sound file is "planted" it is literally copied from a person's local computer to a web server using FTP (file transfer protocol). When the generative instruments within *Sound Garden* require the sound, it is streamed from the server to the on-site computer, routed through various signal processors and then finally sent to the loudspeakers in the physical space and back through the Internet as a new, composite audio stream. Those listening to the web stream can see in the interface that their sound has been planted, and listen for it to manifest in the garden. But how it "grows" is entirely dependent on the chain of signal processors. They cannot see what is happening at the installation site; they can only listen to the sonic transformations triggered by the sensors. People who are on-site can move through the space, feel the temperature, and observe the light quality. This provides additional perspective to the development of the garden, but little in the way of direct control. As an extension of the physical environment, the sensors can be perturbed but not specifically influenced. Like an organic garden that undergoes constant change and development so does this work. People can be involved in this to one degree or another. But ultimately, because every unity in the struct*aurally* coupled interaction receives perturbations (not instructions), the interactions shared between autonomous unities produces an incredibly organic musical experience.

Another related difference is that *Perturb* offers a single site for interaction: one keyboard, one mouse, one monitor. Interaction is asynchronous, but not in the most true or accurate sense of the term. The online interface of *Sound Garden* improves this situation significantly. There is comparatively no limit to the number of people that can work together in the garden, which allows the piece to accommo-

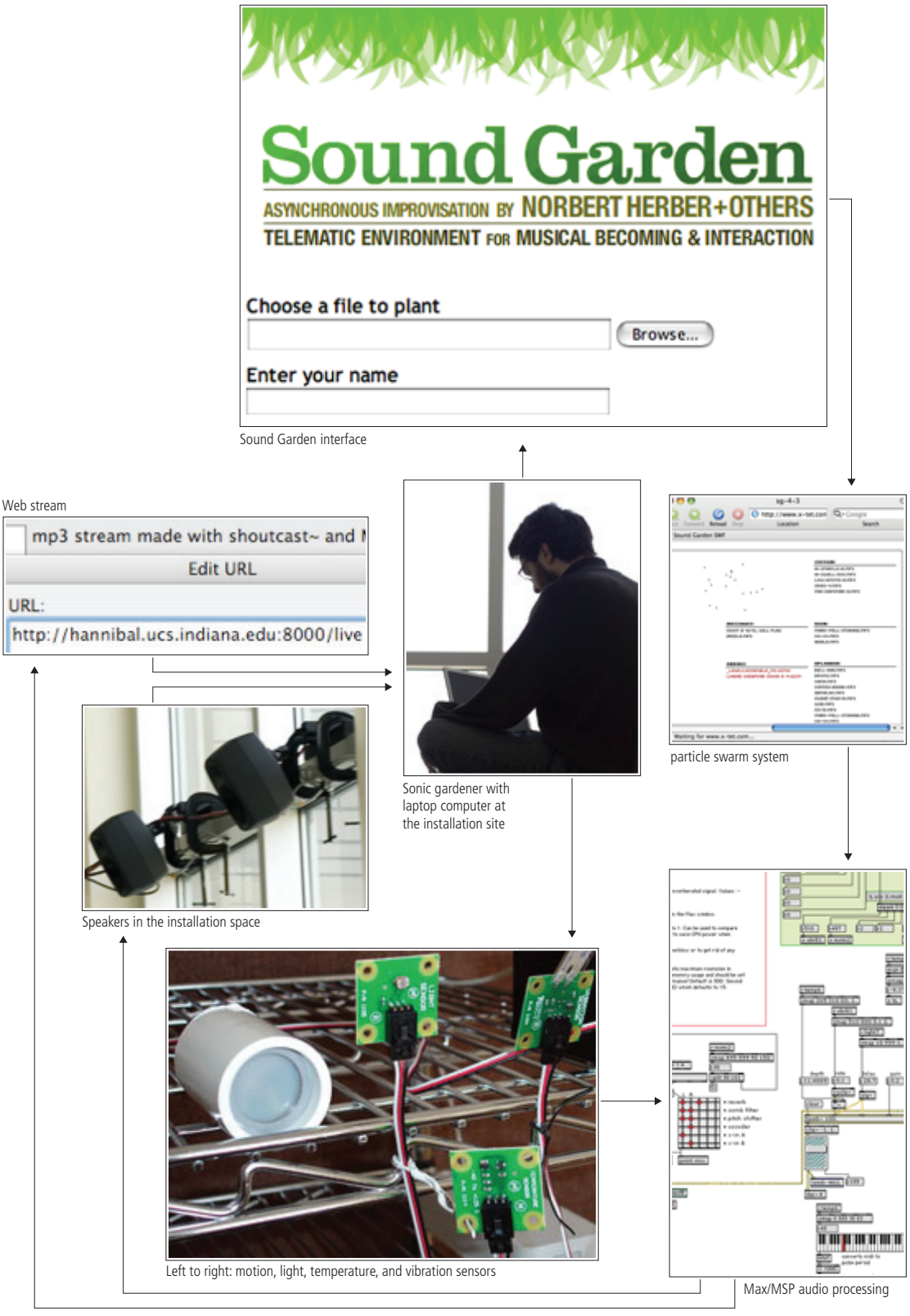

Figure 3.8: Complete systems diagram for *Sound Garden*

date more robust interaction and self-organization. The dynamics of self-organization provide two essential ingredients of *Sound Garden*. A particle swarm algorithm is used to sustain the performance of the generative instruments. As mentioned in the previous chapter, this algorithm has fantastic musical potential. It serves a crucial role supporting the ongoing organic development of *Sound Garden*'s generative music system.

The project is also an experiment in musical self-organization through interaction. Like improvising musicians, those who tend *Sound Garden* are able to make individual contributions to the larger, group work. Similar to the concerns expressed for *Perturb* it is conceivable that this kind of freedom may result in cacophony, leaving *Sound Garden* in a state of complete sonic incoherence. But as improvising musicians listen to each other in the course of performance, or people contribute thoughtfully and respectfully to a community flower garden, I anticipate that *Sound Garden* participants will act with an awareness of the musical ecology created and sustained by this work.

When Sound Garden was initially shown in 2007, this kind of behavior dominated the piece. The variety of sounds planted, and the short lengths of time that passed before they were pruned, revealed that many "gardeners" were busy at work in this sonic ecology making small textural, melodic, and rhythmic contributions that led to an incredibly lively and varied musical experience. This started the first night the piece was made available to the public (Friday, February 23) and continued through the weekend. On Monday it seemed that everyone "went back to work/school" and was unable to sustain the same level of engagement. What happened next was very interesting because it posed a radical departure from the behavior of the piece up to this point. A person planting sounds under the name "John A Knight" (see figure 3.9) started to treat *Sound Garden* as his own platform for Internet radio. For days on end Mr. Knight planted entire songs. Each had a file name that seemed to be a full song title, and he let them play continuously. No one pruned his material from the garden, as if trying to ignore these contributions that paid no attention to the previously established musical direction.

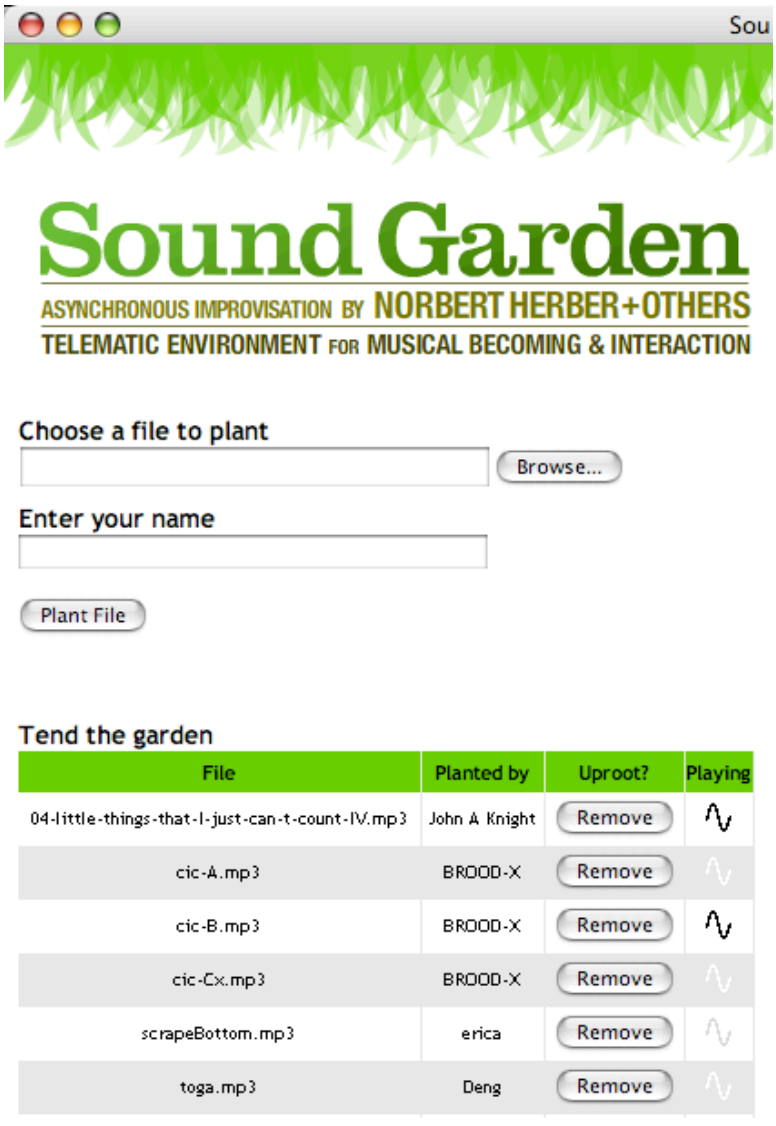

Figure 3.9: *Sound Garden* was not always met with the musical sensitivity afforded by all listening musicians.

This situation was fascinating because it reminded me of times playing in jazz groups where you meet someone who plays in ways incompatible with the rest of the group and is completely unaware of it. Their intentions are not necessarily malicious, but there is a kind of ignorant certainty in their approach that negates all prior efforts to establish a musical direction and leaves the rest of the group wondering what to do. For readers not familiar with these kinds of experiences it can also be compared to a conversation in which someone joins, introduces a completely unrelated topic, and then

prattles on without a thought of listening to others. It was uncanny to see this same dynamic I had first encountered in improvising jazz groups appear in the kind of telematic improvisation enabled by *Sound Garden*. As an artist it was mildly frustrating, but in terms of my research I was pleased to see how behavioral aspects of musical performance could enter into the work. This shows that the piece did in fact take on some of the dynamics of a live improvising group.

Conclusion

This chapter considers music and the dynamics of mediated interaction from a biological perspective. Maturana & Varela's theory of autopoiesis encompasses the autonomous processes of cells that give way to all biological life. This theory cannot however be extended to account for the behavior of metacellular organisms. Therefore, the situation surrounding music and mediated interaction can be explored biologically, but its components are best described as organizationally closed. Whether autopoietic or organizationally closed, the autonomy of these component systems allows them to enter into a structurally coupled relationship in which their autonomy is preserved but made congruous with that of adjacent systems. All exchanges that occur between these systems are therefore perturbations. Communication from one system cannot direct or control the operation of another. The perturbed system will adapt its internal structure relative to the perturbations it receives while simultaneously preserving its autopoiesis or organizational closure.

Struct*aural* coupling considers these dynamics from a musical perspective. It characterizes the relationship between person, generative system, and mediated environment (which includes the music) as one of reciprocal perturbations. When a person enters into this kind of interaction, they can perturb, but never control or direct, the processes that lead to the production of music. This creates a musical experience of simultaneous listening and interaction that involves traditional notions of both "composition" and "instrument." The blurring of these two has been explored by other artists and musicians for a variety of reasons. As it concerns Amergent music, traces of instrument and composition are present, but peripheral to the overall focus of the work.

Both *Perturb* and *Sound Garden* are compositions in that, like works of Experimental music, they were conceived as a set of musical possibilities. Each has a range of possible musical outcomes. Neither can create *all* varieties of music but both produce *a* variety of music within the scope defined for each. This is the result of an internal organization built on set of aesthetic priorities. Also, both works exist as an expression of music and not a performance tool. As discussed earlier in this chapter, some instruments that include elements of composition define their usefulness more broadly, and tilt the balance more heavily in the direction of instrument.

However, these pieces do include some instrumental elements as well. Both pieces can be "played" by adding and removing sounds. *Sound Garden* expands this to people and the physical environment by activating the sensors that perturb the generative music system. Most importantly, both works push back on the player/listener, and exhibit "resistance" in the correlation between music and interaction. What someone does and what they hear become entangled in their overall affective experience. Mutual perturbations that produce music and the feeling of resistance are not just a capability of the system but one of its essential characteristics. In *Perturb*, *Sound Garden*, and other works yet to be discussed, musical "success" is not just the result of clever sample uploading or a bullet-proof generative organization. *All systems* must function together with an organizational closure that sustains itself, and through struct*aural* coupling, sustains its neighboring systems. This idea of adjacent systems and their scope and interrelation within a neighborhood can move in additional directions. Spatial thinking, including psychogeography, urban planning, and architecture all make important contributions to media design and interaction within mediated environments.

CHAPTER 4

Spatial Concepts for Music & Interaction

"When the speakers fail, it feels like the life is sucked out of the place."

– Mr. Q, from *How Mr. Q Manufactured Emotion* (Curtis 2009)

An 81-year-old man, known as "Mr. Q" in his interview with designer Dustin Curtis, worked for years as an audio experience engineer for the Walt Disney Company. He designed and built the speaker systems that played music throughout Disney theme parks. Disney World opened in Orlando, Florida in 1971. It was the first park of its kind to have ambient music play throughout, which in Mr. Q's estimation was one of the most important parts of the park experience (Curtis 2009). The music served to hide the gaps between reality and fantasy. Whether you were queuing up for a ride or walking the exit path once it was complete, music connected every space in the park to create a seamless overall experience.

Mr. Q was particularly proud about a unique research project he and his team tackled in the mid-1990s:

> …today, as you walk through Disney World, the volume of the ambient music does not change. Ever. More than 15,000 speakers have been positioned using complex algorithms to ensure that the sound plays within a range of just a couple decibels throughout the entire park. It is quite a technical feat acoustically, electrically, and mathematically. (Curtis 2009)

He referred to this and other aspects of his work as "manufacturing emotion" (Curtis 2009). And while the role of sound and music in a theme park is not entirely representative of the sound in our daily lives, Mr. Q's story is an interesting one involving sound and its role in a highly stylized physical space.

The last chapter considered how generative systems can be coupled with mediated interaction to produce instrument-like software that functions within digital environments. The design of those instruments, and the ways in which they create or respond to changing relations within a mediated environment, goes beyond the mechanics of interaction. This chapter considers a variety of spatial models that connect sounds and ideas within both physical and conceptual spaces. Spatial practice, and relations involving architecture, acoustics, culture, politics, geography, and art all have a part to play in the way societies produce and use space.

4.1 Cities & Space

Physical spaces—particularly urban spaces—provide a wealth of experience for those who use and live in them. In the way that it will be discussed here, *space* has implications far beyond the character of a "vibrant cultural metropolis." Certainly the markets, restaurants, gathering places, and neighborhoods that give a city its grit or charm are contributing factors, but there is more to space than this set of concerns. Space, when experienced on the level of the individual, can also encompass the relations between various urban qualities. The particular sounds or smells or the look of an urban setting will have different affects on people given variations of time, cultural background, mood or mindset, and openness to experience. The alleyway that one person passes without a glance may be a veritable treasure trove to the person a few steps behind. The precise qualities that account for these differences are myriad and elusive, but their existence is undeniable. Relations between these spaces therefore become the connective threads in the tapestry of an urban landscape. The coalescence and juxtaposi-

tion of urban ambiences construct affective experience as one moves through space. This relationship between an individual in transit and the spaces through which he moves is a powerful metaphor for organizing sound and developing music for mediated environments.

4.1.1 Psychogeography & the Dérive

Psychogeography is a term that speaks to mental associations and perceptions of physical space. This concept, and the ideas it has engendered, are particularly useful in connecting musical sound to the events that unfold in a mediated environment. The term was created by Situationist Guy Debord in 1955 (Wood 2009) to characterize a set of phenomena he and his colleagues were investigating in the early 1950s (Debord 1955). He wrote:

> *Psychogeography* could set for itself the study of the precise laws and specific effects of the geographical environment, consciously organized or not, on the emotions and behavior of individuals. (Debord 1955)

Debord was interested in the way that urban spaces spoke through their features and general appearance, and criticized the way that most people "…generally simply assume elegant streets cause a feeling of satisfaction and that poor street are depressing, and let it go at that" (Debord 1955). While factors concerning construction quality and economics could have a role to play in psychogeographic effects, these are only two of the many potential ingredients that go into the mix. The *geography* in psychogeography has less to do with the contours and composition of the landscape than it does with building materials, sounds, smells, traffic, and other cultural patterns. Debord writes as if the affective process could be explained like a recipe:

> …the variety of possible combinations of ambiences, analogous to the blending of pure chemicals in an infinite number of mixtures, gives rise to feelings as differentiated and complex as any other form of spectacle can evoke. (Debord 1955)

While the ingredients can be identified, the distinct quality of the resulting concoction is synergetic. A newsstand awning and lamp post can produce one effect on a street corner, but move them to the park a few blocks west and the combination will have quite a different affect. Or, in each location, replace the newsstand with a bus stop and an entirely different set of affects can be produced. Psychogeography is less concerned with these kinds of experiments, but more so the discovery that occurs when one is in the city and attuned to the affects of these various dynamics. Movement is important to the overall experience. It is movement through space or *to* a space that allows its presence to be discerned. Debord lists some of the things that movement will reveal:

> The sudden change of ambiance in a street within the space of a few meters; the evident division of a city into zones of distinct psychic atmospheres; the path of least resistance which is automatically followed in aimless strolls… (Debord 1955)

The city can be discovered and redefined as clumps, individual zones that speak with a character or ambience that is entirely their own. There is no set shape or size, there is only an inescapable feeling that makes one area distinct from the next. They can be observed from a distance or explored from within if one's path takes him through its core. While the existence of these spaces is purely psychogeographic, the practice through which they can be discovered is called the *dérive*.

The act of moving through actual, geographically locatable places can be usefully characterized by the Situationist practice of the dérive. Debord described the dérive as, "a technique of rapid passage through varied ambiences," involving "…playful-constructive behavior and awareness of psychogeographical effects…" (Debord 1958). In a dérive (which translates as *drifting*), movement through and across urban environments has its affects on the emotions and behaviors of the drift-er. To dérive is to

walk in a city while attending the street-to-street ambiences that divide a city into zones and generally following psychogeographical preferences. There is no predefined path and no specific destination. In Debord's words, one follows, "…the path of least resistance…" (Debord 1955). The drift-er's route is constructed by their valence of the ambient zones they encounter. They move towards those that appeal and avoid those that do not. Zones are created through their perceived psychogeographical character. To the drift-er each one is an island—a unique space within the archipelago of the larger urban environment. Each contributes to an overall ecology that can be experienced as one drifts from zone to zone or space to space.

Debord wrote clearly about the subjectively-perceived zones that can divide a city into a kind of psychological mosaic, but there is little that translates his ideas directly to a musical work, let alone one that is open to interaction. Within every urban microcosm there are features that either do or do not speak to us. In the case of the dérive, these features are discovered and fit into a larger psychogeographic understanding of the overall environment. It is possible, too, for this process to work in the reverse. Designers, architects, and urban planners can build cities in ways that feed psychogeographic models. With an awareness of how people conceptualize maps of the environments in which they live, it is possible to design new environments that are congruous with these psychologically-based territories.

4.1.2 Urban Planning

When designing space to be part of a musical work, a musician temporarily assumes the role of urban planner. Kevin Lynch was an urban planner who could think like a musician. Space was not something to be controlled or conquered, but explored for the various potentials it had to offer. He taught at MIT from 1948 into the 1980s, working beyond his official retirement in 1978 (Banerjee & Southworth 1990). Lynch questioned space, and how it could be used to serve the broad interests of diverse groups. In the book, *The Image of the City* Lynch builds a strong case to show how thoughtful planning can make cities more amenable. He wrote that the city:

> …must be plastic to the perceptual habits of thousands of citizens, open-ended to change of function and meaning, receptive to the formation of new imagery. It must invite its viewers to explore the world. (Lynch 1960: 119)

This book was the result of a small research project conducted by Lynch and his students. There were four motives that guided their work: an interest in the connection between psychology and an urban environment; a keen interest in city aesthetics at a time when most planners in the US dismissed these concerns as "a matter of taste;" questions about evaluating a city and determining what it could be; and the hope this work could impact practicing planners, encouraging them to "…pay more attention to those who live in a place…" (Lynch 1990: 247). Lynch's conclusions had little to say about actual application of these ideas, but rather they established a framework of ideas upon which to build new modes of professional practice.

The Image of the City expresses the idea that when the uses of a city are apparent, citizens have a clear point of entry—not only to live but to thrive and to find personally fulfilling paths for work, play, and family. Lynch asserts that uses are made evident through their "legibility" in the cityscape. Just as one finds a poster or directional sign legible and can comprehend written thoughts and ideas, the potential of a city should be equally clear when drafted in the language of steel, concrete and brick. Buildings, sidewalks, and other urban features can all be deemed useful in the construction of personal narratives, but with caution: "A landscape whose every rock tells a story may make difficult the creation of fresh stories" (Lynch 1960: 6). Lynch's thoughts on planning leaned more in the direction of the *potential* or *possibility* of the city. In a later essay, reflecting on *The Image of the City* after over 20 years, Lynch addresses this specifically. Newcomers and tourists will never immediately possess

knowledge of a place equal to that of natives. But if the design is done correctly, it will offer more as their familiarity matures. Lynch states, "…the order of a city should be an unfolding order, a pattern one progressively grasps, making deeper and richer connections" (Lynch 1990: 252). The design of a city, to maximize its potential in serving those who reside in it, must never be too rigid or fixed in any particular direction. A person who passes their childhood through senior years in a major metropolitan area should be able to understand its prospective uses whether for their make-believe games or those of their children, their leisure time or that of their aging parents. It is an idealistic vision, but one that serves as a call to action and challenges planners to empower citizens.

Lynch is a guiding force behind the work involved in developing Amergent music. And fortunately, the nature of these projects is much less complicated than planning an entire city, making this an undertaking that is feasible for a single musician in a manageable amount of time! Throughout the creative process, the musician is engaged in the kind of work espoused by Lynch for urban environments, where potentiality is a key ingredient in building a system that can withstand myriad interactions and always have something new to offer. Individual sounds are not "legible" in the sense that they convey a specific meaning that can be literally read. Rather, all sounds work together to establish tonal and textural relationships. When the piece of music is experienced it will sound congruous to the behavior or use of the mediated environment in which it is heard. Several projects served as experiments to test these ideas. All take their core ideas from psychogeography, relying on the practice of the dérive to facilitate interaction and Lynch's idea of urban legibility to guide overall organization of sonic material.

4.1.3 Composition-Instrument Studies

A term significant to the early and middle phases of this research was "composition-instrument." Unlike other complete works that I had completed in the past, these studies specifically endeavored to expose the role of each term (*composition* and *instrument*) and to address questions about listening, interaction, and the overall sonic palette of my works. The research behind this strain of work took many different forms and produced a wide range of output. Earlier projects certainly followed in this model, but in a more straightforward manner. When producing pieces of generative music my main artistic concerns were on the system: sounds and the behaviors or rules that play them. Pieces that include interaction take more time to develop. The struct*aural* coupling interaction model helps clarify the relationship between a person, their actions, and sounds; but the specific mechanics that facilitate interaction and relay sounds out of the computer and back to the listener demand a great deal of attention. These are the components of the overall piece to which the person experiencing the work is most closely connected. If they were not conceived of clearly the entire work suffers, no matter how tightly integrated the sound with the interaction. The next two sections of the chapter will introduce the projects through which spatially-conceived interaction was explored. For audio examples, see section 5 of the supporting DVD.

For the purpose of this thesis, the first few undocumented efforts will be called *dérive studies.* These generated many ideas for future projects and a good deal of reusable computer code, but ultimately no finished pieces. Following in the path of Debord's dérive, these experiments placed their primary emphasis on spatiality. To this end, sound diffusion systems including quadrophonic, 5.1 surround, and 6 channel Ambisonics were explored. Also, because the dérive is literally a *drift* or stroll, the physicality of interaction had to be kept to a minimum. If the listener were to truly drift in sound, their movements had to be intuitive and effortless. I was initially inspired by Char Davies' use of breath to control vertical navigation in her VR installation *Osmose*. Like scuba divers, "immersants" float in the VR environment inhaling and exhaling to move themselves up and down (Davies 2002). A controller responsive to this behavior would have had a lot to offer, but the time involved in fabricating and testing such a device did not further the core set of ideas I was pursuing and the approach was postponed. To simplify matters, the first round of experiments was conducted with off-the-shelf game

system and PC controllers, including Sony Playstation 2, Microsoft XBox360, and 3Dconnexion SpaceNavigator. These devices were either found to be too physically involved, too difficult to learn, or too stylistically connected with other media to serve the needs of this project. In addition, each felt like a creative affectation—a gimmick that distracted from the artistic intentions of the work. None of these have a role in current or future versions of the project, though the chance to experiment with them was enormously helpful as a kind of filtering process.

The next phase of these experiments began from a position of greater technical familiarity. I continued to explore the idea of the dérive, but within the capabilities of a technical system that was already functioning. At this stage in the research process, the interaction model I had developed paid less attention to biology and struct*aural* coupling than it did to the blurring of music making and music listening. The confluence of musical composer and musical instrument was at the fore of my thinking, and led to the title *Composition-Instrument Studies* for these next two experiments. The first, *Composition-Instrument Study I*, consisted of sound-emitting zones in various different configurations.

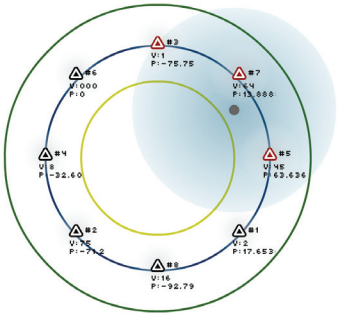

Figure 4.1: Orbits example from *Composition-Instrument Study I.*

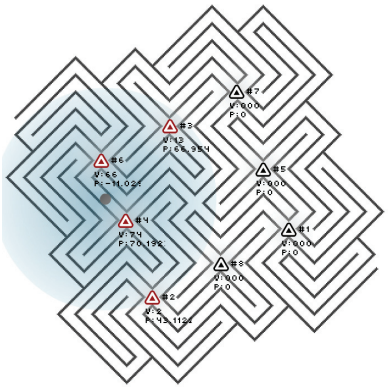

Figure 4.2: Maze example from *Composition-Instrument Study I.*

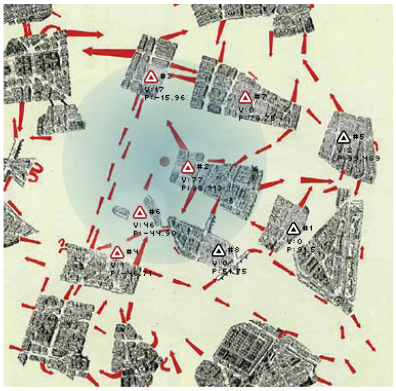

Figure 4.3: Dérive example from *Composition-Instrument Study I.*

Orbits: In the first approach, sound spaces are placed along an orbit (see figure 4.1) to guide the poiesist along a path within a fixed range of the various sonic spaces. As one circles the orbit, the size of the acoustic horizon allows enables the construction of different sound combinations relative to the diameter of the chosen orbit.

Maze: The second approach used a maze called *Nine Crossroads* (see figure 4.2) by Andrea Gilbert (2009). In this example, eight of the nine intersections are home to a sound space that gives the location a unique aural identity. Depending on position in the maze, one to seven spaces may be audible within the acoustic horizon. Again, as position changes relative to each sound space, different permutations lead to shifting musical statements concerning "the maze, at this location, and at this time."

The Dérive: The map used for this variation of the study was created by Debord (1955) and reflects an amalgamation of many dérive excursions (see figure 4.3). It shows the psychogeographic zones of Paris and the paths (red arrows) most frequently used to travel between zones. I coupled several of these zones with sound spaces to give each a unique aural identity. Poiesists can navigate the map and follow Debord's paths or construct an original route as sounds draw listening attention in various directions. Movement through space creates a variety of sonic relationships between the zones that overlap the acoustic horizon. As with a dérive in the physical world the experience is emergent, as location, memory, and sound come together in a variety of novel combinations.

Urban Imageability: The final variation in the study was derived from ideas in Kevin Lynch's book *The Image of the City* (1960). Lynch discusses a research project in which he conducted interviews to gain insight about the legibility of

Boston, Jersey City, and Los Angeles, USA. The interview asked participants to sketch a map of their city and answer a variety of questions about its organization. Lynch and his research team assembled all of this data and drew a new map of each city using the consensus of sketches and verbal interviews. My study uses their map of Boston. Lynch's consensus map reveals a common understanding of urban "spaces" or "zones" that is defined by the architecture, landmarks, streets, and other elements that give the city its form and contribute to its legibility.

This quality dovetails my musical conception. Each zone is paired with a sound space (see figure 4.4) to define its character in the aural dimension. Boston districts such as the Common and the Waterfront have their own sonic identity. Poiests can follow the streets of this map and through their movement construct a sonic perspective of the city image. As one navigates the map, shifts in phrase, texture, and color are based on a "concurrence of Boston"—how it is organized and how its components are interrelated, as understood by the residents who were interviewed and contributed to the map.

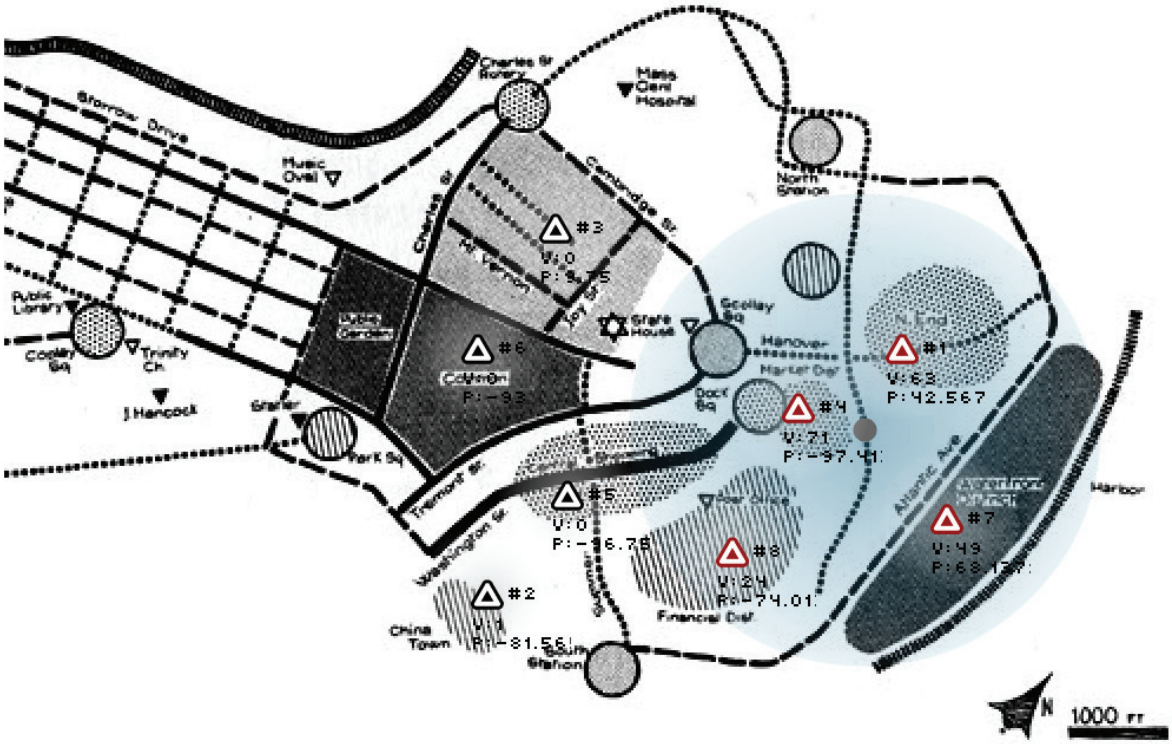

Figure 4.4: Urban imageability example from *Composition-Instrument Study I.*

Composition-Instrument Study II was a small follow-up that included two Andrea Gilbert mazes: *Nine Crossroads* and *Duvet* (2009). The first study revealed an occasional tension in my work, which had to do with the physicality (albeit minor) of manipulating a computer peripheral in order to hear music. My artistic intent was to facilitate musical experience. Electronic device manipulation is something altogether different. These studies revealed that it is very tedious to have to think about working the mouse or keyboard when the mind is more inclined towards listening. However, it wasn't burdensome to listen while navigating these mazes, a discovery that made these studies very important to the overall trajectory of this research. Further thoughts on music and maze navigation are discussed in chapter 7 of this thesis. Documentation of *Composition-Instrument Studies I & II* can be found in section 5 of the supporting DVD, and the project is available to play on your PC. See the DVD Instructions for details.

4.1.4 *Dérive Entre Mille Sons*

The final step in this research process was to consider the strengths and weaknesses of the earlier pieces and produce something that emphasizes their best qualities. *Dérive en mille sons*, which translates as *drifting in a thousand sounds*, was the initial title of the project. It was submitted as an iPhone app prototype for an Institute for Digital Arts & Humanities Fellowship at Indiana University Bloomington, USA. Later I wrote a paper for the Spark Festival of Electronic Music and Arts at the University of Minnesota, USA.

A few months following the Spark Festival the paper was accepted for publication into *Technoetic Arts*, issue 7.1 (see Publications in the end of this thesis). To be certain that the translation of the title accurately communicated the intentions of the work I worked with a native French speaker to develop a new name that could better convey the idea of moving through sound as one might walk through patches of fog. In this work sound is all around; you can move towards it, linger in it, and locate adjacent patches to be explored further. This relationship between sound and person suggested the title *Dérive Entre Mille Sons*, which more accurately expressed the experience of moving through various fields of sonic matter.

Dérive Entre Mille Sons is the final title for the paper and the musical piece. While the dérive as a spatial practice was something I identified as a way to explain how I work with sound in the context of interactive art and media, I had never before explicitly used elements of the dérive in a musical work. Both the written and musical components of the project were based on the dérive as a spatial practice, where the magnetic quality of urban neighborhoods is replaced with sound textures and clusters that attract listeners and suggest directions in which they might drift.

Dérive Entre Mille Sons the musical work uses mobile media technology to artistically examine the relationship between music and the listener. Contemporary media technologies, be they at work, home, or in your pocket, emphasize playback. These devices are designed to facilitate the storage and retrieval of pre-made media assets. This work leverages the processing capabilities that rest dormant within these technologies. Drawing from the writings of Debord and the Situationist practice of the dérive, "drifting" is replaced with tilting a Nintendo Wii controller (Wiimote) and becomes a metaphor for instrumental performance in which the openness and emergence of interactivity is articulated through sound, as music. *Dérive Entre Mille Sons* was a logical extension of my composition-instrument studies as it questioned the physicality of interaction for stand-alone musical works. For an audio example, see section 5 of the supporting DVD.

This project initially proposed spatial-aural interaction with the three-axis accelerometer found in the iPhone. The simple act of tilting the device left to right or forward and back sends input that can redraw ("move") images on the screen. At the time it was proposed this feature had been used to make games ("roll the marble through the maze", "drive a vehicle") and other, more advanced musical applications such as RjDj (Reality Jockey Ltd. 2010). Tilting interaction is suitable for this project because it is incredibly intuitive and physically undemanding. Tilting the device moves the listener through sonic zones. As with psychogeographic zones discovered in the dérive, generative sound clusters and musical phrases are organized into adjacent spaces (see figure 4.5). Tilting the device in the direction of a sonic space that draws their curiosity "moves" the listener towards that zone so that it can be heard more clearly. In the process, other sound spaces are left behind, rendering them either quiet or silent to make what was once foreground into background, and vice versa.

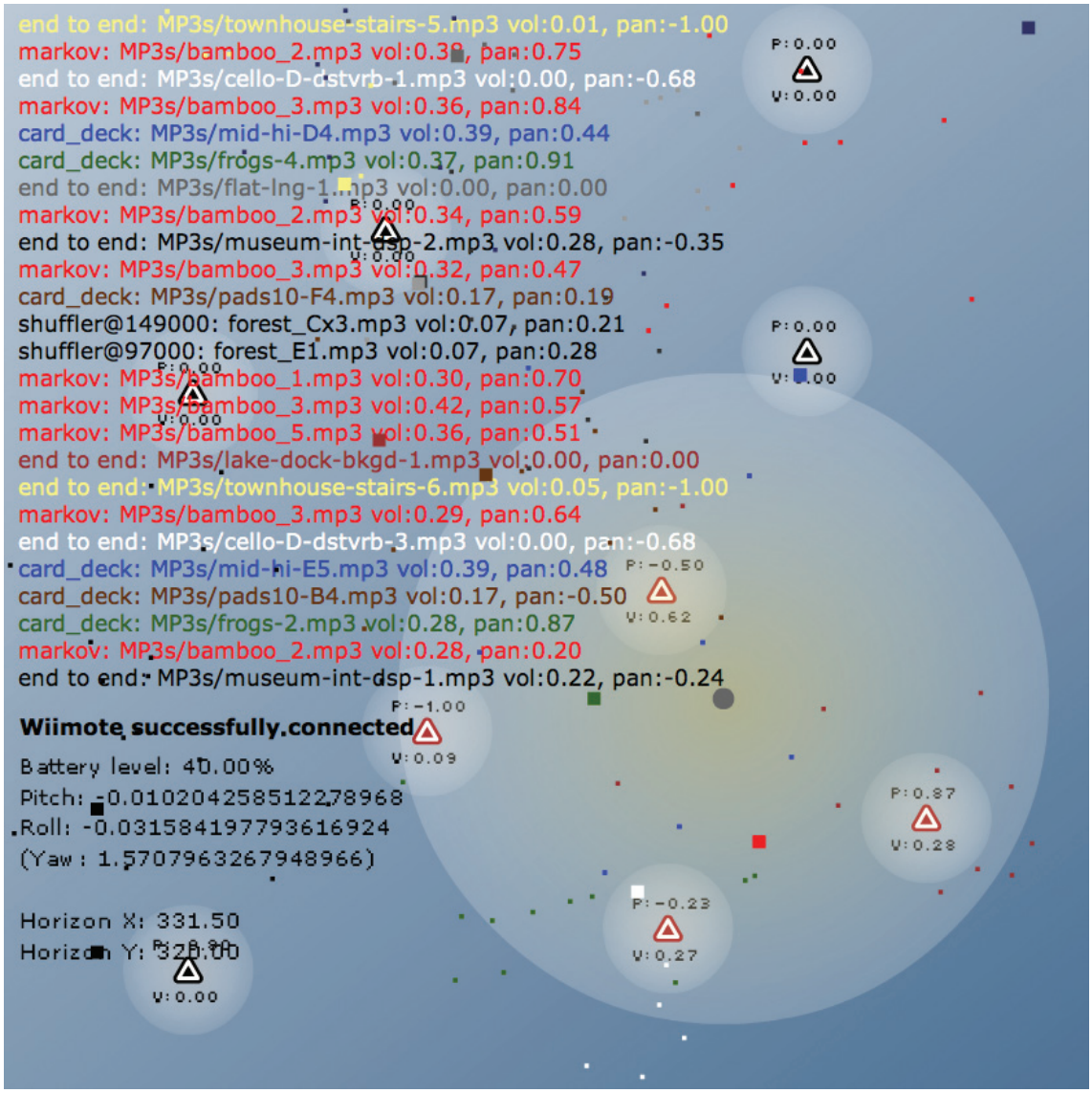

Figure 4.5: *Dérive Entre Mille Sons* reveals its sonic zones, acoustic horizon, Wiimote controller data, and running update of which sounds are currently playing. As a sound-only piece this screen is very helpful in testing and debugging the work.

To-date, the project remains a working prototype for a future iPhone or iPod Touch application. As a computer programming novice I was able to use off-the-shelf software to create a simple yet powerful version of this project. Adobe Flash was sufficient to author a generative music system. To achieve the nuanced, tilting interaction this project demanded I used a Nintendo Wiimote, which has a six-axis accelerometer. To get these elements to communicate, I used the WiiFlash Server developed by Joa Ebert and Thibault Imbert (http://code.google.com/p/wiiflash) and WiiFlashServerJ for Mac OSX developed by Alan Ross (http://lab.adjazent.com). This proof-of-concept was a success, but it showed me that there were too many individual pieces of software to make the work accessible to a broad audience. As a small computer with media playback capabilities that supports physical interaction via a three-axis accelerometer, the iPhone stands alone as an ideal technical platform to realize this work. These and other features suggest many possible futures for this project as development continues. While the ideas surrounding psychogeography and the dérive were essential foundations of this work, they were not the only sources considered for theory, ideas, and inspiration. A more broad investigation of space and sound in space yielded additional useful material.

4.2 Space Speaks

The kind of space explored in this research is best characterized by what Henri Lefebvre calls *represen-*

tational space. It is space that communicates to its observer or inhabitant that "…it is alive: it speaks. It has an affective kernel or centre…" (1991: 42). *Dérive Entre Mille Sons* takes the psychogeographic character of a city, the moods and ambiences that divide it into discrete zones, and translates these into zones of sound within the territory of a mediated environment. This treatment creates the kind of space that:

> …embraces the loci of passion, of action and of lived situations, and thus immediately implies time. Consequently it may be qualified in various ways: it may be directional, situational or relational, because it is essentially qualitative, fluid and dynamic. (Lefebvre 1991: 42)

These spaces come alive in the process of the dérive, as if animated by the movement around, towards, and through them. The zones of *Dérive Entre Mille Sons* and the works that preceded it consist of sounds that become music as the space they occupy is lived in and experienced. The relations between sounds within a zone, and the relations across adjacent zones give rise to the musical experience of this work. In Lefebvre's terms this kind of space is a "third space": "…mediated yet directly experienced, which infuses the work and the moment…" and that it is simultaneously "…fictitious and real…" (Lefebvre 1991: 188). The sonic elements belonging to each space, heard in the moments of mediated experience, give rise to the space itself—a space that is neither one nor the other but something entirely its own, created in the moment of experience, thought, and action.

Physical spaces in urban environments speak to us as we traverse the city. These ideas surrounding psychogeography can be re-conceptualized and expanded into different kinds of representational spaces. Movement through and presence within a non-physical space—virtual, narrative, conceptual, and others explored here—can produce profound conclusions about a particular situation or environment. These spaces form when they are experienced and lived in, which exposes unnoticed relationships between the constituent parts of a larger territory.

4.2.1 Narrative Architecture

Whether it is an epic tale that unfolds over vast realms or the simple geometry of a love triangle, space is a useful tool for telling stories. In his essay *Game Design As Narrative Architecture*, Henry Jenkins (2002) explores a broad range of precedents for spatial storytelling and draws compelling parallels connecting various forms of art and media to contemporary game design where narrative is a desired component in the game play. *Dungeons & Dragons*, the table-top role-playing game (RPG) that paved the way for massively multiplayer online RPGs (MMOPRGs) and virtual worlds such as *World of Warcraft,* begins with an invented space (Jenkins 2002). The dungeon—created by the game designer or dungeon master—is where a player's adventure will take place. Jenkins advocates that game designers explore the philosophy of Kevin Lynch in *The Image of the City*. The idea that urban spaces can be designed to facilitate use and experience translates to narrative game design for cases in which:

> The organization of the plot becomes a matter of designing the geography of imaginary worlds, so that obstacles thwart and affordances facilitate the protagonist's forward movement towards resolution. Over the past several decades, game designers have become more and more adept at setting and varying the rhythm of game play through features of the game space. (Jenkins 2002)

While Jenkins never discusses the dérive, there is a clear connection between his conception of spatially organized plot and psychogeographic effects. In this conception, playing a game can be seen as moving through the geography of an imaginary world. Jenkins' "obstacles" and "affordances" have the same role as urban zones that repel or appeal to the person moving through space. Neither *Dérive Entre Mille Sons* nor any of the dérive-related studies had specific narrative ambitions. They did however take this same spatial-narrative view when it came to making music. Sounds that appeal will draw a

listener nearer to a space. As they move in that direction, other sounds that were audible become silent. This creates an opportunity for currently audible sounds to be heard more clearly or new sounds to be discovered in transit. Similar to the way in which Jenkins proposed that narrative be geographically designed into the world of the game, music was designed into *Dérive Entre Mille Sons.* However, in the case of both it is more appropriate to say that the *potential* for narrative or music is designed into the space. The person who moves within and across spaces has the ability to cultivate their own experience through exploration. In this way, music is not composed but rather seeded in an environment and grown in the process of discovering what it has to offer.

4.2.2 Cyberspace Architecture

Discussions of cyberspace and cyberspace architecture have also informed this investigation of space as a means of organizing sonic material. Unlike the urban planner who must work with solid materials, an artist working in a digital realm is not limited by the physics of the concrete world. Marcos Novak explains how this difference affects the architect working in cyberspace: "…for the first time in history the architect is called upon to design not the object but the principles by which the object is generated and varied in time" (Novak 1991: 251). Form, to accommodate myriad and continuously changing use, must become, in Novak's words, "liquid." It must have the ability to change and adapt endlessly as new relationships are formed through the constant interactions of constituent parts. Changes in cyberspace do not necessarily affect the whole. Smaller communities coalesce and disband. They create transient cultural niches and pockets of shared interest that are spread throughout the whole. Lawrence Lessig also sees this behavior as a matter of architecture:

> …cyberspace is not *a* place; it is many places. Its places don't have one nature; the places of cyberspace have many different "natures." These natures are not given, they are made. They are set (in part at least) by the architectures that constitute these different spaces. (Lessig 1999: 82)

The dérive was used as a metaphor for interaction in some of the projects that went into the research of this thesis. Architecture, as a specific practice, did not weigh heavily in these efforts. But as a means of thinking about space as a fluid and reconfigurable medium, the architecture of cyberspace has shared resonance with my approach. Both consider space as something that forms and re-forms to suit the changing dynamics within an environment or the shifts of interest and perspective of the person within the environment. A territory with its own spatial characteristics can be organized into sub-spaces simply by changing the way one thinks about, or chooses to engage it. The world wide web is especially receptive to this kind of treatment.

The *Web Trend Map* by Information Architects (iA) organizes "…the 200 most successful websites pinned down on the Tokyo Metro Map, ordered by category, proximity, success, popularity and perspective" (Information Architects 2007). Trends and uses of the world wide web have been re-conceptualized as various lines— file sharing, tools, technology, news, community, movies, music, and so on—within the Tokyo metro system (see figure 4.6). Actual web sites are at stations on one or more lines depending on the nature of the site. The more robust the scope or offerings of the site, the bigger the station. For instance, the website for Apple Computer is paired with iTunes to comprise a double station that serves the lines for music, technology, knowhow, movies, moneymaker, and design. In the scheme of the *Web Trend Map,* one can "transfer" from the technology line to the design line at the Apple/iTunes station, much like the actual use and experience of browsing the Apple web site.

The work by iA that produced this map is the result of a deliberate design and a few inside jokes shared between those familiar with the culture of the world wide web. An understanding of Tokyo can also be helpful in understanding the nuance of the map. For instance, an explanation on the iA website reads:

- Google has moved from Shibuya, a humming place for young people, to Shinjuku, a suspicious, messy, Yakuza-controlled, but still pretty cool place to hang out…
- YouTube has conquered Shibuya (Information Architects 2007)

The iA website also notes that the final map also produced some inadvertent, "revealing coincidences":

- The northern part of the Main Sites line (the Yamanote line) is a boring, unknown territory (just like in the real Tokyo)
- Skype has conquered a place that doesn't exist (Information Architects 2007)

The web trend map is a re-conceptualization of online space. It shows how the architecture of the world wide web is liquid. It can be "poured into" the vessel of the Tokyo metro map in ways that reveal idiosyncrasies of its various components. This liquidity is emphasized when the map is redrawn from year-to-year: existing online trends develop or diminish and new fads emerge. All constituent parts are in some way reconfigured, added, or subtracted. Ultimately it remains the same territory with a new overall essence that is revealed through the relationship of its individual parts. Debord writes about a psychogeographically-related story:

> A friend recently told me that he had just wandered through the Harz region of Germany while blindly following the directions of a map of London. This sort of game is obviously only a feeble beginning in comparison to the complete creation of architecture and urbanism that will someday be within the power of everyone. (1955)

The possibilities for this sort of experience are only too familiar with the intervention of contemporary GPS-enabled devices. And this is exactly the kind of experiment conducted in cyberspace by iA to produce their series of web trend maps. The objective of this exercise is not representation but discovery. Just as a map of London could lead one to a charming but hidden side street in a small German town, redrawing cultural phenomena within the space of the metro map (which is its own re-interpretation of physical space) profoundly reveals connections that would otherwise go unnoticed.

This is also the "purpose" of the dérive. While the practice could seem like aimless wandering, there is an end result. What is produced is an understanding or awareness of the place that cannot be easily communicated in other ways. Debord writes that the dérive allows one to produce

> …hitherto lacking maps of influences, maps whose inevitable imprecision at this early stage is no worse than that of the first navigational charts. The only difference is that it is no longer a matter of precisely delineating stable continents, but of changing architecture and urbanism. (1958)

This "objective" of the dérive, or the relationships revealed in the web trend map are good examples that point to the kind of listening experience that can be had when music is spatially conceived. *Dérive Entre Mille Sons* was not formed or fixed as sonic events in time but allowed to unfold like the urban landscape as the listener moves across the territory of the mediated environment. Like the Tokyo metro system map that iA claims "just works" (Information Architects 2007) for their mapping endeavors, *Dérive Entre Mille Sons* was based on a spatial arrangement that best suited the sound material used in the project. Clusters of sounds were organized into complementary groups and paired with a generative instrument to create discrete zones in the mediated space. The proximity of these zones works similarly to the deliberate connections between websites and train lines in iA's web trend map. However, due to the generative potential within each zone there is ample opportunity for sonic surprises and coincidences that make each stroll or drift through *Dérive Entre Mille Sons* one of new sonic discovery.

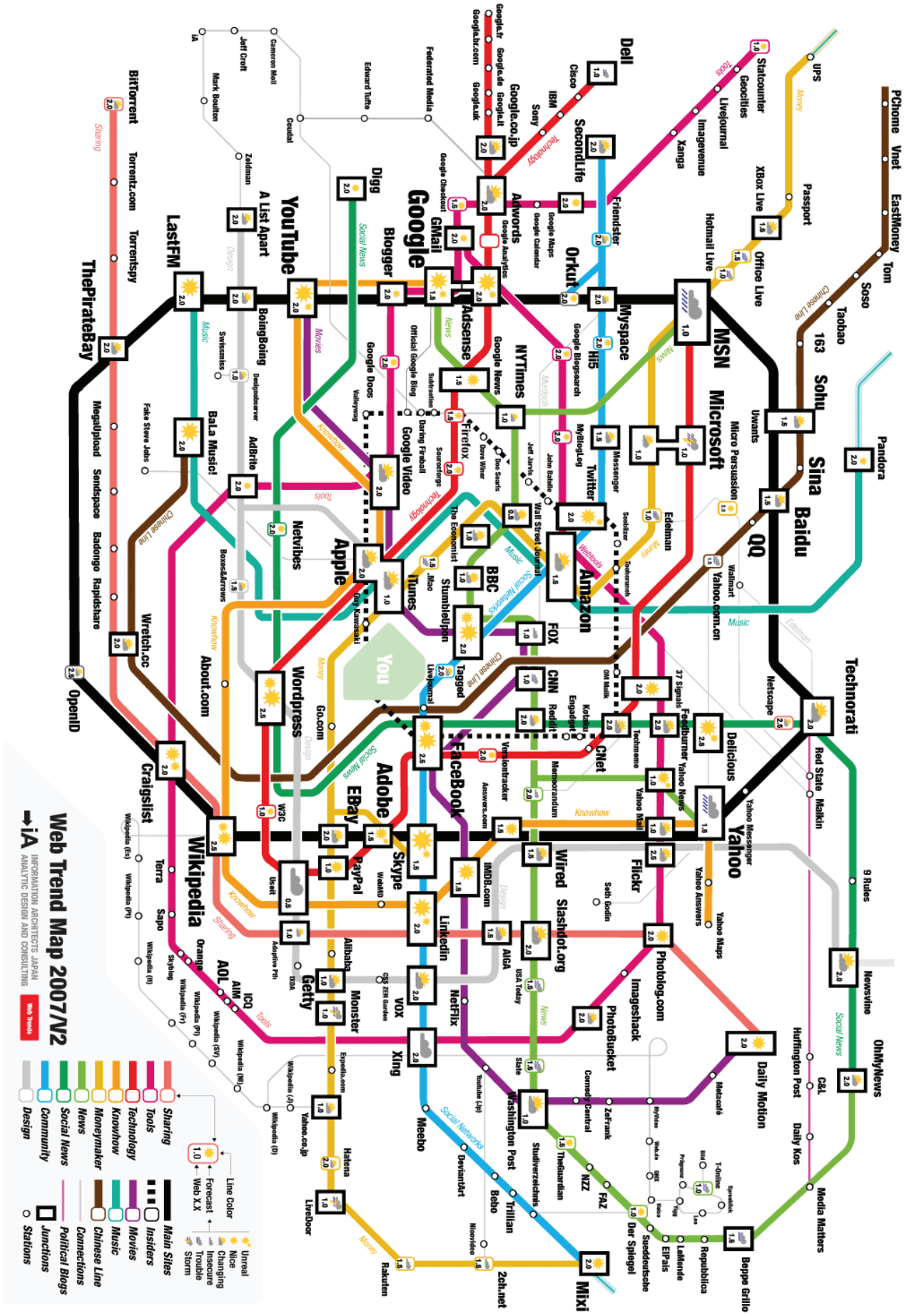

Figure 4.6: Version 2 of the Information Architects *Web Trend Map* from 2007. Versions 1-4 were produced 2006-2009. The latest version (v5) updates dynamically as trends change in real time: http://webtrendmap.com. Of all the maps, 2007/V2 was the most legible to reproduce in the printed format of this thesis.

4.2.3 Sound & Space

The conceptual design of *Dérive Entre Mille Sons* comes primarily from Debord, psychogeography, and the dérive. These ideas were what prompted the first investigations of space and spatial practice and helped me to more clearly understand a latent spatiality present in all of the work I had been doing in the years leading up to this PhD research. The technical side of these projects was aided by the work of Dr. Barry Blesser, whose book *Spaces Speak, Are You Listening? Experiencing Aural Architecture* deals exclusively with the relationship between sound and physical space. Blesser borrows the terms *acoustic horizon*, *acoustic arena*, and *auditory channel* from Barry Truax and "the language of soundscapes" (2007: 22) to discuss the relationship between sound sources and those who hear them. Starting with these terms I developed a mechanism that translates the spatial practice of the dérive into a two-dimensional sonic drift in a mediated environment. An early whiteboard sketch of this is shown in figure 4.7.

Blesser defines an acoustic horizon as "…the maximum distance between a listener and source of sound where the sonic event can still be heard" (2007: 22). To put this in the specific context of *Dérive Entre Mille Sons*, this is the range of hearing for the person engaged in the dérive. Sounds that fall within the acoustic horizon are audible; those beyond it are not. In addition, directionality and

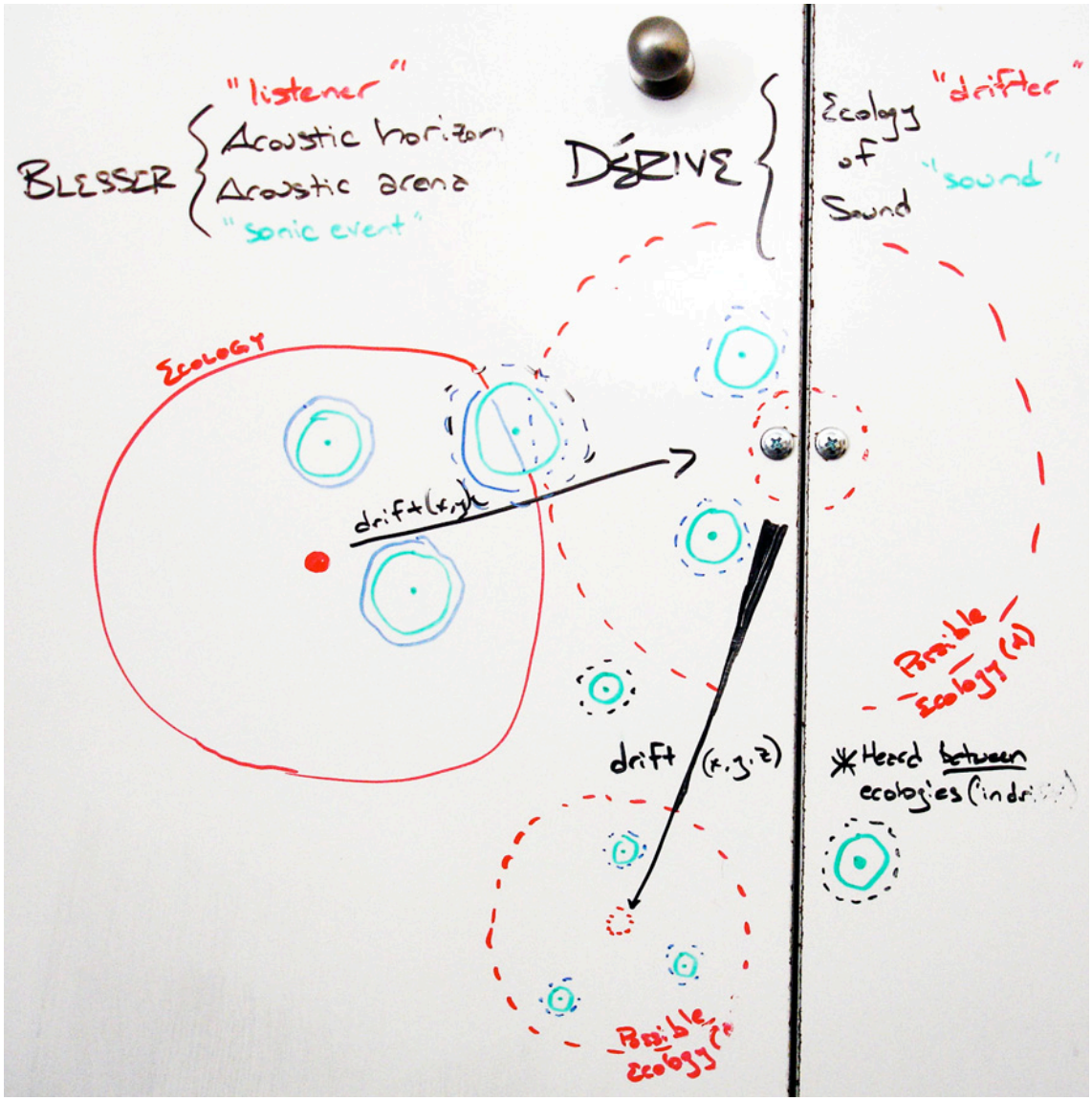

Figure 4.7: Blesser's terms acoustic horizon and acoustic arena figure prominently in the technical mechanism behind *Dérive Entre Mille Sons*. The largest circles represent an acoustic horizon, while the smallest an acoustic arena. Solid lines show what is audible and dashed lines show what is not.

proximity are handled via the control of volume and panning. Sounds emitting from varying degrees to the left or right of a listener will be heard in the corresponding channel of a stereo mix. Similarly, sounds that are more distant are heard at a lower volume while those that are near are louder.

An acoustic arena is similar to an acoustic horizon, but switches the perspective from listener to source. Blesser's acoustic arena "…is centered at the sound source; listeners are inside or outside the arena of the sonic event" (2007: 22). Psychogeography explores the perception of zones that are created in the urban landscape. In *Dérive Entre Mille Sons*, zones are placed within the virtual territory and act as an acoustic arena. Each contains a collection of sounds and a generative instrument. When the listeners' acoustic horizons overlap with the acoustic arena of a zone, the sounds played by the generative instrument are audible. This connection creates an auditory channel. Where Debord's dérive is frequently described as visual in nature, an auditory channel connecting listener and zone make *Dérive Entre Mille Sons* an experience entirely rooted in sound and its affects.

This is an important point to emphasize. While there is a visual component to *Dérive Entre Mille Sons*, it exists purely for the convenience of testing and development. The intentions of the work were such that it be completely aural in nature. To date, the work done on this project has only gone as far as a prototype using the wireless controller from a Nintendo Wii gaming system, aka a *Wiimote*. The final version of the project is intended to be experienced on an Apple iPhone or iPod Touch, where the lightweight, unobtrusive device can be tilted front-to-back and side-to-side while sound reaches the listener through headphones. While both of these devices have screens, my research has shown that this only serves as a distraction. Listeners I have observed focus too much on where they are in the overall landscape when they have a visual reference. When all they have to orient themselves is their ears, there are fewer obstacles between them and the sonic experience I am trying to impart.

When a listener is engaged in spatial listening, Blesser says there are four distinct modes of experience:

> …social, as an arena for community cohesion; navigational, as local objects and geometries that combine into a spatial image; aesthetic, as an enhanced aesthetic texture; and musically, as an artistic extension of instruments. (2007: 64)

My use of these modes in *Dérive Entre Mille Sons* is mixed. Navigation is certainly important, though not in Blesser's same terms. Sound heard in space makes it possible to orient oneself. Orientation towards a single "goal" or final destination is definitely not a part of this work. There is no solution to be found or puzzle to be cracked. However, sound should help to orient listeners in the overall relationship or ecology of sounds created by this work. If they hear something that appeals to them and want to hear it more clearly, the spatial relationship between themselves and the source of interest should facilitate that process.

Aesthetics are important, but where Blesser's sense of aesthetics deals more with how the acoustics of physical space shape sounds, *Dérive Entre Mille Sons* is concerned primarily with the aesthetics of sound relationships. The ways that sounds from adjacent zones mix and mingle, and the variety of experience to be had in the process of the dérive are of great importance in this piece. Most of the time invested in completing this work was spent focusing on these concerns, the details of which will be discussed at length in the next section of this chapter. Blesser's musical mode of experience stems from his emphasis on physical acoustics. A room, church, or concert hall has an important role to play in shaping the sound of an instrumental or vocal performance. This is not something that has factored into the current working prototype of *Dérive Entre Mille Sons*. However, it did exist in some of the earliest sketches for the project and has enormous potential in future versions. Space that serves as an artistic extension of an instrument could be included if it were given its own zone in the territory (see figure 4.8) of the piece.

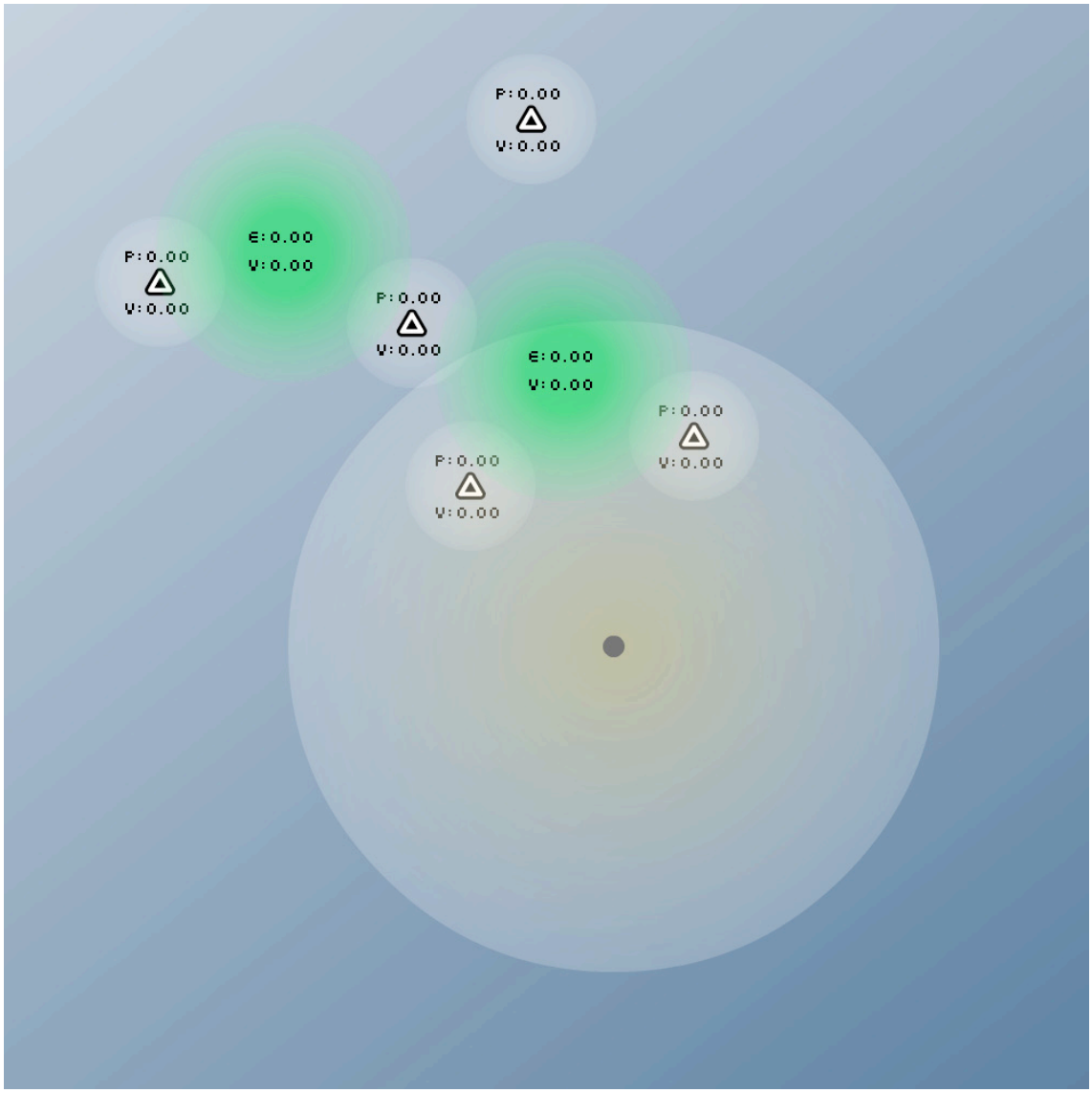

Figure 4.8: Adjacent sonic zones (with a triangle icon) can intersect with effects zones (no icon). Any sounds heard in areas where these overlap will have that effect applied to it. In situations where the effect fills the space with a Gaussian distribution (as proposed by Momeni & Wessel (2003)), the deeper one moves into that space, the more pronounced the effect will be.

An excellent model for this was designed by Ali Momeni and David Wessel. While developing spatial layouts of musical material for live performance control, they produced "interpolation spaces," which allow a composer to spatially organize musical material and control it through an interface with a visual metaphor:

> That is, by moving points around in the space or by transforming their kernels, one can find entirely different sets of interpolated results from the same data set. These transformations would not only expand the palette of musical capabilities that an instrument has, they could also elucidate structural similarities and dissimilarities in the data that may not have been evident in the original spatial layout. (Momeni & Wessel 2003: 62)

In the applications they designed, an interpolation space looks like a cloud. Areas where a cloud is the most opaque represent positions at which the associated sound source, channel, or parameter for transforming sound is heard most prominently. Conversely, areas where the color is diffuse or transparent diminish the effect. This application of spatial sound resonates both with Blesser's ideas of space as an artistic extension of an instrument and the dérive. As one plunges deeper into space, the intensity of an effect applied to a sound, or the volume of the sound itself is escalated. Any overlaps

between interpolation spaces and additional, adjacent sound spaces manifest with synergizing affects, where the character of the overlapping spaces is simultaneously modulated by the properties of the interpolation space.

In the research leading up to *Dérive Entre Mille Sons* this idea was implemented in the very first audio piece using a Max/MSP object inspired by Momeni and Wessels' work called *Colorblobs* (DeTar 2006). While technical difficulties forced me to abandon this course of action, the idea is still powerful and has great potential in future versions. Wessel and Momeni's interpolation spaces have Gaussian distributions that contain a varying range of possibilities. In the system they proposed these can be reconfigured and moved by a musician while performing. This shows that it is just as possible to introduce a degree of generativity to these spaces. Something to modulate the density of the Gaussian distributions, move the interpolation space across the territory of the work, respond to environmental sensors that vary the processing effects as in *Sound Garden*, etcetera, would allow these spaces to make a similar contribution towards shaping the music as do the spaces linked to generative instruments.

4.3 Sound Speaks

When thinking about music and sound, and organizing this work while following spatial models, the connection between location and listening is of the utmost concern. When working with concrete, physical spaces these questions can be answered in a relatively straightforward manner. The space exists, it has certain acoustic properties, and musicians work within the limitation and opportunities these provide. When dealing with space and sound conceptually in a mediated environment, matters are increasingly open-ended. For the projects discussed here, the relationship between sound and space had to be approached with a focus on experience. Following the thinking of Lefebvre and Debord, only by living in and moving through spaces can their character and the relations between them be fully recognized. By moving through sound and space, space is produced: the "…production process and product present themselves as two inseparable aspects, not as two separable ideas" (Lefebvre 1991: 37). Music is made within and by moving through the spaces of these works. Additional perspectives of sound and music in mediated and sociocultural space can provide models that further clarify the unique potential of aural-spatial relations in the projects discussed here.

4.3.1 Narrative Film Music & Simultaneous Vertical Relationship

In narrative cinema, music helps to provide a transparent narrative structure by creating for the viewer a "point of experience" (Gorbman 1987: 3). Music tells the viewers what to look at on the screen and how to feel about the characters in a story by serving as an interpreter for the visual track. Without the "correct" music for the narrative direction of the film, a scene could be completely misread or misunderstood. The sort of guidance provided by the score of a narrative film is too heavy-handed for projects like *Dérive Entre Mille Sons* and works of Amergent music in general. However, more analytical perspectives of film music can offer an interesting perspective.

Film depends upon the synergy of visual and audio elements to increase both understanding and the immersive potency of its story. The sound-image relationship has this effect because the elements of sound and visual track are inextricably linked in a viewer's mind. Both events "happen" at the same time to forge a bond of meaning between what is seen and what is heard. Michel Chion describes this as a "simultaneous vertical relationship" (1994: 40) (see figure 4.9) between audio and narrative. In *Audio-Vision: Sound on Screen*, he discusses the ways in which sound is always linked to some aspect of the visual track. If a sound is heard, and nothing is present to visually identify or acousmatically link to the source of the sound, viewers could be confused and the cohesiveness of the narrative could break down. If the sound elements of a film were to be separated from the visual track they would likewise lose the context the film provides, (Chion 1994) rendering them into an abstract composition. The incomplete, silent visual track would also be left open to broad interpretation. From the

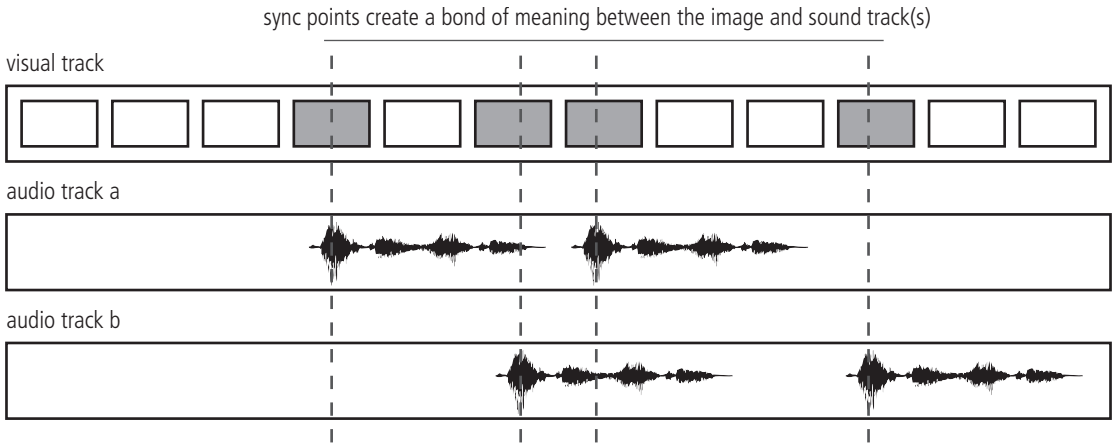

Figure 4.9: Chion's simultaneous vertical relationship creates a bond between audio events in the soundtrack and visual events in the image track. In this relationship, movement from left to right shows the passage of time. When significant audio and visual events occur simultaneously, they are linked, one "on top of" the other. This is no different from the idea of audio-visual synchronization, but offers a more powerful characterization of the relationship since the two components are treated independently within the whole.

perspective of "Hollywood" and narrative films, this creates potential problems. However, Chion's concept of the "simultaneous vertical relationship," while apropos to a critique of sound in narrative films, has compelling implications to works of Amergent music as well.

The image track and sound track in Chion's characterization represent parallel streams of content and information. Chion conceives of this relationship as one that exists between image and sound, but as it fits into the workings of *Dérive Entre Mille Sons* and Amergent music in general, the relationship of separate but concurrent "sound tracks" or zones of sound is more appropriate. Using the dérive as a metaphor that allows listeners to explore and interact with sounds exposes this relationship. In all of the works that use the dérive as a means of interaction, there is a continuous background track or atmosphere that plays to establish the overall tone or sound of the piece. This can be compared to R. Murray Schafer's "keynote sounds," those elements of the soundscape that create the overall tone of a place (Schafer 1977: 9).

The music of this work does not play in a linear fashion with the passage of time, rather the listener must drift through space for music to become manifest. Temporal change and development is subordinated to spatial negotiation as listening curiosity draws listeners towards sound. Zones with acoustic arenas that overlap with the listener's acoustic horizon form the primary content of (what is heard in) this musical experience. These sounds are heard with the background track to create a simultaneous vertical relationship that is bound more to space than time. Unlike the relationship Chion proposes, where sound track and image track are uncoupled and left to play linearly in time, *Dérive Entre Mille Sons* depends on position and proximity to establish the sonic relations of the work. As the listener's drift takes him nearer to other audible, adjacent zones (see figure 4.10), these are heard together as well.

The organization of all these pieces associates sounds as a group. Sound groups are paired with zones in the overall territory of the work and played following the rules and dynamics of each zone's generative instrument. This adds novelty to the simultaneous vertical relationship. Unlike a film where the relationship between these elements is carefully planned and synchronized, Amergent music benefits from the surprise that comes with an untethered connection between the components that can form vertical bonds. In his discussion of image and sound track relations, Chion offers another relevant term, *synchresis*. Synchresis combines the words *synchronize* and *synthesis* to describe the phenomena that occur when significant audio and visual events are synchronized and produce meaning (Chion 1994). It is an affect that is experienced most acutely while performing Chion's "Forced Marriage"

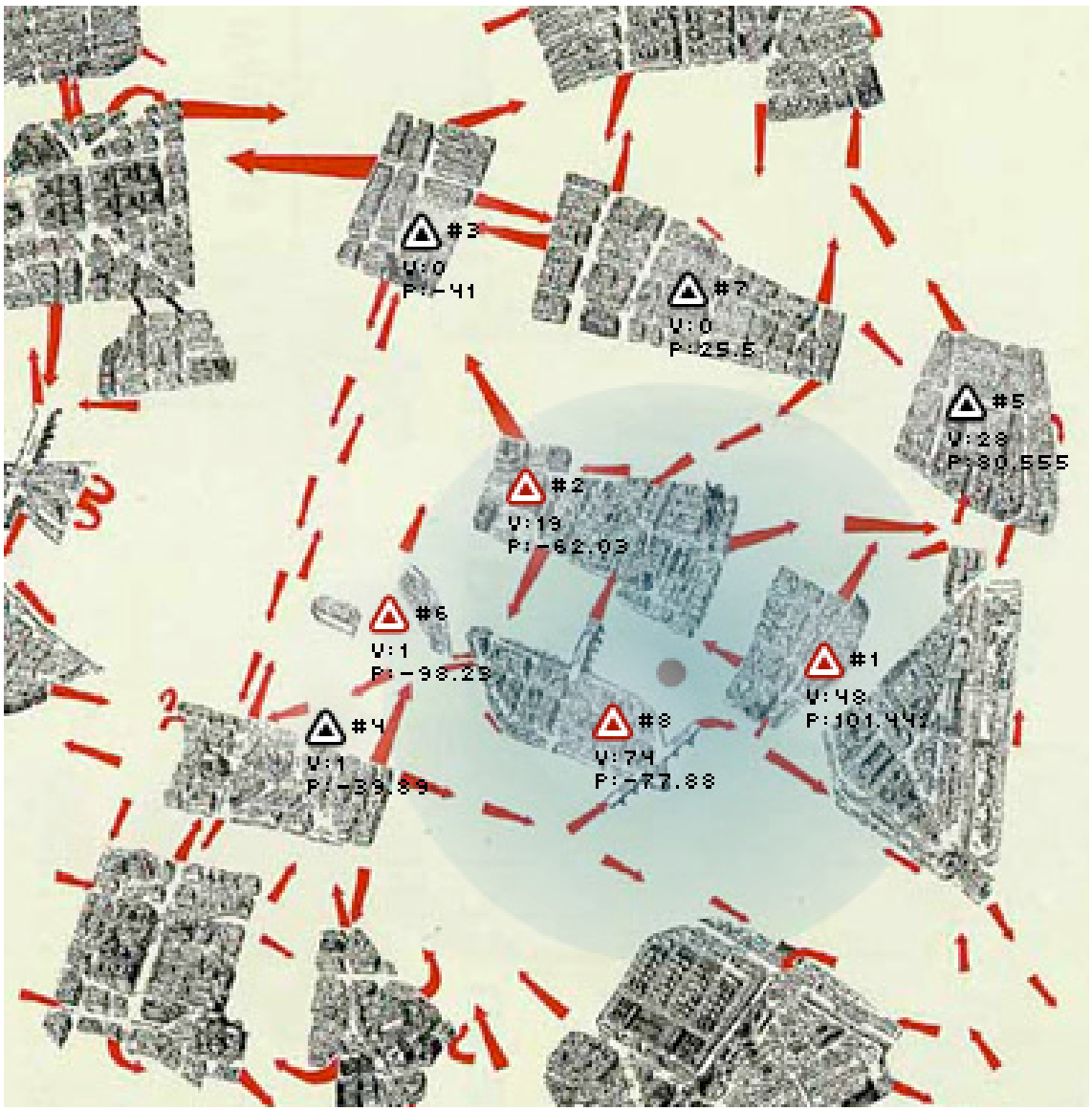

Figure 4.10: Debord's dérive map of Paris shows the psychogeographic zones he discovered in his drift-ings through the city (1957). *Composition-Instrument Study I* positioned generative instruments (represented by the triangles) within the zones Debord identified to create a sonic re-interpretation of a psychogeographic Paris.

exercise. In the Forced Marriage, one repeatedly watches a sequence or scene from a film while playing different audio tracks to accompany each new viewing (Chion 1994: 188-9). The results can be astonishing. The same film clip is interpreted and re-interpreted with each new piece of music. Sonic and visual events that have no prior relationship come together to produce powerful connections, or points of synchresis.

In a work of Amergent music, a different kind of synchresis abounds. Everything that is heard is the result of sounds grouped and positioned within zones, generative instrument dynamics, and the course and tempo of the listener's dérive. This is not a relationship of pure synchresis as described by Chion, but it shares resonance with the original term. Amergent music and spatial interaction through the dérive leverage the unique affects that come from unforeseen combinations of artistic material but also flatten or extend them in time. A fleeting point of synchresis discovered in a Forced Marriage may last only a moment, but the sonic combinations to be discovered in the works discussed here spread these points out into overlapping and continuous sonic gestures.

As the creator these works, there is no way for me to control where a listener's drifting will take them.

Individual zones are organized within a territory so as to create the greatest potential for sonic discovery and exploration within the musical experience. The kinds of sounds that go into a zone, as well as their interrelationships and connections to the larger territory of the work, are yet another matter in the creative process. While discussions of film music address some of these concerns, as a creative model it is too limited in its scope for most of the projects discussed in this thesis. Other conceptions of sound and environment can be liberating in generating ideas for these and future works of Amergent music.

4.3.2 Rhythmanalysis

Psychogeographic effects are abstract to begin with, but removing them from a physical environment and organizing a sonic psychogeography creates a new kind of spatial practice that is both abstract and immaterial. The dérive makes it possible to experience space, but again, sound that produces space is an elusive concept at best. It can be engaged and lived, but is otherwise difficult to communicate and share with the uninitiated. Psychogeography and spatial practice in environments that are purely sonic become easier to grasp through an understanding of Rhythmanalysis.

Henri Lefevbre writes that Rhythmanalysis is both a theory and practice that can help one learn about the character of a place or a culture by listening to its rhythms (Lefebvre 2004). Lefebvre describes the work of the rhythmanalyst as a kind of listening in which the specific content of each sound, while important, is secondary to the overall interactions of individual sounds. Harmony, dissonance, density, intensity, arrangement, context, frequency and repetition are all vital characteristics. Lefebvre calls on the double meaning of the word *entend*, to show that the rhythmanalyst will both "notice" and "understand" (2004: 88) sounds that are encountered. To perform a rhythmanalysis is to listen to the sounds of a place, to observe the constituent layers and their dynamic relations, and to use that sonic data to construct an understanding of one's subject.

Rhythms require repetition, but not the repetition of machinic precision. Rhythms are composed of "movement and becoming":

> …rhythm preserves both the measure that initiates the process and the re-commencement of this process with modifications, therefore with its multiplicity and plurality. Without repeating identically 'the same', but by subordinating the same to alterity and even alteration, which is to say, difference. (Lefebvre 2004: 79)

A generative instrument working its way continuously through a list of sound files has a rhythm. On one hand, it is a precise machine, but on the other, what it produces seems to spring from nature. Lefebvre uses the example of rhythms in the waves of the sea: each is subtly different, yet the waves approach the shore with persistent regularity. Flowers make a good example as well. Each grows and forms uniquely within the rhythm of the seasons. In a group of Shuffler instruments, various sounds are set to play at regular intervals—a precise rhythm. However, this is more accurately a *Lefebvrian* rhythm because the intervals are often incommensurate and the instruments are unlikely to ever play the exact same sonic combination. Furthermore, the envelope of each sound has a unique shape, which makes the precise combination of sounds in the mix even more difficult to exactly reproduce. There is rhythm; there is regularity, but it is one marked by difference.

Lefebvre also speaks to sound character in a rhythmanalysis. Terms like harmony and density are important in the works that use the dérive as its metaphor for interaction. In the first two *Composition-Instrument Studies* I worked primarily with synthesized sounds that had a diffuse, spatial quality. I imagined a world filled with multicolored patches of ethereal, sonic fog and tried to convey that idea in the lightness, airiness, and general texture of the sounds I created. I found that too many "foggy" sounds mixed in ways that diminished the unique texture of each on an individual basis, so more per-

cussive sounds were introduced, along with sounds that were gritty or scratchy. While "foggy" was the right visual metaphor for working on these pieces, textural sonic thinking led to the most successful sound palette in the end. Examples of this work are in section 5 of the supporting DVD.

The focus of *Dérive Entre Mille Sons* was to explore space conceptually as a means of structuring music around spatial interaction. I was also interested in the acoustic aspects of physical space. "Eigentone," (Sonnenschein 2001: 187) the sound created by the natural resonance of a room or space, or R. Murray Schafer's "keynote sounds" (1977: 9) were guiding concepts in developing a new sound palette. I made a library of field recordings while traveling in Minnesota and Wisconsin (USA) and Cairo, Egypt. When making these recordings I was primarily interested in capturing the sound of environments that struck me as unique: ponds, lakes, residential neighborhoods, cafes, and mosques to name a few. In particular, I was less interested in the voices of a conversation than I was with the way the voices echoed in a narrow stairwell. I wanted to capture the soft chorus of frogs singing in the trees, but was not particularly concerned with the sound of *a frog*.

After the recordings were complete, each was edited and digitally processed to emphasize its most compelling, spatially-derived qualities. In the final piece, these sounds were organized with additional synthesized sounds to create a collection of sonic zones comprised of real, processed, and synthetic musical material. After all of the processing and layering of the field recordings, the listener is left with an experience that is foremost acousmatic. Representation was not the objective, as any chance of that was dashed after the recordings went through their first round of digital processing. However the *character* of the space featured in the recordings does make its way in to the final piece. In retrospect I recognize this because I was there. Listeners are unaware but this in no way detracts from the sonic experience. To their ears this is the sound of the place at which they have arrived, whether it is a point they have reached intentionally or a pause for reverie along the way. To dérive sonic neighborhoods is to drift and *entend*. Listening to the character of each new zone reveals its space and its nature, and what those relations contribute to the overall territory.

4.3.3 The Dérive & Musical Interaction

Both of the *Composition-Instrument* studies and *Dérive Entre Mille Sons* were recursive exercises of research and practice. The results of each have led to important and useful conclusions about these and future projects that concern interaction and music in mediated environments. The use of spatial models to organize sound proved to be both intuitive and conceptually stable. This kind of organization also revealed important considerations for future works that use spatial systems.

The treatment of specific sounds and their interrelationship within a zone was one particularly challenging aspect of this work. It was expected that the overall organization of sounds would be crucial in creating zones with enough sonic magnetism to draw a listener in. But what I did not expect was that the level of organization started at the macro level of the overall territory and went down to the microscopic details of each individual sound file and behavior of the generative instruments. After spending a good deal of time listening and dérive-ing on my own, in addition to listening to others spend time with these pieces, the ways in which sound worked to orient a listener became much clearer. When a listener drifts into a new zone, if the sounds within it are not completely continuous, it can be disorienting as to whether they are really "there" (within the zone) or not. The effect can be like an aural mirage: the listener first hears the zone when they are far away from it. It draws them in and they drift towards it. But moments later, when their acoustic horizon has an even greater overlap with the zone's acoustic arena, it falls silent. This happens when a generative instrument is currently between sounds, or when the envelopes of shorter sounds have reached a point at which they are decaying and becoming quiet.

Zones and spaces that have more intermittent musical behavior associated with them can be deceiv-

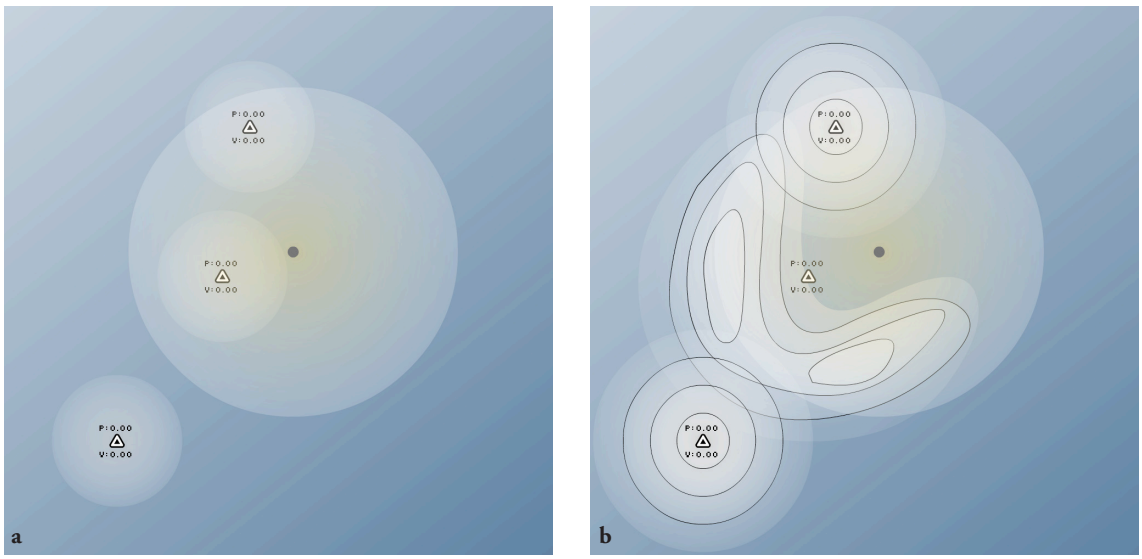

Figure 4.11: In the current organization of the work (A) individual zones contain a single generative instrument. If the sounds of any audible zone are not playing, the existence of the zone is called into question. An organization like a topographic map (B) could minimize this by adding additional layers of sound to each zone. The flat, two-dimensional zones in the current version of the project would be replaced by groups of contour lines. In the topographic version, sonic zones look like hills and mountains, where the lines are closely-spaced. Elevation, as expressed on a map becomes analogous to the affective kernel of a sonic space.

ing. One way around this was to cluster zones into "neighborhoods" that have both continuously-sounding and intermittent behaviors. This kind of organization helped to a degree but listeners reported to me that some disorientation did still occur. A frequent question I was asked is, "Where did that sound go?" In these situations listeners usually have heard something compelling and drifted in that direction only to find that it was "gone." Of course the sound never goes away, but its "appearance" depends on the dynamics of the generative instrument within each zone. Before this project can be shared with the public in future versions, a new relationship between generative instruments, their available sounds, and the overall organization of sonic zones should be explored.

To date this has not been fully resolved. One possible solution could be to make each territory a complete "mini-work" within itself so that as a listener drifts to a distant territory something will always be audible. However, I fear that this could lead to a homogenous experience across the entire landscape. Individual territories have the potential to become more discrete as their increased cohesiveness produces a striated rather than Gaussian or "foggy" blend of sounds across the entire territory of the work. Topographic maps provide an interesting potential solution as well (See figure 4.11). This would involve a radical re-organization of musical material in the current version of the project and may even require a greater body of sound resources from which to draw.

Various devices to facilitate interaction were also explored in these works. Game controllers and 3D navigation devices were tested and eventually discarded. The physicality of interaction had to be kept to a minimum in order for the musical experience to become the sole focus of the work. As discussed earlier, the Nintendo Wiimote which provided a means of movement through tilting, was a fantastic solution with a few exceptions. As with many of the projects discussed in this thesis, satisfactory results have been a matter of finding balance between extremes. In the course of my own dérive-ings and talking with others who have spent time with *Dérive Entre Mille Sons* it is clear that too much or too little interaction can cause the work to lose its potency. In some situations, especially when listeners become disoriented, they begin to drift desperately. And in their drive to hear something, the effortless reverie afforded by the dérive is destroyed. At the opposite end of the spectrum, too little movement leads to moderate musical stagnation. Because the work was designed around the dérive there was an initial expectation that the listener would be moving or remain in nearly-continuous mo-

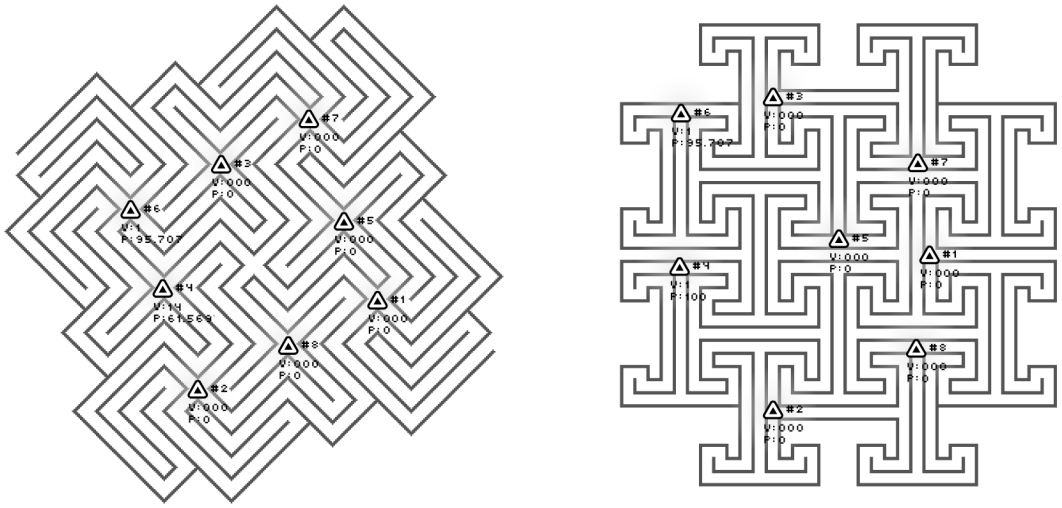

Figure 4.12: *Composition-Instrument Study II* includes two mazes, *Nine Crossroads* (left) and *Duvet* (right) by Andrea Gilbert.

tion. Once the work was complete it become clear that this was entirely unrealistic. Frequently when listening to *Dérive Entre Mille Sons* you find yourself in a place that sounds fantastic and you want to stay there. In terms of the musical concerns of the work this is one of its successes. But as this concerns the interaction, it raises the question of where to go next. If a listener is immersed within one or more zones it is unlikely that he will be able to hear something new that draws him out, and moves him in a new direction. Unlike an actual dérive where it may be possible to see vague but interesting contours of a building many blocks away, the aural dérive discussed here currently has nothing comparable. Future versions would be well served by the inclusion of something sonically equivalent to a vanishing point, or in the case of this work, a temporary extension of the listener's acoustic horizon.

Finally, an additional idea with broader implications came out of these projects. Earlier in this chapter there was a discussion of visual references within *Dérive Entre Mille Sons*, and how this made it more difficult to fully engage in an immersive listening experience. This was also apparent in the *Composition-Instrument* studies that involved mazes, but with an entirely different outcome. In both of the mazes that were used, *Nine Crossroads* and *Duvet* by Andrea Gilbert (see figure 4.12) (2009), engagement in the space of the maze was intensely visual but it *did not* detract from the musical experience. Rather, music became a byproduct of interaction and passage through the maze, while remaining a crucial component of the overall experience.

The territory changed dramatically in these two studies. In *Nine Crossroads* the placement of sonic zones is more or less aesthetic to match the symmetry of the maze. In *Duvet*, zones were deliberately placed at points along the path between the entrance and exit of the maze. In the end, the musical affect created through zone positions was only nominally different. And because the range of the acoustic horizon was relatively small given the scale of the maze, sonic zones did not necessarily help to show the way out. What this did reveal, however, is that when you are concentrating on getting out of the maze, any ambition to find interesting musical sound combinations disappears. To a third-party listener, the music that is produced while maze-ing is just as interesting as the music that comes from the process of the dérive. But to the person navigating the maze or tilting the controller, these are two very different experiences: one in which music is the entire focus of interaction, and another in which it seems to "just happen" but is in fact closely tied to their existence and movement within and across spaces. This shows that the concepts and mechanisms involved—struct*aurally* coupled interaction and a spatial organization of musical material—can function in a variety of future projects. It can be more controlled and performative as in *Dérive Entre Mille Sons* or concomitant as in the mazes.

Conclusion

Psychogeography and the dérive show how the delineation of space can be experienced in an urban environment. These spatial practices can be leveraged towards musical interaction in mediated environments as has been demonstrated by the projects *Composition-Instrument Studies I-II* and *Dérive Entre Mille Sons*. Unlike an actual city where political, social, and cultural factors give rise to the development of space, a mediated environment is designed. Design, however, does not presuppose use. Design can and should serve robust uses of space, and facilitate new possibilities for those who exist within it.

Each of the projects discussed in this chapter was guided by theories of space. Architectures of networked information, culture, communication, narrative, and physical space were all considered in the development of these works. Sound and music—the primary focus of this research—can also produce space. It imparts to each space a unique quality given its repetitions and rhythms. As an exercise of research and practice, sound and space were designed to coexist in a relationship in which one could not exist without the other: spaces or zones exist and are noticed because they have sound; sound is audible within an acoustic arena and produces its space. This approach can be reflected back onto some of the other ideas related in this chapter, such as sound that functions within the space of information or the space of a narrative. Londontown, the last example of Amergent music to be discussed in this thesis, is such a project. The music of this work is produced through the dynamics of a narrative-driven virtual world, and the drift-ings of an avatar across narrative and design space.

CHAPTER 5

Londontown and the Continuity of Experience

"Art is the exposure to the tensions and problems of a false world so that man may endure exposing himself to the tensions and problems of the real world."

– Morse Peckham, *Man's Rage for Chaos: biology, behavior, and the arts* (1965: 314)

The title of this chapter and the quote by Morse Peckham may at first appear to be at odds with one another. Maintaining a continuity of experience with reality is exactly the thing Peckham argues that art should not do if it is to serve as a "…rehearsal for those real situations in which it is vital for our survival to endure cognitive tension…" (1965: 314). Rehearsal is the point on which this chapter and Peckham agree, however. If the rehearsal is to be effective, the work of art should maintain a sufficient degree of tension and confusion so as to be preparatory—it must create an experience that is adequately disorienting and sustain this experience throughout the work. Moments in which art's "false world" falters cause the rehearsal to break down. Cognitive tensions release and the challenge posed by the work is diminished. Its ability to prepare one to experience the world differently is lost or at best, postponed.

The research involved in creating works of Amergent music has been significantly helpful in not only seeing but hearing the world differently. Spatial concepts explored in relation to psychogeography and the Dérive produced several interesting standalone musical works. And while the results were interesting to listen to, they did not explore the potential of Amergent music in ways that demonstrate the flexibility and power of the genre. *Londontown* is an ongoing project focused on the development of a narrative-driven virtual world set in Victorian London. It involves, literally, the creation of a false world, one that is persistent and demands sonic continuity to affectively hold the world together. With its unique take on storytelling and seeded narrative, the project provided the perfect vehicle for testing the ideas behind Amergent music.

5.1 Spatial Practice: using space; living space in a virtual world

Amergent music is primarily concerned with sonic change over time. Those changes can be made relative to the environment in which the music is experienced or by specific actions taken on the part of the listener. That they are aware of how (technically or procedurally) their presence in a mediated environment shapes the music is irrelevant, but it is crucial for all musical development to be discernible and for there to be a clear connection between what they do (or have done) and what they hear. Amergent music operates as an ambience, following Brian Eno's requirement for Ambient music to be "…as ignorable as it is interesting" (1996: 296). Amergent music also represents a sonic "atmosphere," "influence," and "tint" (Eno 1996: 296), but one that will gradually shift over time. Listeners are unlikely to notice sweeping changes in their aural environment, but will discover that they are in a very different sonic "place" than they were when they first started.

Space is a useful metaphor to create and discuss music that behaves in this way. The idea that listeners can find themselves in "different places" is just one example of how powerful space, as a musical concept, can be. You sit at home or you sit in a restaurant. These are distinctly different places and each has its own sense of space. Apart from the obvious visual and aural differences, there are social differences that separate the two. In most restaurants it would be socially inappropriate to remove your socks and shoes and rest your feet on the table. At home this is your prerogative. These extremes represent two ends of a social space. And in between these is a variety of conditions that can modulate depending upon the unique environment and situation, for instance in a casual restaurant shoes off,

socks on, and feet under the table would be acceptable. Space is interesting because it is a fluid continuum. It is clearly defined, yet within it there can be a variety of conditions modulated by the extremes.

Amergent music uses this idea of a fluid continuum to pair musical potential with movement along a continuum or within a space. In practice, what has proven to be useful is to monitor movement within several different spaces simultaneously. In the way that a person may move between spousal space, parental space, employer space, and colleague space in the course of a day, it is possible to move within simultaneous musical spaces. In this chapter, the specific case of space as a tool for developing musical behaviors will be examined through a discussion and analysis of the project *Londontown*.

Londontown is a virtual world: an online social environment to be inhabited by thousands of human beings. Virtual worlds are similar to computer games that have either cooperative or competitive multiplayer modes, but they are not games. The world persists—time passes and events unfold—even when its citizens are not all present. As a project for this doctoral thesis, Londontown applies concepts of spatial practice and generative music to a narrative-driven virtual world.

I am involved with a team of writers, artists, and programmers, in creating a "vertical slice," a version of the world that has depth in its behavior and functionality but is narrow in scope. Rather than occupy the entirety of London, the vertical slice takes place in and around the Crystal Palace, at the original site in Hyde Park. I am using my style of Amergent music for the non-diegetic, character-driven music in the game. As a player-character moves through the world, his social, economic, familial, and professional experiences are made up from a confluence of prior successes, failures, romances, and intrigues—all the result of his actions in the world. Amergent music uses this tapestry of affect to construct musical underscoring that is directly drawn from the in-world dynamics of his current situation and based on a model of spatial relationships.

5.1.1 Spatial Theory: Lefebvre

The idea of space as a communicative medium has been discussed to an extent in previous chapters of this thesis. But when it comes to the specific focus of Amergent music further exploration is needed. Henri Lefebvre has written extensively on spatial practice. He differentiates physical space from social space, conceptual space, and space lived through images and symbols. He further defines a triadic relationship between representations of space, representational space, and spatial practice (Lefebvre 1991). In his essay *Allegories of Space*, Espen Aarseth (2007) discusses Lefebvre and how his conceptions of space could be useful in studying computer game and virtual world design. Ultimately, Aarseth is hesitant to pursue this thread, but I have found it to be extremely useful when thinking about ways to connect musical behavior with interactions in these sorts of environments. As the space of the imagination—one lived through images and symbols—Lefebvre's "representational spaces" (1991: 39) are particularly useful. He characterizes this kind of space as one that speaks with "…an affective kernel or centre…" (Lefebvre 1991: 42). My musical interpretation of this concept works to identify a theme or idea that is central to the mediated environment and to define it as a representational space.

An individual space is further defined by pairing it with a set of sonic possibilities. Field recordings, instrumental samples and phrases, synthesized sounds, and percussive patterns are just some of the audio elements that can be coupled with a space. It would be limiting to formalize the way sound and space are connected in this arrangement. Sounds are chosen based on a variety of variables relevant to a specific project. In the case of *Londontown*, specific aspects of the world and the way players interact with the world were chosen. The details of these are discussed later in this chapter, but in general, Amergent music aims to connect play and interaction to the mediated environment in ways that emphasize the uniqueness of each mediated experience.

As a result of this uniqueness, each space is not meant to have a binary, on/off sort of character. To

this end, the sounds of a space are chosen carefully to reflect the variety and nuance it contains. For instance, spaces that are more psychological may have an intensity of timbre but be rhythmically still, or spaces that suggest action will have more texture to introduce subtle rhythms that can be built upon if the intensity needs to be raised. These sounds are then ready to be played by generative instruments. Certain generative instruments, like the Shuffler(), are best for handling spaces where there are a variety of changes that must happen in short spans of time. In contrast, the End2End() instrument responds to change very slowly, but is much more effective for setting up foundational musical textures on which other sounds can build. The individuality of each space is defined by a constantly evolving, generative playback behavior and a specific palette of sounds. What will be heard is known generally but not specifically, which lends each space a character that is consistent over long periods of time but organic from moment to moment.

5.1.2 Spatial Theory: Debord revisited

Other spatial practices, including psychogeography and the dérive have a significant role to play in this conception of music, sound, and mediated interaction. What characterizes a space, or more specifically what is heard within a space to give it an identity is the first step in making a work of Amergent music. But for this music to reach its full potential (and have the most to offer its listeners) it is movement through space, movement across adjacent spaces, and movement within overlapping spaces that provides the most profound aural connection between one's actions and the mediated environment.

The dérive is based on the psychogeographic character of urban spaces. As you walk through the city some areas attract and draw you in; others do not and you move on until something more appealing causes you to change course. In this practice it is the boundaries and edges of attractive spaces that can provide the greatest interest. One boundary draws you towards the first space and another boundary beckons you to the next space. In the moment of transition something very interesting happens. As you move from one space to the next, you are in an intermediary space that shares the character or flavor of the adjacent two, three, or more spaces found at the given intersection. This is where the practice of the dérive holds the greatest musical potential.

It is in the "cracks" between intersections and boundaries where unimaginable spaces exist. These spaces are fleeting—almost evanescent—and indiscernible until you find yourself inside them. These are also the spaces that make Amergent music affectively powerful. They are the points at which change relative to actions taken within the mediated environment are audible. One space can be heard, but its uniqueness is thrown into relief at the introduction of another space. Simultaneously these two produce a third space which makes one's passage ever more apparent. The third space is ephemeral, and dissolves once movement from the first to the next space is complete. In an interview with Kristine McKenna, Brian Eno discussed a similar phenomenon:

> Each thing you add modifies the whole set of things that went before and you suddenly find yourself at a place that you couldn't possibly have conceived of, a place that's strange and curious to you. That sense of mystery, learning to live with it and make use of it, is extremely important. (Tamm 1995: 65)

In his contributions to the presentation *An Adaptive, Generative Music System for Games* (Larson 2010), composer Jim Hedges used this quote to discuss something that happens to musicians when creating generative music. Generative systems are generally so closely entangled that when one element changes it often affects everything else. These effects can be felt both immediately and gradually as the system is allowed to progress. When making generative music it is not uncommon to experience moments of complete surprise. Unimaginable sonic combinations emerge and dissipate, leaving the generative musician feeling simultaneously like the composer and the audience. The sense of mystery

Eno associates with unexpected "places" is exactly the feeling created by drifting from space to adjacent space, and the spatial organization of individual generative systems creates many opportunities for these effects to be heard and experienced.

Amergent music is based on the use of multiple generative systems. In the case of *Londontown,* the use of multiple spaces and the arrangement of these spaces were handled differently. Various aspects of the world—specifically those a player-character can affect and those they are most affected by—are assigned to a space. Consequently, movement within or across one of these spaces is no longer something residents are aware of. They exist in the world having conversations, doing work, and generally carrying-on in the ways that interest them most. They are focused on their experiences, but all the while the choices they make place them at a new location within each respective space. For example, as they get training in a new craft they move to a position of greater experience within their "Skills space," or when they start work for the day or are hired for a job they enter into their "Profession space." Players are not aware of these spatial adjustments. They take place in the computer code that runs to support *Londontown*. The spatial adjustments simply track player choices and the consequences of those choices, which are in turn translated into usable information for the generative music system coupled to that space. For instance, when a player-character starts work they enter their "profession space" and the rules that govern the generative system for that space take effect. If they in some way improve their lot vis-à-vis their career, they move into a different location of profession space where a different set of rules takes effect. A player-character's actions and consequences are manifested as music by triggering different sets of rules that govern the playback behavior of sound resources.

It is at these moments (between starting work and the first step towards professional success, as in the last example) where players will briefly hear a third space created by the overlapping boundaries of the first two. Certainly the difference between the two spaces is discernible, but the unique (and sometimes odd) third space acts as a sure signal that something has developed in the *Londontown* world. The affect of this musical behavior is never so drastic as to disrupt the continuity of the world (musical or otherwise), but it communicates enough of a message to help player-characters better understand their environment and situation.

5.1.3 Spatial Theory: further thoughts on urban planning as a musical paradigm

Earlier, this thesis explored the work of Kevin Lynch from *The Image of the City* (1960). It was discussed as being related to psychogeography, as Lynch endeavors to help urban planners better understand the ways in which people interpret and use the cities where they live. Among other things, Lynch calls for cities to be *legible* (Lynch 1960). He argues that if the features of an urban environment are apparent they become a sort of affordance (Norman 1989: 9) that not only reveals a general functionality but a specific usefulness for each person who encounters them. This kind of thinking was a crucial part of the musical organization that went into *Londontown*.

In the world of urban planning, a city park can have paths, benches, flowerbeds, and so on. But where these paths lead, the points at which the benches are placed, and the location of flower beds relative to both of these other features presents the park planner with a list of challenging problems: how can you facilitate various styles of movement—everything from fitness to leisure—on park paths? How do you position benches so as to provide privacy but not isolation? Can the flowerbeds work both as an invitation into the park and a reason to stay? For *Londontown* I was faced with similar questions: what sounds best communicate the idea of upper-, middle-, and lower-class status in society? Regardless of class, how does advancement in one's profession (both legal and criminal) change sonically over time? Choices can build or tarnish a player-character's reputation; how can an instrument convey the repute of the characters you meet? Ultimately the answers to these questions came down to legibility, and using a sound palette that makes a player-character's actions legible to them.

This was a difficult problem to solve. On 29 April 2010 in conversation with Lee Sheldon, the lead designer of *Londontown*, I was advised, "music should always encourage the player...use carrots, not sticks, to stimulate their experiences in the world." In the end I created an axis ranging from cloudy to lucid, where lucid communicates "what you are doing makes sense," and cloudy says "your actions are confusing." This solution involved no negative feedback. Using legible sounds and combinations of sounds, the music was affectively constructive and encouraging. When a resident enters the world and takes on a quest (a task they agree to complete for reward) they make a commitment that must be followed through. Music that can communicate the clarity or cloudiness of their actions in regards to completing that task makes a resident's actions much more legible as they move about and explore the world.

In the virtual world of *Londontown* it is likely that people will be there to earn respect, make money, gain power, and advance themselves in general. But the real focus of the world is on stories and the ability to construct a personal, narrative experience. Residents should be able to enter the world as a lower-class cobbler or upper-class gentleman thief and have two completely different experiences. In the specific case of music, what a resident hears when they are in the world as such different avatars should still convey the general musical tone of *Londontown* but a version of the music that is unique to the class and profession he has chosen and to the way he conducts himself in this role. A player-character can start in the same place but take new paths each time he visits the world. The same can be said of any urban setting. In *The Image of the City*, Kevin Lynch describes buildings, sidewalks, and other urban features as useful for the construction of personal narratives, "A landscape whose every rock tells a story may make difficult the creation of fresh stories" (Lynch 1960: 6). I heed this as a sort of warning, in that if the music of *Londontown* is too specific in its commentary on player-character actions it will run the risk of telling the same story on each visit. Even if a resident chooses to play as the same sort of character, or uses a similar strategy to get them through the challenges the world presents, their experience will not be the same and therefore should not sound the same. Amergent, and ultimately a generative, musical approach works to ensure the creation of fresh narrative possibilities with each visit to the world. Organizing the musical structure into discreet spaces creates a more responsive connection between the actions a player-character takes and the sounds that are available as musical material. And by using a variety of generative systems to organize and play those resources, there is less repetition within the music that makes each new story fresh to the ears.

5.1.4 *Londontown* Character Parameters

Spatial practice played a significant role in the musical development of *Londontown*. The project puts residents inside an idealized version of Victorian London that is seeded with potential for action, adventure, intrigue, political maneuvering, and savvy social advancement. The world is designed in such a way as to accommodate all of these possibilities, which not only adds to the variety of options set out for residents of *Londontown*, but adds to the overall texture and variety of the world. Though residents may not be specifically interested in political sparring, they can hear news of a political conflict and may have to navigate obstacles created in the wake of a particularly heated debate. In keeping with the rich, textural fabric of the world's narrative, the music must reflect the variety of situations one can encounter in *Londontown* and be able to shift tone and temperament with the changing dynamics of the world. The flexibility of a spatial approach makes this possible.

As discussed earlier, aspects of the world that most affected residents, or those they had the greatest hand in shaping, were assigned to a space. Each respective space was coupled to a generative system that best reflected the potential dynamics of the space in terms of instrumental behavior and available palette of sounds. As player-characters explored the world their actions dictated movement within and across these various spaces leading to a unique musical output particular to their present situation. The process of defining these spaces was lengthy. It involved constant consultation with the

Londontown design document, regular testing and revision of musical prototypes, and a good deal of speculative music making, where choices are made based on how something might *potentially* sound rather than how it actually sounds. This kind of guesswork is tedious but necessary. You have no idea what will actually happen in the world, so consequently you have no idea what specific events will come together to produce the music at any given moment in time. But you do have a general idea of *a set* of potential interactions based on *a set* of available behaviors. You know who the player-characters are as residents in the world (their professional and social credibility) and you have some ideas about their relationship with those they meet. The *Londontown* design document (Sheldon 2010) provided most of the information that was needed to reach an understanding of what tangible data would be available for creating music in real time. With it as my guide I developed five distinct spaces that most profoundly connect the mechanics of the world with choices a player makes.

5.1.4.1 Class Space

When players create a character they decide to enter *Londontown* as a member of either the upper, middle, or lower class. Gains or losses in financial and/or social status can cause a player to move up or down to the next class, though these sorts of changes are designed to happen slowly because it was deemed unrealistic for a player to constantly flip-flop in the social strata. Each class has a unique set of advantages and disadvantages. Players choose a class based on their preference as to the kind of experience they want to have in the world. Attaining higher levels of respect and financial security do not necessarily constitute a reward. For instance, it is demanding to maintain the luxurious lifestyle of an upper-class character while middle-class characters have the greatest deal of mobility.

With these properties in mind, Class space is intended to set the overall musical tone. It provides a continuous background or foundation to set all other musical elements in the foreground. As such, this space is constructed with two generative instruments: an End2End() instrument that plays a continuous eigentone loop, and four Shuffler() instruments playing various pitch clusters on two different synthesizer programs.

The Wobbly Harp program started as a preset for an acoustic harp but was transformed into a deep and rhythmically bouncy sound with an unpredictable texture. This quality gives the sound a stable presence that changes from rough to diffuse. The Transparent Shimmer program has more of an ethereal quality. When it plays there is a core to the sound but seemingly no boundary. The distribution of these instruments is different for each class, giving the upper class an overall "closed-in" tone, the lower class something more open and gritty, and the middle class something in between. The middle and lower classes both have a harmonic arrangement that modulates between major and minor triads, but at different rates which gives each a distinctly different mood (the lower class is heavier, for example). By comparison, the upper-class Shuffler() instruments play a series of stacked perfect 4ths to give this space an uncertain sound of tenuous stability.

The eigentone loops play a small but crucial role in further differentiating each of the three classes. "Eigentone" (Sonnenschein 2001: 187), or room tone, speaks further to the idea of space. Listening to the sound of rooms, stairways, and other architectural spaces opens one up to the wealth of sound that surrounds us on a daily basis. Not only is there *something* to hear but there is *a lot* to hear. The unique acoustic properties of the spaces we inhabit lend each an identity as individual as the color of the walls, furnishings, and overall shape and volume.

The idea that this could be put to musical use first struck me after reading a quote from Keith Rowe's liner notes to *Duos for Doris*. He said, "Somehow I wanted to move what I'm doing (intention) towards this notion of atmosphere...music as time, energising the air, making the silence (unintention) audible" (Toop 2005: 326). The idea of energizing the air and bringing greater attention to what I *was not* consciously hearing was very appealing. I was further encouraged after listening to the music

of Richard Chartier. Chartier's music is minimal to the point of being diaphanous. He recommends listening on headphones or through a quiet amplification system (Chartier 2010) which reinforces the sparseness of his aesthetic. Listening to Chartier's music has been both rewarding and instructive. I enjoy what I hear on the level of artistic appreciation; he is a brilliant musician. He is also technically astute and uses contemporary digital tools to emphasize the contrast of high/low frequency and loud/soft dynamics that permeate much of his work. Listening to his body of work has also taught me to be more sensitive to the sonic world I inhabit. Many times when listening to his work I find myself "stretching" my ears to locate a sound—what was that? From where did it come? Often times these sounds are not part of his work but something in my listening environment: the plumbing in a hotel, a car passing on the street or the dishwasher transitioning to a new cycle. Not only have I become aware of the variety of sounds that surround me but I am increasingly conscious of the musicality these sounds possess. What is easily ignored as a household machine holds equally fertile potential as an instrument sample or ingredient of a sonic texture.

Both techniques were used for the Class space eigentones of *Londontown*. The middle-class eigentone uses recordings of people talking in a large room with marble floors and walls and the occasional sound of horses pulling a carriage over cobblestones. The sound of the room worked well to convey the idea of a busy marketplace and the horses clearly connect with one mode of transportation available in the Victorian era. The upper-class eigentone was created from the sounds of stirring a teacup and a scratchy 78 rpm wax record, and the lower-class eigentone was constructed through the sounds of a blacksmith's shop: a hammer, a bellows, and hiss of a wood fire. These sounds were all subjected to digital signal processing. Sound-by-sound, this varied from light equalization and reverb to heavy time stretching and pitch shifting with a granular sampler. There were few directives guiding this work other than the idea to capture, preserve, or extract and emphasize the sound of an acoustic space present in each.

The Class space eigentones were not meant to be expressive or symbolic of anything in particular. Working from accounts in two separate books, *Victorian Soundscapes* by John M. Picker (2003) and *Pandæmonium* by Humphrey Jennings (1985), I was able to gather ideas for the sonic world that surrounded people in Victorian England. A crowd in a room finished in marble, the stirring of a teacup, a scratchy 78 rpm wax record, and various sounds from a blacksmith shop are all sounds that had a literal or conceptual connection to each class and, above all, could create three distinct sonic spaces to enhance and blend with the foundation music created by the four Shuffler() instruments.

Furthermore, class has a role to play in shaping a parameter in one of the other spaces. The Skills space is one that players enter into any time they use a learned skill or engage in training for a new skill. String instruments are coupled to this space, and the kind of string instrument is defined by class. Lower classes hear the manifestations of their skill use played by a sampled viola, while middle-class residents have a richer-sounding cello, and upper classes hear a full string section. This is one case where the stereotype of each class was enforced. A lush string section sonically connects with the luxurious lifestyle of the social elite, and as class status decreases so does the richness of each instrument. Because these are sampled sounds, I was able to further enhance these differences through electronic manipulation. Higher classes have a longer note sustain, a more dramatic attack, and a more pronounced reverberation decay. While these differences don't affect the sound of the Class space specifically, they contribute to a difference in the overall musical character of each class.

5.1.4.2 Profession Space

Doing work and having a profession is a part of life in *Londontown*. This provides players with a virtual income and gives them a means of advancement if they are interested in exploring the world in that way. This does not mean there is an expectation for productivity. Rather than pursue the industrious life of a dock manager, players may prefer to spend their time idly as a card player. In these

terms, "work" is defined loosely in the design of the world and it provides, above all else, an additional "…reason to go there" (de Kerckhove 2001: 63). And because there are so many potentially different "reasons to go there," Profession is the dimension for each player-character that has the greatest amount of breadth and depth.

In more general terms, anything a player does in relation to his working life constitutes movement within Professional space. To fit the wide variety of professional opportunities available to a player-character, this space is the most sonically diverse and expansive. Any time a player-character makes a choice that reflects on his professional life, he enters into, or moves within, the Professional space. The next section of this document elaborates in specific detail how these are treated musically.

5.1.4.3 Skills Space

Like skills in the physical world, skills in *Londontown* are acquired to help advance one's personal and professional prospects. After a player-character learns a new skill, any time they employ it they enter into the Skills space. At this point in the development of the project there is a discrepancy between what I intended to do musically with the Skills space and what is currently working in the vertical slice prototype. The Skills space and the sort of nuance it should be able to convey in future versions of Londontown is discussed in detail in chapter 7. With the current version of the vertical slice, each player has a single skill, or more aptly, a general ability to do things.

When a player-character exercises this ability he moves into the Skills space. Depending on his level of proficiency, the sound of the Skills space varies in density, where low to high levels of skill correlate with a thin to thick orchestration and intensity of phrasing. As mentioned earlier, social class standing has a part to play in defining the sound of the Skills space. Members of the lower class hear violas, the middle class cellos, and the upper class a full string section. Again, the idea was to sonically connect depth of timbre with a player-character's position in the social strata. This arrangement is further enhanced by the generative instrument used to play these sounds. The Skills space is heard through the combination of two Seq() instruments. When a player-character starts using a skill and enters into the Skills space, these instruments begin to play. Each plays through the pitches of a simple four-note scale at a rate determined by the player-character's level of ability. Over the course of his time in *Londontown* this ability increases and with it the rate at which each Seq() instrument plays through the available sounds. Player-characters with beginning level abilities hear slowly unfolding melodies; those who are more advanced hear cascading harmonies that shift over time relative to the other sounds playing in the Class and the other relevant spaces. Skills are something a player-character employs no matter what his current situation in the world. Regardless of class and ability level, the notes that belong to this space are harmonically related to all other available sounds such that they will always act to color or enhance other audible spaces but never suggest movement outside of them.

5.1.4.4 Origin Space

Origin is another player-defined space that can be determined when a new character is created upon entering *Londontown* for the first time. The Origin space is probably the smallest space overall. This is because, musically, it consists of no more than a series of melodic phrases or fragments. Each of these was recorded on instruments, and composed in a musical style native to the place of origin. These melodies play at the story beats (Douglass & Harnden 1996: 57), or significant points of arrival in a player-character's development—completion of a quest, meeting a potential ally, professional accomplishment, and so on. In terms of game mechanics, Origin is a useful space because it allows players to hear direct confirmation that they have accomplished something in the world. Furthermore it does this in a way that connects the acknowledgement sonically with their character. For instance, if the character is from Ireland they will hear tin whistle and bodhran. Origin is a space that does not currently exist in the vertical slice prototype of *Londontown* but is part of plan for future versions.

5.1.4.5 Reputation Space

Reputation is the most unique space in the music scheme. It reflects the reputation of other player-characters or non-player-characters (NPCs) you meet in the world. Your actions work to construct a personal reputation space but it is not audible to you. Rather, the reputations of other characters fill the reputation space you hear, making Reputation an "aura of approachability." You will hear the strong or weak reputation of characters you meet when you begin to interact with them.

The sound of the Reputation space is played on piano. This was a clear choice after completing some of the earliest prototypes for the *Londontown* music. Piano contributed a complementary voice to the overall sound of the project, it fit within the historical framework, and it bridged any potential gap between the three social classes. In addition, the attack of the piano and its ability to add color to existing musical material allowed me to use this instrument as the brightest and most transparent layer in the overall musical construction.

The piano that makes up the Reputation space is performed by two Scaler instruments. I approached this as the "right hand" and "left hand" of a virtual pianist. For encounters with characters of a positive reputation, the left hand plays from an available nine notes (~1.5 octaves) of a minor pentatonic scale and the right hand has an available twelve notes (~2 octaves) of a major pentatonic scale starting a minor third + two octaves above the left hand. For less reputable associates, the instruments retain all of the other parameters but switch their available pitches to notes of a half step/whole-step octatonic scale. This scale retains many of the same pitches in both pentatonic scales and introduces others that don't exactly fit the overall harmonic character of the music. In keeping with the directive to always encourage a player, the awkwardness these scales create gives each non-reputable encounter a sound that is uncertain and occasionally uncomfortable, but never sinister or threatening. In addition, this arrangement of two scaler instruments allows the piano to find a compromise for situations in which you encounter a group of mixed reputations. All permutations of the two pentatonic and two octatonic scales are possible depending on the specific situation. Lastly, to increase the authenticity of the entire performance, the left hand plays less frequently and with less activity than the right hand.

Though it is usually musically inadvisable to use a computer for something better left to the finesse of a human performer, the dynamics of *Londontown* demanded it. Generative music can respond to the myriad combinations that emerge from the narrative of the world. For all spaces—and especially Reputation—the variety of combinations would demand too many individual sound assets, all of which would have to be created for generic situations. With a pair of generative instruments I am able to evoke the performance of the music demanded and be certain that it will sound fresh every time it is heard. The notes and harmonic structure of this space were important but the phrasing of the notes and the silences between them were equally if not more important. I was inspired by *Eusebius*, movement 5 from *Carnaval* Op. 9 by Robert Schumann (1992). This piece has a lightness and sombre airiness that gave me a clear sense of many vistas appropriate to the project: the gentle slopes of Hyde Park, morning dew on the grass, a narrow strip of cobblestones, fog, and the diffuse light of a gas lamp. In the music of *Londontown* the piano takes on a mythic quality. It connects all residents and must work to create a space that has a clear sonic consistency and identity throughout.

5.1.5 *Londontown* Profession Types

Within the Profession space there are subdivisions for various kinds of professions available in *Londontown*. These were designed around the four types of MMO players defined by Richard Bartle (1996). All of the professions are suited to different styles of play that can be expected in a virtual world. Of course, enlistment in a profession never restricts players to a particular sort of engagement with the world. But by providing the kind of work expected in these professions, each creates the kinds of opportunities different players may seek. From a musical perspective the task was to look at

the possible actions and behaviors of each type and develop a palette of sounds that could reflect the potential dynamics.

5.1.5.1 Achievement Professions

These professions are for players who treat the virtual world as if it were a game. They give themselves game-oriented goals and strive to achieve them (Bartle 1996). In the *Londontown* vertical slice the achievement professions are Articled Clerk, Merchant, and Tailor (Sheldon 2010). In keeping with this idea, the sound of Professional space for an achiever is non-rhythmic but intense. This works to lend a more focused, almost pointed character to the music when a player-character is focused on setting and meeting goals in the virtual world.

5.1.5.2 Exploration Professions

As the name suggests, people who enter into these professions are those who like the thrill of investigating and wandering through new territory. According to Bartle (1996), explorers like to learn as much about the world as they can, often at the expense of advancing their character. Players can explore the *Londontown* vertical slice as a Fleet Street Reporter or Nurse (Sheldon 2010). The sound of the exploration profession is the most sonically open—contemplative and even moody so as to absorb the widest variety of musical possibilities. If explorers are likely to see the world with greater depth than others, the sound of their profession must be the most pliable and accepting of other sounds.

5.1.5.3 Social Professions

Bartle describes social players as those who use the world to engage others, which means communication and role-playing are important to them, as is the sense of community that can be derived from this sort of experience (1996). Vertical slice social professions in *Londontown* include Street Artist, Busker (street musician), Chef, Servant, and Hostess (Sheldon 2010). It is likely that player-characters in these professions will spend more of their time around others, which means that Reputation space is likely to be a dominant sound in their version of the world. Consequently, the Social profession sound is light and airy. It was created by modifying a synthesized handbell and adding some delay to introduce randomness to the decay. The sound initially speaks clearly in the overall texture of the music but decays with an open resonance allowing it to linger more subtly.

5.1.5.4 Action Professions

Bartle's fourth type includes "Killers," those who impose themselves on others in the world through kindness (which is rare) or through viciousness. The vertical slice does not support combat; consequently physical violence and murder are not currently part of *Londontown*. Killer behavior is impossible. But for those who seek a more physical existence in the world, there are the Action professions which include Consulting Detective and Lady Con Artist (Sheldon 2010). The Action sound palette was developed around a general set of ideas including "the military," "law enforcement," and "pursuit on foot." It consists of two parts: a synthesized lead and a set of percussion patterns.

The synthesized lead was designed from the ground up to have an intense, urgent, slightly brassy tone reminiscent of horns calling troops to order in the distance. Its soft attack and gradual decay allow it to fit neatly into the mix along with the other sounds but it is always heard as a clear lead in the overall arrangement. The percussion patterns were created with fragments from a commercial orchestral sound sample library. There are thirteen patterns altogether, which provides a broad range of intensity. The sounds themselves are mixed. There are clear military snare drums, noisy drums with thick skin heads, cymbal hits and scrapes, a clave and an anvil. This variety keeps with the loose theme developed for this space and provides a good deal of contrast across the various patterns. In later versions of the *Londontown* world there are design plans for light combat, making the musical ideas behind this pro-

fession extensible for features yet to come.

5.1.5.5 Movement within Profession Space

Any choices made by a player-character, or any circumstances that arise relative to their profession, will constitute a move within the Professional space. All of the professions follow the same template or general set of procedures to correlate spatial changes with sonic changes. There are five discrete locales within Profession space: a neutral point at the center, two points moving towards greater clarity and two moving towards greater ambiguity (see figure 5.1). In this case, ambiguity and clarity are determined relative to the choices a player-character has made with regards to performance of the task at hand. Within each point is a set of three notes that forms either a major or minor triad. These pitches, when heard against those of the foundational Class space, create compelling tonal combinations that bind class and profession in a single cohesive musical statement.

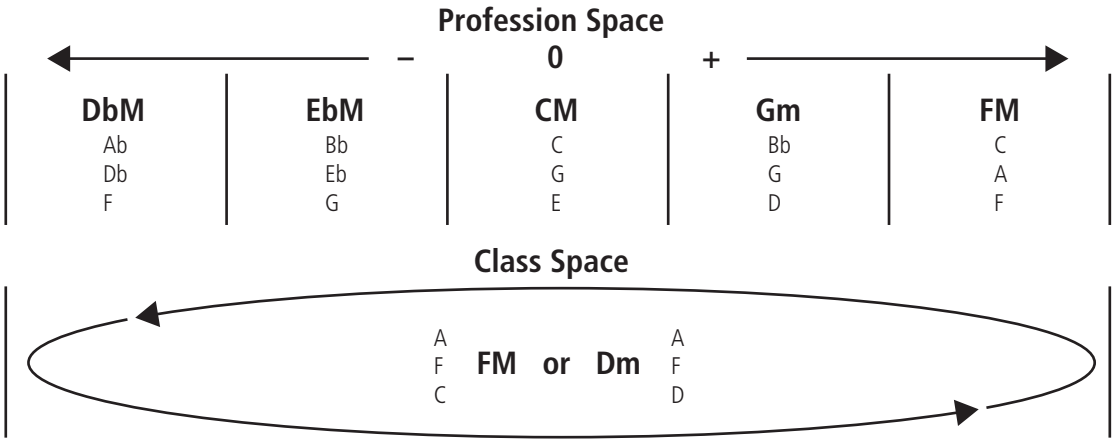

Figure 5.1: Profession space is organized along a single continuum ranging from sonically cloudy (–) to lucid (+). Each point along the axis has a harmonic structure that works to complement that of the Class space.

Visually this arrangement may seem to break with the assertion that the world will have a seamless overall musical flow that closely couples sound with interaction. What you do not see here is how this structure unfolds over time. While each space fits neatly along the axis of the space, the sounds themselves do not. When a player-character makes a choice, they enter into a new space and a new set of sounds becomes available to reflect this change. However, any sounds that are currently playing when this happens will continue to play and bleed over the edges. This means that sounds from a previous space can be winding down and decaying while sounds from the new, adjacent space are first introduced. This is the precise situation that Eno speaks of in his earlier characterization of generative music. The unexpected (and often unintended) combination of sounds leaves one listening to something strange and new, yet in the case of *Londontown*, it is exactly what they should hear given the events that leading them up to that moment. This idea is one of the core strengths of Amergent music and with any experience of music that allows listeners to hear how their presence in an environment contributes to its sound. Furthermore, the idea resonates with the experience of *becoming* that adds depth and wonder to our daily existence in the physical world.

5.2 Becoming and the Construction of Mediated Reality

The priority of Amergent music is to maintain the continuity of mediated reality through sound. In the early stages of this research, this was done through an examination of emergence, where multiple, chaotic interactions produce an ordered whole (Ascott 2003). Interaction is a means of organization that forms the work of art or music. It is not necessarily *the* work, but *a version of* the work that retains a general affective core or identity but is unique in its detail. As research progressed, the mechanics

of interaction and the construction of mediated reality gained support through metaphysics and philosophies of becoming that meditate on human perceptions of reality.

5.2.1 Process Philosophy

Amergent music uses multiple, spatially organized generative systems to sustain the continuity of a mediated reality. Movement leads to the temporary presence of a new space created by the overlapping sounds of adjacent, permanent spaces. The sound of this is unexpected, yet musically satisfying and true to the becoming of a mediated reality. Virtual worlds like *Londontown* and other mediated environments situate residents (users, players, etc.) in a reality that is emergent and ever-changing. Henri Bergson writes, "Matter or mind, reality has appeared to us as a perpetual becoming. It makes itself or it unmakes itself, but it is never something made" (Bergson 1998: 272). Bergson also draws a useful comparison between the mechanism of conceptual thought and the mechanism of the cinematograph. His metaphor poses the idea that we create reality as the viewers of a filmstrip with limitless frames. Each frame flickers into view to show reality in the making. But as this frame is replaced by the next, a new reality presents itself, unmaking the past, and revealing the potential for a future that is still in the making.

Amergent music—through the constant flux of the generative process and further revised via interactions and perturbations—has these same dynamics. It is a music that is both making and unmaking, but never made. Charles Hartshorne writes that where process philosophy "…is a doctrine of being in becoming, permanence in the novel…" (Browning 1965: xix), Amergent music is characterized by a becoming of sound. The permanence of a musical work is found in the novel and fleeting combination of sounds produced by generative techniques and perturbations to these through systems of interaction.

A musical work is only as permanent as the reality we experience. We are "in it" but we can neither slow nor freeze it. Experience is not tangible but must be recognized in the flow of becoming. Ilya Prigogine discusses this in relation to the philosophy of Alfred North Whitehead:

> For him, being is inseparable from becoming. … Physics and metaphysics are indeed coming together today in a conception of the world in which process, becoming, is taken as a primary constituent of physical existence and where, unlike Leibnitz' monads, existing entities can interact and therefore also be born and die. (1984: 303)

While Amergent music exists as part of a mediated reality, the components that comprise it are not monadic. The ingredients that make Amergent music are processes that unfold in a continuous becoming. At the most bare-bones technical level, there are digital sound files that exist in binary code on some sort of digital storage device. But this is not the music. Amergent music only exists in the process of becoming. As these sound files are played as part of a generative system they enter into process and are heard as a becoming of music.

William James considered the idea of being in becoming similarly, and put it into graphic language. Consider the illustration (figure 5.2) reproduced in *Philosophers Of Process*. James shows that three processes of thought are initiated: a, b, and c. The arc of each process illustrates how it develops, peaks, and decays. The process for a has not yet ended, the process for c is in-progress, while b is still building. The vertical line represents a "time-instant" (Browning & Myers 1998: 91) in which all three processes are present and at various states in their development. Processes a, b, and c are identical to the sounds of individual spaces in a work of Amergent music. The vertical line represents what is heard at the moment in which one's interaction moves them out of space a, into space c, and more deeply into space b. Individual time-instants are experienced like the frames running through Bergson's cinematograph. Individual moments mean little on their own, but when experienced in succession as a passage of time or movement through space, a sonic reality emerges as a becoming of music.

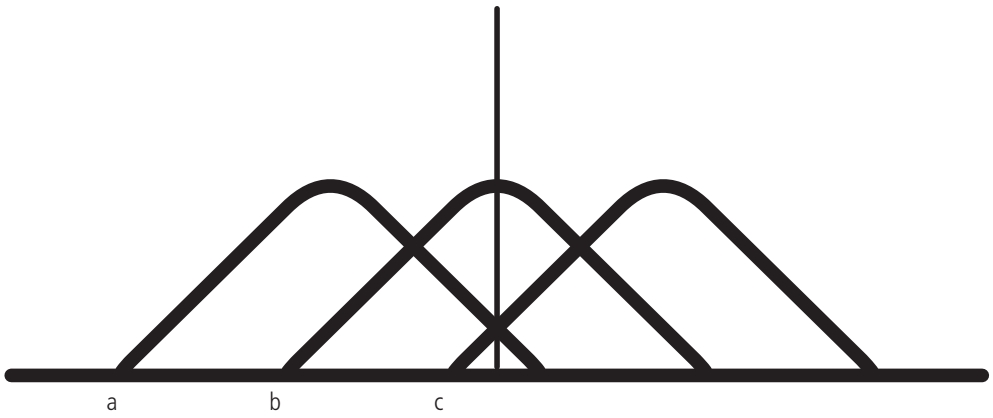

Figure 5.2: Here, James shows three "…neural processes correlated with the thoughts of those three letters [a, b, & c]" (Browning & Myers 1998: 91). At the present moment (the vertical line), each is at a different level of intensity either rising, peaking, or waning.

5.2.2 Mobile Sections, Affect & Intensity

Movement, and the movement of component parts, is foundational for Gilles Deleuze in *Cinema 1: the movement-image*. His examination of Bergson and *Creative Evolution* concludes at the idea of mobile sections. When individual, constituent parts move over time and produce qualitative change(s) within a whole, the whole becomes a mobile section (Deleuze 1986). Movement that produces a mobile section is much like the movement of individual sounds within a generative system. Though sounds don't physically move in terms of position, there is movement in the envelope of a sound (the overall shape of its amplitude), in timbral shifts, and with any other modulations or effects that change a sound over time. Generative instruments like the Shuffler() have their own sort of movement as well. Sounds set to play at varying intervals fall in and out of phase with one another in heavy gallops and gentle steps on tip-toes. Similarly, pitched sounds play in myriad combinations to produce colorful harmonic textures. As discussed elsewhere in this thesis, movements—harmonic, textural and timbral—are what make a generative system a mobile section. Sonic transformation is apparent in these qualities and it produces qualitative change within a generative system and within the space coupled to it.

As it concerns Amergent music and the research that produced this thesis, the sonic activity of a generative system, functioning as mobile section, creates movement that is the becoming of music. This music does not signify; nothing is meant to "represent." Its sound is reflective of potential in the virtual world—a reminder of the current becoming and those yet to be experienced. It reveals a confluence of relevant matters given the current situation of the player-character. What is heard in each moment is as likely to be the result of their most recent decision as it is a result of their fifth decision from last Tuesday. This music deals in the emergence of a mediated environment and contributes to the affect of situations created or discovered by player-characters.

Brian Massumi characterizes affect as "…the connecting thread of experience" (2002: 217). It is neither emotional nor personal, but "trans-situational" as "…an autonomy of event-connection continuing across its own serialized capture in context" (Massumi 2002: 217). Amergent music uses affect to maintain a continuity of experience in *Londontown*. Sounds—becoming music—are heard in passage across and through design spaces to construct a player-character's affective experience of the world. The overlapping of sound envelopes, like James' striated processes of reality, link moment to moment and event to event. In the flow of becoming constituent parts blend to form a mobile section that leads to qualitative change in the overall experience of the virtual world.

When viewed in the flow of becoming, affect can be more clearly understood as having more than a

single value but a varying mixture of values contributing to it. To account for the complexity and nuance that contributes to affect, Deleuze refers to *intensities*. Claire Colebrook explains:

> If we see the world, usually as a set of extended objects and as part of a uniform and measurable space, this is because we have synthesized intensities. Intensities are not just qualities—such as redness—they are the becoming of qualities: say the burning and wavering infrared light we eventually see as red. (2002: 39)

Intensity is the becoming of a quality; the quality of affect is intensive. The affect of Amergent music is produced through multiple, layered combinations of sound that swell and recede as they follow both their own internal order (timbre and envelope) and the order of the generative system that plays them. Each has its own quality. But in a layered configuration that varies density over time, the becoming of a quality, or an intensity, emerges. The generative systems that make up the sound of various spaces in *Londontown* (Class, Skills, Profession, Origin, and Reputation) are therefore more aptly called *Intensities*. As a player-character's experience of the world develops, the dynamics of emergence and intensity serve to connect experience in this mediated reality. Brian Massumi comments:

> Intensity is immanent to matter and to events, to mind and to body and to every level of bifurcation composing them and which they compose. Thus it also cannot but be experienced, in effect—in the proliferations of levels of organization it ceaselessly gives rise to, generates and regenerates, at every suspended moment. (2002: 33)

With this point Massumi connects James and Deleuze in a way that is most relevant to *Londontown* and Amergent music in general. A constantly churning, endlessly revising generative system can be discussed as dynamic, harmonic, textural, timbral—but it is all just a matter of intensity. In the musical system devised for *Londontown*, multiple generative systems create multiple Intensities and work together to weave the connective thread of this mediated reality. As they are perturbed by the interactions of player-characters in the virtual world, Intensities are accordingly transformed and with them the affects of one's experience.

The ontology of mediated environments is the driving force behind Amergent music. In the course of this research, metaphysics and philosophy were initially found to provide useful terms for the sake of comparison and explanation. Over time the artistic merits of these theories became apparent. Each offers a perspective against which to compare the experience of hearing Amergent music. This music does not seek to duplicate an experience of non-mediated reality, but to explore resonances between theory and artistic practice and construct a continuous and immersive mediated reality.

5.2.3 Intensity & Musical Mediation in Victorian London

For *Londontown*, all in-game music was generated relative to player choices. At the start of the project it was essential to identify the factors related to player characters that contribute to musical continuity and development. When entering *Londontown*, all players must create a character. The *Londontown* design doc states:

> Character Creation allows them to easily choose what class they wish to start out in, their names, where they are from and what they look like. Choice of Class restricts Residents to certain types of Names, Places of Origin and Physical Characteristics. Choice of Place of Origin can influence success at Professions, as indicated… (Sheldon 2010)

Because character is such an essential building block to the experience of *Londontown*, the music system was player-centric in its conception. While in the world, non-diegetic music (the musical part of a soundtrack) is generated relative to a set of in-world parameters—Intensities—that are specific to a player-character and the things they can/may do in the world.

There are three kinds of Intensities: Player-Defined, Player-Developed, and Seeded. Player-Defined intensities are established at the outset when a character is created and will form the foundation of the soundtrack. Player-Developed intensities are those most closely connected with the specific events of a player-character's growth and development. Seeded intensities are linked to third-parties: people, places, and things in the world that offer creative or strategic possibilities to a player-character. Tables 5.1-5.5 detail the various Intensities proposed for *Londontown* and the ways in which these correlate to the instruments and sounds that comprise the generative music system.

Table 5.1: *Londontown* Class Intensities

Class (Player-Defined intensity)	
Four Shuffler() instruments Sets the overall tone An ambience; present throughout the world Presence or density set by instrumentation	
Lower class	• "World is won by cunning and ingenuity and the labor of your two hands whether you are a cobbler or a thief." (Sheldon 2010) • Overall density is sparse to diffuse • FM/Dm harmonic structure
Middle class	• "World is one of mobility and money. A member of the middle class can aspire to greater things with a wider range of options (both legal and illegal) than the other classes." (Sheldon 2010) • Overall density is diffuse • Am/CM harmonic structure
Upper class	• "World is beautiful and bountiful on the surface with power and pleasure foremost. But it is always a challenge to maintain appearances and the 'right' connections (both legal and illegal) to succeed in society." (Sheldon 2010) • Overall density is diffuse to lush • Em/Asus4 harmonic structure

Table 5.2: *Londontown* Profession Intensities

Profession (Player-Defined intensity)	
Three Shuffler() instruments. Fairly dominant lead Intensity. This in addition to the class and reputation (of others heard nearby) make a complete non-diegetic accompaniment. This Intensity may not be relevant when a character is engaged in leisure or any non-professional activities, which helps enhance the distinctions between "work days" and "days off."	
Achievement profession: law, politics, commerce dock manager (middle class) tailor (middle class)	Intense; non-rhythmic. A lead sound to pull others along with it. AbM, BbM, GM, Dm, CM over class intensity
Action profession: law enforcement, security, crime constable (lower class) thief (lower class)	Intense; rhythmic. Sits "around" or acts as a frame to other tracks. DbM, EbM, CM, Gm, FM over class intensity
Exploration profession: question askers, problem solvers journalist (middle class) curator (upper class)	Moody, contemplative, sonically open to absorb a variety of musical possibilities. EbM, BbM, GM, CM, FM over class intensity
Social profession: artists, servants, leisure street artist (lower class) caterer (middle class)	Light and airy. It's plausible that social players will spend more of their time around others, so the Reputation Intensity is likely to be more dominant. A Social profession Intensity has a subtle presence. DbM, EbM, CM, Gm, FM over class intensity

Table 5.3: *Londontown* Skills Intensities

Skills (Player-Developed intensity)	
Seq() instrument A thin texture that plays when a player is required to use an acquired skill to perform a task. Density of the texture is set relative to the character's proficiency with a given skill. Two Hexatonic Major scales create varying harmonic and melodic textures	
Lower class	viola: short attack & decay
Middle class	cello: moderate attack; short decay
Upper class	full string section: moderate attack; long decay

Table 5.4: *Londontown* Reputation Intensities

Reputation (Player-Developed intensity)	
Scaler() instrument A "silent" layer: the reputation a player builds is heard only by other players Acts as an "aura of approachability" for NPCs and other player-characters Players hear a reputation track comprised of nearest player characters and/or NPCs Can act to foreshadow or warn against a potentially dangerous encounter. Fairly dominant lead layer. This in addition to the class and profession should make a complete non-diegetic accompaniment. Wherever a player goes their reputation precedes them.	
Reputable	piano (minor pentatonic/Major pentatonic); full strings (Major pentatonic)
Untrustworthy	piano (half/whole octatonic);

Table 5.5: *Londontown* Utility Intensities

Utility (Seeded intensity)	
Similar to Reputation Intensity as an "aura of approachability" but applies to people, objects, and sites within the world. Will signal whether the person, object, or place to which it is attached can be useful to a player pursuing a quest or seeking to further their interests in the world. **This Intensity is not yet implemented in the project.**	
Useful	Short melodic phrase based on Profession Intensity sounds
Not useful	No sound; if a Utility Intensity is playing, silence it

5.3 Creating a Musically Mediated Reality

The music for *Londontown* required that creative attention be focused on two priorities: that it convey an overall cinematic quality, and that it maintain a continuity of experience for players who reside in the world. The continuity of experience has occupied much of the discussion in this chapter so far. The use of generative systems and arrangement of musical material relative to potential player-character interactions with the world show that Amergent music presents a unique means of creating music that grows and changes with a persistent mediated environment.

The demand that the music take on a cinematic quality posed an interesting challenge. To be specific, "cinematic" means that the music should reference the sound of classic Hollywood scores by composers like Bernard Hermann and Jerry Goldsmith. Sampled string instruments were essential to the project, and each was prepared to blend with all synthesized and other sampled sounds to complete the entire musical piece. Compared to the strings, these sounds had a more subtle, transparent quality that worked well in situations where combined layers of sound were more important than any one individual instrument. The final music paid homage to a Hollywood score but was above all malleable, and could grow and adapt with the world.

5.3.1 System for Interaction: Londontown journalism quest walk-through

In *Londontown*, all significant interactions with the world are based on *quests*: simple tasks a player-character must complete to gain skill, money, influence, or some other advantage. In the vertical slice there are hundreds of quests and in the final version there will be thousands. Because they have such an important role in the design of the world, the design of the music system can be best explained by looking at a few specific quests.

Quests are shared with the design team as a script, but the term *script* should be understood loosely. Unlike scripts for plays and movies with a specific trajectory of action and dialogue, a virtual world script contains possibilities for action and dialogue given the range of possible choices a player-character may make in any given situation. This example outlines the steps a player-character must pursue to show they have the aptitude to work as a journalist and enter into that profession. In short, a player-character must:

1. Approach another player-character (PC) or NPC and engage them in conversation.
2. Encourage that PC or NPC to gossip.
3. Judge the validity of this gossip. If it appears to be true, share it with a newspaper editor as a story lead. The editor will either accept or reject the lead.
4. Once a player-character has accumulated three leads they are allowed to enter the journalism profession.

An example walk-through of this quest can be found in section 6 of the supporting DVD. While working to complete these steps, player-characters inevitably move into (and within) the Profession space, Skill space, and Reputation space (in the quest walk-through these are labeled as *Leads*, *Talking*, and *Reputation* respectively). In the next section, a few specific cases are discussed that pair musical events with choices made along the way to complete a quest.

5.3.2 Resultant Musical World

In the vertical slice of *Londontown* there are a limited number of professions spread over all three social classes. At the time of this writing the vertical slice was still in development. The testing done to evaluate the music was conducted with all currently available resources. Consequently, the class-profession combinations (see table 5.6) used in these tests do not represent a "best-case scenario" to any degree at all. They simply provide the mix of potential events that act as a catalyst for producing music in *Londontown*.

Table 5.6: Londontown Music Tests Organized by Profession & Class

Profession (Type)	Class	Quest Description
Thief (Action)	Low	You are hired to steal a portrait; success means financial reward
Street Artist (Social)	Low	You are hired to draw a portrait that will identify a criminal
Tailor (Achievement)	Middle	You must get organized and work your way through a mountain of orders
Curator (Exploration)	Upper	You are called to assist the head curator in an important task

The music tests recorded for *Londontown* are speculative in that they consider what is known about the design of the virtual world and explore the possibilities within that frame. This music provides answers to such questions as, "what would it sound like if...?" Given the extensibility of the Amergent music system that was created for this project, any scenario from the *Londontown* world can be set up and run through a variety of "what if..." conditions. This sort of testing serves two purposes. First,

it enables one to hear if the music system is as robust as believed to be. Compared to the Journalism quest walk-through, these tests put all of the generative instruments to work and explored a variety of changes within each Intensity. Secondly, testing produces artifacts that help to evaluate whether the sound of various in-world experiences are aurally congruent with the visual and narrative experience of the world. Test recordings of various quests and player-character class-profession combinations are discussed further in chapter 7 and can be heard in section 6 of the supporting DVD.

5.3.3 *Londontown* Eigentone Tracks

Thus far any discussion of eigentones has been framed as something "in addition to" the music when in fact this element is very much a part of the music. And while it is not subject to the constant change and development that comes from player-character interaction in the world, it is the ingredient that helps the other voices speak clearly and establishes the overall musical character I was after.

As mentioned earlier, one touchstone for the *Londontown* music was the work of Richard Chartier. In part, this was an aesthetic choice, but largely, the aesthetics were based on a required musical functionality or need I had identified for the project. One main directive for the Londontown music was that it have a cinematic quality. If you think about a narrative film as an audience's window to a new world, its music can be thought of as a pane of stained glass in that window. Speaking in very general terms, narrative film music is strongly shaded to color the story world in an incredibly deliberate and specific way. It helps the director tell a story by guiding audience interpretation of the images and sounds that are presented in the theater (Gorbman 1987). One's view through the window is entirely affected by the color of the glass. And while it may change shades it is always seen-through, permanently binding the visual and audio tracks as one (Chion 1994). Though *Londontown* is designed with narrative experience in mind, it is not *the story* being told but *a story* that has been seeded in the world and left for player-characters to discover and grow in the directions they find most compelling. Consequently, the music of *Londontown* cannot use such a heavy-handed approach that makes specific commentary on events that unfold on the screen. Future events are unfathomable and therefore it is impossible to take specific steps that musically guide interpretation. This music deals in narrative potential—the myriad choices to be made and a broad spectrum of possible outcomes in which players create their own stories.

Returning to film music and the stained glass metaphor, *Londontown* required a level of musical specificity (or tinted-ness) that was appropriate to the seeded narrative of the virtual world. As mentioned earlier, Eno's Ambient music was meant to provide an "atmosphere" (1996: 296) or hue in the listening environment. This style provided an initial direction. Richard Chartier's music was helpful as well, and I considered these two to be at opposite ends of a continuum. Eno-esque Ambient music is sparse, but still lush and immersive. If Ambient music is like glass, its tint is subtle. Chartier's ultra-minimal electronic compositions are more like gossamer than glass: it alters one's view to a world but the specific adjustment is, at times, uncertain. Chartier sets an extreme example for what I wanted to do with *Londontown*, which is best described as *gauzy*. The music, like coarse linen should be sheer enough so as to allow some of the real world to pass through untinged, but still have enough aural presence to affect one's experience in the world.

The overall texture and density of the music was extremely important to this project for several reasons. In trying to balance the sound of film music with the priority for rich interaction in a world with seeded narrative, density and texture made all the difference. A gauzy or "threadbare" music has substance that adds to the flavor and detail of the mediated world, but it also allows that world into the music. It balances the immersive ambience of Eno with the diaphanous acousmatics of Chartier to create space for the listener's experience of the world. He is not simply interpreting what he sees and hears before him, he is negotiating possible realities in the virtual world. Affect forges the connection (albeit fleeting) to the mediated environment he currently occupies.

The preparations for this music demanded hours of listening to hear how it would perform over the hours (and hours…) that pass in *Londontown*. The first conclusion was that this music cannot exist alone: it *requires interaction* to sound its best. For instance, the techniques employed in *Londontown* could not be used to make music for a comparatively static museum environment. All of the Intensities that comprise the various layers of this music have been organized to expect frequent perturbation. When there is nothing to perturb them they stagnate and the music becomes repetitious. This does not threaten the musical viability of the world. It was designed as a dynamic environment and there will always be enough happening to keep the musical mix "agitated." Even player-characters who sneak through the world will sufficiently perturb the various musical Intensities to maintain the flow of musical becoming.

The research involved in *Londontown* shows that generative music systems meant to function in mediated environments cannot be generic; there is no such thing as "one size fits all." A commonality in some shared assets is to be expected, but the particulars that couple music to environment—sounds, generative instruments, inputs, perturbations, etcetera—should have a unique configuration custom-fitted for the specific project. For Amergent music to reach its full potential all dynamics that go into making an environment, those ontological characteristics that comprise its essence, should be closely connected to the processes of music-making. Features that lend a mediated environment its uniqueness show which musical behaviors are likely to have the greatest impact in forming its sonic traits. The *Londontown* project also provided a good deal of insight on generative music systems in general and many possible directions for future projects.

5.3.4 Generative System

The generative music system developed for *Londontown* was drawn from many previous projects, especially *Dérive Entre Mille Sons* and the *Dérive Studies*. These were the first projects to experiment with interaction and spatially organized music, which form the core of *Londontown*'s generative system. Other aspects such as the sextet of generative instruments have been in progress for much longer. Systems such as the Particle Swarm Optimization algorithm were abandoned along the way. This system served me very well for many previous projects but was unnecessary for *Londontown*. The wealth of dynamics that comprise the virtual world provide more than enough data to maintain musical interest over time. Virtual life replaced artificial life as the driving force behind a musical work. In the way that prior projects created the tools necessary to complete *Londontown*, *Londontown* has done its share in helping to define additional tools for works yet to come.

One of the greatest challenges faced in developing generative music for *Londontown* or any of the other projects discussed in this thesis was testing and prototyping. Generally speaking, applications made for music production do not support generative behaviors. Conversely a piece of software intended to create generative music uses behaviors and logic that would be incredibly difficult if not impossible to duplicate in the finished work (Nodal (www.csse.monash.edu.au/~cema/nodal) & Noatikl (http://intermorphic.com/tools/noatikl) are two such examples). In addition, none of these applications offer a means of simulating the variety of perturbations that will push and pull the music in new directions.

Max/MSP is one of the most flexible audio and video processing tools available and it provided a solution both stable and extensible. All of the generative instruments were coded using objects native to the Max/MSP environment. These instruments exhibited the behavior and logic required but were not built to produce any sound. The synthesizers and samplers that run in Apple's Logic were used to fulfill that aspect of the system. Logic and Max/MSP were then connected by sending MIDI messages from one application to another using the Macintosh IAC bus (Harrop 2007). This system used Max/MSP to handle the logic and parameters for each generative instrument and Logic to render them as sound. Messages including pitch, duration, and velocity were passed to samplers, drum machines, and synthesizers to give each generative instrument its voice. Logic was used further to process these

sounds through equalization, reverb, delay and other effects that created the final mix. The system is nothing like the software that will be used for the final version of *Londontown*, but it provides a fast and reliable way to test sounds and behaviors before they are prepared for the final production.

A technical discussion as to how the sound files themselves will be played in the final version of *Londontown* is not germane to this thesis. However, one aspect of the process warrants discussion. *Londontown* will use Wwise (pronounced *wise*) by Audiokinetic (www.audiokinetic.com). Wwise is an audio middleware tool that sits "between" those who develop audio assets and the software engine running at the core of the virtual world. It facilitates sophisticated control over many audio parameters for realtime environments. Many 3D computer games use Wwise to create realistic proximity effects, simulated reverberation for 3D-modeled environments, and polyphonic management for sound effect and music tracks. The music developed for *Londontown* requires this kind of sophisticated tool to manage the logic of the generative instruments and number of simultaneous audio channels.

Wwise is not yet implemented in the final *Londontown* environment. The software offers behaviors to create branching musical structures and variable-dependent adaptive musical compositions that swap pre-composed musical tracks. These techniques are useful for some projects but they don't come close to offering the kind of musical nuance that is possible with a generative approach. Branching behaviors are limited by operations that only account for a means of playback. Initial prototyping suggests that in order to execute Amergent music, the built-in sound design behaviors are the most flexible and powerful and the most capable of processing the in-world dynamics that drive the music.

Within Wwise, the behaviors that best match those of the generative instruments are those developed for sound design. Timers, randomizers with weighted randomization, and the ability to nest one behavior inside another are vital characteristics of the generative instruments. Sound design or sound effect behaviors are meant to simulate the unpredictable and organic events that unfold and create the sound of a mediated world. Generative music also strives to be organic, and Amergent music takes this a step further. It preserves an organic quality, but exerts a level of control over the sound assets so as to closely couple sonic transformation with virtual world dynamics.

Conclusion

Londontown has proven to be an excellent vehicle for exploring the techniques and theories behind Amergent music. As a virtual world it provides a rich tapestry of dynamics from which to create music that is new at every step and reflective of the circumstances and context that have led player-characters to each moment. The world is seeded with narrative, which places all interactions in a particular story context, created through both the initial choices that define a player-character and the more gradual choices made over time. The elements that create context are organized both spatially and sonically. This closely-coupled relationship between sound and interaction produces music that is affective in the situations that arise.

The design of the virtual world creates a mediated reality for the player-characters who inhabit *Londontown*. Amergent music, as a part of this mediated reality, leverages the emergence of interaction towards a becoming of music. Sound, as a medium for continuous making and unmaking, resonates in the philosophies of becoming running through Bergson, Deleuze, and Massumi. Audio files play; the envelopes of their attack, sustain and release dovetail and collide to create a music of constantly-shifting textures and tonalities. Sounds themselves are carefully produced to fit into a spatial organization that further enhances this becoming. Like a Deleuzian intensity, single sounds do little to shape this mediated reality. The organization of layered Intensities sets the ground for a multidimensional music that reflects the confluence of negotiations and interactions between player-characters in the *Londontown* world.

The technical formalities of *Londontown* have been instructive and suggest that while tools for development and realization can be general, one's use of tools must be specific to an individual project. Techniques employed in past projects were integrated and uniquely tailored to accommodate interactions within the virtual world. The project has been a musical success, and demonstrates the extensibility of Amergent music while simultaneously showing the way forward for projects yet to come.

CHAPTER 6

Amergent Music

"…reality has appeared to us as a perpetual becoming. It makes itself or it unmakes itself, but it is never something made."

– Henri Bergson, *Creative Evolution* (1998: 272)

+= –= !=

1. a computer language reinterpretation of Bergson's *becoming*; that reality is never made (!=) but continuously in the process of making (+=) and unmaking (–=)

2. symbol for Amergent music

Various forms and practices of music share a resonance with the work discussed in this thesis but there are none closely enough related to situate this work in an existing genre or style. The term Amergent music was developed in the course of this research as a means to separate this work from the diverse sources that have informed, inspired, and given rise to it. Amergent music was created in and of mediated environments. It synthesizes the becoming and emergence of mediated interaction with generative processes and ambient aesthetics. The act of music-making involves seeded sound potential and presence in a mediated environment where sound, in the flow of interaction and generative processes, is experienced as a becoming of music.

Whereas effect is a result, emergence is a behavior. The patterns of a cellular automata or swarm algorithm are visually evident as an effect—or result—of a simple rule set. Where affect is a physical and mental sensation in the flow of becoming, *amergence* is a phenomenon of consciousness. It characterizes emergent behavior with an additional, affective dimension. Amergence refers to a qualitative behavior of potential. In a mediated world emergence is a given, but through further listening and observation (to *entend* in the Lefebvrian sense of noticing and understanding (2004: 88)) there is amergence. It reveals subjective details of the emergent behavior that surrounds us.

A work of Amergent music is rooted in the ontology and innate dynamics of a media technology. It must understand and recognize the functioning order of the environment or platform that supports it. In terms of the "content" or "subject" of the work, that which is to be communicated or explored (through interactions with the environment) is organized into sonic spaces—fluctuating intensities of musical potential. Nothing is given. Transformations within a space, a novelty within the moment, become apparent through the layering of several spaces to reveal a world characterized by its affect. Sounds come together to spin a connective thread of musical experience that is *brought-forth* by virtue of one's presence and engagement in a mediated environment.

6.1 Soundscape & Acoustic Ecology in Mediated Worlds

In the physical world governments and laws can work to foster human survival and well-being. When something happens to threaten either of these concerns, one inevitable response involves questions of legislation: what can be done to prevent this in the future? At the time of writing this thesis, crude oil is spewing from an underwater well into the Gulf of Mexico (New York Times 2010). Not only are people asking how or why this happened, but how a firm could be permitted to drill without clear

evidence of contingency plans in the case of catastrophe. Where is the law that states, "you cannot drill unless you are able to clean up your mess"?

In mediated worlds, law is defined differently. For example, in the vertical slice of *Londontown*, no physical combat is allowed. This isn't a law that requires enforcement, however. The designer of the world calls for there to be no fighting and so combat of any sort is not written into the computer code that defines the world. Or, to use William Mitchell's succinct phrase, "code is law" (Lessig 1999: 6). Lawrence Lessig characterizes this in the more constructive sense of regulation:

> In real space we recognize how laws regulate—through constitutions, statutes, and other legal codes. In cyberspace we must understand how code regulates—how software and hardware that make cyberspace what it is *regulate* cyberspace as it is. (1999: 6)

His explanation of laws in cyberspace also apply to other kinds of mediated environments. Laws can prohibit unwanted behavior. From the technical side of virtual world or cyberspace development, this can be viewed as a matter of design: unwelcome behaviors are simply not possible in this world because there is no code to support them. This same approach easily transposes to other "laws" of the world including the handling of physics. Weight, speed, and gravity can all be defined in ways that make a mediated world what it needs to be.

The processes behind Amergent music act as a set of laws that define the sound of a mediated world. In a virtual space musical tendencies replace natural acoustics to create a sonically unique world. An Amergent approach has some Cage-like overtones, but it is not meant to reference John Cage or aleatoric composition in any specific way. Cage is significant because he was among those 20th-century musicians who opened ears to the musical possibilities of any sound. He stated, "Music is sounds, sounds around us whether we're in or out of concert halls: cf. Thoreau" (in Schafer 1977: 5). The reference to Thoreau is particularly illustrative of his views. During his two-years of sustained solitude on Walden Pond he would revel in the sounds of flora, fauna, and even human sounds of transportation that fell within earshot (Thoreau 1854). Thoreau writes of these experiences with the kind of passion usually reserved for piano and symphony orchestra. He found a true wealth of experience in the sound world of Walden, where the banter of frogs and owls gave rise to a profound meditation on his being in the world.

These ideas are extended by R. Murray Shafer, who coined the term *soundscape* and developed formalized means to describe the aural world in which we live. He believed that the soundscape was:

> …a huge musical composition, unfolding around us ceaselessly. We are simultaneously its audience, its performers and its composers. Which sounds do we want to preserve, encourage, multiply? When we know this, the boring or destructive sounds will become conspicuous enough and we will know why we must eliminate them. (Schafer 1977: 205)

Schafer's view is in agreement with Cage and Thoreau, but with a tone of museum-like austerity, and is best characterized as "beauty under threat." He finds beauty in some but not all sounds. Had Schafer been Thoreau's guest at Walden it is unlikely he would have found the same kind of wonder in the sounds of horse-drawn carriages and locomotives. Schafer's preferred soundscape is exclusive—some sounds are welcome and others are not. It is on this point where the aesthetics of Schafer and the contemporary Acoustic Ecology movement differ with Cage.

It is also at this point where the agreements and disagreements between these creative philosophies and Amergent music are most clear. The most obvious disagreement is that Amergent music is organized through computer code and digital resources. It becomes "law" in its environment of operation. Whereas Cage and Schafer celebrate (from their individual viewpoints) the natural resonances and unexpected beauty that arises organically, Amergent music is made from a comparatively limited pal-

ette. There is beauty and novelty but only a fraction of what is to be found in the natural world. This presents a challenge rather than a shortcoming, however. If Amergent music is to aspire to anything, it is not to re-present but rather to convey the rich aural diversity of the physical world in ways congruent with the idiosyncrasies of the virtual.

Schafer's view that those *in the world* are directly responsible for the sound *of the world* is central to Amergent music. This is clear in projects like *Londontown* where the actions of player-characters are clearly linked to the development of the world and the music that forms part of that reality. Transformations to a player-character's immediate reality are triggered by movement through Profession and Skills Intensities. The Reputation intensity shapes reality more indirectly as the actions of others find a voice. Responsibility for a musical reality is also prevalent, and perhaps more directly obvious, in projects like *Sound Garden* and *Perturb*. The boundaries of these "worlds" are defined by the music alone. Though there is an interface and a physical site (or sites) from which the music emits, it is the music that holds these worlds together. All who join in the sustenance of *Perturb* and *Sound Garden* are literally contributing to the composition, either by adding new or subtracting existing sounds from the generative system. Either way, what is heard comes as a direct result of the organization of the generative system and the actions of those individuals in the world that perturb the systems supporting this organization.

Francisco López—ecologist, composer, sound recordist, and prolific soundscape composer—has strong objections to Schafer's idea of soundscape. "It is basically a 'silencing', as if 'noisy' were an evil condition in itself and also an exclusive feature of [the] post-industrial human-influenced world" (Toop 2004: 67). López works in ways more congruent with Pierre Schaeffer and Michel Chion. Schaeffer identified *objets sonores* (sonorous objects) as sounds that were stripped from their original environment and used freely as artistic material (2004). Unlinked from its initial context, a sound could be considered simply for its acoustic properties, free of all referential attachments. Michel Chion called this approach *reduced listening*: "…the listening mode that focuses on the traits of the sound itself, independent of its cause and of its meaning" (1994: 29). Chion contends that reduced listening "…disrupts lazy habits and opens up a world of previously unimagined questions for those who try it" (1994: 30). Both artists, in separating sounds from their sources, are free to engage in a practice void of representation.

López discusses this further in his essay *Environmental Sound Matter*, a discourse on the ideas and practice behind his CD *La Selva.* He is explicit in his disinterest to identify sound sources or to be referential in any way. One reason behind this is authenticity. The entire environment—not just its creatures—make up the sound of La Selva (the Costa Rican rainforest). López places a great deal of emphasis on plants, which are usually overlooked but permeate these kinds of environments:

> …what we call the sound of rain or wind we could better call the sound of plant leaves and branches. If our perspective of nature sounds were more focused on the environment as a whole, instead of on behavioral manifestations of the organisms we foresee as most similar to us, we could also deal with plant bioacoustics. (1998)

Animals and insects have the loudest voices in La Selva, but these are not the only elements that contribute to its sound. Plants make the rain and wind more audible and act as reflective and absorptive surfaces that contribute to the overall acoustics of the rainforest environment: "As soon as the call is in the air, it doesn't belong to the frog that produced it anymore" (López 1998). The focus and technique behind Lopez's work on *La Selva* is very different from that of Amergent music. There are some important aesthetic connections, however. In most cases, the sound sources are sonorous objects in the most pure sense of the term. Whether synthesized from nothing or sampled and dislocated from its original source, the individual components that go into a work of Amergent music present listeners with a sound world that is truly unique. Each generative system plays these sounds in permutations

and combinations that demand focus and attention in the moment and in the flow of becoming. Individual sounds have little strength on their own; it is only through this flow of becoming that music can be discovered. In addition, the role of the whole environment is crucial to Amergent music. Unlike La Selva where there is an existing environment that gives the body of bioacoustic sounds a unique acoustic fingerprint, Amergent music has an environment of relation. Circumstances rather than acoustic resonances contribute to the overall musical results. The generative processes that have unfolded—and what has happened in the environment before someone enters it—largely determines what is heard and what potentially lies in store as listening continues over time. Whereas the natural acoustics of La Selva serve to shape the sound of the environment, the transformation of Intensities and the organic development of generative systems form the acoustic "law" of Amergent music.

It could be argued that López, Schafer, Cage and Thoreau are unique and that their dedication to listening is an extreme or special case. The soundscape is an undeniable part of human existence; yet outside the fields of environmentalists, soundscape composers, and artists, creative attachment or even a general awareness of the soundscape has not entered the contemporary zeitgeist. The same is not true of mediated environments. These "places" are new to those who visit them. The percepts and relations of the physical world dissolve into something "other" that demands a shift in attention. The habits of "real life" can betray once one has entered into a mediated reality.

The environment itself suggests the mode and focus of attention that best serve its inhabitants. In mediated environments, listening is one of the few senses that provides a means of perception. As part of the mediated environment, Amergent music facilitates this kind of connection as it assumes a soundscape-like role. Its character is largely defined by those who exist in the environment; they understand their current reality partly based on what they hear. This close relationship between person and sound environment can be compared to that between the Kaluli people of Papua New Guinea and their home in the Bosavi rainforest. Steven Feld notes how the sounds of the forest serve as a continuous connection to their immediate reality:

> Kaluli interpret these ever-present sound patterns as clocks of quotidian reality, engaging the soundscape in a continual motion of tuning in and out, changing perceptual focus, attending like an auditory zoom lens that scans from micro to wide-angle to telephoto as figure and ground shift and sound textures change with the daily and seasonal cycles. (1994: 126-7)

The dense texture and overlapping rhythms of the flora and fauna help the Kaluli orient themselves and better understand the conditions of their immediate environment. Time of day, location, as well as forest height, depth, and distance (Feld 1994) are all conditions expressed in the Bosavi soundscape. The connection is not only functional but cultural. The Kaluli song form *dulugu ganalan*, or "lift-up-over sounding" is closely linked to the rainforest environment. Feld describes how the Kaluli will sing in this densely layered and rhythmic style with cicadas or a waterfall. This both forges their aural-environmental connection more substantially and allows them to connect with memories and their greater cultural legacy (Feld 1994). As it concerns this research, Amergent music does not aspire to the rich heritage of "lift-up-over sounding." It does however find resonance in the degree of participation and aural engagement. Music can function as this kind of soundscape in a mediated environment. It can provide reminders of the possibilities and potential interactions that exist. The dense and multi-layered Bosavi soundscape is especially related to the layered intensities of Amergent music. In the way that the Kaluli are able to feel time, location, and memory through their shifting aural environment, the transformation of intensities produces affects that serve in the orientation and perception of a mediated reality.

This substantial connection with the immediate environment recalls the urban planning work of Kevin Lynch who sought to develop legible cities, in which a potential use of the environment could

be easily discerned. Where Lynch used the visual metaphor of legibility, the aural metaphor of soundscape is more closely related to this research. Discussions of the soundscape in particular focus on the environment as an object of listening. But the act of listening, and the behaviors or devices associated with listening, are an important part of the overall relationship between individual and the sound environment.

6.2 Listening Modes of Mediated Interaction

American composer Earle Brown, while looking for ways to open musical form and incorporate elements of improvisation into his music during the 1950s, found a great deal of inspiration in the mobiles of sculptor Alexander Calder. Brown described them to guitarist Derek Bailey as:

> …transforming works of art, I mean they have indigenous transformational factors in their construction, and this seemed to me to be just beautiful. As you walk into a museum and you look at a mobile you see a configuration that's moving very subtly. You walk in the same building the next day and it's a different configuration yet it's the same piece, the same work by Calder. (1992: 60)

Brown identifies a core or center that maintains the overall identity of Calder's mobiles. Though they have gone through a transformation, the substance of the work is unchanged. His thoughts on musical structure are also noted by Michael Nyman in *Experimental Music: Cage and beyond*. Brown emphasizes that one importance of composition is to be both a means of sonic identification and musical point-of-departure:

> There must be a fixed (even if flexible) sound-content, to establish the *character* of the work, in order to be called 'open' or 'available' *form*. We recognize people regardless of what they are doing or saying or how they are dressed if their basic identity has been established as a constant but flexible function of being alive. (Nyman 1999: 70)

Brown was interested in approaching music with an openness that allowed the essential character of the work to permeate every performance. A work's character is like the affective core of Lefebvre's representational spaces. In Amergent music this is the domain of intensities. Coupled to the various generative systems, these flow through the entirety of the musical work to create overlapping synergies of sound that form its affective essence. The experience of hearing—and more importantly listening to—the defining character of the work is a different matter entirely. The contemporary relationship between sound and receiver is a complicated one modulated by technology and the specific situation of mediation.

6.2.1 Listening and the Mediation of Sound Space

The differences between hearing and listening were first distinguished by the French physician Mattieu-Francois-Regis Buisson around the year 1802 (Sterne 2003: 102). Active aural attention and focus was characterized by the word *auscultation*, a noun that refers to the act of "listening or harkening" (Sterne 2003: 100). These differences were later amplified by R.T.H. Laennec, who is credited with inventing the stethoscope and the phrase "mediate auscultation" (Sterne 2003: 100). In his book, *The Audible Past: cultural origins of sound reproduction*, Jonathan Sterne comments on Laennec's contributions:

> Every movement of the organs in the human thorax could be tracked by listening to the body with the aid of an instrument, and those movements could be rendered meaningful. This was Laennec's innovation, not the physical composition of a simple device to accomplish the task. (2003: 102)

While he created a device that heightened aural experience, it was the practice of listening that Sterne

finds so significant. Listening had to be learned. The practice started in the professional sphere of middle-class doctors and telegraphers. They discovered "audile technique" and with it the means to "inhabit their own private acoustic space and still come together in the same room or even across long distances. They could listen alone and they could listen together" (Sterne 2003: 138). Sterne notes a noticeable shift in the audience at opera, film, and vaudeville productions, where people felt a sense of entitlement in their private acoustic space (2003). Home audiences were no exception to this.

Beside the gramophone they were, in William Kenney's words, "alone together" (Sterne 2003: 163) in a sonic world of simultaneous connection and insulation. Sterne characterizes this as a lesson in mediation: "listeners isolate themselves in order to have a collective experience through the gramophone" (2003: 163). The gramophone (and certainly the radio) are early mediating technologies with a dialectic quality. They provided a reason for people to come together. Anticipation of or discussion following a listening experience fostered social cohesion as listeners were brought together in their reflections of a shared experience. During the listening experience, through the mediation of technology, they were alone in a private acoustic world. The bond of social cohesion before and after is equal in strength only to the agreement for solitude and mutual silence throughout the listening experience. Good aural fences make good listening neighbors.

With contemporary technology the arrangement for practiced listening is faceted and complex. Personal, social, political, and geographic space can be delineated and reconfigured by bells, the car radio, the mobile phone, the personal stereo (Walkman or iPod), reggae sound systems, and so on (Bull & Back 2003; Blesser & Salter 2007; Levitin 2007). The Internet, with its host of peer-to-peer networks, sites for social networking, and services like Pandora (www.pandora.com) and Last.fm (www.last.fm), expand the discussion even further. A comprehensive list of technologies and their specific interventions in spatial arrangements goes beyond the scope of this thesis. But historically there are many precedents that have shaped listening and the relationship that is established between listeners and mediating technologies.

Amergent music presents a new situation of mediated listening. This stems more from a re-thinking of contemporary technology than it does specific technical advances. In the projects discussed in this thesis, sounds are not channeled through or reproduced by a mediating technology. Rather music is seeded to be part of the technological system. The sound world that emerges is equally personal to that of the nineteenth-century gramophone listener, if not more so. What they encounter is original to the particular situation and circumstances in which it is created, making their ownership of the environment all the greater. This arrangement is less clear when considering the specific cases of works where interactions with the mediated environment are open. In *Perturb*, *Sound Garden*, and *Londontown* the sound world is comprised of both individual and shared responsibility. However, like Schafer's conception of the soundscape, all who exist within the mediated reality are responsible for its creation and sustenance. Whether it involves the metaphoric "planting" of a sound or a business decision that puts you on the wrong side of Scotland Yard, interactions act as perturbations that resound through the world creating sonic transformations that affect all who are in it. Listening to Amergent music in a mediated world involves listening that can be, to revise Kenney's statement: alone/together, together. Sound becoming music is one thread of an experience both collective and individual. It has dimensions of both aesthetic enjoyment and tangible connection to one's mediated reality.

6.2.2 Suikinkutsu: ritual and sound experience

Mediating technologies can focus listening behavior by providing an object or conduit for listening. What will be heard may not be entirely given but the source from which the sound emits is definite and listening can be focused. The Japanese *suikinkutsu* provides an interesting example in which listening is focused yet the object(s) of experience is not.

A suikinkutsu is found near the basin where people wash hands and purify before entering a garden (Brewer 2007). The device itself consists of an inverted clay vessel, partly filled with water, that has been buried in soil and rocks at the foot of the basin. In the base of the vessel there is a small opening called *suimon*, or"water hole" (Watanabe 2004: 6429). This is covered by small to medium-sized rocks that form a sort of drain around the basin. A technical drawing of a suikinkutsu has been reproduced in figure 6.1 After someone washes their hands, water runs down into the drain, around the rocks, and through the suimon where it drips slowly into the vessel. Droplets splash and resonate within the vessel, the sound of which emits back through the suimon and is audible to those standing at the basin.

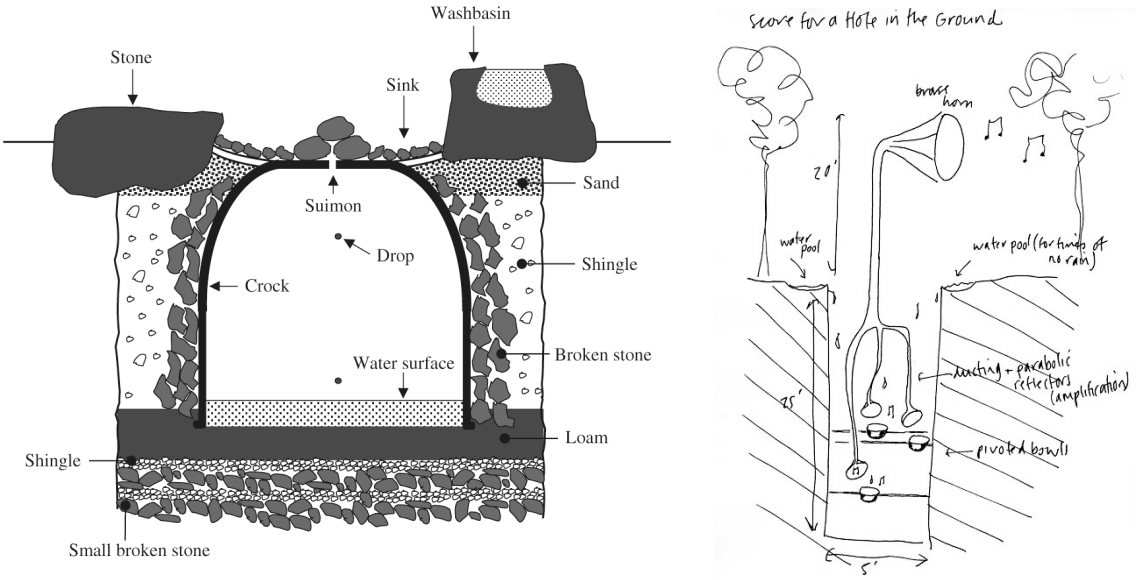

Figure 6.1: The components and construction of a suikinkutsu (left), reproduced here from *Analytical Study of Acoustic Mechanism of Suikinkutsu* by Yoshio Watanabe (2004). Jem Finer's *Score for a Hole in the Ground* (2006) is a contemporary musical work that draws much of its initial inspiration from suikinkutsu in the temple gardens of Kyoto. On the right is a sketch from Finer's original proposal (2005).

The sound of the suikinkutsu is beautiful and the construction of the device is marked by elegant simplicity, but neither of these qualities are what makes the experience of using a suikinkutsu so unique. After washing hands, awareness that the suikinkutsu is present is cause to heighten listening attention. The sound that emits from the suimon is audible but soft. In the process of "stretching" ones ears to hear the resonance of droplets inside the clay vessel, a wealth of other sounds suddenly becomes apparent. Birdsong, wind blowing through plants and trees, other nearby water features are all elements that can be heard before and after the moments spent waiting for the splash(es) within the suikinkutsu.

The suikinkutsu acts as a reframing device. The act of washing ones hands could be seen as banal—just another tedious but necessary step in life. The suikinkutsu reveals something more profound. In these dull moments there is beauty if one is receptive and allows it to be revealed. The birds, the wind, the rhythmic flowing of water are always present but only for those prepared to hear them. By slowing down and opening up to the careful consideration of one sound, an entire world of sound springs forth.

This sonic practice is rooted in unintention. The suikinkutsu is not deliberately played like media technology or a musical instrument. It is simply there, and can be perturbed in the process of washing hands. This relationship is like the ontogenetic unities of Maturana and Varela's structural coupling. When washing hands at the suikinkutsu, there is no way to deliberately trigger the sound-emitting mechanism, it can only be perturbed. The flow of water around the rocks, the amount that drips through the suimon, and a host of other variables can in no way be directed or controlled. However,

the perturbation of one small splash causes water to enter the suikinkutsu and produce a sound. Like the arrangement between listener and generative system, the relationship between listener (hand-washer) and suikinkutsu is struct*aurally*-coupled.

Sound emits from the suikinkutsu as a perturbation both to the environment and listener. In addition, having become more aurally aware of their current situation, a listener is more open to the sounds of their environment which are received as perturbations in their ontogenesis. As with the spatial and sonic organization of generative systems that lead to Amergent music, none of this is controlled or deliberate; there is simply an arrangement of a situation. As the situation unfolds each party perturbs the other to create the sound experience surrounding the suikinkutsu or mediated environment. It is sound and music through unintention. Amergent music is discovered but it cannot be deliberately created. Some of the most profound experiences of sound and music happen when one is least expecting them. If a mediated environment is seeded with sound and sound opportunities, the experience of that environment has bountiful musical potential.

6.2.3 Listening as Use and Consumption of Sound

The sound installations of composer Michael J. Schumacher are designed for small spaces and intend to transport listeners to new experiential worlds of sound. Writing on Schumacher's work, Julian Cowley references Gaston Bachelard and his idea of "intimate immensity" (Cowley 2002: 11) to explain the sense of inward expansion these pieces can evoke. In 2005, Schumacher discussed his interest in developing a commercial platform for sound art (Maier 2005). Just as paintings, sculptures, and other art works rest on surfaces or hang from the walls of living environments, Schumacher envisioned domestic sound art with a computer-driven, multi-channel speaker system that would transform the fundamental relationship people have with sound, and cultivate long-term sonic experiences (2003; Maier 2005). He discusses these pieces and the experience of sound art relative to a larger trend in which listening to sound or music has changed from a practice involving aesthetic engagement to one of consumption. He elaborates:

> People "use" sound to cheer themselves up, calm themselves down, as movement motivator. There's this sense that you can pick the right song and it will alter or intensify your mood to the exact, right degree. It's like having a glass of wine or smoking a joint. (Maier 2005: 68)

While Schumacher does not crusade against this practice, his work is oriented to break this habit. He prepares sounds for the kind of experience that Schaeffer would call "acousmatic listening" (2004: 77) what López would call "profound listening" (1998) and what Chion would call "reduced listening" (1994: 30). Sounds are removed from their sources, transformed, and re-contextualized in the slow unfolding of the piece. Schumacher notes that those who experience the work in their home environment find themselves confronting a unique aural reality:

> By giving up what one thought of as control, one gains freedom, a relationship with sound, and by extension, the environment as a whole that is not subject to changes in mood, but is fundamentally "in tune" with the entire range of phenomena that are encountered. (Maier 2005: 68)

In true acousmatic fashion, Schumacher uses sound as a medium and leaves interpretation to individuals. He is clearly not interested in imparting the kind of listening experience that deliberately manipulates listeners physically or psychologically. However, stimulation and manipulation frequently characterizes the relationship many people have with music.

Cognitive psychologist and neuroscientist Daniel Levitin, in a report to Philips Consumer Electronics, discusses the various uses of music in people's day-to-day lives. He agrees with Schumacher in the comparison of music to the use of caffeine and alcohol, "…they use a certain kind of music

to help get them going in the morning, another kind to unwind after work" (Levitin 2007: 2). He also cites specific examples in which music provides exercise stimulation, comfort in emotional crises, academic study aid, and background accompaniment for brain surgeons during their most concentration-intensive procedures (Levitin 2007). Schumacher's assertion of "control" is also accurate in characterizing the listening relationship with music. In the study *Uses of Music in Everyday Life*, (North, Hargreaves & Hargreaves 2004), scientists monitored the listening habits of 346 people over a period of 14 days. Among the findings was the conclusion that music is used as a resource to exercise control over one's current environment and to set the right tone for their current activities. When choosing musical accompaniment, those studied said that their choice was most likely motivated by the need to pass time, a force of habit, or an effort to create the right atmosphere (North, Hargreaves & Hargreaves 2004). Interestingly, in situations where music was present but it was not their choice, those studied responded by saying that the music created the right atmosphere, was enjoyable, or had no effect at all. Few people claimed that situations in which music was beyond their control led to annoyance (North, Hargreaves & Hargreaves 2004: 32-4). One of the authors' conclusions was that when music is beyond control, people are simply unengaged, which was consistent with one of their initial hypotheses:

> …we might expect that the greater availability of music in the modern day might have led to music as a commodity being in some way "cheapened" such that people's reasons for listening to it are rather passive and detached. (North, Hargreaves & Hargreaves 2004: 48)

Music is more widely available now than at any time in history. $0.99 songs through iTunes, free promotional downloads, and black market file-sharing networks provide unprecedented access to musical recordings. A seemingly limitless supply reduces the value of the product and musical recordings become less special to those who own them. In addition, music permeates many of the businesses, restaurants, and shops in North America and Europe where these studies took place. Like the free drinks that keep gamers in a casino, music also "…helps the consumer buy, the patient relax, the worker work; its goal is to render the individual an untroublesome social subject" (Gorbman 1987: 5). When listeners are less critical of their surroundings and situation, they can be more easily controlled. Jacques Attali writes:

> It slips into the growing spaces of activity void of meaning and relations, into the organization of our everyday life: in all the worlds' hotels, all of the elevators, all of the factories and offices, all of the airplanes, all of the cars, everywhere, it signifies the presence of a power that needs no flag or symbol: musical repetition confirms the presence of repetitive consumption, of the flow of noises as ersatz sociality. (1985: 111)

The practice of regulating commercial and business spaces with music has long been the focus of the Muzak Corporation. *Muzak* and the term *elevator music* are often used interchangeably. While Muzak was heard inside the elevators that came with increasingly tall buildings of the 1930s, the idea was first introduced by Major General George Owen Squier to increase the productivity of typing pools (Lanza 1994; Hagenbaugh 2004). Popular tunes played by saccharine strings in musically uninteresting arrangements is a long-gone stereotype. The contemporary services of Muzak can be likened to a satellite DJ service, where company consultants develop aural branding—a customized playlist of songs that project an image appropriate to the client. A testimonial from the Muzak web site confirms this objective:

> I do not have a business but I am so impressed with the music that is being played at the 99 Cent Store and found myself shopping longer just to hear the music.
>
> —Linda L., customer (Muzak LLC 2010)

Like other forms of music and sound discussed in this thesis, Muzak, "functional music," (Jones &

Schumacher 1992: 158) or "programmed music," (Sterne 1997: 24) heard in shopping centers and workplaces has the ability to reconfigure space. In a study on the Mall of America, Jonathan Sterne draws on Deleuze and Guattari who write that the mall "…builds and encloses the acoustical space, and manages the transitions from one location to another…" (1997: 31). Sterne arrives at conclusions that synthesize some of the ideas of Debord and Lefebvre. The mall can be understood as a collection of adjacent spaces; a mixture of individual "private" commercial spaces, connective public thoroughfares, and a large amusement park. The character of these spaces is differentiated by their outward appearance, but is more clearly defined through the use of programmed music and the homogenous sound of each individual space. The brand—a lifestyle and personal identity for sale—is just as audible as it is visible. Jones and Schumacher write about the commercial imperative this serves:

> Orderly consumption requires particular spatial arrangements of commodities and consuming subjects. Programmed music systems have come to play an important role in the reproduction of this social and symbolic order. They are used to mark out and aestheticize these spaces, to invest them with symbolic meaning, and to define the relations of the self, to goods and to others in ways that enhance commercial interests. (1992: 165)

Programmed music is seen very differently depending on the perspective and agenda of those who write about it. The businessperson of course sees an opportunity to attract customers. Programmed music provides comfort and familiarity, and can help consumers become acquainted with the goods and services that are offered. Scholars writing from a critical theory perspective hear programmed music as a threat. Those who are not immune to its charms will be unknowingly pacified and manipulated. It represents the spread of unchecked power and order. Artists observe the trend and respond in ways that disrupt or challenge the conventions established by programmed music. Michael Schumacher, as an intervention to the consumption of music in private space, makes acousmatic installations specifically designed for small, enclosed environments. Most notably to this research, Brian Eno developed Ambient music as a reaction to the function and sound of Muzak.

While much of Eno's Ambient work is celebrated for its sonic beauty, the value in the conceptual elements behind the work can be overlooked. One of the first Ambient records was *Music for Airports* (1978). In the album's liner notes Eno discussed this music as the result of cultural and artistic circumstances. He pointed to a trend from the early 1970s in which people played recorded music to create a mood, and that he and his friends were sharing cassettes of still, relatively homogenous music that could be treated as an aural backdrop (Eno 1996). Of course Muzak had long-since monopolized this idea and "elevator music" was well-established in the public sphere. The reputation and ubiquity of Muzak was part of his critique. Though *the sound* of Muzak was generally considered to be unfulfilling by many listeners, Eno found something curious in its function. He considered the possibility that environmental or mood music could actually have something of substance to offer the listener, and that in it would be the opportunity to "…induce calm and a space to think" (Eno 1996: 296). Rather than exert control over the environment, Eno sought to empower listeners. By tinting their environment with Ambient music, sound acted as a catalyst for reflection and reverie. It accommodates various levels of attention, and is ultimately meant to be "…as ignorable as it is interesting" (Eno 1996: 296). Amergent music intends to extend this aesthetic. The diffuse Ambient sound gives mediated environments a clear sonic identity. And with the ability of generative systems to sustain music continuously over time, sound is as persistent as the environment to which it belongs. An overall Ambient character also allows other features of the mediated environment to be apprehended. In the case of Amergent music, "space to think" means space to consider the images, interactions, and other elements that comprise a mediated reality.

Human relationships with music and emergent trends in listening generated some of the ideas behind *Music for Airports.* Eno's later CD *Thursday Afternoon* (1985) shows that developments in technology

can also motivate artistic ambition. It reveals a confluence of musical and technical circumstances that lead to a work uniquely suited to its medium. The recorded piece is 61 minutes long, which at the time was only possible on compact disc (Eno 1985). In addition, digital discs have no surface noise. This allowed *Thursday Afternoon* to feature passages that were very quiet and musically sparse (Eno 1985). In this work the technical, conceptual, and musical aspects are entangled, with each serving the interests of the other.

Amergent music strikes out from this position as well. The processing capabilities of contemporary digital devices enable the production of music in real time. Inputs and sensors responsive to touch, gesture, light, sound, motion, and distance extend the potential of realtime production to include human involvement. In the specific case of the music presented in this thesis, involvement is not only possible, it is necessary to sustain musical interest and vitality. Amergent music seeks to leverage the strengths and potentials of new technology towards a more robust musical end. Not only is it music *for* an environment but it is music *of* an environment.

6.3 Future Potential of Amergent Music

One of the primary motivations behind this music has been to formulate the work in ways appropriate to the environment where it will be received or experienced. This consideration goes beyond wanting something to "fit in" to a particular context. It is more deeply concerned with acknowledging the inherent strengths and weaknesses of an environment or technology platform, and using these either as assets or limitations that serve the interests of the entire work. This approach could be broadly characterized as one of ecologic sustainability. Jane Jacobs, writing on the topic of urban planning, discusses the need to understand inherent qualities and behaviors of a city before one can begin to improve its design. In fact, much of Jacob's book *The Death and Life of Great American Cities* (2000) is devoted to the topic of healthy neighborhoods. Their current, sustaining order is one of the best sources to consider when planning new, or revitalizing old, urban spaces.

Where neighborhoods have the dynamics of social, familial, and economic spheres that shape its functioning order, the technoetic nature of a mediated environment determines the ways in which sound and music are best suited to it. In the case of urban revitalization, the dynamics of a healthy neighborhood can be studied and transposed to an area that is suffering if the source and inter-workings of these dynamics is understood (Jacobs 2000). With Amergent music this works by understanding the mechanics of the mediated environment. Knowledge of the system provides an idea as to the potential behaviors and interactions that can take place. There is also intention: what is the motivation behind this environment? *Londontown* as a virtual world was created with an entirely different set of priorities than *Dérive Entre Mille Sons*, yet both use similar mechanisms for musical interaction. The technical specifics behind a work may have many common elements. However, the kinds of sounds that can be produced, and the transformations afforded through perturbations to the underlying generative system, are profoundly connected to the unique properties and behaviors of the mediated environment.

6.3.1 Personal Computer, Smartphone, & Communications Applications

As an artist who spends most of his time working with computers of various shapes and sizes, it is natural to think about ways in which my work could improve or enhance the use of these devices. If an opportunity were to arise I would have to enter into the project carefully. Specialized mediated environments like *Londontown* and *Sound Garden* are comparatively narrow endeavors: the scope of the world is clearly defined and the experience it will impart is focused on an established set of priorities. The operating system of a computing device is, by comparison, wide open. Take as an example, Brian Eno's account of "The Microsoft Sound," which was the start-up sound for the Windows '95 operating system. He said that the request called for:

> …a piece of music that is inspiring, universal, blah-blah, da-da-da, optimistic, futuristic, sentimental, emotional, this whole list of adjectives…and it must be 3 1/4 seconds long. (Selvin 1996)

Technical limitations of 3.25 seconds aside, the production of a single sound that can embody such a diverse range of emotion is a challenge that could be easily written off as a fool's errand. But this story is a reminder of the priority for technology (and the sounds that support use of it) to accommodate myriad uses for an audience of diverse artistic and practical sensibilities.

Listening can help make clear the shape, material, texture, and other properties of a physical object (Sterne 2003; Hermann & Ritter 2004). Subtle differences in pitch, timbre, and envelope of a sound make these qualities apparent. Correlating sounds and their acoustic qualities to the use of a computer system enters the domain of usability, user experience, and the field of Sonification. Sonification intends to make finely-detailed data sets more easily readable as non-speech audio (Hermann & Ritter 1999). Current research projects in this field have shown that sonification techniques can be used to enhance the usability of a computer system (Barra et al. 2002; Absar & Guastavino 2008). Amergent music similarly deals with transformations to a body of sounds. In reaction to perturbations through physical presence or use of a mediated environment, music emerges from a field of sonic potential. Amergent music and Sonification are not identical, but the techniques discussed in this thesis can be usefully employed to produce music that functions as a sonification.

In terms of usability, generative techniques are not always helpful; some sounds are best left alone. For example, the Trash sound in the Macintosh operating system is both metallic and fibrous. It sounds like a crumpled piece of paper being tossed into an office trash bin. The sound is coherent and consistent. Every time a file is discarded, the Trash sound plays to reinforce and confirm the action. In the case of files inadvertently thrown away it additionally serves as a warning. Through personal experience with this operating system I can remember several occasions in which the Trash sound helped me to avoid an accidental deletion. Sounds that function in this way gain strength in their consistency. But in cases of other tasks that can take longer to perform, musical emergence could lead to a sound experience that is more communicative of the work in progress. Consider the following hypothetical examples:

- To track progress of files that are copying or downloading, the amount of data to be transferred is divided into quarters. A set of Shuffler() instruments play sounds from four different sets for 0-24%, 25-49%, 50-74%, and 75-100% respectively. The Shuffler() instruments will maintain a performance that is constantly shifting to ensure that even in situations in which files take a long time to transfer the sound never becomes stagnant or tiresome.

- Various applications for e-mail, Internet, graphics, writing, and so on are tagged with sounds. These can be determined by the user to match their work habits for each application. Use of an application takes on a spatial metaphor: when the program is launched, the user enters that space. Applications that are currently in use determine the overall mix of sounds. Those currently in focus are heard most clearly; those in the background are less audible. Use of applications over longer periods of time could be used to lend additional weight to the mix parameters.

- Considering the current Google trend to move desktop applications online, this idea could also be used for linked web sites on the Internet. In this way, the technique leads to a kind of semantic web music. Sounds are tagged to various sites at the developer's discretion; they use these in the overall design similar to the way they would typefaces, colors, and images. These sounds are collected and stored as one surfs the web, and become available as sonic material for a generative system. Playback is weighted due to the current URL, while sound tags that correlate a current location to previous locations reveal trends to become the sonic equivalent of a tag cloud.

While these projects are speculative in nature, they do not depart drastically from the ideas and techniques employed in the works discussed in this thesis. The underlying spatial metaphor of Amergent music provides a straightforward solution as an art-driven approach to a technical problem of design.

6.3.2 Virtual Worlds, Games & Entertainment

Marty O'Donnell, composer of the music heard in the popular *Halo* game series says that the first rule of game audio is "Do no annoying" (Schmidt 2010). This statement addresses one of the foremost critiques leveled against the music of computer games—excessive repetition (Harland 2000; Collins 2008). While there are other compositional choices that could produce "annoying" music, pieces in which the same rhythm or melodic phrase is heard over and over become especially grating on the ears and patience of the player. In his talk at the 2010 Game Developer's Conference, Kurt Larson started his talk by addressing this concern from an economic perspective. He compared potential budgets for the music in a typical single-person computer game and an MMO (massively multiplayer online game) or virtual world. A typical game will provide 30 hours of playtime. One minute of music for every hour played would cost the game developer $45,000 at the industry rate of $1,500 per minute of finished music (Larson 2010). In virtual worlds, playtime can exceed 1,000 hours; even up to 7,000 hours in cases of the most engaged players. For the virtual world to have a continuous supply of new music, the budget jumps to $630,000,000 when billed at the same rate (Larson 2010). This untenable figure shows that generative techniques, and their ability to create music variety over long periods of time, present an ideal solution for virtual worlds and games that are expected to have hours upon hours of use.

While there are clear similarities between virtual worlds and computer games, those who design virtual worlds make distinctions between these places and games (Bartle 2004; Castronova 2007). Semantic differences aside, it is evident that both engage people, serve as entertainment, and potentially occupy hours of their leisure time. Games that allow players to model creatures, cities, and homes are more accurately described as "software toys" (TED Conferences 2007; Falstein 2007: 35). Like an Erector set, Lego, or any other toy for building, games like *Sim City* (1989) and *Spore* (2008) allow players to build a model city or civilization and watch what happens as they maintain it over time. This facet of games, that which gives them their "toy-ness," is something that has held my interest for years and is included in the foreseeable future of my research. While hundreds of hours of my childhood were spent playing computer games, *thousands* of hours were likely spent playing with Lego building blocks. I see in Amergent music the potential for a "Lego" quality, where thousands of hours of playtime are characterized by surprise and novelty as new combinations of sound are experienced in the act of play. I do not suggest that Amergent music could become a toy in its own right, but rather the techniques involved could be used to enhance the sound-producing feature of many contemporary toys.

Hinske et. al. quote Judy Ellis from the Toy Design Program at the Fashion Institute of Technology who says, "a really great toy invites discovery, enhances a child's play environment, and is fun, educational, and age appropriate" (2008: 79). In their own design project, Hinske and his colleagues use sound to provide "…immediate and location-aware feedback" (2008: 84), however the technology used to facilitate this was hidden in the play environment so as to "…not let children neglect the traditional play and limit their own imaginations" (2008: 85). Audio-producing technology was used unobtrusively to fill an experiential role that was crucial to the success of the play environment. As the father of a 4-year-old and a 1-year-old, I have come into contact with many different toys available today. It strikes me how many of these require batteries—not to make them go or move, but to give them an aural dimension through prerecorded sounds and music. My criticism of these toys, like the popular critique of computer game music, is that the sound is too homogenous. My son has recently developed a fascination with plastic beverage bottles. One of these containers has an argu-

ably far greater sound potential than any of the battery-powered toys in our home. These objects, even those produced by so-called "educational" manufacturers, offer little to no variety at all. Malone and Lepper write that in learning environments, "…curiosity is the most direct intrinsic motivation for learning" (1987: 235) and that it is possible to "…stimulate curiosity by presenting an apparent inconsistency…" (1987: 236). Schaller, using the work of Malone and Lepper, further claims that, "audio and visual effects, particularly, in computer games may enhance sensory curiosity. When learners are surprised or intrigued by paradoxes, or incompleteness, it arouses cognitive curiosity" (Schaller 2005: 2). Incompleteness, inconsistency, and paradox are impossible to achieve with a homogenous sound palette and a one-dimensional relationship between a child and the toy.

This lack of sonic diversity in contemporary toys is troubling for additional reasons. On the most basic level it violates O'Donnell's rule to "do no annoying." Hearing the exact same "beep" or rendition of *Twinkle Twinkle Little Star* every time a button is pressed is aggravating. The computer chip that plays these sounds is not programmed to provide any difference or variation. Unlike the plastic bottle that makes a different kind of resonant "thud" with each new strike, the computer-driven sound toy has little to offer. Static, overly-simplistic sounds and potential interactions do nothing to invite curiosity, introduce surprise, and stimulate the imagination. It is difficult for children to invent new worlds when the tools at their disposal are only suited to a single task.

In his short story *To the Legoland Station*, Michael Chabon discusses his dismay with the version of Lego toys available to his children. Compared to the open-ended, systemic nature of Legos as remembered from his childhood he observes a "…sense of imposition, of predetermined boundaries and contours, of a formulary of play…" (Chabon 2009: 52) Contemporary Lego sets depart from classic right-angled blocks in primary colors. Specifically-shaped pieces designed for *a single model* in particular are as common within a set as the more utilitarian pieces of yore. In the end, Chabon reconciles with the new Lego regime. He recognizes the creative potential in "…the aesthetic of the Lego drawer, of the mash-up, the pastiche that destroys its sources at the same time that it makes use of and reinvents them" (Chabon 2009: 57). Despite the new strain of specificity in Lego pieces there is a lasting openness in their design. The interchangeability of pieces will always facilitate unplanned connections and combinations. Pieces licensed from the *Harry Potter* and *Star Wars* universes can happily coexist in the model of an utterly alien vehicle or residence. In terms of this research, the interchangeable, bottom-up nature of Lego blocks can be compared to the acousmatic and generative nature of Amergent music. Sounds, once removed from their original environment, take on an entirely new dimension. The generative process of Amergent music operates as a force of recontextualization—background becomes foreground, what was loud is made soft, and so on. Sounds lose their specificity and become aural property of a new and invented world. The sorts of interaction made possible with contemporary technology further act to extend these sonic possibilities.

Interactions with mediated environments—or in the case discussed here, interactions with a toy—could be handled in similar ways. Technically speaking, sensors (like those used in *Sound Garden*) can monitor touch, temperature, light levels, and other physical perturbations. An accelerometer measures motion and degrees of tilted-ness, as the prototype for *Dérive Entre Mille Sons* demonstrates. These techniques are relevant to the research presented here and represent just some of technical means for managing inputs and interactions with a child's toy. Arguments concerning cost of implementation can be met using Kurt Larson's reasoning behind the budget for audio in games and virtual worlds. If something is expected both to include music and facilitate hours of play, it follows that those priorities be nurtured in tandem. When compared to the production of prerecorded sound and music files, a generative approach is far more extensible and will be able to create greater sonic variety over much longer periods of time.

Not every toy will hold the creative potential of Legos and serve as a catalyst to the imaginations of children, but this is a worthwhile goal. These ambitions resonate with the work of Professor Seymour Papert:

> Constructionism means learning by making something. LEGO is an example, writing computer programs is an example, painting is an example. And what you learn in the process of doing that sinks much deeper, its roots go deeper into the subsoil of the mind than anything anybody can tell you. (The LEGO Group 2010)

Papert has witnessed and developed scenarios in which children learn through doing. By building models and simulations they come to a more personal and usable understanding of math, physics, and other areas related to their creative inquiries. Papert was curious to explore "…the conditions under which intellectual models will take root" (Papert 1980). I can foresee an application of Amergent music that contributes to such an environment or condition. Whether it involves children working as creators, using generative techniques to explore sound worlds of their own design, or playing with toys that augment the worlds of their imagination, the potential for sonic surprise and novelty make it a useful approach.

Conclusion

Amergent music is rooted in the functioning order of the media technology that supports it. As with a soundscape in the physical world, the media object or environment created by this technology comes to be characterized by the sound and sonic transformation created through Amergent music and its relation to all perturbations received by the object or felt within the environment. An affective recognition of this connection makes dynamics of the current situation apparent and reveals future possibilities inherent to the environment.

This experience and these affects are the result of listening. Listening can be focused on a particular subject within the environment, but this can lead to an additional listening focus towards other subjects or sounds initially unattended. While much listening in the contemporary media landscape is unengaged, Amergent music works to create a listening experience that is both functional and reflective in situations of mediated interaction. Its affects cultivate an awareness of the environment that functions both as an orienting strategy and an aesthetic experience.

There are many potential applications for Amergent music in the future. Implementations in the realm of art, communications, and entertainment have been discussed here. These are the areas that initially inspired and continue to support the projects completed in the course of this research. The conclusions reached suggest additional utility beyond the scope of this thesis. All applications of Amergent music, present and future, reveal an emerging relationship between people and the mediated environments in which they interact. The use of a system—and the choices made within that system—manifests a sonic synergy coupling the observer, the observed, and the produced.

CHAPTER 7

Constructing a Musical Reality

"…We must arrange our music…so that people realise that they themselves are doing it, and not that something is being done to them."

– John Cage in *Generation*, an interview with Roger Reynolds, 1962. (Ascott 2003: 123)

Cage's landmark "silent" piece, or as it is also called *4'33"*, is the best example of this idea come into musical fruition. It is not a composer's particular arrangement of sounds that makes music as much as it is the listener's ability and willingness to include sounds in that privileged category. Musicians working in ways complementary to Cage contrast the traditional compositional proposition "I think this arrangement of sounds is interesting" with "What would it sound like if…" This is the imperative of Experimental music and one of the foundational musical questions behind the work of this thesis. Music that has an unknown outcome shares an ontological resonance with technoetic environments that possess similar uncertainties.

A more literal interpretation of Cage's statement reveals one of the inherent tensions of Amergent music, and the relationship of music to technoetic environments in general. As one exists in these environments, his actions resonate throughout, potentially a/effecting every other person or element also within it. This kind of presence forms the basis of a relationship that not only includes the permeable sound/music boundary espoused by Cage, but a more literal version of the idea that "they themselves are doing it." The interconnectedness of these environments is not unique. The Dalai Lama reminds us that in our immediate reality, "Everything we do has some effect, some impact" (1999: 63). The difference is that in technoetic environments these a/effects can be sensed more immediately, or they can be used for exploration and experimentation as a simulation, and as the foundation of a mediated reality with the ability to transform consciousness.

This view of the world, in relation to music and art, has suggested a path of inquiry that follows in the steps of cybernetics. As Roy Ascott originally suggested in 1967:

> It is necessary to differentiate between *l'esprit cybernétique*…and cybernetics as a descriptive method. Now, art, like any process or system, can be examined from the cybernetic point of view; it can also derive technical and theoretical support from this science—as in the past it has done from optics or geometry. This is not unimportant, since the artist's range can be extended considerably… But it is important to remember that the cybernetic vision in art, which will unify art with a cybernated society, is a matter of "stance," a fundamental attitude to events and human relationships, before it is in any sense a technical or procedural matter. (2003: 127)

In this research, cybernetics has provided models and a framework for structuring new ideas and techniques. It has facilitated the development of a fledgling practice and given voice to thoughts that were initially easier to execute as an artwork than explicate in a larger or more robust context. This thesis is the culmination of a musical approach that draws on the theories and concepts of cybernetics but is not a literal manifestation of the circuits and wires one often associates with the field. Contemporary music practice exemplified by Eric Archer (http://ericarcher.net), Bleep Labs (http://bleeplabs.com), the Handmade Music community (http://handmademusic.noisepages.com), and circuit bending in general are deeply engaged in that visage of cybernetics, but I cannot speak to the deeper role of connectivity in these works. The approach advocated by this research looks at cybernetics as a means of

coordinating the behavioral relationship between the art work and person engaged in it. Like W. Ross Ashby's homeostat, music is regulated to be congruous with the dynamics of the environment and the behavior of those who exist within it.

7.1 Music as Behavior; Music as Movement

The idea of music as a behavior came not from discussions or writings about music but rather of biology. Humberto Maturana and Francisco Varela's research has contributed profoundly to informing this work. Structural coupling, the relationship of mutual perturbations that binds adjacent autopoietic unities in a shared environment became struct*aural* coupling, in which two organizationally closed (like autopoietic) systems—a person and a system for generative music—are likewise bound in a continuous exchange of interactions within a mediated environment. Perturbation is the key concept in this relationship. All involved parties maintain their autonomy, organizational closure, functioning order, and so on, yet are still receptive to external forces. These forces (perturbations) cannot control them or specify changes in particular, but trigger responses within the domain of the system's requisite organizational closure. This relationship was particularly compelling because it precisely mirrored what I had established in the first experiments with interaction involving generative music systems.

Discussions of art are similarly useful. In the 1967 article previously quoted, Roy Ascott imagined that such an art practice was possible:

> The necessary conditions of behaviourist art are that the spectator is involved and that the artwork in some way behaves. Now it seems likely that in the artist's attempt to create structures that are probabilistic, the artifact may result from biological modelling. In short, it may be developed with the properties of growth. (2003: 129)

Clearly, even from this early perspective, a cybernetic view of biology that facilitated the modeling of living systems held great artistic potential. The idea of music as a behavior was seeded with Maturana and Varela's structural coupling, but did not come to fruition until late in this research process. There were several initial ideas that did not sit well or "feel right" to me. One was the idea that any kind of music operating in an environment of mediated interaction must change. Change how? When? And into what? Throughout the history of computer games music has always changed in some way. Even *Space Invaders* (one of the earliest computer games made by Midway in 1978) would increase the tempo of a simple four-note melody as the player's situation grew more dire (Collins 2008: 12). I was determined to draw a clear distinction between the differences of this early approach, everything else that has happened since, and what it is that I do.

The second concern was the term "composition." This word is reminiscent of the western art music traditions that are far too deterministic to support the kind of music I pursue. Even the re-definition "organized sound" purported by Edgard Varèse, John Cage, Frank Zappa, and others did not appeal as they were too inclusive. Mozart organized his sounds too. The idea of organized sound is more appropriate to those musical practices that explore *sound* first and foremost. My background as an improviser and interest in developing music congruous to the ontology of contemporary technology focuses more on the *behavior* of music. Music was viewed as an unfolding process: What does it do over time? And how does it react in relation to one's use of the technology that supports it? Behavior is an ideal way to answer these general concerns and questions. It addresses the actions of music over time, and by viewing interactions as perturbations, it clarifies questions of change. This music doesn't just get slower, louder, or darker in relation to external events—it *behaves*.

Maturana & Varela write, "Behavior is not something that the living being does in itself (for in it there are only internal structural changes) but something that we point to" (1992: 138). Amergent music

is built around musical systems that are capable of sending and receiving perturbations. These stimuli trigger in each system "internal structural changes" that produce the events interpreted as "behavior" to an observer. Consider the following statement from *The Tree of Knowledge*:

> Thus, the behavior of living beings is not an invention of the nervous system and it is not exclusively associated with it, for the observer will see behavior when he looks at any living being in its environment. What the nervous system does is expand the realm of possible behaviors by endowing the organism with a tremendously versatile and plastic structure. (Maturana & Varela 1992: 138)

Now replace all instances of *organism* and *living being(s)* with *music*, and *nervous system* with *generative system*:

> Thus, the behavior of **music** is not an invention of the **generative system** and it is not exclusively associated with it, for the observer will see behavior when he looks at any **music** in its environment. What the **generative system** does is expand the realm of possible behaviors by endowing the **music** with a tremendously versatile and plastic structure.

This presents a welcome alternative to the standard notion that, in any work where music is coupled to interaction, "the music changes." Yes, there is change. But "change" and "change of state" can be more robustly described as dimensions of behavior. There is no deliberate action, no pre-planned response defined *a priori* within a database of all possible actions of the generative system, but a genuinely unique response given the conditions/perturbations the system confronts in the moment of action.

The distinctions between linear music and Amergent music can be further clarified with an additional example offered by Maturana & Varela. In *The Tree of Knowledge* they discuss the case of a particular plant (*Sagittaria sagitufolia*) that can transform between aquatic and terrestrial forms depending on the current water levels in its environment. This is behavior because there are "…structural changes that appear as observable changes in the plant's form to compensate for recurrent disturbances of the environment" (Maturana & Varela 1992: 143). They contrast this with the feeding behavior of an amoeba, arguing that the amoeba's actions are much easier for an observer to interpret as behavior because there is visible movement, whereas the sagittaria moves so slowly in its transformation it is often mistaken as part of the plant's development. An observer has a much more difficult time calling this kind of movement behavior. It is much easier for them to think the plant grew that way because there was either too much or too little water around it. They argue that behavior is a structural response to external forces no matter what the tempo.

The case of behavior vs. development in the sagittaria is much like the case of Amergent vs. linear music. Music that is composed in a linear model is told exactly what it must do to "behave" and meet the expectations of the person responsible for it. It operates in a prescribed situation and it must conform to a set of demands. Much of the music that can be heard in contemporary mediated environments and art works is trapped in such a model of linear thinking. Alf Clausen, composer for the cartoon series *The Simpsons* recommends, "score the emotion not the action" (Chilvers 2004). This is appropriate for cartoons but not for environments of mediated interaction. Namely—what emotion? The emotional tenor is unknown. Even if emotion could be surmised, it is not known what actions would produce it. It *is* known, however, what *ingredients* will be used to produce both action and emotion. That is the behavioral advantage of Amergent music.

It can, by comparison, act on its own accord. It is not "doing what it is told" nor is it predestined to purposefully connect with the events of its environment. The generative systems that give rise to it simply respond to perturbations in the maintenance of their own internal functioning order. Compared side-by-side, an observer may hear a piece of linear music and a piece of Amergent music and think that both suit their expectations given the environment. But alter or transform that environ-

ment, and due to the lack of behavioral adaptation in a linear piece, its presence will be awkward or ill-fitted when heard a second time. Like an organism, the Amergent piece is far more capable of responding to environmental changes and perturbations in the maintenance of its identity and functioning order.

7.2 First-, Second-, Third-order Cybernetic Systems

The cybernetic perspective of this research has served to inform a means of musical production that is ontologically congruent with the technoetic environments in which the music is created and heard. In the process of developing such a system, other factors surrounding the relationship between music, environment, and listener/interact-er came to light. Struct*aural* coupling is a cybernetic model of interaction based on the relationship of structural coupling (Maturana & Varela 1992; Maturana 1978; Varela 1979). It was developed in an attempt to reconcile the emergent experience of mediated interaction with a musical experience that complemented these same dynamics. Struct*aural* coupling is based on the idea of a generative music system coupled to the person engaged with the work. Both are organizationally closed, which means they are like the autopoietic unities of structural coupling, and function together through a series of reciprocal perturbations. The technical and musical functioning of this system was useful for the projects that were explored in the course of this research. In addition, its role in the larger context of music and art works had much to reveal about its cybernetic origins.

Throughout this thesis, various works of Experimental, Ambient, Generative, and Amergent music have been discussed. Cybernetics has played a role (implicitly or explicitly) in each. Especially as it concerns Amergent music, the relationship between the musical work and the system that creates it varies across the variety of projects presented here. However, the commonalities between these reveal a cybernetic relationship of a third-order, in which the person engaged in interaction becomes part of the very system that gives rise to the work they are experiencing.

7.2.1 First-Order Systems

Gordon Pask describes first-order systems (1°)[1] as "…classical black boxes and negative feedback" (1996: 355). Heinz von Foerster refers to another of Pask's characterizations of first-order systems, stating that "…the observer enters the system by stipulating the system's purpose" (2003a: 285). In short, 1° systems focus on autonomy and regulation. In a musical context this is represented by instructions that lead to the autonomy and regulation (or organization) of sounds. Table 7.1 cites examples of relevant musical works and presents a simple 1° stipulation. These first-order stipulations do not represent any of these works in their entirety. All, except for those works of Amergent music by the author, are not complete until they reach the second-order stipulation. The Amergent pieces must reach the third-order stipulation to be complete. The first-order can be loosely described as various means of structural organization and algorithms that will lead to the production and performance of a musical work.

7.2.2 Second-Order Systems

Again von Foerster agrees with Pask and characterizes the second-order (2°) as cases in which "…the observer enters the system by stipulating his own purpose" (2003a: 285). The observer's purpose is frequently experimental: "what does (or could) this sound like?" This proposition calls to mind W. Ross Ashby's characterization that a system is "…not a thing, but a list of variables. This list can be varied, and the experimenter's commonest task is that of varying the list…that gives the required singleness" (1956: 40). In these 2° musical systems (see Table 7.2), sounds are integrated with the system as variables in a musical experiment.

1 The abbreviations for first-order (1°), second-order (2°), and third-order (3°) are borrowed from Kenny & Boxer (1990).

Table 7.1 First-Order Systems in Experimental, Ambient, Generative, and Amergent music

TITLE (GENRE)	MUSICIAN	1º SYSTEM
In C (Experimental)	Terry Riley	Elastic structure; sequential progression through the set of 53 phrases
Paragraph 7 of "The Great Learning" (Experimental)	Cornelius Cardew	Instructions for piece: "Do not sing the same note on two consecutive lines" "Sing any note that you can hear" Otherwise, "choose your next note freely" (Eno 1976: 3)
Music for Airports (Ambient)	Brian Eno	Tape phasing structure at intervals of 21" 17" 25" 18" 31" 20" 22" (see chapter 2)
Bloom (Generative)	Brian Eno & Peter Chilvers	Looping drone; melody generator
Dérive Entre Mille Sons (Amergent)	Norbert Herber	Generative instruments: Shuffler(), DeckOfCards(), Seq(), End2End() (see chapter 2); spatial arrangement of audible zones

Table 7.2 Second-Order Systems in Experimental, Ambient, Generative, and Amergent music

TITLE (GENRE)	MUSICIAN	2º SYSTEM
In C (Experimental)	Terry Riley	Phrases composed loosely in key of C; progression advances at performer's discretion
Paragraph 7 of "The Great Learning" (Experimental)	Cornelius Cardew	"[A]ccidents that are at work" such as "'unreliability' of a mixed group of singers," "beat frequency," "resonant frequency" of the room, "preference" or "taste" of the individual performers (Eno 1976: 4)
Music for Airports (Ambient)	Brian Eno	Pitched sounds are phased at various intervals to produce shifting tonalities over time (see chapter 2)
Bloom (Generative)	Brian Eno & Peter Chilvers	Drone plays in multiple keys; melodies constructed of pitches harmonically related to the drone
Dérive Entre Mille Sons (Amergent)	Norbert Herber	Sound palette assigned to generative instruments and linked to individual sonic zones within a spatial layout

The system does not simply exist in some "final" form, but rather changes due to the role of the observer—the "composer" or musician who makes use of the system. In Generative and Amergent music, the system is a list of variables including the parameters of a generative instrument and a palette of sounds to which it is coupled.

7.2.3 Third-Order Systems

This stipulation applies only to the works of Amergent music discussed in this thesis: *Perturb* and *Sound Garden* (chapter 3), *Dérive Entre Mille Sons* (chapter 4), and *Londontown* (chapter 5). In the third-order (3º) the observer and system have a shared purpose. The observer's purpose is an extension of the 2º question, asking "*why* does it sound this way and what does that say about the 'place I'm in'?" In the 3º, the observer is more technoetically oriented and coupled to an ever-changing 2º system. The reciprocal perturbations constitute both a question and an assertion of an unfolding, mutual purpose, as interactions indicate intent or desire and seek to draw out experience.

This "drawing-out" in the 3º system demonstrates that both generative system and observer are situated inside the work as an environment. However, as von Foerster states, "…the environment as we perceive it is our invention" (2003b: 1). The work of Amergent music does not exist without the dynamics that are created and sustained between the generative system and the observer. This is illustrated in figure 7.1. It is the same struct*aural* coupling diagram as presented in chapter 3, but with an additional layer of information that reveals the presence of 1º, 2º, and 3º stipulations. The recipro-

cal perturbations exchanged between observer and generative system construct a mediated reality of emergence and becoming. Chris Lucas writes:

> The current 'state-of-the-art' is in third-order cybernetics, where the observer is part of the coevolving system. This is a more intrinsic (embodied) methodology and shows the ongoing convergence of all the various systemic disciplines, as part of the general world paradigm shift noticed recently towards more integrated approaches to science and life. In 21-st Century systematics, boundaries between systems are only partial and this implies that we must evolve with our systems and cannot remain static outsiders. Thus our mental beliefs echo our systemic behaviours, we co-create our realities and therefore internal and external realities become one. (2001)

In technoetic environments this is a reality dominated by emergence, where the synergy of localized interactions churn endlessly, producing novelty in *this* moment, and in the next, and the next, and so on. There is an objective. These works produce a transformation of consciousness that can be sustained by the artwork, not just a transformation of *any* consciousness. Stafford Beer thought of cybernetics as the science of exceedingly complex systems—of systems that *become* in an unpredictable manner—and a science that focused "… on adaptation, on ways of coming to terms performatively with the unknown" (Pickering 2008: 129). As a musician who cultivates or helps to cultivate these kinds of mediated experiences, *becoming* is always known. The ontology of that becoming will always be partly determined by the capabilities of the technical system that sustains the processes of mediation. But within those capabilities there is a great deal that is unknown. Struct*aural* coupling provides a 3° system that behaves so as to seamlessly integrate a musical becoming within the totality of the evolving, mediated reality.

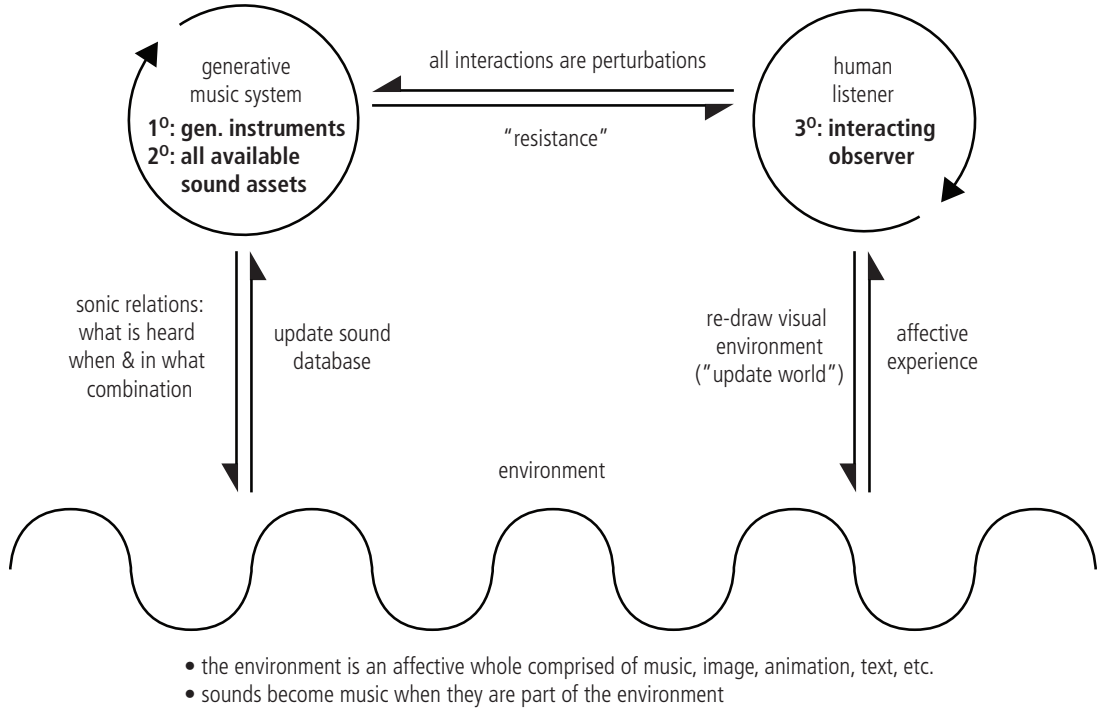

Figure 7.1: Struct*aural* coupling facilitates interaction within a 3° cybernetic system. The 1° is represented by the generative instruments, and the 2° by the system of sounds used by these instruments to create a complete generative system. The interacting observer constitutes the 3° as the reciprocal perturbations shared between them and the generative system give way to the environment out of which the affective experience emerges.

In the context of business (strategic management) consulting, Vincent Kenny and Philip Boxer write:

> We need to have a domain which contextualises the activities of, and relations among, the participant observer ontologies of the 2° domain… 3° cybernetics must be a domain which

> allows us to come to contextualise this 'subject', with his 'ethical system' and his higher-order 'purpose.' We need to understand his phylogenesis as observer. (1990)

While the work discussed here is miles away from the field of business and strategic management consulting, Kenny & Boxer express a shared need to characterize the overall dynamics and possible outcomes for situations in which an observer is coupled to another system and the pair have a shared purpose. What is most interesting is their reference to this person as a "participant observer," which implies he has both active and passive roles in this overall process. In a 3° stipulation, system and individual evolve together. In works of Amergent music this partnership of transformation, continuous perturbation, and the tension of simultaneous (in)activity plays an essential role in shaping the experience of a technoetic environment.

7.3 Amergence and the Poiesist

This research began as a simple question directed at music and a coupled technological environment, but additionally led to unexpected answers concerning the person involved in the interaction. The relationship described earlier makes it clear that this person is more than a docile listener. But he is also not involved to the degree that would engage him in any kind of "work." The role of this person and the experience it affords was one of the more elusive and surprising outcomes of this research process.

With information technology and usability, the term *user* is common and effectively suggests the demand this person has for the utility of an object or the mediated environment (Norman 1989; Krug 2006). The potential of involvement and engagement with an interactive art work calls for the use of the term *participant* (Cornock & Edmonds 1973; Popper 1975). But whereas *user* has too much implied agency, *participant* has too little for the discussion at hand. *Player*, as used in games, conveys a more carefree sense of agency but it also connotes the hands-on act of playing music. This is of course related, but too specific to other realms of music making to be of use in this context.

In her book, *Utopian Entrepreneur* (2001), Brenda Laurel used the term *partner* to suggest a mutual agreement between artists or designers and the person engaged in their work. She favored the term because unlike *participant*, there was clarity in the consensual nature of the agreement or relationship (Laurel 2001). There is also *vuser*, a combination of *viewer* and *user*, coined by Bill Seaman in 1998 (1999: 11), which encapsulates elements of surrender and agency inherent to these environments. In works such as those discussed in this thesis, a combination of *user, listener*, and *participant* is apropos, but none speak sufficiently to the ontology of technoetic environments.

Martin Heidegger's lecture *The Question Concerning Technology* argues that it is not important to ask what technology can get for us, but to become aware of what it can reveal about ourselves and the world in which we live. Technology is most beneficial in the long-term when it is used to reveal and explore, not to exploit. If there is a question concerning technology, it is a question of *how*, and it focuses on a sustainable future. Technology itself challenges us to think about its essence—what is that? Heidegger discusses its tendency towards "revealing" and "enframing." Through enframing, "… the subjugation of the world to already given human ends…" (Pickering 2008: 131), technology provides resources, tools, and processes—a "standing-reserve"—that gives way to further technological developments. It has a recursive essence that, if not handled carefully, subjugates us to the service of technology at the expense of spiritual and other aspects of human development. Heidegger writes:

> So long as we represent technology as an instrument, we remain transfixed in the will to master it. We press on past the essence of technology. When, however, we ask how the instrumental unfolds essentially as a kind of causality, then we experience this essential unfolding as the destining of a revealing.
>
> …When we look into the ambiguous essence of technology, we behold the constellation,

> the stellar course of the mystery.
>
> The question concerning technology is the question concerning the constellation in which revealing and concealing, in which the essential unfolding of truth propriates.
>
> But what help is it to look into the constellation of truth? We look into the danger and see the growth of the saving power. (1977: 337-8)

Technology exists as a continuous cycle of "… revealing and concealing…" in which truth can be discovered. Through this process, "…the essential unfolding of the essence of technology…" should be approached with caution because the truth it offers is intertwined with demise. Pickering observes that Heidegger's notion of *revealing* "…points us to a politics of emergence…" (2008: 131). A vision of the tumult in a cellular automata creates a useful impression. Cells churning off and on, flickering in and out of coherent groups and patterns appears similar to Heidegger's processes of revealing and concealing. Like order in any self-organizing system, truth is evanescent.

Heidegger's dynamics of revealing are discussed as an entangled network in which technology contains equal measures of interwoven "danger" and "saving power." He writes:

> Human activity can never directly counter this danger. Human achievement alone can never banish it. But human reflection can ponder the fact that all saving power must be of a higher essence than what is endangered, though at the same time kindred to it. (1977: 339)

The danger is the effect of technology, the tangible results of enframing and standing-reserve. The saving power is affect; the unfolding of "… ambiguity points to the mystery of all revealing, i.e., of truth" (Heidegger 1977: 337). Heidegger asserts that those who are attentive to the strand of revealing containing saving power are the ones who will become truly free. This dialectic of revealing is similar to the semantic tension between *effect* and *affect* that led to the term Amergent music. *Amergent* combines action and emotion. *Emergence* as a characterization of the action involved in reciprocal perturbation, and *Affect* as the emotional impact of this continuous exchange. Each dynamic is necessary to the processes that give rise to the musical experience.

While Amergent music has independence and autonomy within its environment, it does not unfold entirely of its own accord. The person who is simultaneously listening and engaged in the mediated environment is largely responsible for the totality of what is heard. This is the *poiesist*, the one who draws music out through the agency of their interaction. Heidegger writes:

> There was a time when it was not technology alone that bore the name technē. Once the revealing that brings forth truth into the splendor of radiant appearance was also called technē.
>
> There was a time when the bringing-forth of the true into the beautiful was called technē. The poiēsis of fine arts was also called technē.
>
> …What was art—perhaps only for that brief but magnificent age? Why did art bear the modest name technē? Because it was a revealing that brought forth and made present, and therefore belonged within poiēsis. It was finally that revealing which holds complete sway in all fine arts, in poetry, and in everything poetical that obtained poiēsis as its proper name. (Heidegger 1977: 339)

Poiesis is a bringing-forth. In works of Amergent music the person engaged in the experience, formerly known as the *participant*, *user*, *player* and so on, is more appropriately called the *poiesist*. The experience of interaction facilitated by Amergent music is a poiesis—a bringing-forth or drawing-out—the catalyst to a becoming or emergence of sounds into music. The poiesist draws sound out to

reveal music; the poiesist engages with the "…the constellation in which revealing and concealing, in which the essential unfolding of truth propriates" (Heidegger 1977: 338). This process and the experience of sound it engenders is amergent.

7.4 Applications of Amergent Music

I am grateful to Brian Eno who has served as an advisor to help guide this research. At an advising session in July of 2006 we discussed the prospects of an approach to technoetic and media arts that leverages emergence. In particular, we discussed using generative processes in ways that connect actions to a musical transformation congruous to the dynamics of the mediated environment. While we agreed that this has very interesting and rich potential, there are a lot of obstacles—the most difficult of which involves explaining the concept in a way that others will understand and support. He related to me some of his difficulties in explaining the ideas behind Ambient music and said that not until he followed a similar approach to video art did he feel that people "got it." What I gathered from his story was that the idea of music that changed so slowly and aspired to be "…as ignorable as it is interesting" (Eno 1996: 296) was a challenge for many listeners at first.

As of this writing, more than 30 years after *Music for Airports*, it is difficult to imagine how "ambient" could have been confusing; but so it went. Today, when I talk about Eno's work with graduate and undergraduate students the sound of his music is not radical to their ears but the idea of a musician deliberately striving to make something ignorable always catches them by surprise. Eno's statement runs contrary to the romantic stereotype of the "suffering artist with heart-wrenching truths to be communicated," and it acknowledges a prevalent, contemporary engagement with music. North, et. al. and Levitin (see chapter 6) found that music is used as a physical or emotional asset, and that even in cases in which listeners are sonically detached, music is still capable of setting a mood for non-listening-related activities (2004; 2007). Whether it is a theme park, computer game, digital art installation, or many of the other works discussed in this thesis, music is frequently employed to create the right atmosphere. In discussing the procedural music system behind *Spore*, Aaron McLaren said he aspired to a situation in which players thought that the music facilitated their creativity and allowed them to focus on game play, but was never intrusive (2008). Amergent music similarly aspires to a useful transparency, but it has always sought to leverage affect as a direct result of the events that transpire within a mediated environment. The mood is not defined but seeded as a variety of sound potentials. It is up to the poiesist to draw these out and discover what is unique about the environment in which he finds himself.

Over the past years I have gained a great deal of confidence from Eno's support of my work and his optimism for the use of generative techniques within technoetic and media arts. This research, and the music that was produced in the process, is not however immune to criticism. Because Amergent music draws on some of the same foundational concepts established by Ambient music, many concerns or critiques it receives are motivated by similar misunderstandings. Amergent music is meant to register affect, and to serve as a catalyst for transforming consciousness within works of technoetic and media art. While the original musical works discussed in this thesis are useful for illustrating the concepts of Amergent music, there are still aspects of each project that need to be addressed for the ideas presented here to fulfill their greatest potential.

7.4.1 Critique of *Londontown* Music

When Brian Eno relayed his story about the difficulties of explaining Ambient music to others I could identify with him. I was two years into this research process and grappling with similar semantic challenges. We discussed how I might be able to overcome this struggle and he suggested using a false narrative. This turned out to be the best advice of all, though instead I was able to participate in a project where there was an actual narrative. *Londontown* was precisely the right opportunity for

this course of research. As a narrative-driven virtual world it perfectly met my need for a project with robust interaction that gives way to profound emergence.

The first prototype was based on *Londontown*'s journalism quest (as already discussed in chapter 5). This was an ideal way to start, though when the work was done it turned out to be more of an experiment than anything else. The musical results produced by the prototype revealed that the scope of the narrative requiring music would be much larger than initially anticipated. As related to the quest, in which the player tries to enter the journalism profession by gathering leads for new stories, I developed music based on Intensities for reputation, conversation, and story lead tally. After some testing it was clearly successful on a musical level, but the overall approach only worked for the journalism quest *in particular*. It was too specific given the proposed scope for the entirety of *Londontown*. The idea of using Intensities had to be scaled to a more general level that could be applied to the widest possible variety of characters. Though it will not be used directly in future versions of the project, this first prototype is unique. It was the first simple, straightforward demonstration of Amergent music I was able to make. It presents a narrative that is easy to understand, and the music connects to the story in very (to borrow Kevin Lynch's term) "legible" ways. It has been a useful tool for presenting the ideas behind this research to audiences with general and specialized knowledge alike. To see and hear the journalism quest prototype, go to section 6 of the supporting DVD. Or to try it for yourself, see the DVD Instructions earlier in this document.

As previously discussed in chapters 2 and 5, a more robust software prototype was developed with Max/MSP and Logic to explore the combination of Intensities and sound palettes relative to the various avatars one can become once they enter *Londontown*. The results of this work are documented in section 6 of the supporting DVD. There are four annotated quest walk-throughs that demonstrate how the Amergent system proposed for *Londontown* will respond to perturbations both made and received in the virtual world. These were produced similarly to the Journalism quest walk-through. Using quest scripts for a lower-class thief, a lower-class street artist, a middle-class tailor, and an upper-class curator, I simulated the possible interactions and "played" the generative instruments that fit within each character's Profession, Reputation, and Skills Intensities. Each example represents a *possible* rather than *definitive* sonic version of each quest. Time was taken exploring all potential interactions so as to document the widest possible range of musical potential offered by each quest. What was done serves the purpose of this research in a musical sense, and as a project for experimenting with the ideas proposed in this thesis, it has been successful. As a musical work I do not believe that it is finished, however. The underlying system of Intensities, the generative instruments, and the available palette of sounds all require further development. I believe the current system to be sufficient for work being done in the commercial world. But for future projects, knowing that the full potential has not been realized, every aspect would benefit from some modifications and improvements.

In the current version of the Max/MSP prototype there are no visuals that make reference to the world and no narrative that ensues when a player is engaged in a quest. This makes it difficult to comprehensively evaluate the effectiveness of the music. It is possible to toggle settings on and off as done with the initial journalism quest prototype. As the one *doing* this, there is a clear sense of agency: I know what events are happening, I manipulate the mouse to make those happen, and I hear the results. Listening to these recordings after the fact does not produce the same affect. As will be discussed in the next section, Amergent music requires perturbation if it is to sound as intended. Hearing it with no discernible connection to the interactions that were performed leaves one with an incomplete picture. However, each of the four recordings that were made tells a different story. Though it is not clear precisely what happens in each, the fact that there are four distinct narratives is a sign that the music is performing as intended.

Londontown is based on an ontology of emergence. As a virtual world, it *becomes* through countless player-to-player, player-to-world, and world-to-player interactions. There is no trace of binary affect, but rather a spectrum of what can help and what can damage, what is confusing and what is discernible. Choices must be made based on the context of one's situation and environment, which is always in flux. This was the reason for developing a musical system that is similarly rooted in an ontology of emergence. When the musical system can manifest behavior congruous to that of the technoetic environment that supports it, the two become very capable partners. One way to sustain an absence of binary values in the music was through the idea of Intensities. Deleuze characterizes intensity as the becoming of a quality. It neither *is* nor *is not* a particular quality, but rather some combination producing the affect of a particular quality. Profession and Skills are two such qualities that significantly affect a player's existence in *Londontown*, and are treated as Intensities in the generative music system.

In terms of differentiating the various profession types in *Londontown* (action, exploration, achievement, and social), the musical results produced through this Intensity are successful. For professions within the same social class (thief and street artist) or across different classes (middle-class tailor vs. upper-class curator), the music that plays relative to the interactions of each character is unique. The Skills Intensity needs improvement in this regard, however. This Intensity was organized by class as well. The use of skills by lower-, middle-, and upper-class characters are heard on viola, cello, and full string section respectively. In context, the differences in this arrangement are too fine to be heard clearly. Most importantly, there is no way to distinguish how one kind of skill might potentially be different from another (a mental vs. a physical skill, for example). While a Skills Intensity is an important part of the overall musical system, there needs to be a more thoroughly developed sound palette that represents the variety of possible skills that can be mastered in the *Londontown* world.

Also, in terms of the overall sound of the music, I am pleased that it sounds "cinematic" as was requested by the lead designer. While it does not have a distinctive Hollywood sound, it does have moments of sweeping drama and, most importantly, it does not become too musically active so as to demand a surplus of listening attention. The class eigentones also give the music of each social class a distinct sonic fingerprint. Current recordings of this music demonstrate that it is difficult to achieve the spatial quality I had intended. This may be due to the eigentones themselves, or to the unpredictable dynamics in other parts of the overall musical mix. Whether it is a problem of engineering or software design, it is nonetheless one worth solving. The eigentones currently serve an unintended role in the *Londontown* music that makes them a vital part of the overall composite sound. When the other parts of the music reach a point of rest (as will happen from time to time) the eigentone track can be heard playing very softly. In moments that might otherwise be overly sparse, these tracks add just enough interest to act as a primer and to hold the music together until future sonic events unfold.

7.4.2 Listening & Interaction

The aesthetic tension between "ignorable" and "interesting" is one of the essential ingredients in Brian Eno's Ambient music. This can initially be interpreted as a sort of polar relationship, but on closer examination one finds that these dynamics are something of the strands of cord that twist into a braid—they are at once separate and same. A related quality Eno emphasized is that "Ambient Music must be able to accommodate many levels of listening attention without enforcing one in particular…" (1996: 296). These statements are similar, but there is a difference in that "ignorable/interesting" speaks to the music itself, whereas "mobile levels of listening attention" reflects on the involvement of the listener.

In discussing *Composition-Instrument Study I* with me via e-mail, Eno offered the following critique on 10 February 2008:

> I personally feel there is little value added (and even possibly some subtracted) by 'interaction' of the kind that your system makes possible. But that might be my taste. However, when I want to listen to music, I normally want to enter a state of something like surrender to it...I don't want to be the controller. Of course I love being the person who sets up the rules for the piece, but then I want to see what it does by itself without my input.

In the same e-mail message he went on to discuss how, when developing *77 Million Paintings* (2006), he considered various options for allowing viewers a degree of navigational control:

> I toyed with these for a long while, but ultimately I decided against any of them: it seemed to me that futzing about with a controller was an entirely different mental process from actually watching and enjoying the work itself, and in fact the two activities seemed inimical to each other. (2008)

He concluded his e-mail critique with specific concerns about the piece I asked him to consider:

> I don't want this to sound like a negative criticism: I think where you've found yourself is a very interesting place. But what I also think is that there is a danger that you end up between two stools - on the one hand making a musical experience that isn't rich enough to be sustaining, and on the other making a tool which isn't fine enough to exert any meaningful control. (2008)

This was one of the most useful critiques I received throughout the entire research process. Eno's comments speak directly to my initial research question and address one of the fundamental relationships of sound and interaction discovered along the way. I first found that when a generative system was coupled with a person and their interactions, the entire system could be characterized in ways that were indicative of both a musical instrument and a composition. All works of Amergent music presented here have this dual nature. It is experienced most keenly by the poiesist engaged in the work itself. But as the one responsible for setting the initial conditions of the music, I find that it is difficult not to approach the work in all possible permutations: as a composition, as an instrument, and as a composition-instrument. Eno's critique asked me to reconsider the experience of the poiesist and think more carefully about the balance between surrender and agency.

I agreed with Eno's statements over e-mail that "… futzing about with a controller was an entirely different mental process from actually watching and enjoying the work itself…." I found this to be true with *Sound Garden*, where gardening provided a metaphor for interaction. The actual process involved a mouse and keyboard, but it was slow. Those who planted and pruned sounds in the work could interact and then wait to hear the affect of what happens. Later projects that involved a less asynchronous mode of interaction were more challenging in this regard. *Dérive Entre Mille Sons* was the first project that gave me an opportunity to experiment with less physically overt modes of interaction. As discussed in chapter 4, breath-controlled navigation in Char Davies' *Osmose* was an important touchstone. Though both the iPhone and iPod Touch are an ideal platform with a three-axis accelerometer, a Nintendo Wii controller (Wiimote) was incredibly successful in the development of a project prototype. There are also future plans for a physical installation using the WiiFit Balance Board that would allow poiesists to sit in a meditative position and shift their weight (rather than tilt a device) in the direction of their dérive. In some ways this may be the ideal interface, as there is nothing in the hands of the poiesist yet they still have a great deal of control over the environment created through their interactions. The amount of effort exerted would (hopefully) not get in the way of such an experience.

As it specifically concerns Amergent music, there is another dimension to this as well. Surrender, or the giving-over of oneself to an experience, comprises part, but not the entirety of Amergence. Surrender alone is too passive. In the kind of relationship that is established between a poiesist and the

environment created through a musical experience there is both action and emotion. Experience is constructed through one's negotiation of the perturbations he encounters. The poiesist draws-out or brings-forth the affective experience. Their role is one both of agency and surrender. The affective tension between agency and surrender is similar to the kind of listening experience surrounding a Suikinkutsu (see chapter 6). With this device, one kind of activity (washing hands) serves to engender an experience of sound, and in it to reveal something unknown. The suikinkutsu calls one's attention to natural sounds within the temple, many of which are unnoticed. Through the act of washing there is a bringing-forth, and the process of purification reveals what has always been but has not been perceived as such. In Amergent music this is the kind of experience that is created. It is not a listening experience of complete surrender to sound, nor is it as intensive or goal-oriented as a flow state (Csikszentmihalyi 1990). It is both active and introspective—an experience of consciousness that is brought-forth through a dynamic kind of surrender. The poiesist constructs this experience of reality through his very participation in it.

In *Composition-Instrument Study I* and *Composition-Instrument Study II*, this was most apparent through the use of mazes. In other sections of the studies (particularly the "dérives" over psychogeographic maps of Boston and Paris), the visual interface suggested that there was something important on the screen. This assumption subtracted from the overall musical experience. It created the impression that there was an objective or goal to visit each sound-emitting zone, like an aural form of the worst kind of tourism. The dérive is a pursuit of impressions that is far more concerned with the experience of play and exploration than it is the collection of trophies. I found, through my own experience and interviews of others, that while it was focused on finding ones way through a maze, this puzzle-solving activity superseded any thought of intentional music making. The difference was that in the mazes of these studies, music as a "goal to be achieved" was replaced by an activity which gives rise to music and musical experience that could be characterized by saying, "I found a way out of the maze… and it sounded really interesting along the way." Musical experience is a consequence of one's presence and engagement in the mediated environment.

Projects like *Londontown* benefit from this kind of interaction as well. Though the virtual world is still in development, the prototype interactions I have designed demonstrate similar affects. The music comes to life only through perturbations (interactions) within the world and dulls when there is no activity. It is possible to say that, musically speaking, there is nothing worth *surrendering to* unless something is happening. While not an ideal approach for all works, this arrangement suits *Londontown* perfectly. It is a burgeoning virtual world filled with the activities of human player-characters (avatars) and AI-controlled non-player-characters. The myriad interactions between these parties should ensure that the musical experience of *Londontown* is rarely stale and consistently congruous with the dynamics of the world itself.

In the end, "between two stools" is exactly where this work needs to be, though not in the original sense of that phrase! Eno's e-mail critique identified one stool as a musical experience and the other as an instrument. What I have sought to do is avoid these extremes, and explore the musical possibilities of a rich middle-ground. Amergent music departs from a similar position as Ambient music in that it is meant to function within an environment. Environments have changed however. Contemporary technology has created augmented spaces and new "places" characterized by their liminality and emergence. These environments are mediated. One's use-of and presence-within them can be simultaneously observed and used to make the aural experience of the environment congruent with the visual. In the way Schafer asserts that we are all responsible for the soundscape of our physical world (1977), Amergent music allows poiesists to shape the sound of the mediated realities they visit.

In works like *Londontown* this is, in some ways, easier to accomplish because people have a reason to visit the world. Their actions and presence can be tracked across various Intensities and used to

construct a musical reality. Poiesists are more deeply engaged with what they are doing in the world, and less-so concerned with the musical consequences of their actions. The overall affect is a fusion of action and sound. This, paired with visual and other elements of the world, comprises the totality of a mediated experience. Pieces like *Dérive Entre Mille Sons* make this relationship more challenging, primarily because they are stand-alone works. There are no characters or story, simply sounds and the potential for a poiesist to engage them in different ways. In my research these kinds of projects have been, I believe, less musically successful. I am not discouraged, however. The process of creating, experiencing, and sharing *Dérive Entre Mille Sons* with others has demonstrated that a stand-alone work of Amergent music requires a different kind of connection between sounds and interaction than has been established in the other works discussed here. The use of Intensities is still viable, as are various modes of interaction that demand a minimal amount of physical effort. The challenge of a stand-alone work is in defining the relationship between sound and poiesist so as to find the most compelling balance of action and listening experience. I endeavor to create works in which one's engagement is as carefree as that of the dérive, where listening and drifting become part of a single act. While none of the stand-alone musical works created thus far have been able to achieve such a relationship, the process of this research—including both artistic and academic endeavors—has revealed that it is possible, and that it holds great potential for making music uniquely suited to the emerging landscape of technoetic and media art.

Conclusion

In the *Biology of Cognition* (the first part of *Autopoiesis and Cognition*) Humberto Maturana tells a story (1980: 53-5) that serves as a useful (and final) summary to the musical ideas presented in this thesis:

Two groups of workers are assembled and each given the task of building something. In the first group a leader is appointed and he is given a book with drawings, measurements, and a discussion of the materials required to build a house. The leader dutifully follows the *descriptions* in the book and guides his team through all of the various tasks required to build their house to suit every last detail of the design.

The second group has no leader. Instead each member starts in a single row and is given an identical copy of a book filled with a general set of instructions. In it there is no mention of *house*, no discussion of pipes or windows or electrical wires, and no drawings whatsoever. There are only instructions specifying what a worker should do given their starting position and all other possible positions they might encounter as the process ensues and their relations to the other workers changes.

An observer visits the worksite of the first group to see that they are in fact building a house. He clearly sees that it is a house and the workers know that it is a house they are building. They have seen the plans and discussed them to be certain that the finished product matches the description which they were provided.

The observer then travels to visit the site where the second group is working. There he finds that another house is in the process of construction, though if he were to ask the workers what it is they are building they could not give a definite answer, all they could do is point to individual steps within the process such as, "when the two-by-four is positioned like that, I put the nails in like this." In the second group there is no description to follow, only steps that constitute a process of changing relationships between the workers and available materials. Maturana writes:

> That the observer should call this system a house is a feature of his cognitive domain, not of the system itself. (1980: 54)

Performing a similar transposition from earlier in this chapter, the statement yields:

> That the observer should call this system **music** is a feature of his cognitive domain, not of the system itself.

The observer sees what he sees and hears what he hears. That it is a house or a piece of music is his construction and a function of his cognitive domain. The origin or defining order of what he hears is particular to the generating system and does not need to be known in advance for an observer to form his perception(s). Amergent music, like the working process of the second group in Maturana's story, *becomes*. It is emergent through a series of interactions based on changing relationships. How this is done is of little importance to the poiesist, yet he can hear transformations and accept them as part of his ongoing mediated reality. From a musical perspective this is not done to deliberately model what Maturana tells us about human cognition. It is not an attempt at making mediated reality *really* real. It simply offers a mechanism for creating music that is complementary to the flow of becoming in the human domain of perception, and for making that flow congruous to the perpetual emergence experienced in technoetic and media arts.

Appendix

This appendix cites the awards, publications, presentations, and other activities that are relevant to the research that produced this thesis.

A.1: Publication Citations

Herber, N 2009, *'Dérive Entre Mille Sons:* a psychogeographic approach to mobile music and mediated interaction', *Technoetic Arts: A Journal of Speculative Research*, vol. 7, no. 1, pp. 3-12.

Herber, N 2007, 'The Composition-Instrument: emergence, improvisation and interaction in games and new media', in *From Pac-Man to Pop Music: interactive audio in games and new media*, ed. K Collins, Ashgate, Hampshire; Burlington, VT, pp. 103-23.

These publications have been reproduced in the final section of this thesis.

A.2: Grant Awards

2006, *Perform.Media: transdsiciplinary festival and symposium of creativity, research, theory and technoculture.* $500 award.

2006, *Arts Week 2007*. $2,000 award.

A.3: Gallery Shows & Public Installations

2009, *Sound Garden*. Telematic installation. At: SPARK Festival of Electronic Music and Arts, University of Minnesota, Minneapolis, USA, 17–22 February.

2007, *Sound Garden*. Telematic installation. At: Arts Week 2007, Radio-TV Center, Bloomington, USA, 21 February–7 March.

2006, *Perturb*. Music installation. At: Perform.Media: transdsiciplinary festival and symposium of creativity, research, theory and technoculture, SoFA Gallery, Henry Radford Hope School of Fine Arts, Indiana University, Bloomington, USA, 29 September–14 October.

2006, *A(rt)Life 2.5.* Artificial life & generative music installation. At: RES Art (Robotic & Emergent Systems), part of ALIFE X: Tenth International Conference on the Simulation and Synthesis of Living Systems, SoFA Gallery, Henry Radford Hope School of Fine Arts, Indiana University, Bloomington, USA, 3–7 June.

2006, *A(rt)Life 2.0.* Artificial life & generative music installation. At: SoFA Gallery, Henry Radford Hope School of Fine Arts. Indiana University, Bloomington, USA, 24 January–4 February.

2005, *AUTOMATICBODY*. Projection with generative music & video. At: Project X Theatre, Dallas, USA, 9 April.

2004, *PSO[2].* Projection with generative music. At: Qi & Complexity, Red Gate Gallery, Beijing, China, 24–26 November.

A.4: Conference Papers & Presentations

2009, 'Dérive en Mille Sons (Drifting in a Thousand Sounds)', paper presented at 2009 SPARK Festival of Electronic Music & Arts, Weisman Art Museum, Minneapolis, USA, 20 February.

2007, 'On the Sound of Becoming: musical perturbations', paper presented at the Planetary Collegium Summit Meeting, UQÀM, Montréal, 22 April.

2006, 'Asynchronous Improvisation: towards a generative approach to music and interaction', paper presented at F.A.q: Questions about Art, Consciousness & Technology, SESC Avenida Paulista, São Paulo, Brazil, 30 November.

2006, 'The Composition-Instrument: musical emergence and interaction', paper presented via videoconference at Audio Mostly: a conference on sound in games, Sonic Institute, Piteå, Sweden, 11 October.

2006, 'The Composition-Instrument: musical emergence and interaction', working paper presented at Consciousness Reframed 8th International Research Conference, University of Plymouth, England, 21 July.

2006, 'Robotic & Emergent Systems', participation in the Artist Symposium ALIFE X: Tenth International Conference on the Simulation and Synthesis of Living Systems, Indiana University, Bloomington, USA, 4 June.

2005, 'Sound, Technology, and Modes of Engagement', paper presented at Transmodalities: Mind, Art, New Media, Sabanci University, Istanbul, Turkey, 2 December.

2005, 'Emergent Music', paper presented at Altered States: transformations of perception, place and performance, University of Plymouth, England, 24 July.

2005, 'Wabi Sonics: Tea Aesthetics, Zen, and Composition in Experimental and Ambient Music', paper presented at Shaping Consciousness: New Media, Spirituality, and Identity, Dallas Museum of Art, Dallas, USA, 7 April.

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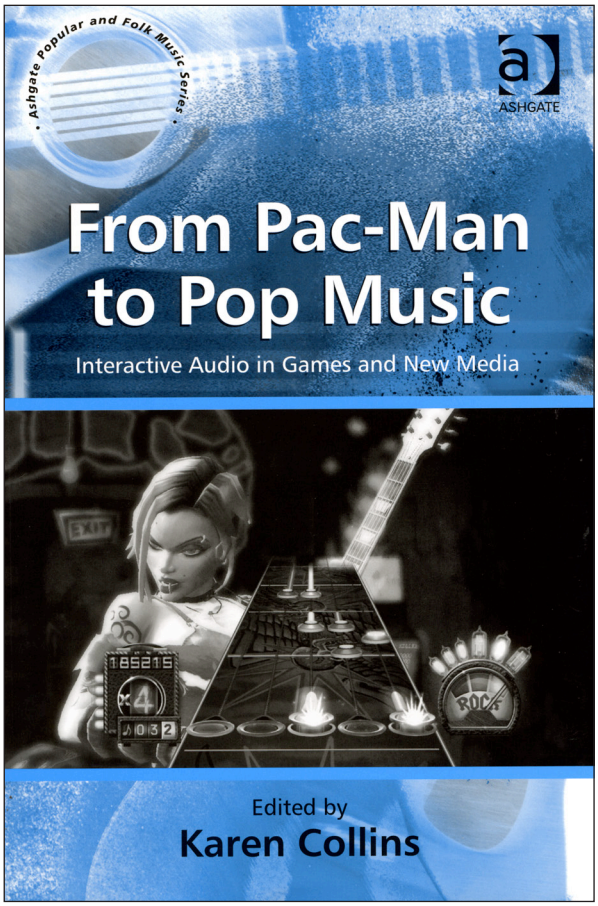

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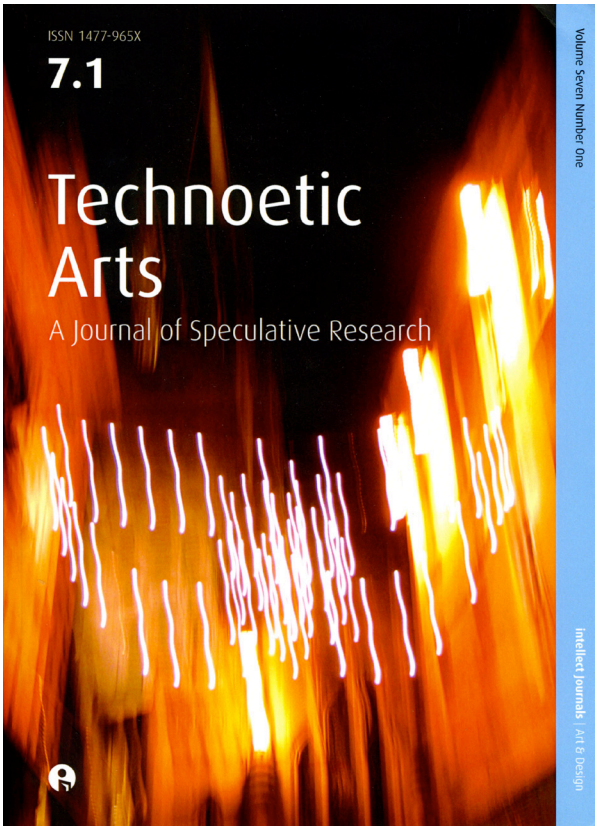

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Chapter 7

The composition-instrument: emergence, improvisation and interaction in games and new media[1]

Norbert Herber

In the conventional practice of music, the process of composition can be understood as the conception and organization of musical ideas, whereas an instrument provides the equipment necessary to realize such a work. In contemporary interactive media such as multimedia websites, computer games and other interactive applications involving the personal computer and mobile devices, this distinction remains largely the same. The composition of the music heard in these environments consists of musical statements to be heard and instructions to be executed in the course of an interaction. Often these structures call for a great deal of random sequencing and repetition following a linear structure.[2] The instrument can be designed as a software synthesizer or as a database of recordings or samples, and is used as a sound resource to suit the demands of each piece of music within the project.[3] For example, consider the iMuse engine by LucasArts. In this system branching or layered instrumental tracks act as the compositional structure and cut-up musical phrases (samples) can be mixed with synthesized instruments to realize that structure in sound.[4] Whatever the design and compositional scheme, contemporary computer games and other interactive media limit the responsibilities of composition and instrument. Each is asked to function in its traditionally separate role and is treated as distinct within the structure underlying the media product.

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1 This chapter is based on a paper originally published in the Proceedings of the Audio Mostly Conference: a Conference on Sound in Games, and in *HZ* journal #9, January 2007, http://www.fylkingen.se/hz/n9/herber.html (accessed 11 June 2007).

2 Kurt Harland, 'Composing for Interactive Music', *Gamasutra* (2000): www.gamasutra.com/features/20000217/harland_01.htm (accessed 11 June 2007) and in Alexander Brandon, 'Building an Adaptive Audio Experience', *Game Developer*, October 2002, pp. 28–33.

3 Given the enormous variety of playback engines, file formats and other technical specifications, there are too many different audio technologies to mention specific cases. See the IAsig (Interactive Audio Special Interest Group) website for a comprehensive summary of the formats and technologies in current use: http://www.iasig.org/wg/index.shtml (accessed 11 June 2007).

4 Alexander Brandon, *Audio for Games: planning, process and production* (Indianapolis, 2005), pp. 86–8.

There is need for a critique of music in contemporary interactive media. And the separation of composition and instrument, while not wholly damaging to the experience of the media, should not be immune from scrutiny. Music that operates in a binary, linear mode does little to recognize the emergence, or becoming, that one experiences in the course of an interactive exchange. A traditional, narrative compositional approach leaves no room for the potential of a becoming of music. When involved in a game, a player isn't sitting back passively absorbing events as they unfold on screen; they are engaged. A player actively negotiates environments, converses with others and strives for goals. They work to build meaning and to have an experience that is only possible in the world created by the game. Their interactions in this environment are unique, and represent a kind of becoming where myriad events collide to unfold as experience in the course of their play. This kind of experience can also be described as emergent. Scientific knowledge understands emergence as complex, ordered behaviour that is initiated under random conditions and arises from local, non-linear interactions. Emergent behaviour is generated through 'bottom-up' processes rather than by 'top-down', hierarchical control[5]. Unlike a film, where a narrative dominates the trajectory of a viewer's experience, games present a player with potentialities. Their interactions with the environment, other characters and ultimately the 'rules' of the game can lead to a wide variety of possible outcomes. The non-linear and emergent experience of interactivity is incongruous with the overly repetitive, linear music that is often heard in games and other digital media. It is time to ask: what kinds of compositional techniques can be used to create a music that recognizes the emergence and the potential of becoming found in a digitally-based interaction with games and new media?

Blurring the traditionally distinct roles of composition and instrument provides one possible answer to this question. This approach allows a piece of music to play, or undergo a performance like a traditional composition. When it plays, it enables a musical experience of sound. But it can also be played like a conventional instrument. This treatment allows the musical output of the work to be modified in the course of an interaction. Such an 'instrumentalization' transforms the work into an agent for further musical expression and exploration. Thus, a composition-instrument is a work that can play and be played simultaneously.

A composition-instrument is not a specific piece of music or interactive work in itself but a means of approaching any work where music can be created and transformed. Composition-instrument is a conceptual framework that helps facilitate the creation of musical systems for interactive media, art and game environments. This chapter will discuss the historical context of this compositional approach and show how it is beginning to emerge in the current field of interactive media. The example of an original work aspires to demonstrate how a composition-instrument approach to music exhibits a congruity with the emergent nature of the medium. And finally, discussion of a contemporary computer game project exposes the potential of this musical concept in the world of games, digital art and new media.

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5 Steven Johnson, *Emergence: the connected lives of ants, brains, cities, and software* (New York, 2001), pp. 17–23.

History

Though the idea of a composition-instrument hybrid is situated in the praxis of computer games, new media and digital art, the historical precursors to this kind of compositional approach lie in an entirely different field and stem from three different musical traditions: experimental, improvisatory and generative. Each of these traditions has established aesthetic approaches, creative processes and musical style. A historical perspective helps to reveal how these attributes can be woven into the fabric of a compositional approach for music that operates in art and media environments with telematic and digitally-based interaction.

The roots of a composition-instrument approach can be found in experimental music. American composer Earle Brown was looking for ways to open musical form and incorporate elements of improvisation into his music during the 1950s. He found a great deal of inspiration in the mobiles of sculptor Alexander Calder. Brown described them to guitarist and author Derek Bailey as:[6]

> ... transforming works of art, I mean they have indigenous transformational factors in their construction, and this seemed to me to be just beautiful. As you walk into a museum and you look at a mobile you see a configuration that's moving very subtly. You walk in the same building the next day and it's a different configuration yet it's the same piece, the same work by Calder.

Brown's thoughts on musical structure are also noted by Michael Nyman in *Experimental Music: Cage and Beyond*[7]. Brown emphasizes that one importance of composition is to be both a means of sonic identification and a musical point-of-departure:

> There must be a fixed (even if flexible) sound-content, to establish the *character* of the work, in order to be called 'open' or 'available' *form*. We recognize people regardless of what they are doing or saying or how they are dressed if their basic *identity* has been established as a constant but flexible function of being alive.

Brown was interested in approaching music with an openness that allowed every performance to render a unique musical output that retains the essential character of the work. These compositional ideas, however, were not exclusive to Brown and his music.

Terry Riley's *In C*, composed in 1964, is a seminal work in both the experimental and minimalist music traditions, and shares in the compositional approach discussed by Brown. The piece consists of 53 melodic phrases (or patterns) and can be performed by any number of players. The piece is notated, but was conceived with an improvisatory spirit that demands careful listening by all involved in the performance. Players are asked to perform each of the 53 phrases in order, but may advance at their own pace, repeating a phrase or a resting between phrases as they see fit. Performers are asked to try to stay within two or three phrases of each other

6 Derek Bailey, *Improvisation: its nature and practice in music* (New York, 1992), p. 60.

7 Michael Nyman, *Experimental Music: Cage and Beyond* (Cambridge, 1999), p. 70.

and should not fall too far behind or rush ahead of the rest of the group. An eighth note pulse played on the high Cs of a piano or mallet instrument helps regulate the tempo, as it is essential to play each phrase in strict rhythm.[8]

The musical outcome of *In C* is a seething texture of melodic patterns in which phrases emerge, transform and dissolve in a continuous organic process. Though the 53 patterns are prescribed, the choices made by individual musicians will inevitably vary, leading to an inimitable version of the piece every time it is performed. Riley's composition reflects the imperative of self-identification expressed by Brown, but it also illustrates some of John Cage's thoughts on experimental music,[9] when he writes that the 'experiment' is essentially a composition where 'the outcome of which is unknown'. In performance, *In C* has indefinite outcomes and yet is always recognizable as *In C* due to the 'personality' of the composition – the patterns and performance directions that comprise the work.[10]

There are links between experimental music practice and improvisatory music. Free Improvisation is a good example of this. The genre took root in Europe in the early 1960s, with London serving as a major hub in its development.[11] This genre, in spite of labels and stereotypes, still involved elements of composition. One instance of this can be found in the coalescence of performing groups. In his essay 'Les instants composés', Dan Warburton notes that 'The majority of professional improvisers are choosy about who they play with ... and tend to restrict themselves to their own personal repertoire of techniques.'[12] In this case a kind of composition takes place through the selection of co-performers to join in an improvising ensemble.

David Borgo, in a recent publication on music improvisation and complex systems,[13] acknowledges that this characteristic in Free Improvisation praxis comprises an important aspect of the musical organization and composition in these performances. Free improvised music depends upon some amount of organization, even if it is minimal. In musical situations where there is no preparation or discussion of musical intentions, an established rapport or relationship between performers serves as a kind of composition. This provides organization through familiarity and shared sensibilities. Borgo describes an improvising ensemble as an 'open system' that emerges from bottom-up processes driven by players' relationships and interactions, their training and the performance environment or overall musical situation. Likewise, listening is always an overriding compositional factor because it regulates the dynamics of the performance. Players are constantly aware of their own contributions as well as the contributions of others, and make split-second decisions based on the overall musical output of the group.

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8 Terry Riley, *In C* (1964): http://www.otherminds.org/SCORES/InC.pdf (accessed 11 June 2007).

9 John Cage, *Silence: lectures and writings* (Middleton, CT, 1973), pp. 13–17.

10 The score for *In C* is available in PDF format at http://www.otherminds.org/shtml/Scores.shtml (accessed 11 June 2007).

11 Bailey, *Improvisation: its nature and practice in music*, pp. 83–142.

12 Dan Warburton, 'Les instants composés', in Brian Marley and Mark Wastell (eds), *Blocks of Consciousness and the Unbroken Continuum* (London, 2005), p. 109.

13 David Borgo, *Sync or swarm: improvising music in a complex age*, (New York, 2005), pp. 124–6.

Composition in this genre can be more formalized as well. Saxophonist Steve Lacy talks very openly about how he uses composition as a means of mobilizing a performance and creating a musically fertile situation that can nurture an improvised piece. He stated:

> I'm attracted to improvisation because of something I value. That is a freshness, a certain quality, which can only be obtained through improvisation, something you cannot possibly get from writing. It is something to do with 'edge'. Always being on the brink of the unknown and being prepared for the leap. And when you go on out there you have all your years of preparation and all your sensibilities and your prepared means but it is a leap into the unknown. If through that leap you find something then it has a value which I don't think can be found in any other way. I place a higher value on that than on what you can prepare. But I am also hooked on what you can prepare, especially in the way that it can take you to the edge. What I write is to take you to the edge safely so that you can go on out there and find this other stuff.[14]

In Lacy's view precomposed material acts as a point-of-departure or primer for the improvised piece. Improvising musicians will decide on the totality of the work, but the composition helps get them there.

A similar aesthetic is evident in John Zorn's compositional approach to his game pieces, which he considered as a latter-day version of Riley's *In C*, 'something that is fun to play, relatively easy, written on one sheet of paper. Game pieces came about through improvising with other people, seeing that things I wanted to have happen weren't happening.'[15] Zorn discusses the compositional direction he followed:

> The game pieces worked because I was collaborating with improvisers who had developed very personal languages, and I could harness those languages in ways that made the players feel they were creating and participating. In these pieces, they were not being told what to *do*. You don't tell a great improviser what to *do* – they're going to get bored right away.[16]

In an interview with Christoph Cox,[17] Zorn explains his rationale behind this position. He emphasizes how the individuality of the players he selected to perform the game pieces was an essential part of the compositional process:

> I wanted to find something to harness the personal languages that the improvisers had developed on their own, languages that were so idiosyncratic as to be almost un-notateable (to write it down would be to ruin it). The answer for me was to deal with *form* not with *content*, with *relationships* not with *sound*.

Zorn understood the musicians in his ensemble and knew what they were and were not interested in playing. He was able to situate their personal musical vocabularies

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14 Bailey, *Improvisation: its nature and practice in music*, pp. 57–8.

15 Anne McCutchan and C. Baker, *The Muse That Sings: Composers speak about the creative process* (Oxford, 1999), p. 164.

16 McCutchan and Baker, *The Muse That Sings: Composers speak about the creative process*, p. 164.

17 Christoph Cox and Daniel Warner, *Audio culture: readings in modern music* (New York, 2004), p. 199.

in a larger structure that allowed for freedom and individual expression while also satisfying his own musical objectives.

Experimental music composition, and techniques or processes of composition found in various forms of improvised music, are similar to the work involved in modelling an emergent, self-organizing system. Generally, all involve a bottom-up structural approach that generates emergent dynamics through a lack of centralized control. The same can be said of generative music. Musician, composer and visual artist Brian Eno has been working with a variety of generative structures throughout his career. He looks at works like *In C,* or anything where the composer makes no top-down directions, as precursors to generative music. In these works detailed directions are not provided. Instead there is 'a set of conditions by which something will come into existence'.[18]

Eno's influential Ambient recording *Music for Airports* was created using generative techniques. Rather than deal directly with notes and form, generative composers create systems with musical potential. Eno refers to this as 'making seeds rather than forests', and 'letting the forests grow themselves', drawing on useful metaphors from arboriculture. An important aspect of this approach, however, is in setting constraints so that the generative system is able to produce what its creator (and hopefully others) will find to be interesting. In a dialogue with Will Wright, the designer of *The Sims* and *SimCity*, Eno explains the reasoning behind this: 'You have to care about your inputs and your systems a lot more since you aren't designing the whole thing (you are not specifying in detail the whole thing) you're making something that by definition is going to generate itself in a different way at different times.'[19] Completed in 2006, *77 Million Paintings* by Brian Eno (Figure 7.1) is an example of the artist's generative approach in a visual medium. Working from a body of predefined images, the software will generate an enormous variety of paintings by compounding these images in novel ways. Given the amount of available material, it is very unlikely that anyone will ever see two identical images.

18 David Toop, *Haunted Weather: music, silence, and memory* (London, 2004), p. 184.

19 Brian Eno and Will Wright, *Playing With Time*, Long Now Foundation Seminar, audio recording (San Francisco, 26 June 2006).

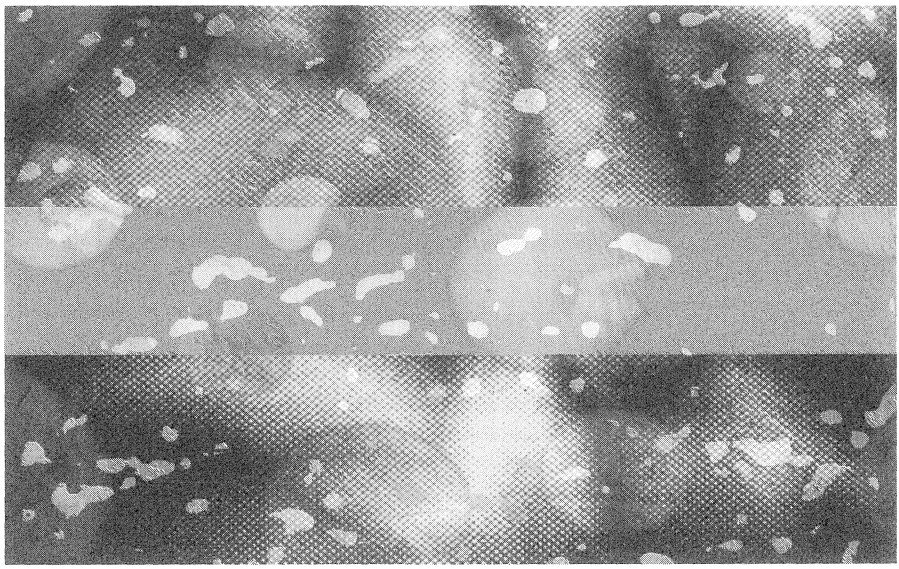

Figure 7.1 *77 Million Paintings* by Brian Eno

The steps involved in making this sort of music may at first seem vague or confusing, but in fact there is no 'secret recipe' for composing generative music. *Ovalprocess* (2000) by Markus Popp is a good illustration of this particular compositional situation and shows how a generative work can be conceived. Popp works in a very hands-on fashion; his pieces are built slowly through a laborious approach of cut-and-paste sequencing.[20] While the *Ovalprocess* CD itself was the result of his musical endeavours, it was originally distributed with a software application that simulated Popp's compositional thinking. Says Popp:

> *Ovalprocess* is a model of how I work, and is designed according to completely different ideas to making a professional audio productivity software application ... Instead, it's a very modest attempt at providing the user with one possible way to reconsider his or her expectations about working in sound or in software. In general, *Ovalprocess* is much less meant to be a statement in the software domain than it is towards being a statement in the music domain.[21]

This software enabled people to step into his mental compositional model and, using the sound material provided on the CD, create their own music.

Popp's intentions behind the *Ovalprocess* software can be found in other discussions of computers and music composition. Michael Hamman,[22] who has written

20 Sam Inglis, 'Markus Popp: Music as Software', *Sound on Sound*, (2002): http://www.soundonsound.com/sos/oct02/articles/oval.asp?print=yes (accessed 11 June 2007).

21 Inglis, 'Markus Popp: Music As Software'.

22 Michael Hamman, 'Structure as Performance: Cognitive Musicology and the Objectification of Procedure', in J. Tabor (ed.), *Otto Laske: Navigating New Musical Horizons*, (New York, 1999), pp. 37–52.

extensively on the subject, notes that, 'Computers become not merely tools for the making of artistic works (artefacts); they become instruments for the objectification of the very processes by which such works might be made.' The computer, as an instrument, uses software to internalize a composer's creative process and treats that process as a guide to create new musical works.[23] This scenario illustrates a sort of 'general recipe' for generative music: Take one system of musical thinking (in the specific case of *Ovalprocess*, Markus Popp's compositional method programmed as software), add a collection of sonic material to be used by this system, and listen. After it is started, and the generative music system begins to incorporate some sound material, a piece of music is revealed – of which each performance sounds potentially different than the last.

Through non-hierarchical, bottom-up compositional techniques, the sound of experimental, improvisatory and generative music exhibits emergence. In these musical works, the simple rules or relationships that form a composition act together and lead to unexpected, unpredictable or novel results. Musical gestures are not composed but take ephemeral form and emerge at the time of performance. One can also expect to encounter this quality – this becoming – in the emergence of telematic systems and in the experience of interactive games, art and media.

Contemporary related works

While a true blurring of composition and instrument has not been fully realized in contemporary practice, there are a number of works that show the potential embedded in this approach. All examples discussed here demonstrate the latent quality of 'composition-instrument' in the current art and media landscape. These works each share the characteristics asynchrony, emergence and generative-ness. Asynchrony is a key factor in the processes of interaction. An input will have an effect on the musical output of the system but it may not be immediately or fully apparent at the moment of interaction. While at first this approach may seem misleading or unresponsive, it is essential in shaping the music and the listening experience it creates. Whereas an immediate response would cause participants (more formally known as users) to focus on functionality and 'what it (the software/music) can do', a delay – however slight – helps keep them focused on listening and allows for a more gradual and introspective process of discovery. Additionally, it retains the potential for musical surprise. The listening participant can hear that the music shifts in character but is unlikely to be able to anticipate the nature of its transformation.

Change occurs by way of interaction but also through various means of generation. All of the works discussed here contain, in some way, generative processes that affect the sound as well as the visuals and overall experience of the piece. These processes occur in a variety of ways including participant, user or player interaction, random ordering and selection and computer algorithms. Depending upon the nature of the

23 This idea is also emphasised by Otto Laske in *Compositional Theory: an enrichment of music theory*, (1989).

work, several generative processes may be used, each in a different way, leading to a unique experience for the participant and listener.

As discussed earlier, emergence is an important quality implicit in the sound and development of experimental, improvised and generative music. It is also a fundamental aspect of contemporary digital artworks, and can arise from a variety of sources, 'ordering itself from a multiplicity of chaotic interactions'.[24] The pieces discussed here are no exception. Whether through the layering of sonic and visual patterns, navigation of a dataspace, evolutionary algorithms or telematic exchange, one cannot ignore the emergent properties that characterize these works.

Electroplankton

Electroplankton, created for the Nintendo DS game system by Toshio Iwai, was released in Japan in 2005, and later in Europe and North America in 2006. Iwai writes that the idea draws on his fascination with different objects across the course of his life – a microscope, a tape recorder, a synthesizer and the Nintendo Entertainment System (NES).[25] Some consider it a game; others a musical toy. Either way, *Electroplankton* captivates player and audience alike with its engaging use of sound and animation controlled via the touch-sensitive screen of the Nintendo DS device. Using a stylus, players are able to draw, twirl, tap and sweep an array of animated plankton characters on the screen. There are ten different plankton 'species'; each with its own sounds and sound-producing characteristics. Plankton and their behaviour are linked to a pitched sound or a short recording made by the player using the device's built-in microphone. Manipulating an individual plankton (or its environment) initiates a change in the sound(s) associated with it – a different pitch, timbre, rhythm, phrase length and so on. As multiple plankton are manipulated, a shift in the overall sonic output of the system is apparent, causing the music of *Electroplankton* to produce textural patterns and foreground/background modulations similar to those of *In C* (as described earlier).

Interactions with the plankton turn the Nintendo DS into an instrument that can be played purposely through the manipulation of the on-screen animations. Simultaneously, the software programming that links sounds to the plankton and their environment represents a musical ordering, or composition, that is implicit in *Electroplankton*. The coupling of these attributes perfectly illustrates how the combination or blurring of composition and instrument can lead to an interactive work with profound musical potential.

Additional examples

The musical qualities embedded in *Electroplankton* provide a clear – but not a sole – example of ways in which a composition-instrument approach is latent in

24 Roy Ascott, 'Telenoia', in Roy Ascott and Edward Shanken (eds), *Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness* (Berkeley, CA 2003), p. 275.

25 Nintendo of America, *Electroplankton instruction booklet* (Redmond, WA, 2006), p. 57.

contemporary games and digital art works. Following are several short descriptions of additional projects that share a similar musical sensibility. To retain the focus of this chapter, lengthy discussions have been avoided. However, readers are encouraged to pursue further investigation into these projects beginning with the websites provided in this text.

Rez, designed by Tetsuya Mizuguchi for Sega Dreamcast and Sony PlayStation 2, is described as a musical shooter game. Players enter the cyberworld of a sleeping computer network to destroy viruses and awaken the system.[26] Each successful shot leads to the performance of sounds and musical phrases that perform/compose the soundtrack for *Rez* in real time as a direct result of the game-play. Both the visual and audio experience leads players to feel an immersive, trance-like state that makes the game incredibly captivating.[27]

Eden, by Jon McCormack, is described as an 'interactive, self-generating, artificial ecosystem'.[28] In more general terms, it is a generative installation artwork of sound, light and animation, driven by Artificial Life systems and environmental sensors.[29] *Eden* situates visitors in a room, standing outside the virtual ecosystem that is represented by a projected, cellular lattice in the room's centre. A visitor's presence in the room can impact the ecosystem favourably. Someone standing in a particular location makes the adjacent space more fertile for the creatures, or 'sonic agents', that inhabit *Eden*. The lives of these creatures involve eating, mating, fighting, moving about the environment, and central to the musical character of the piece – singing. In various ways, all of these activities lead to both the visual and aural events that comprise the work.[30] In exhibition, the *Eden* environment is projected onto two large, translucent screens arranged to form an 'X' (see Figure 7.2).[31] The audio speakers and environmental sensors required for the work are not pictured here.

26 Sonicteam/Sega. 'Rez Story', (2001): http://www.sonicteam.com/rez/e/story/index.html (accessed 11 June 2007).

27 More information on *Rez* can be found at http://www.sonicteam.com/rez (accessed 11 June 2007). Readers may also be interested to see other musically-focused games that require physical or 'twitch' skills such as *Amplitude*, *Band Brothers* (a.k.a. *Jam With the Band* or *Dai Gassou! Band Brothers*), *Dance Dance Revolution* (a.k.a. *Dancing Stage*), and *Guitar Hero*.

28 Jon McCormack, 'Eden: an evolutionary sonic ecosystem', (2000): http://www.csse.monash.edu.au/~jonmc/projects/eden/eden.html (accessed 11 June 2007).

29 Jon McCormack, 'Evolving for the Audience', *International Journal of Design Computing* 4 (2002).

30 More information about *Eden* and McCormack's publications can be found at http://www.csse.monash.edu.au/~jonmc/projects/eden/eden.html (accessed 11 June 2007).

31 McCormack, 'Evolving for the Audience'.

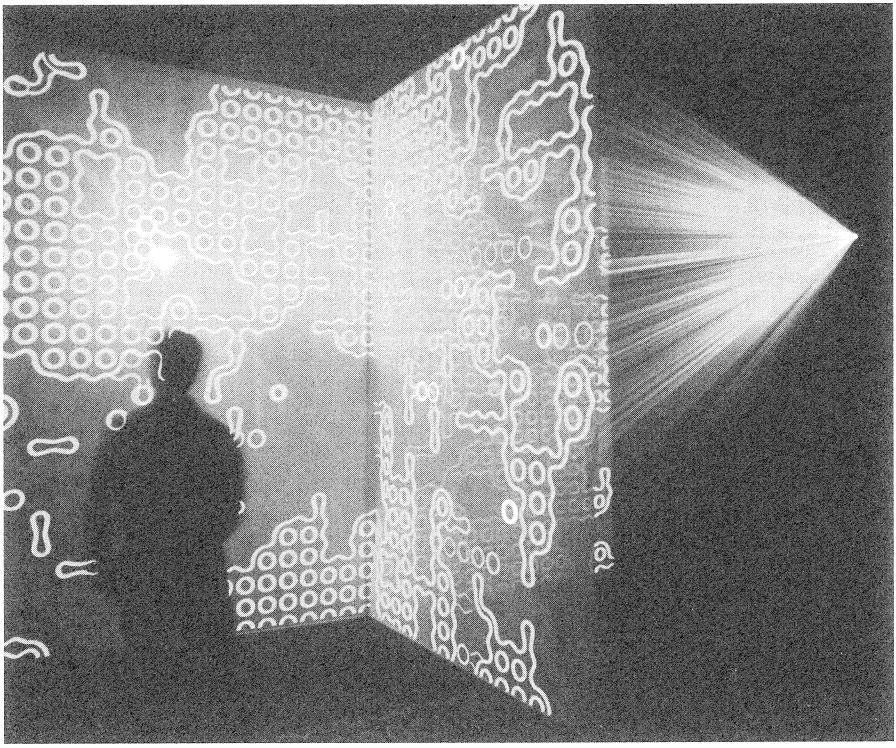

Figure 7.2 *Eden* by Jon McCormack

Intelligent Street was a telematic sound installation where users could compose their sound environment through SMS messages sent via mobile phone[32]. The piece was developed in 2003 by Henrik Lörstad, Mark d'Inverno and John Eacott, with help from the Ambigence Group. *Intelligent Street* was situated simultaneously at the University of Westminster, London and the Interactive Institute, Piteå, Sweden via live video connection. Users at either end of the connection were able to see and hear the results of their interactions. Using freely-associated, non-musical terms such as 'air' or 'mellow', participants sent an SMS message to *Intelligent Street*, and were able to hear how their contribution impacted the overall composition.[33] Simultaneously, all received messages were superimposed over the video feed to create a graphic representation of the audible sounds at any given time. *Intelligent Street* showed how music could be used to set the mood of a physical space through

32 Henrik Lörstad, Mark d'Inverno and John Eacott, 'The Intelligent Street: Responsive sound environments for social interaction', *Proceedings of the 2004 ACM SIGCHI International Conference on Advances in computer entertainment technology*, 74 (2004): 155–62.

33 Ibid.

processes of co-operation and composition across groups of people in distributed environments.[34]

PANSE, or Public Access Network Sound Engine, is an open platform for the development of audio-visual netArt created by Palle Thayer. The project exists online as a streaming audio application, and consists of a synthesizer, two step sequencers and an effects generator.[35] PANSE creates an opportunity for artists and musicians to create interfaces that control, or animations that are controlled by, the PANSE audio stream. Information about PANSE including technical specifics for connecting to the stream and interface authoring is online at http://130.208.220.190/panse.

Composition-instrument interactions and perturbations

As a conceptual framework for music and interaction, composition-instrument cannot be understood as a series of causal, linear relationships. The framework is ultimately a system with many individual, interrelated components (see Figure 7.3). It is helpful to understand this through the lens of Humberto Maturana and Francisco Varela's 'structural coupling',[36] where ontogenetic unities are represented by the generative system and the participant engaged in the work. Rather than see the participant's interaction as a 'cause' that leads to a specific 'effect', the composition-instrument model considers each interaction as a perturbation that echoes throughout the system and affects the other components. In the composition-instrument framework there is no set beginning or definitive source of an interaction. Rather, all components – generative system, environment and participant – exist in a relationship where a perturbation from any one will affect the others and eventually be reciprocated. Any of the three components can be identified as the origination point of a perturbation and the interaction model will follow the same flow of events.

34 Jo-Anne Green, M. Riel and H. Thorington, 'Intelligent Street', *networked_performance*, (2004): http://www.turbulence.org/blog/archives/000122.html. Further information about Intelligent Street is available at John Eacott's website (www.informal.org), Henrik Lörstad's website (http://www.lorstad.se/Lorstad/musik.html), and the Interactive Institute of Sweden (http://www.tii.se/sonic.backup/intelligentstreet) (accessed 11 June 2007).

35 Palle Thayer, '/PANSE', (2003): http://130.208.220.190/panse/whats.htm (accessed 11 June 2007).

36 Humberto R. Maturana and F.J. Varela, *The tree of knowledge: the biological roots of human understanding* (Boston, 1992), pp. 74–5.

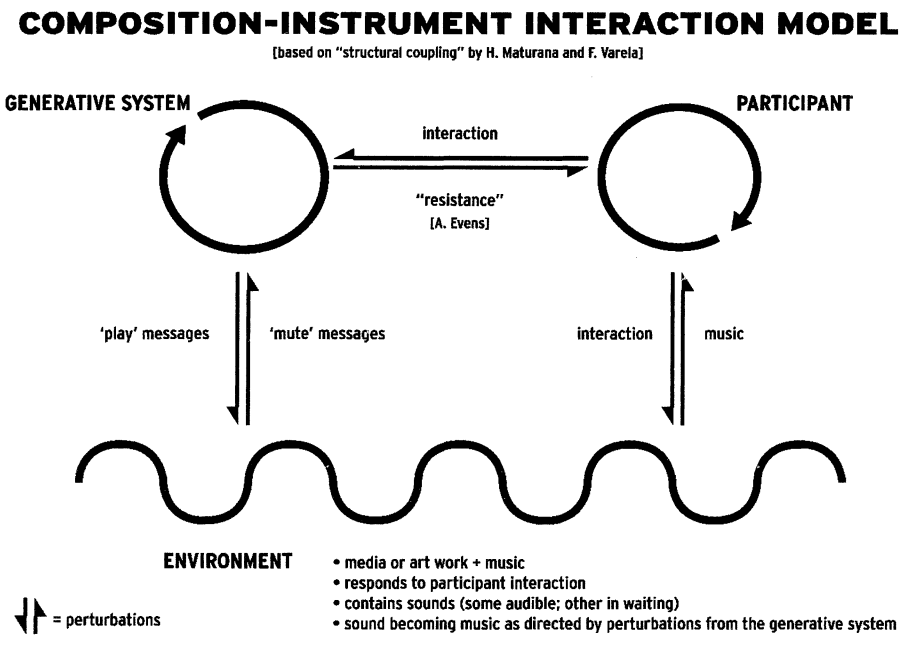

Figure 7.3 The composition-instrument framework

To make a general example, consider the case when a perturbation is first introduced by the participant. Their input will prompt a change to the internal, structural dynamics of both the generative system and the environment for interaction. A perturbation to the generative system can change the pattern determining when it decides to play a sound or sounds. A perturbation to the environment may make new sounds available and store old sounds for use a later time. These structural changes are not without consequence. Once complete they are sent back throughout the system as reciprocal perturbations. The environment sends 'mute' messages back to the generative system. Instructions from the generative system cue available sounds in the environment to become music. And most significantly, because they are listening, the music serves as a perturbation that affects the participant. What they hear in the music (their interpretation) can lead to a more complete understanding of the media environment or current in-game state. This awareness, developed in the process of interaction, constitutes a shift in the participant's internal structural dynamics, and sets the stage for further reciprocal perturbations. Maturana and Varela refer to this situation as structural coupling, where there is 'a history of recurrent interactions leading to the structural congruence between two (or more) systems'.[37] In the composition-instrument model, structural coupling is apparent in the presence of persistent perturbations. It binds the compositional order of the generative system with the sonic make-up of the environment to create an instrument that is capable of producing music in the course of participant (player) interaction.

37 Ibid., p. 75.

In a composition-instrument work, there is a perturbation that creates tension between the fixedness of the composition and the potential afforded by the instrument. This tension is similar to what Aden Evens refers to as the 'resistance of the instrument'.[38] It is the quality that 'pushes back' to reveal the nature, and ultimately the possibilities, of the instrument. In its resistance, the instrument is not submissive to the will of the musician. It reveals its character relative to the desire of the musician in a kind of co-operative struggle.[39] Resistance sits like a reflective pane of glass between musician and instrument; looking through it reveals that both elements merge into one. In a composition-instrument work, resistance takes the form of a generative system that is linked to participant interactions in such a way as to affect the work's musical unfolding. A perturbation will never affect a specific result, but afford a glimpse into the larger musical world implicit in both the instrument and the composition.

As a conceptual musical framework, the composition-instrument exposes its potentialities via participant interactions with a generative system. The system 'pushes back' in the form of sound and invites additional input. This exchange between participant and system ensues as a progression of interactions or reciprocal perturbations. As this exchange matures, the character of the system and the meaning it carries is revealed through sound, both in terms of what it is currently and what it could become.

The composition-instrument in contemporary projects

As stated earlier, a composition-instrument approach is latent in contemporary practice. There are many excellent projects where the seeds of this approach are visible but no single work has yet realized the full potential bound within the idea. Following is a discussion of projects that either seek – or have great potential – to embody the composition-instrument approach.

Sound Garden as a model of interaction

Sound Garden is a project developed by the author in tandem with the research that helped inform this chapter. The title alludes to the nature of interaction to be explored the work. It was created to provide an illustration of the composition-instrument idea, and to explore this model of interaction as it relates to sound, technology and location in physical and virtual space. *Sound Garden* shows how music can be composed and performed in real time via generative systems and participant interaction, as shown in Figure 7.4. At the installation site participants can make a wireless Internet connection and 'plant' or 'prune' sound files from the garden. The music of *Sound Garden* is amplified through these four speakers and can also be heard in an online web stream.

38 Aden Evens, 'Sound ideas: music, machines, and experience'. *Theory out of Bounds* 27 (Minnesota, 2005), pp. 160–73.

39 Ibid., p. 161.

Figure 7.4 Sound Garden: (photograph by Elizabeth Raymer)

Composition-instrument was initially defined as a work that can 'play and be played', and serves as a conceptual framework for music in interactive media and digital art. The concept seeks to find a balance; neither the ability to 'play' nor 'be played' should dominate a participant's experience. If interactions are too direct ('be played' is too apparent), the piece becomes too much like an instrument and the significance of other aspects of the artwork can be diminished. Similarly, if an unresponsive musical environment obscures interactions and 'play' dominates the experience,

the work loses its novelty in being tied to the course of participant interactions. The composition-instrument approach permits equilibrium between these two and as a result, acknowledges user interactions as perturbations in the overall musical system. It does not take on the clear cause–effect nature of a musical instrument (press a key to hear a note, for example). Instead it allows interactions to manifest as sound, gradually following the course of the composition's generative system. Perturbations introduce new sounds into the composition's aural palette and can subtly reshape the musical character of the work.

Sound Garden consists of a physical installation and online interface for interaction. It is a continuous work, meaning 'performance' is not defined by any particular duration. Listeners situate themselves in the garden (either on-site or online) and remain indefinitely.

In the tradition of the physical work associated with organic gardens (planting, watering, fertilizing, weeding, pruning and so on). The online interface allows listeners to tend their sonic environment and take an active role in its composition and care. Using a web browser to make selections from a menu, participants can contribute their own digital audio files (musical material, voice and environmental recordings and so on) and become gardeners who help to form the overall sonic landscape of *Sound Garden*.

Due to the uniqueness of each sound, the 'seeds' that are planted will significantly affect the primary characteristics of the garden. A generative musical system uses Particle Swarm Optimisation[40] to grow these seeds and define the overall structure. But *Sound Garden* is also largely shaped by events that occur at the site of installation. Environmental sensors tracking ambient light levels, temperature, motion and vibration act on individual sounds that compose the garden. These sensors serve as additional layers in the musical system, and control a variety of signal processing parameters. As environmental conditions shift and change, the sensors reflect that change in the garden's constant growth and development.

In this continuous, generative work, artificial life algorithms are used to maintain performance and ensure organic development over time. This project is also an experiment in musical self-organization. Like improvising musicians, those who visit *Sound Garden* are able to make an individual contribution to the larger, group work. It could be said that this kind of freedom results in cacophony and leaves *Sound Garden* in a state of complete sonic incoherence (noise). But much in the way that improvising musicians listen to each other in the course of performance, or people contribute thoughtfully and respectfully to a community flower garden, *Sound Garden* participants generally act with sensitivity in response to the musical ecology that is created and sustained by the work.[41]

Sound Garden was created to demonstrate the musical and technical characteristics of a composition-instrument approach. The strength of the piece is in its musical expressiveness and flexibility, but it does not fully address the connection between

40 James Kennedy and R. Eberhart, 'Particle Swarm Optimization', *Proceedings from the IEEE International Conference on Neural Networks* 4 (1995): pp. 1942–8.

41 Photos and recordings are available at http://www.x-tet.com/soundgarden (accessed 11 June 2007).

music conceived in the composition-instrument approach and an interactive system or artwork. There are, however, other contemporary projects where the foundations of a substantial connection between music and interaction seem to be in the process of formation.

Spore – The Potential of Becoming

Spore, the current project of game designer Will Wright (*SimCity*, *The Sims*) is a project where a composition-instrument approach could be fruitfully employed. *Spore* was originally set for commercial release in the second half of 2007.[42] However, at the time this book went to press it was announced that the release date would be pushed later to early 2008 or possibly 2009,[43] which means that much of the argument offered here is speculative. Not all details concerning *Spore*'s game-play and features have been officially confirmed. However, there have been enough published articles, screen captures, online videos and interviews with Wright to leave one with a good impression of the overall flavour of *Spore*.

In the game, players have the ability to design their own characters. These creatures can look like lizards, horses, trolls or cutesy cartoons – whatever a player decides to create. One potential difficulty with this feature then becomes animating such a creature. How can the game accurately simulate the motion of creatures that walk with tentacles or creatures that have legs like waterfowl or other exotic means of locomotion? This challenge presents one of the most promising aspects of *Spore* – the use of 'procedurally generated content'.[44] GameSpot news describes this as 'content that's created on the fly by the game in response to a few key decisions that players make, such as how they make their creatures look, walk, eat, and fight'.[45] The technology behind this aspect of *Spore* has not been revealed, but Wright describes it using an analogy: 'think of it as sharing the DNA template of a creature while the game, like a womb, builds the "phenotypes" of the animal, which represent a few megabytes of texturing, animation, etc.'[46] *Spore* also uses 'content pollination' to complete the make-up of one player's world using the assets of another player.[47] The basic sharing of resources is simple enough to grasp, but to be able to distribute

42 Andrew Park, 'Will Wright talks Spore, Leipzig, next-gen', *GameSpot* (2006): http://www.gamespot.com/news/6155498.html. 'Electronic Arts', *Next Generation-Interactive Entertainment Today* (2007): http://www.next-gen.biz/index.php?option=com_content&task=view&id=1638&Itemid=2.

43 Wikipedia contributors, 'Spore (video game)', Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/wiki/Spore(video_game). See also SeekingAlpha.com, 'Electronic Arts F4Q07 (Qtr End 3/31/07) Earnings Call Transcript', 8 May 2007, http://software.seekingalpha.com/article/34946 (accessed 11 June 2007).

44 Wikipedia contributors, 'Spore (video game)', Park, 'Will Wright talks Spore, Leipzig, next-gen'.

45 Ibid.

46 Wikipedia contributors, 'Spore (video game)'.

47 Steve Boxer, 'From a germ of an idea to the Spore of a franchise', *Guardian Unlimited* (2006): http://technology.guardian.co.uk/games/story/0,,1835600,00.html (accessed 11 June 2007).

these resources realistically and allow them to engage in believable interactions with another environment must involve a complex Artificial Life (or A-Life-like) system. If the world of *Spore* is to be a fluid ecosystem as promised, there will have to be some sort of self-organizing system or generative, non-linear dynamics that underlie the entire game and allow it to unfold in a natural, organic fashion.

The generative aspects of *Spore* (whether documented in an article or speculated here) show that it has, as a central component of its functionality, the ability to *become*. Wright has commented that at one point the game was titled 'Sim Everything'.[48] Most likely this is due to the ability of the game to become any kind of world the player/designer intends. This focus on customization of experience, growth and becoming are what make *Spore* such an ideal environment for music. In addition to exploring (to name a few) the physical, dietary and architectural possibilities of culture in this game environment, it would also be interesting to explore musical possibilities. What sounds resonate with a particular species? What devices do they use to make music, and what is the sound of that music?

In a game of becoming like *Spore*, a composition-instrument approach would be very advantageous. Composition-instrument monitors interactions carefully and sees each as perturbation that will have a gradual consequence within the system where it is sensed. In the way that procedural content generation leads to a natural mode of locomotion for a creature, perturbations to the musical system lead to a natural development of sounds that define that creature and its culture. As creature and culture develop and evolve, the sounds and music that are part of their identity take on new forms and tonalities. The generative nature of *Spore* can help to sustain this development. The game maintains its own internal sense of progress and evolution as it grows new creatures and new landscapes, generates climates and pollinates one world with the contents of another. This continuous process of generation provides the exact dynamics that enable a composition-instrument piece to play autonomously, while a game player's interactions in the *Spore* world "improvise" music within this overall structure.

It was confirmed in January of 2007 that Brian Eno has been hired to compose the music for *Spore*. The only knowledge of his plans can be drawn from his demonstration of a working prototype called the 'Shuffler' at the University of Arts in Berlin.[49] Peter Chilvers, who has been working closely with Eno on the Spore project, originally designed the 'Shuffler'.[50] According to Eno, Chilvers has an early version of the 'Shuffler' on his website,[51] and was asked to develop an expanded version of this for *Spore*. Chilvers has been working with generative music since his involvement with Steve Grand's *Creatures* games.[52] In writing about his music for

48 Ibid.

49 Sascha Pohflepp, 'Before and After Darwin', *We Make Money Not Art* (2007): http://www.we-make-money-not-art.com/archives/009261.php (accessed 11 June, 2007).

50 Brian Eno, *E-mail interview*, 10 April 2007.

51 http://www.peterchilvers.com/generative.php (accessed 11 June, 2007).

52 Peter Chilvers, 'generativemusic.com', *Artist's web site* (2005): http://www.generativemusic.com (accessed 11 June 2007).

Creatures,[53] he discusses opting for a generative compositional approach. Each piece of music in *Creatures* is tied to a set of 'players' in a sort of virtual band. A player has its own set of instructions that will respond, for example, to the emotional state(s) of the character(s) on screen or to any threats present in a character's environment.[54] Chilvers notes that his music builds the mood and atmosphere, and that it compensates 'for the lack of information to other senses such as smell and touch. It can also impart information about thoughts and characters that is not otherwise evident.'[55]

If this same aesthetic of music and interaction carries from *Creatures* to *Spore*, and the 'Shuffler' is employed to generate music in real time drawing from the dynamics of game play, it will effectively couple procedurally generated visual content to procedurally generated sound and music. No specific comparisons can be made between the use of the 'Shuffler' system and the composition-instrument framework, but there is certainly shared currency in the use of generative systems and in their connection with the interactions and experience of a player or participant. The prospects for Spore are compelling, but how the shuffler will manifest in actual game-play will have to be seen and heard once the game is finally released. *Spore* promises to be musically sublime and is likely to represent a significant step forward in the creative potential of music for games and new media in both its commercial and artistic manifestations.

Composition-instrument as an open episteme

Interaction within the composition-instrument framework is similar to what Michael Hamman refers to as an 'open episteme'.[56] Episteme, as used in his text, refers to the process by which the description of a mechanism is revealed, and how that description forecasts an output by the mechanism. Hamman describes a 'closed episteme', one that is bound to cultural, technical or historical expectations. These leave little room for innovation because their use is assumed based on prior exposure or understanding. An 'open episteme' is one in which the frame for understanding is emergent. One's conception of its use changes relative to the particularities of an interaction with the mechanism at the time of interaction.

The open episteme offers a porous understanding, 'open to input from a particularized situation'.[57] A composition-instrument framework leads to such

53 This online article reads as if it were written by someone at Gameware Development. In fact, Chilvers notes that he wrote this and that it had later 'rather weirdly been shifted into third person' (Chilvers, 'generativemusic.com').

54 Gameware Development, 'The Music Behind Creatures' (2004): http://www.gamewaredevelopment.co.uk/creatures_more.php?id=459_0_6_0_M27 (accessed 11 June, 2007).

55 Ibid.

56 Michael Hamman, 'From Symbol to Semiotic: Representation, Signification, and the Composition of Music Interaction', *Journal of New Music Research* 28/2 (1999): pp. 90–104 (accessed 11 June 2007).

57 Ibid.

an understanding because the interactive systems that facilitate this approach are themselves open, and produce unique outputs relative to the myriad interactions conducted within them. This makes the frame for understanding the system emergent – its outputs will always be specific to an interaction at a certain time, in a certain place and under certain conditions. As the parameters surrounding the interaction shift, the system's output shifts. And most significantly, the person engaged in interaction experiences an emergent shift in their reception of that output and in their mental model of the system and its possibilities.

Conclusion

A composition-instrument approach embodies qualities of music formally understood as 'composed' and 'improvised'. Works that use this idea are like generative music compositions in that they have their own internal order or organization. They are also like instruments in that they can be played, or performed upon, and in the course of that performance, make an impact that modifies the character or course of the music outputted by the generative system. This 'instrumentalization' allows for perturbations in the generative system and leads to an emergent becoming of music. When coupled with an interactive game system, the composition-instrument piece becomes a soundtrack that is both responsive to the game state and autonomous in its ability to adapt and develop relative to that state. This approach to music for games, or any sort of interactive digital system, hopes to open new opportunities for music in digital art and media, and to break down the linear models that have stifled creative progress in this area.

As a conceptual framework for music in computer games, digital art and new media, the composition-instrument approach is in its infancy. It has proven to be useful in projects conducted by the author (*Sound Garden* as discussed earlier, and *Perturb*[58] completed in 2006), but has had little opportunity to stretch into other areas. *Perturb* and *Sound Garden* are both technically 'open' interactive systems such as Wikipedia or Slashdot,[59] and can be modified by anyone. 'Closed' systems, such as traditional websites, feature preset content by a single author, and are 'interactive' in that the sequence of content is chosen by a user. While it is entirely possible for the composition-instrument framework to function in a closed system, it has not yet been attempted. A game like *Super Mario Bros.* (Nintendo 1985) is technically closed but due to the richness of the world, the experience while playing can be closer to the sense one has in an open system. (Do we call it a semi-open system?) Encounters with foes, obstacles, hidden surprises and a variety of different environments lead to a kind of emergent experience through game-play. This kind of game offers the right kind of opportunities that can be exploited 'instrumentally' and used to perform the game soundtrack in real time in the course of interaction and play. Clearly these questions show the way forward for the composition-instrument framework. As research and compositional efforts progress, the idea will be the subject of much

58 A description, photos and sound recordings are online at http://www.x-tet.com/perturb (accessed 11 June 2007).

59 http://www.wikipedia.org and http://slashdot.org (accessed 11 June, 2007).

experimentation. With luck, it will reveal new musical potential for games, digital art, telematic systems and other emerging forms of new media.

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Dérive entre Mille Sons: a psychogeographic approach to mobile music and mediated interaction

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Abstract

Dérive en Mille Sons (Drifting in a Thousand Sounds) *is a musical work that uses mobile media technology to artistically examine the relationship between music and the listener. Contemporary media technologies, be they at work, home or in your pocket, emphasize playback. These devices are designed to facilitate the storage and retrieval of pre-made media assets. This work leverages the processing capabilities that rest dormant within these technologies. Drawing from the writings of Guy Debord and the situationist/surrealist practice of the* dérive*, 'drifting' becomes a metaphor for instrumental performance in which the openness and emergence of interactivity is articulated through sound, as music.*

Keywords

Music
interactivity
mobile media
psychogeography
rhythmanalysis
Amergent music

1. Introduction

The conceptual framework for *Dérive en Mille Sons* has, until recently, been a latent component in my musical work and writings on music and mediated interaction. The project discussed in this article looks simultaneously to the past and the future. Every work I have completed to date has (unknowingly) been influenced by this thinking and it is likely that I will build on these ideas for years to come. Much thanks is owed to Henry Jenkins, whose essay 'Game Design as Narrative Architecture' (2002) helped clarify a direction in the research for this article. I am also grateful to my colleagues and supervisors in the Planetary Collegium for challenging me to critically examine every aspect of my artistic process. A reflexive critique led me to understand that what was once dismissed as intuition can be traced to a body of knowledge that deserves much deeper inquiry. A discussion of sonification, and a more thorough exploration of Lefevbre, de Certeau, and Deleuze are absent but will be required in the future as part of a complete, theoretical examination of my work.

For the present, this article represents a beginning where theories of space and sound are linked with music and mediated interaction. The research has, so far, produced a prototype work. I intend to augment what I have done with the development of two new musical pieces for the Apple iPhone – one that emphasizes the device's three-axis accelerometer and another that emphasizes its telematic capabilities. The practical and theoretical aspects of this work will continue in tandem, moving towards an

understanding of the emergent dynamics of mediated, interactive exchange and their potential role in the construction of musical sound.

2. Processing vs storage

In the work that I do, one primary objective has been to make contributions that are appropriate given the environment where the work will be received or experienced. This consideration goes beyond wanting something to 'fit in'. It is more deeply concerned with acknowledging the inherent strengths and weaknesses of an environment or technology platform, and using these either as assets or limitations that serve the interests of the entire work. This approach could be broadly characterized as 'sustainability' or 'ecology'. Jane Jacobs (2000), writing on the topic of urban planning, discusses the need to understand inherent qualities and behaviours of a city before one can begin to improve its design. In fact, much of Jacob's book *The Death and Life of Great American Cities* is devoted to the topic of healthy neighbourhoods and how their sustaining order is the best source to consider when planning new or revitalizing old urban spaces.

Brian Eno is an important musical innovator in this regard. While much of his ambient work is celebrated for its sonic beauty and freshness, value in the conceptual elements behind the work can be overlooked. One of the first ambient records was *Music for Airports*. Eno has commented how this music was the result of cultural and artistic circumstances. He reflects on a trend from the early 1970s in which people played recorded music to create a mood, and that he and his friends were sharing cassettes of still relatively homogenous music that could be treated as an aural backdrop or surrounding (Eno 1996). Of course this was not a new idea. Muzak had been doing this sort of thing since the 1930s (Lanza 2004) and 'elevator music' was well-established in the public sphere. This was part of his critique. Though the limpid strings and saccharine melodies of muzak was generally considered to be unfulfilling by many listeners, Eno found something curious in the *function* of muzak. He considered the possibility that environmental or mood music could actually have something of substance to offer the listener, and in it would be the opportunity to '…induce calm and a space to think' (Eno 1996).

This approach can also be found with Eno's CD, *Thursday Afternoon*. Here, a confluence of musical and technical matters led to a work uniquely suited to its medium. The recorded piece is 61 minutes long, which at the time was only possible on compact disc (Eno 1985). Also, because a CD is digital and has no surface noise, *Thursday Afternoon* features passages that are quiet and musically sparse (Eno 1985). In this work the conceptual and musical aspects are entangled with each serving the interests of the other.

Chris Crawford has also written on the artistic potential of creative and technical synergy. In 'The Art of Computer Game Design' he discusses six precepts to help game designers perfect their art by understanding the strengths and weaknesses of their medium. Crawford asserts that computers are far more useful for processing information than for simply storing it. Consequently, his fifth precept is 'store less and process more' (Crawford 1982). Computer games derive much of their artistic merit from responsiveness and interactivity, and information *processing* is essential in facilitating these behaviours. Because computers are natural number crunchers, game

programs can be written to exploit this fundamental strength, which makes *computer* games different from the kinds of games that preceded them. The computer can be told to respond to a choice made by the player and offer a new set of choices. As those choices multiply and begin to represent consequences from myriad prior interactions the player is confronted with a spectrum of possibilities, each with its own unique outcome and potential for further exploration. This kind of interactivity is only sustainable through processing. A computer program that is limited to re-presentation of canned assets will be, by comparison, very limited in its output.

Crawford's observations and lessons should not be limited to game design. Much (if not all) of the digital technology used by contemporary artists and musicians has the ability to process and facilitate interaction between computer systems, individuals and entire networks of online participants. Once processing has enabled robust interaction, emergence comes to characterize the overall behaviour of the system.

3. Emergence

Emergence is a fundamental behaviour of interactive systems. Scientific knowledge understands emergence as complex, ordered behaviour that is initiated under random conditions and arises from local, non-linear interactions. Emergent behaviour is generated through 'bottom-up' processes rather than by 'top-down', hierarchical control (Johnson 2001). In contemporary digital art works, emergence arises from a variety of sources, 'ordering itself from a multiplicity of chaotic interactions' (Ascott 2003). Rules are initially set and coded but after some time, a myriad of new uses and creations spring forth as people turn the system to their own ends. Investigation into Slashdot[1] (Johnson 2001), The Sims and Spore by Will Wright (Pearce 2002), and the A-Life artwork of Jon McCormack (2009) will show ways in which emergence is not only a behaviour, but essential to the communication of each interactive system.

Musical emergence can be heard in free improv, especially the strain that grew out of London, England and took root throughout Europe in the early 1960s (Bailey 1992). This style of improvised music exhibits emergence throughout a performance, and is sustained primarily through the training, experience and musical sensibilities of each player rather than a written score. Experimental music also provides a good model for musical emergence. Pieces like *In C* by Terry Riley are an excellent example of how 'bottom-up' processes can lead to diverse and unexpected musical results. For this work there is a simple score with directions. Performers are asked to play through a series of repeated melodic figures while listening to other members of the ensemble to ensure that everyone maintains a similar pace. The result is a seething texture of sound that offers listeners unexpected changes in melody, texture and intensity with every performance.

Generative music is also reliant on emergent behaviour. 'Generative' means that the entire musical work is defined as a set of rules or potentialities and usually written out in a computer-readable format. Brian Eno, the musician who coined the term 'generative music', noted that this musical approach is like making a seed, while the composition of a symphony is like engineering an entire forest (Toop 2001). The work is not determined at the outset; rather it is allowed to unfold on its own accord in different ways at

1. http://slashdot.org

different times. Eno has been a proponent of these kinds of systems or 'machines' throughout his career (Eno 1996). *Music for Airports* and *Thursday Afternoon* (already discussed here) as well as his recent works *77 Million Paintings*, music for the games Spore and Bloom (also for the iPhone) are all generative works. In each of these there is emergence. While the systems that sustain these works are simple in their organization, melodies and rhythmic or visual patterns spring forth in different ways to offer a rich experience each time one of these pieces is encountered.

Generative techniques use computers as processors. Michael J. Schumacher's recent *Five Sound Installations* uses a variety of mathematical algorithms to structure melodies and forms (Schumacher 2007). Brian Eno and the audio team from Maxis used his 'Shuffler' technique (Pohflepp 2007) and random number generators (IGDA 2008) to develop the music of Spore. Like *Thursday Afternoon*, these are works that recognize the capabilities of their host system and leverage those towards a musical end. Musical works have more to offer listeners when their features are highlighted by, or mesh with, the inherent technical character of their playback platform. *Dérive en Mille Sons* was made in this mould, but with the additional dimension that it be receptive to the kinds of interaction made possible with the iPhone. Certainly this device can play digital recordings, but it is programmed to play media files in a linear fashion – start to finish, a selection from the middle, and so on. This arrangement is not responsive to the ebb and flow of interactive exchange. A generative approach uses the processing strength of the iPhone to create unique musical permutations on each listening, and is essential to complement the unpredictable dynamics of interaction. With an emergent, adaptable music 'engine' in place, interaction can be structured around metaphors that encourage open-ended exploration and discovery.

4. Psychogeography and rhythmanalysis

This project draws its name and interaction model from the 'Theory of the Dérive' (1958) by writer and situationist, Guy Debord. The act of moving through actual, geographically locatable places can be usefully characterized by the surrealist and situationist practice of the *dérive*. Debord described the *dérive* as 'a technique of rapid passage through varied ambiences' involving '…playful-constructive behavior and awareness of psychogeographical effects…' (Debord 1958). In a *dérive* (which translates as 'drift'), movement through and across urban environments has an effect on the emotions and behaviours of the drift*er*. Debord writes that differing ambiences from street to street can divide a city into zones. To *dérive* is to walk in a city while attending to psychogeographical preferences. There is no predefined path and no specific destination. The drifter follows a path constructed by the valence of the ambient zones they encounter, moving towards those that appeal and avoiding those that do not. Each zone, created by its perceived psychogeographical character, becomes a unique space within the larger urban environment and contributes to an overall ecology that can be experienced as one drifts from zone to zone or space to space.

Debord (1955) writes clearly about subjectively perceived zones that can divide a city into a kind of psychological mosaic, but there is little that

translates directly to a musical work, let alone one that is open to interaction. Within each urban microcosm there are features that either do or do not draw us near. In physical or even virtual space this idea connects easily with storefronts, sidewalks and other tangible features. It is somewhat abstract to think about psychogeography in an environment that is purely sonic, but this becomes easier to grasp through an understanding of *rhythmanalysis*. Henri Lefevbre (2004) writes that rhythmanalysis is both a theory and practice that can help one learn about the character of a place or a culture by listening to its rhythms. Lefebvre describes the work of the rhythmanalyst as a kind of listening in which the specific content of each sound, while important, is secondary to the overall interactions of individual sounds. Harmony, dissonance, density, intensity, arrangement, context, frequency and repetition are all vital characteristics. Lefebvre calls on the double meaning of the word 'entend', to show that the rhythmanalyst will both 'notice' and 'understand' (Lefebvre 2004) sounds that are encountered. To perform a rhythmanalysis is to listen to the sounds of a place, to comprehend the layers of meaning they carry, and to use that sonic data to construct an understanding of one's subject. To *dérive* sonic neighbourhoods is to drift and *entend*. Listening to the character of each new zone reveals something about the nature of that zone and its contribution to the overall territory.

5. *Dérive en Mille Sons*

This project, drawing from Debord's theory of the *dérive*, introduces spatial–aural interaction with the three-axis accelerometer found in the iPhone. The simple act of tilting the device left to right or forward and back sends input that can redraw ('move') images on the screen. To date this feature has been used to make games ('roll the marble through the maze', 'drive a vehicle') and other, more advanced musical applications (see RjDj later in this article). Tilting interaction is suitable for this project because it is so intuitive. In fact, no practice is required at all. One is only expected to launch the application on the device, plug in their headphones, and begin.

Tilting the iPhone moves the listener through sonic zones. As with psychogeographic zones discovered in the *dérive*, generative sound clusters and musical phrases are organized into adjacent spaces. Tilting the device in the direction of a sonic space that draws their curiosity 'moves' the listener towards that zone so that it can be heard more clearly. In the process, other sound spaces are left behind rendering them either quiet or silent to make what was once foreground, background and vice versa.

5.1 Building a sound palette

Dérive en Mille Sons was initiated as an inquiry into ideas about music and mediated interaction and pursued purely as musical work. Drawing on Debord and the underlying concept of psychogeography, space was always a central concern. I was interested to explore space conceptually as a means of structuring music around interaction. But I was also interested in the sonic aspects of space. *Eigentone*, the sound created by the natural resonance of a room or space (Sonnenschein 2001), or 'keynote sounds' as defined by R. Murray Schafer (1977) were guiding concepts. I constructed a palette of field recordings that were made while travelling in Minnesota

and Wisconsin (USA) and Cairo, Egypt. When making these recordings I was primarily interested in capturing the sound of environments that struck me as unique: ponds, lakes, residential neighbourhoods, cafés and mosques, for instance. After the recordings were complete, each was edited and digitally processed to emphasize its most compelling, spatially derived qualities. In the final generative piece, these sounds were layered with additional synthesized sounds to create a collection of sonic zones comprised of the real, the processed and the synthetic.

Individual zones were organized to be sonically unique and cohesive, just as Debord characterized psychogeographic zones. These zones are 'representational spaces' that speak with an '…an affective kernel or centre…' (Lefebvre 1991). Within every zone, a carefully organized sound palette is subject to the dynamics of a zone-specific generative system. Each system plays through the sounds in its palette according to predetermined rules. This produces unique combinations and permutations and lends each space a distinct quality. Thinking beyond the traits of individual spaces or zones it was additionally important to think about their arrangement within the overall territory. The value of the *dérive* lies not only in the qualities of an individual zone but in the interplay at their edges, and the cumulative affect produced when moving through one after another after another after another… Of course, in actual cities, the arrangement of zones is emergent – the result of governmental, geographic, social and cultural concerns that have come to bear over years of time. *Dérive en Mille Sons* cannot currently support this kind of behaviour. It was composed as a musical *dérive* to acknowledge the opportunities for surprise and discovery that can be found through a compelling succession and layering of sounds. However, this sort of emergence is a consideration for future variations of the piece.

5.2 Sound, legibility and interaction

When designing space to be part of a musical work, a musician temporarily assumes the role of urban planner. Questioning space, and how it can be used to serve the broad interests of diverse groups is a good place to start. In his book, *The Image of the City* Kevin Lynch (1960) builds a strong case to show how thoughtful planning can make cities more amenable. The city '…must be plastic to the perceptual habits of thousands of citizens, open-ended to change of function and meaning, receptive to the formation of new imagery. It must invite its viewers to explore the world' (Lynch 1960). When uses and the use of a city are apparent, citizens have a clear entry – not only to live but to thrive and to find personally fulfilling paths for work, play and family. Lynch asserts that uses are made evident through their 'legibility' in the cityscape. Just as one finds a book legible and can comprehend thoughts and ideas, the potential of a city should be equally clear (Lynch 1960). When first choosing sounds, and then organizing those sounds into legible, spatialized groups, the musician is engaged in the kind of work espoused by Lynch for urban environments, where potentiality is a key ingredient in building a system that can withstand myriad interactions and always have something new to offer.

This *dérive* is completely aural in nature. From a musical perspective it grants the listener a much greater deal of autonomy because they are no longer a passive receptor. 'Drifting' interaction allows the listener to share

an active role akin to a performer or composer, where the music they hear is, for the most part, their own construction. Here, a rhythmanalytic approach to listening is hard to avoid. With no visual reference, listening drifters find their ears carefully attuned to the environment as they pass by or through uniquely imprinted sonic zones. In addition, listeners often find themselves in areas where they overlap several adjacent zones. In this situation sounds mix and collide to construct hybrid or composite locations that would be impossible in the streets, neighbourhoods and markets of a city. The physical simplicity of interaction with *Dérive en Mille Sons*' adds an additional dimension to the overall experience. Tilting is a natural motion that can be done almost unconsciously. This subtle movement helps overcome potential distraction with the mechanics of interaction. Listeners can fully immerse themselves in music without the burden of performing awkward keystroke combinations, button presses or joystick manoeuvres.

5.3 Project prototype

In the summer of 2008 I created a simple prototype for this project. As a computer-programming novice I was able to use off-the-shelf software to create a simple yet powerful version of this project. Adobe Flash was sufficient to author a generative music system. To achieve the nuanced, tilting interaction this project demanded I used a Nintendo Wii controller (Wiimote) which has a six-axis accelerometer. To get these elements to communicate, I used the WiiFlash Server[2] developed by Joa Ebert, Thibault Imbert, and Alan Ross and the WiiFlash Server for Mac developed by Tojio Labs.[3] This proof-of-concept was a success, but it showed me that there were too many individual pieces of software to make the work accessible to a broad audience. As a small computer with media playback capabilities that supports physical interaction via a three-axis accelerometer, the iPhone stands alone as an ideal technical platform to realize this work. These and other features suggest many possible futures for this project as development continues.

6. Future directions

Shortly after writing a formal grant application to help fund this project, I learned about a platform for iPhone called RjDj.[4] RjDj uses physical and sonic input from the iPhone to make music. Pieces, or 'scenes' for RjDj are written in Pure Data (PD),[5] a graphical programming environment for real-time sound, video and graphics processing. RjDj is not a standalone iPhone app. It acts as a host for individual scenes, so to experience music in RjDj, it is necessary to launch the RjDj application and load a specific scene. Collections of RjDj scenes are called an album.

The album *Shake* includes two scenes by artists Matt Robertson and Mike Reed, aka Moodbungalow,[6] called 'Meno' and 'Satseauxmann'. Both of these involve tilting interaction, revealing RjDj as capable of realizing the interaction mechanism for *Dérive en Mille Sons*. As of this writing, the RjDj platform supports all of the proposed functionality for the project and provides a straightforward means of production. It does not, however, offer much room to grow. While the initial project could be a success running on the RjDj platform, it is unknown if RjDj would be able to support new directions in the future.

2. http://www.wiiflash.org
3. http://lab.tojio.com
4. http://rjdj.me/what
5. http://puredata.info
6. http://www.moodbungalow.com

7. http://www.apple.com/iphone/appstore

8. http://www.x-tet.com/soundgarden

Initially, the project was started with the intention to become a standalone iPhone app that could be distributed via the Apple iPhone App Store.[7] With funding and assistance this will be possible and looks to be the most sustainable path going forward. As an 'official' iPhone app, *Dérive en Mille Sons* could potentially grow in ways that take full advantage of the device's capabilities.

One such direction would be to use A-GPS (Assisted GPS) to enable sonic geotagging. Rather than assign locational metadata to a photograph (as one might do with Flickr (2009)), it would be possible to associate a sound or sounds with a location. This scheme would combine the ideas outlined here with *Sound Garden*,[8] a musical installation I completed in 2007. In *Sound Garden*, participants access an online interface and 'plant' or 'prune' MP3 sound files. The garden consists of a generative music system and environmental sensors. The generative system plays the sound files that have been planted and the environmental sensors control an array of digital signal processors that mix and modulate this audio output. In the project, references to gardening reveal the metaphors for interaction. As one adds or subtracts from the garden, or as local environmental conditions shift, the overall musical output and growth changes and adapts. I can imagine a version of *Dérive en Mille Sons* where sounds are not planted, but used as geotags. This would allow someone to *dérive* (in the original, Debordian sense) with their iPhone so that as they move across sonically tagged physical spaces. *Dérive en Mille Sons* is drawing its source material from sounds left at (or tagged to) their current listening location. In this geographically generative variation, the musical possibilities are determined by the initial properties of the piece, the movements of the listener and all of the sonic geotags left by those who have gone before them. In an almost warped way, this *dérive* of geographically specific sounds references R. Murray Schafer's original concept of the soundscape (1977) as a global musical composition for which we are all responsible. This is not an intention of the proposed work, though when viewed through this lens it does reveal further variations that are potentially artistic, political and ludic in nature.

7. Conclusion

Dérive en Mille Sons uses mobile media technology to artistically examine the relationship between music and the listener. It is both a musical work and an investigation of contemporary media technologies. Devices that emphasize playback and the storage of pre-made media assets fail to fully leverage the processing capabilities that make these technologies ripe with opportunity. The Apple iPhone is such a technology. The potential for works that deal with sound, music and physical interaction is enormous. Guy Debord has written on psychogeography and the practice of the *dérive*. These ideas can serve as useful metaphors for mediated interaction, while urban planning provides a new model to consider for the organization and arrangement of sonic material. Sounds that are encountered in space – be it geographic, virtual or conceptual – carry meaning. When attended properly, the relationship of sounds within a given space and the contrast of sounds across adjacent spaces communicate to listeners. With the additional ability to navigate these spaces, the arrangement between listener and music becomes something new altogether.

7.1 Amergent music

Where *effect* is a result, *emergence* is a behaviour. The patterns of a cellular automata or swarm algorithm are visually evident as an effect – or result – of a simple rule set.

Where *affect* is a condition that produces emotion, *amergence* is a phenomenon of consciousness. This term characterizes emergent behaviour with an additional, psychological dimension.

Amergence refers to behaviour that can be witnessed and read. In our mediated world emergence is a given, but through further observation (to *entend* in the Lefebvre-ian sense of noticing and understanding) we find amergence. It reveals subjective details of the emergent behaviour that surrounds us.

Dérive en Mille Sons is a work of amergent music. It is rooted in a study of the innate dynamics of a media technology. The musical work must understand and recognize the functioning order of the environment or platform that supports it. In terms of the 'content' or 'subject' of the work, that which is to be communicated or explored (via mediated interaction) is organized into sonic spaces, each of which is subject to change. This arrangement works to represent degrees of potential or possibility. Nothing is black and white. Fluctuations within a space, or novelty that becomes apparent through the layering of several spaces, points to a world characterized by nuance. Kevin Lynch (1960) describes buildings, sidewalks and other urban features as useful for the construction of personal narratives: 'a landscape whose every rock tells a story may make difficult the creation of fresh stories'. Similarly, amergent music does this for mediated interaction, where use of a system, or choices within that system, manifest a sonic synergy coupling the observer and the observed. The emergence of mediated interaction is made 'legible' (Lynch 1960) through sound as music.

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