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Analyzing with Compositional Static Artifacts of MIDI-mediated Mixed-Media Music

A dissertation submitted in partial satisfaction of the
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in Music

by

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ABSTRACT: Analyzing with Compositional Static Artifacts of MIDI-mediated Mixed-Media Music

by

Elizabeth Jean Hambleton

This dissertation examines the static artifacts of electroacoustic multimedia music written after the development of MIDI (Musical Instrument Digital Interface) in 1983. *Static artifacts* is an umbrella term I have coined for the collective types of traditional and extended musical notation, text or graphic scores, screenshots of digital audio workspaces (hereafter: DAWs), code, and so on that are non-dynamic visual manifestations of a piece of music. The digital era brought about fundamental shifts in compositional practices and notation. In this dissertation, I examine some of the varied ways that composers use technology in mixed-media electroacoustic works, considering both how they notate the electronics and how one may analyze the work taking into account the technology and unique notation.

I demonstrate methods of analysis in several case studies focusing on compositions by Philippe Hurel, Trevor Wishart, Anne Deane Berman, and Paulo Chagas, and with particular attention to their static artifacts. I draw from notation studies and semiotics to support recent theories of electroacoustic analysis by scholars such as of Simon Emmerson and Leigh Landy (2016). I also use the method of multimedia analysis from Nicholas Cook (1999) for works that incorporate visual, textual, and dramatic elements. Where applicable, I

apply the composers' written thoughts, from books or articles, to the static artifact they made for a piece of music. Wishart and Chagas, for example, have both written extensively on their own styles and on the state of electronic music and electronics in music. While I find there are more similarities than differences between the case studies, each composer manages a unique way of incorporating electronics into their music and into their static artifact. My work provides analysts with more tools for electroacoustic analysis by shedding light on the static artifact.

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Introduction

In academic settings, music professors most often teach analysis through listening to a piece and annotating a score. For most music in the Western canon from 1600-1950, this score features a five-line staff with symbols that denote pitch and rhythm. In electroacoustic music, however, there is often no score at all, and analysis takes on a different notational form. Especially in the 1980s and onwards, instances of multimedia evolved into a particularly different kind of compositional environment thanks to several technological advances that compounded on one another. It seems that, by and large, music theory has decided to forego score study for electronic music. However, composers do record their process, and make notated and annotated documents that reflect and reveal their thought process and workflow that performers and analysts can read – in other words, they make a different kind of score. How can music analysts use this new kind of score? And what benefit does it serve us?

Take, for example, Priscilla McLean's piece *Desert Voices* (1999), for MIDI violin, digital processor, and recorded sounds. The piece is interactive and incorporates microphone techniques to alter the recorded sounds. The violin is played normally, but it is like an electric guitar in that the sounds emitted are processed and necessarily different than a standard acoustic violin sound, featuring alterations like distortion, reverberation, and emphasizing unusual harmonic spectra. There is even an optional video slideshow. How can the analyst approach this piece? There are a few established methods for analyzing

electroacoustic music like this, but they can only assess a single performance. The issue with multimedia works with live electronics like this is that there is so much variety and potential for a different performance.

Luckily, McLean provides some useful documents: a score with quasi-traditional notation (which is what the violinist reads), the libretto ("Corn Pollen Path" by Malcolm Benali, a Navajo poet), McLean's program notes, and a Max patch chart revealing the ways the MIDI violin is modified, and the effects applied to the pre-recorded sounds such as reverberation and pitch shifting, respectively. The score is likely the most familiar piece to a music theorist and will certainly prove useful in tracing pitch and rhythmic motifs. This is already a great benefit; however, it is not enough to accurately analyze the piece as a whole. The libretto is a contribution, too; reading the text and gathering the subtext is essential to understanding McLean's message. Furthermore, the Max charts are the most important for analyzing the timbral changes and the aleatoric nature of the piece's form. Finally, the lynchpin to everything is McLean's program notes, where she explains certain details about what to listen for and how she put the piece together. All in all, these four pieces of documentation added together give the analyst enough to analyze the multimedia piece's realization and potentiality. I call this collection of documents the *static artifact*.

This dissertation examines the static artifacts of electroacoustic multimedia music written after the development of MIDI (Musical Instrument Digital Interface) in 1983 and develops a methodological toolkit. *Static artifact* is an umbrella term I have coined to encompass traditional and extended musical notation, text or graphic scores, screenshots of

digital audio workspaces (hereafter: DAWs), code, and other non-dynamic visual manifestations of a piece of music. The digital era brought about fundamental shifts in compositional practices and notation. In this dissertation, I examine some of the varied ways that composers use technology in mixed-media electroacoustic works, considering both how they notate the electronics and how one may analyze the work taking into account the technology and unique notation.

I demonstrate methods of analysis in several case studies focusing on their static artifacts. I also draw from notation studies and semiotics to support recent theories of electroacoustic analysis by scholars such as the contributors to Simon Emmerson and Leigh Landy's *Expanding the Horizon of Electroacoustic Music Analysis*.[1] I also use a multimedia-analysis method from Nicholas Cook[2] for works that incorporate visual, textual, and/or dramatic elements. Where applicable, I apply the composers' written thoughts, from books or articles, to the static artifact they made for a piece of music. Trevor Wishart and Paulo Chagas, for example, have both written extensively on their own styles and on the state of electronic music and electronics in music. While I find there are more similarities than differences between the case studies, each composer manages a unique way of incorporating electronics into their music and into their static artifact. My work provides analysts with more tools for electroacoustic analysis by shedding light on the static artifact product.

[1] Simon Emmerson and Leigh Landy, *Expanding the Horizon of Electroacoustic Music Analysis.*
[2] Nicholas Cook, *Analysing Musical Multimedia*.

Methodology

In this dissertation, I identify shifts in ideology and new modes of analysis that correlate to shifts in technology and accompany compositional thought and process. I examine primary sources (scores, original analyses, possibly interviews) and secondary sources (corresponding literature, analyses of scores or opuses by other academics). As this research focuses on the visual element of music, there are several figures and tables from the composers' static artifacts in the chapters.

Because one of the goals of this dissertation is to show the range of notation and compositional practices, the methodologies vary correspondingly and are chosen specifically for what they offer each case study. Part of the nature of my dissertation is exploring different methods and models of electroacoustic analysis and applying them to analyzing the score. These include Nicholas Cook's dyadic media analysis, Mary Simoni's perceptual-analytical model of electroacoustic analysis, Simon Waters' analysis of sampling and resampling, and John Young's novel electronic forms.

I chose the case studies based on three criteria. The first consideration was the chronology; I wanted case studies starting at least five years after 1983 so that MIDI would have been established and normalized for some years in most electronic studios, but also before the year 2000 so that the worldwide web would not yet have been commonly adopted in all studios or universities, and certainly before smartphone technology, since I believe both are delineations of another major shift. The second consideration was geography and schools

of thought. French *musique concrète* and German *elektronische Musik* have long been pitted against one another, so I wanted to include one composer representing the *Institut de Recherche et Coordination Acoustique/Musicque* (IRCAM, the home studio of Boulez and Xenakis) and another from *Westdeutsche Rundfunk* (WDR, the home studio of Stockhausen). For the others, I chose one British composer and one American. The third consideration was the canonization of composers; I wanted to use my dissertation as a platform to bring up less-canonically recognized composers, but still ones I find important and iconic of their studio alignment. For WDR, I chose Paulo Chagas because he often worked with Stockhausen and was instrumental in building and using the new studio space in the '90s, so he was an important character in Stockhausen's narrative as well as a renowned composer and theorist in his own right. In IRCAM, Philippe Hurel was a composer in residence and also worked closely with several other iconic IRCAM composers such as Jonathan Harvey. For America, I chose someone close to home: Anne Deane Berman, who studied music composition in the Music department and multimedia art in the Media Arts and Technology department of the University of California Santa Barbara. Finally, for England, Trevor Wishart is a philosopher and theorist as well as a composer, and made waves with both his compositions (especially *Red Bird* [1978]) and his books.

Chapter Outlines

This dissertation is divided into two sections: history and analytical case studies. The first section contains this introduction and the first two chapters. The first chapter discusses technological changes and development in the 20th and 21st centuries and the parallel the

notational developments and innovations in 20th- and 21st-century music. The second chapter explores theories and philosophies of electroacoustic multimedia in the MIDI era. These chapters serve to situate my questions and research, and introduce the major theories and philosophies I employ in my case studies. The second section contains four case studies that showcase these philosophical and technological changes. These case studies are *Leçon de choses* (1993) by Philippe Hurel (Paris), *Scylla and Charybdis* (1992) by Trevor Wishart (England), *Positive Thinking* (1993) by Anne Deane Berman (California), and *Migration* (1995-7) by Paulo Chagas (Cologne).

The first chapter covers technology objectively in terms of hardware and software developments, as well as how music communities adopted and adapted the new technologies. This gives insight to the compositional processes as technology promotes certain types and manners of composition and notation. By examining key genres and focusing on a case study or two for each, I will demonstrate how the static artifact manifests and how it may be incorporated in the analysis. The primary areas of focus will include interactive and generative electroacoustic music. Here, I define and expand upon my new term, "static artifact." I explain why my term is novel and important for the 21st century discussion of notation and electronic music as a broader concept than 'score' but narrower than 'trace,' and how it can be used in lieu of or in conjunction with a traditional score.

Introduction

Drawing on accounts by Ikutaro Kakehashi,[3] Trevor Wishart,[4] Max Mathews,[5] and Joel Chadabe,[6] I discuss the major shift that occurred in the mid-1980s for three reasons, all of which hinge around the invention of MIDI. The first is the breaking down of proprietary hardware and software barriers; the second is the rise of the personal/home computer, which is directly linked to the rise of the home digital audio workspace; the third reason, also linked to the computer, is the movement away from studios and to individualized composition, which in turn created a reliance on academic institutions for those wedded to the concept of a communal studio. These primary sources weave a narrative that supports the delineation of a pre-MIDI era and a post-MIDI era and provide key historical positioning of my case studies.

Alongside Kakehashi and Chadabe, I draw on Julio d'Escriván, whose book *Music Technology* (2012) provides one of the best histories of MIDI and music coding (e.g. CSound) that I have found to date. He discusses the pros and cons of technology and its influence on composers' literacy and compositional styles. He also touches on audiovisual elements as manifested in Max/MSP. Additionally, d'Escriván's chapter titled "Electronic Music and the Moving Image" in *The Cambridge Companion to Electronic Music* (2017) offers approaches for analysis that I will apply to works that incorporate visual elements, namely Wishart and Berman.

[3] One of the creators of MIDI
[4] Also the composer of my second case study
[5] Namesake of the Max language and digital audio workspace
[6] Author of the seminal text *Electric Sound*: *The Past and Promise of Electronic Music* (1997)

Another key resource is Adam Bell's recent book, *Dawn of the DAW* (2018). This book details the history of the Paris and Cologne studios, the move to synthesizers, and the move from synthesizers to DAWs. Bell examines the movement from cultural, economic, and artistic lenses, creating a compelling narrative of how technology changed composition and vice versa from the late 20th century into the present. Bell and I ask many of the same questions: how did composers change their methods when moving to MIDI-based DAWs, and how did their communities adjust to the changing purpose and place of the studio? One aim for my dissertation is to attempt to answer some questions that Bell left open, such as what did the music *look like* (i.e., what do the static artifacts look like), and how can we use that static artifact to analyze the music as a potential form rather than a realized form, as we can do with recordings?

Score study and notation studies go hand in hand, both for understanding the choices composers make in writing their works and for analyzing the form and meaning of the music. In order to make sense of static artifacts, I draw from notation studies, especially extended notation and graphic notation. Many of my sources on twentieth-century notation draw attention to parallels in how music and notation changed in the past, and how it changed (or perhaps *should change*) in the present. These ideas are present in almost every theorist's text about changing notation in the 20th century, as well as many composers' articles and score notes.

For instance, Boretz & Cone's book *Perspectives of Notation and Performance* is a collection of essays on modern notation, delineating its problems, possibilities, and

performance techniques. The through-line of this collection of chapters is the relationship between composer and performer, and how notation mediates that relationship. This mediation is of particular interest to the case studies with live performance aspects in which the performer has to engage with live electronics and static electronic tracks simultaneously. Second, *Extended Notation* by Christian Dimpker is one of the few twentieth-century notation manuals to branch out into multimedia notation practices. This book is more of a guide, but offers standardized and alternative methods of writing and interpreting certain musical actions. Dimpker's book is particularly helpful in parsing Wishart's antiscores and the case study, *Scylla and Charybdis*, which has many theatrical elements.

Other writers like Hugo Cole[7] and Tim Rutherford-Johnson[8] prescribe methods and ideas to update notation to an ideal state. Hugo Cole bases his writing in Peirce's semiology, while Rutherford-Johnson subscribes more to Saussure. These authors offer methods of applied semiotic analysis of notation, an important step in analyzing a score or static artifact overall. Rounding out this section of notation study is David Cline's *The Graph Music of Morton Feldman* (2016), which explores the mechanics of reading Feldman's graphic scores. The philosophies and mechanics demonstrated in Feldman's compositional choices in his scores and Cline's concepts and methods for reading them back is translatable into extended techniques as seen in the scores I examine in this dissertation as well as the art of reading

[7] Hugo Cole, *Sounds and Signs.*
[8] Tim Rutherford-Johnson, *Music After the Fall.*

stems and patches in DAWs and composer's sketches of soundscapes and imagined movements.

The second chapter will discuss innovations in notation in the 20th and 21st centuries through the lens of composers and analysts. I introduce the theories, philosophies, and models applicable to multimedia electroacoustic musical works. This includes Simon Emmerson's language grid,[9] Trevor Wishart's lattice model,[10] and Leigh Landy's acousmatic-influenced sonic analysis theory.[11] Mary Simoni's edited anthology *Analytical Methods of Electroacoustic Music* provides the theorists' take on new electronic music, focusing on composers like Paul Lansky, Alvin Lucier, Jonathan Harvey, and Barry Truax. The sources here are relevant because they either discuss the composers I use in my case studies or are referenced by the composers in their own works.

Another core source is Thomas Licata's edited volume *Electroacoustic Music: Analytical Perspectives*, which contains nine essays by composers on case studies in composition. Topics range from symbolism to serialism to score manipulation. They focus on the somewhat older and more established electronic composers like Karlheinz Stockhausen and Jean-Claude Risset. These compositional methods relate to my case studies on Hurel and Chagas. Yet more, Hurel worked with Risset for a few months around the time he wrote

[9] Simon Emmerson, *The Language of Electroacoustic Music.*
[10] Trevor Wishart, *Audible Design.*
[11] Leigh Landy, *The Art of Organised Sound.*

Leçon de choses, and Chagas worked with Stockhausen at ZKM and taught him to use MIDI-based DAWs.

To situate their compositions as case studies, I introduce Trevor Wishart's manuals on composition, and Paulo Chagas's theoretical and philosophical writings. Wishart's books contain his musings on the role of the composer in modern music, in electronic music more specifically, and also his approach to analyzing modern compositions.[12] Next, Chagas's "Composition in Circular Sound Space" and *Unsayable Music: Six Reflections on Musical Semiotics, Electroacoustic and Digital Music* explore the sociocultural effects of electronic music as a paired shift with the new hardware and software, for which he also provides brief explanations. In his article, he provides anecdotes about the older generation of composers attempting to adapt to digital, MIDI-based systems, and the challenges they faced. This provides an intriguing insight to some kind of dividing line between composers who adopt MIDI and those who develop alongside it, and the kind of music and static artifacts they concoct. Chagas's thoughts are critical for my analysis of his *Migration* (1997) piece, but also for Hurel and Wishart, which employ space in important and varied ways.

Bringing the composers' own words into the conversation, whether specific to the composition or about music and composition more generally, is an essential part of the analysis I do in the case studies. These shed light on elements to look for in the compositions.

[12] Trevor Wishart, *Audible Design*; Trevor Wishart, *Sonic Art.*

Introduction

With the historical, philosophical, and technological background set, I then dive into case studies. This section presents four central case studies. Each study has been chosen to demonstrate a separate composer's approach to mixed-media composition in the MIDI era. Each case study incorporates the MIDI protocol that universally connects hardware and software – none of the sounds are produced by MIDI alone. In these chapters, I introduce and discuss the methods and frameworks for analyzing electroacoustic music in the applicable multimedia environment. Further, I show ways in which the composers' writing process and artistic, narrative, and semiotic intentions are manifested as a visual artifact that the theorist can examine.

Chapters 3 introduces the first case study, which examines a work that use multiple sources for sounds and sound manipulation. This case study is Philippe Hurel's *Leçon de choses* (1993) for orchestra, tape, and Max patches, which Hurel composed while working at the IRCAM in Paris. The piece has live performance, fixed media, and live electronics. The static artifact mostly uses traditional notation with some graphic and microtonal additions, and also digitally-created electronic patches to create and to manipulate sound. My analysis covers form, motivic content, and meaning, and how Hurel notates electronic performance and electronic output.

For this analysis, I draw from Emmerson & Landy's 2016 book on electroacoustic analysis, as well as Mary Simoni's work on electronics and Simon Waters' work on hybrid musical styles. *Leçon* exemplifies several traits typical of IRCAM compositions, namely the full symphonic orchestration plus live electronics, and the way the composer turns a simple

germ of a sound into a full-fledged composition via Max software, which was an exclusive proprietary software in IRCAM until 1990.

The fourth chapter and second case study is Trevor Wishart's antiscore of *Scylla and Charybdis* (1992) for semi-aleatoric dramatic performance and fixed media techniques. This work incorporates theatrical performance and audience interaction along with fixed and live electronics. The *antiscore*, as Wishart calls it, is intended to be the 'opposite of a score,' parsing each artistic element into its own page or category rather than putting everything in context in one unit. Furthermore, it has a somewhat more robust static artifact to examine compared to some of Wishart's more purely computer music pieces like *Red Bird* (1978) and *Tongues of Fire* (1993). Wishart's artifact for *Scylla* combines computer patches, tech set-up, and theatrical instructions, all of which relate symbiotically.

I draw on Wishart's academic and philosophical writings to analyze his works. I also return to Mary Simoni and Simon Waters to compare *Scylla* to *Leçon* more directly. Wishart's works are different when composed to those coming out of IRCAM, or most studios and schools of thought, in fact. He prefers to customize software or code from scratch. He also strives to create something different rather than master something established, hence the antiscore and the unorthodox orchestration and parameters of composition. This case study reveals an entirely different approach to composing for mixed media works in the MIDI era – but the analytical approaches I use are largely the same.

Introduction

The third case study, chapter five, is a multimedia and multimodal work by Anne Deane Berman, *Positive Thinking* (1993) for poetry recitation, flute, tape, and slideshow. Berman's works are all programmatic, multimedia, use computer-processing in some way, and have fairly well-documented static artifacts available, making her an ideal candidate for this dissertation. As something more of a 'media artist' than a 'composer,' Berman creates a poignant work of art on the AIDS epidemic that speaks to many senses at once, mediated by electronic sound and image. The static artifact includes the words, the flute notation, and performance instructions for the slideshow operator and tape creation. While the other three case studies pair fixed media with live electronics for sound emanation and creation, Berman's electronic parts are all fixed media while the flute and the visuals are live – literally. Either the screen shows projections of living normal and HIV+ blood cells, or the video can come from a generative Max patch that creates a similar effect. To analyze *Positive Thinking* holistically as an instance of multimedia, I draw on Nicolas Cook's multimedia method of analysis.[13] Using this framework, I analyze how Berman relates or juxtaposes the flute music to the text, to the slideshow, and to the tape part in her relatively traditionally notated score.

The fourth and final case study in chapter 6 explores the realm of music mixing with space and plastic arts, is Paulo Chagas's *Migration* (1995-7), which uses the famous rotating octophonic speaker set-up at WDR that Stockhausen also used to *Octophonie*. *Migration*

[13] Nicolas Cook, *Analysing Musical Multimedia.*

explores not only space but *moving* space, and Chagas composes with the listener's perception in mind. Chagas is also well versed in the shift from analog to digital, and has written a fair amount on the composer's reaction to MIDI when it entered German studios like WDR and *Zentrum für Komputermusik* (ZKM).

I use Chagas's philosophical and theoretical writings, discussed in chapter 3, to situate *Migration*'s static artifact, which contains the quasi-traditionally notated score plus a set of Max patch diagrams and spatialization maps. I will demonstrate an analysis using not only listening and spectrograms, but also the graphic score, diagrams, program notes, and an article he published in 2004 that references it. In this case, these disparate elements work together as the static artifact.

In my conclusion, I summarize the answers discovered to these research questions: "How have composers who eagerly and consciously adopted the MIDI protocol in the 1980s and '90s adapted their compositional process and notation," and also, "How can music theory use their documentation?" The short answer is that through putting many composers, theorists, and audio programmers from the '90s and 2000s in conversation with one another, I am able to depict general themes that arise in notation and scores / static artifacts. The four case studies reveal disparate different methods and approaches to the notation and static artifact creation. My contribution is parsing the composers' static artifact for inclusion in the analysis and adjusting the framing of modern electroacoustic theories to include this new kind of score study rather than relying solely on aural analysis.

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

Introduction

Art is bound by its media and technology. A photograph cannot chronologically trace a complete narrative, nor can a mosaic create photorealistic images. We see this in music, too, as technology delimits the musical possibilities; the constraints of music written for the piano keyboard are different from those for the phonograph. Developments in technology thus create new possibilities in musical expression. Recording and playback devices invented in the twentieth century were a major technological shift for music, and after World War II composers earnestly used the new technology to rethink the possibilities of music composition. Composers learned to alter recordings to create new sounds, and oscillators and synthesizers used electricity to create novel sounds from scratch. Music entered the electronic era.

To define electroacoustic music, I will use Leigh Landy's definition from his 2007 book *Understanding the Art of Sound Organization*. He defines electroacoustic music as "any music in which electricity has had some involvement in sound registration and/or production other than that of simple microphone recording or amplification."[14] This is open-ended enough to encompass a huge variety of art, from soundwalks and sound installations to granular synthesis and microsound to rock & roll with electric guitar.

[14] Landy, *Understanding the Art of Sound Organization,* 61.

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

The new instruments and techniques of sound creation were very different from traditional acoustic instruments, and electronic music composers struggled to (re)present their music through the traditional notation that had served the common-practice era of music. Music historian Peter Manning states, "at least in the conventional sense, [notation] is replaced at best by functional descriptions of the technical procedures employed in realizing a work, and at worst just the acoustic results."[15] In other words, unlike traditional notation, electronic notation is largely descriptive. This shift led musicians away from thinking of electronic notation as a useful score, whether for performance or for analysis.

To further define electroacoustic music, I refer to Paulo Chagas's distinction between the terms *electroacoustic music* and *computer music*. Chagas writes,

> While the term 'electroacoustic music' has an artistic connotation, evoking the activities of composition and performance, the term 'computer music' emphasizes the convergence of art, science, and technology. The computer became a multifunctional tool that replaced analog technology as a medium of production, composition, and performance. Digital technology improved and expanded the possibilities of electroacoustic music and opened new fields of interdisciplinary creativity such as algorithmic composition, human-machine interactivity, music cognition, psychoacoustics, artificial intelligence, and robotics.[16]

The world of electronic music is enormous and widely varied.[17] This dissertation will focus on a limited subset, and each of my case studies incorporate live and fixed electronics and some level of electronically enabled spatialization.

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[15] Manning "The Significance of Techné", 82
[16] Chagas, *Unsayable Music,* 104.
[17] Landy offers a fairly comprehensive list of types of electronic music in *The Art of Organised Sound,* 9-17

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

The case studies in my dissertation use software and hardware that communicate with MIDI, and the composers plainly state that the MIDI protocol influenced their technology and, in turn, their electronic music. Theoretical contributions to establishing firm definitions and delimitations between related terms, as Landy and Chagas do, help us choose a well-suited framework for analysis. In the case studies, choosing a fitting model and paradigm is an important first step. In my case studies, I then attempt to integrate score analysis with a fitting framework, drawing on the available static artifacts, providing an element that has been missing from many previous analyses of electroacoustic music.

Each case study comes from a different compositional style and tradition, and these first two chapters on history and context of electroacoustic composition and analysis are designed to shed light on the case studies' contexts. Each composer studied and worked under mutually distinct circumstances and traditions. Philippe Hurel worked at IRCAM alongside spectral composers; Trevor Wishart works in the UK in a university setting; Anne Deane Berman worked in California with a distinctly American perspective; and Paulo Chagas worked at the WDR and imbued his compositions with his experience as an immigrant. Hurel and Chagas thought primarily in terms of sound objects, while Berman and Wishart focused on interwoven narratives. All four had unique personal philosophies on notation, and these distinctions only begin to scratch the surface of their activities. This chapter provides the context that will illuminate necessary distinctions and connotations before diving into the case studies.

A brief history of electroacoustic music and its notation

Electronics in music affected how composers approached, worked with, and notated multimedia music. It all started with the tape recorder. With recording and replay, sounds and music had new roles and abilities. Music no longer stayed in one place, and it was no longer an ephemeral event that happened only once. What does it mean for artists if sound can escape its time and space and create new spaces? As Trevor Wishart reflects on it:

> With the arrival of sound recording the question of source-identification of sounds increased in importance. Previously the landscape of a sound had been perceived as the physical source of the sound: what now was to be made of a recording of Beethoven's 'Pastoral' symphony played on loudspeakers?... We must therefore seek a redefinition of the term 'landscape.' If the term is to have any significance in electroacoustic music we must define it as the source from which we imagine the sounds to come. The loudspeaker has, in effect, allowed us to set up a virtual acoustic space into which we may project an image of any real existing acoustic space, and the existence of the virtual acoustic space presents us with new creative possibilities.[18]

Previously written musical compositions could have a new life in this world of recording, and modern compositions could explore new ways of using recording technology for its identity and artistry. Or, as Denis Smalley puts it quite a bit more dramatically, "Gone are the familiar articulations of instruments and vocal utterance; gone is the stability of note and interval; gone too is the reference of beat and metre."[19]

[18] Wishart in Emmerson 1997, 43
[19] Dennis Smalley, "The Listening Imagination," 107.

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

The tape recorder changed what music could be. In his book exploring the history of electronic music through his unique lens as a composer who studied with several renowned composers, including Stockhausen and Risset, and became an established composer himself, Paulo Chagas cites the tape recorder as not only the primary tool of electronic music and the impetus for change, but it was also *the* tool of electronic music. All the techniques of recording and montage, the new kinds of musical gestures composers developed and the subsequent software and programming languages, are rooted in the tape recorder. As Chagas succinctly puts it:

> Conceived originally as a medium for storing and retrieving sound information, the tape recorder was converted into a tool for experimenting and composing with sound and for producing a new type of music. Different techniques of recording and montage were used for material preparation and formal shaping; for example, cue-and-stick techniques (cutting the tape in fragments and recombining the fragments in a different order), playback techniques (reverse playback, variable-speed playback), loop techniques, tape speed manipulations and play-erase-record techniques with feedback control.[20]

The upshot is that sound used to be tethered to sources, and their sources had a sheet of notation in front of them. Now that music and the sounds in music are spatialized, interactively generated, or focus on timbre or their spectra, a flat sheet of paper with five-line staves will not suffice anymore. Composers have been creative with inventing symbols, but in the area of electronic music, there is a lot of notation that is not codified.

[20] Chagas, *Unsayable Music*, 109.

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

As the common narrative goes, electronic music began in two different schools of thought that begat two different national styles of composition: *elektronische Musik* out of German serialism, and *musique concrète* out of French abstraction. Composer Vladimir Ussachevsky noted that the Germans tended to be systematic and methodological, leaning towards serialism and algorithms for their musical structures; the French were more spontaneous and experimental.[21] As Paulo Chagas frames it:

> The fundamental distinction between Cologne and Paris studio is as follows: "On the one hand, the musique concrete of the Paris studio develops a poetics of detachment from the music and attachment to the sound; it disengages sound consciousness from the models of traditional vocal and instrumental music and, at the same time, moves toward interactions focused on sound identities, cultural and social references. On the other hand, elektronische Musik develops a poetics of detachment from the sound and attachment to the music; it disentangles consciousness from the representative background of sound as a meaningful artifact and focuses on the musical relevance of sound phenomenon by exploring its vibratory nature. The methods of timbre composition concentrated on parametrical and combinatorial thinking link elektronische Musik to the polyphony of the Middle Ages and the Renaissance and to the experimental music of the beginning of the 20th century, particularly the aesthetics of atonalism, twelve-tone music, and serialism.[22]

Many German composers researching and composing *elektronische Musik* at the *Westdeutsche Rundfunk* (WDR) began with serialism and dodecaphony from the Second Viennese School, and grand gestures *à la* Wagner.[23] Many composers in those early days, like Gottfried Michael Koenig and Karlheinz Stockhausen, used equipment to extend the

[21] Braun, *Music and technology in the twentieth century*, 13.
[22] Chagas, *Unsayable Music*, 108-9.
[23] Emmerson, *Living Electronic Music*, 23.

possible parameterization of sounds beyond what acoustic instruments commonly do. Many tried to notate their works by rigorously documenting their process of creation. Many other composers forwent a score altogether. Without need of a notation system for musical composition and performance, why notate at all?

In the French electronic scene, Pierre Schaeffer is considered the godfather of musique concrete and acousmatic music. He worked at the *Group Recherche Musicale* (GRM) to develop methods of collecting and modifying recorded sounds into compositions. Schaeffer and others write about the sound object, which theorist Denis Baggi explains can be understood as both a note and a set of voices. [24] It is simultaneously one thing and an amalgamation of many. Schaeffer brings up two problems inherent in computer-based composition for which he sought answers:

> First, no (natural) sound obeys the abstract formulae or laws of the acousticians. If the composer wishes to somehow achieve anything with the structure of a particular sound, he must – each time anew – analyse the components of this sound with the greatest precision…Many a classical composer could rejoice over a good clarinetist or be annoyed by a bad one; nevertheless he composed for 'the' clarinet.[25]

But the electronic music composer has no such definition of instrument. The closest thing we have is fetishization; one may say the 1960 Pittsburgh synth has such and such iconic or "classic" sound, for example, though such a claim is dubious.[26] Furthermore, Schaeffer says,

[24] Baggi, *Computer-generated Music*, 1-2.
[25] Boehmer, "Koenig – Sound Composition – *Essay*," 167, quoting Schaeffer.
[26] For more on electronic music fetishization, see Stan Link's article "The Work of Reproduction in the Mechanical Aging of an Art: Listening to Noise" in *Computer Music Journal*.

> The second problem deals directly with composition itself. In cases where sounds have become kinetic, have been elevated from the micro- to the macro-level, listening should, indeed must, obviously concentrate on what happens within the sound. In so far as a composition consists of more than one sound, the problem also arises of the meaningful interweaving of those multidimensional sounds.[27]

Pierre Schaeffer and Pierre Henry's collaboration *Symphonie pour un homme seule* (1950) has an organizational chart for the realization of the work, but he did not try to notate the music in a way that an analyst could read. Schaeffer and his colleagues and students diligently journaled their processes, but there is no real descriptive or prescriptive notation.

Composer and theorist Henri Pousseur describes the philosophical paradigms of mid-century electronic music in terms of novel sound organization and layering that acoustic music did not have at the time, at least not to such an extent. In his words:

> Electronic music articulates a continuous interaction between different levels of sound organization…The musical sound is not an isolated object but can be understood only in a compositional context; it is not possible to speak of sound phenomena even when isolated, without considering their compositional possibilities.[28]

Composers have either concocted personal ways of writing and notating these digital signals or the paths they took to create them, or the software creators designed a method for them. In the modern models of electroacoustic analysis provided, in this dissertation I propose ways of examining these written or otherwise-notated elements and incorporating them into the analysis.

[27] Ibid.
[28] Pousseur, "L'Apothéose de Rameau," 127.

There were, of course, many other rising studios and musical techniques and schools of thought across the globe. Electronic instruments like the theremin and *ondes martenot* were commercially produced by the 1930s and used in compositions across the globe. American composer John Cage produced *Imaginary Landscape No. 1* for layered variable-speed record players 1939, and the first composition made on and for magnetic tape music was composed by Egyptian composer Halim El-Dabh in 1945.[29] Cage and El-Dabh both used individual kinds of graphic notation to describe their works on paper.

Graphic scores were nothing new in music, but they played an important role for electronic music.[30] Graphic scores remove the constraint of the five-line staff and give composers freedom to compose unburdened by pitch or rhythm, if they so choose. Graphic scores tend to be more about gestures and movement versus stasis. For acoustic music, this often translates to guided improvisation. For electronic music, a graphic may relate to a synthesizer patch chart, or represent a sound wave, it might depict the general contour of various parameters, or it may be completely abstract, like many of John Cage's iconic works.

On the topic of graphic scores and their use in electronic music, David Cope suggests graphic scores give more power and creativity to the performer, at the cost of removing some control from the composer. "Once composers have granted shared responsibilities, it is not difficult to understand the motivation behind graphic or less exact notational systems. New

[29] Denise Seachrist, *The Musical World of Halim El-Dabh*.
[30] Cole, *Sounds and Signs*.

instruments and techniques have evolved simultaneously with unique sounds, creating new and significant composer-performer relationships."[31] He suggests that all graphic scores, whether for electronic music or not, have some element of aleatoricism by dint of this new compose-performer relationship that must not be overlooked. For example, in William Duckworth's mixed-media composition *Walden Variations* (1971) may have the performers move between events and movements freely, and the form is ambiguous and open to interpretation. The graphic score for *Solitude* for any live performer(s) (2001) by Hans-Christoph Steiner has a Pure Data-generated graphic score that roughly suggests pitch, timing, and timbral colors with written instructions, though the instructions have little bearing on the form and realization overall.[32]

Composer and ecomusicologist R. Murray Schafer philosophizes that all notation and sonification are arbitrary. He writes,

> I do not fault acoustic or phonetic machines for their inability to solve the problems of simultaneous representation of the total sound image. That the two-dimensional image is sufficient for many kinds of investigation has…a correspondence in our perceptual tendency to identify a limited number of significant features in any sound heard.…*All visual projections of sounds are arbitrary and fictitious*.[33]

[31] David Cope, *New Directions in Music*, 62.
[32] In chapter 2, I will delve into this coordination of symbolic notation and the composer-performer relationship.
[33] R.M. Schafer, *European Sound Diary*, 127; emphasis original.

In other words, a sound contains so much more than a piece of paper can truly represent, and all representations are poor sketches of what they mean to portray. This is an inherent trait for music; electronic music and its new extended capabilities only make it more obvious.

Evolving technology & notation: programming

Another new technology, electronic computers, came out of WWII and became useful tools for art as well as daily life. Electronic sounds could be synthesized with a computer, and programming languages could create or play back sound. The first major development in computer music was Max Mathew's MUSIC programming languages. MUSIC (retroactively MUSIC I) was developed by Mathews at bell Labs in 1957.[34] It was the first computer program specifically designed to generate digital audio waveforms. In other words, it was the first programming language designed to be an instrument of composition. Mathews created five iterations of the language to keep up with evolving technology and users' needs and demands. It became relatively widely adopted by MUSIC IV (1963) but was still a niche tool. Joel Chadabe notes that "musicians generally like to work intuitively, hearing their music as they perform, trying things out as they compose, occasionally singing a tune. MUSIC V was not intuitive. It wasn't just that a composer's 'notation' was in non-singable computer code, it was also that the program did not operate in real time."[35]

[34] Manning, "The Significance of *Techné*."
[35] Chadabe, *Electric Sound*, 112.

Its offshoots, however, did gain traction in the electroacoustic scene. John Chowning's Music10 (1966) was widely used on the American west coast in the 1960s and 1970s; Csound (1985) combined the design of MUSIC with the language C, and is still in use today; MUSIC V was picked up by John Gardener and Jean-Louis Richer at IRCAM and augmented to process as well as synthesize sounds. Mathews would later take up the IRCAM-augmented MUSIC V to create Max/MSP[36], which will be described in the next section.

Greek composer Iannis Xenakis designed UPIC in the 1970s as a system of composing with an intuitive, alternate method of notation for electroacoustic music because he found symbolic notation "a hindrance."[37] With UPIC, the composer draws the shape mapped to a two-dimensional pitch-time space, and can use the same drawing mechanic to create a waveform they want the computer to synthesize. This thus merges the act of notating a sound object with synthesizing one. UPIC ended up an important inspiration for Miller Puckette and his programs and programming languages Max and Pd. Max and Pd are revered as the most common visual programming languages today for both commercial and artistic electronic music.

At GRM, the scene was turning from abstract electroacoustic composition to include more acousmatic sounds and styles. Darren Copeland writes,

[36] A graphical programming environment for developing real-time musical and interactive applications.
[37] Bosseur, *Sound and the Visual Arts*, 51.

> The first step was Luc Ferrari's *Presque rien*…The work was controversial at GRM during the year of its creation in 1970 because it consisted entirely of a time-compressed sound recording of day-long activities on a beach in Corsica. The emphasis on hearing sounds as they were, and not abstracting them into musical materials, made this piece a pivotal step in reconciling these different attitudes toward environmental sounds.[38]

Composers continued to use Schaeffer's acousmatic style and process at GRM. But a new studio opened in 1977 that allowed a state-of-the-art space for experimental music: the *Institut de Recherche et Coordination Acoustique/Musique* (IRCAM). IRCAM would eventually become the birthplace of major DAWs and programming languages for composition like Max/MSP and OpenMusic[39]. The likes of Jean-Claude Risset explored digital synthesis with top-of-the-line hardware and creative programming languages and software. The software out of IRCAM is highly visual, and many composers find it to be a satisfactory replacement to a traditional score. IRCAM is also responsible for sound analysis programs like AudioSculpt that have robust visualizations of spectra and are some of the best visualizations for analyzing timbre. Composers can use these graphic environments to edit sounds, and analysts can use them to better understand them.

Risset used MUSIC throughout the 1960s-1980s, and he described the data as the "computer score" for sound.[40] He openly believed that the "computer score," or the data and lines of code used to effect musical edits or sound creation, "allow an observe to analyze compositionally significant traits of a sound structure, and characterize musical ideas… [By

[38] Quoted in Minevich, *Art of Immersive Soundscapes* 180.
[39] A visual environment based on the earlier PatchWork software, using the computer language Lisp.
[40] Risset 1996, in Licata *Electroacoustic Music: Analytical Perspectives*, 5.

studying MUSIC V data,] "one is able to analyze the scores, not only the notes, but also the sounds."[41]

Risset's compositional philosophy was not so dissimilar to an approach to acoustic composition. He thought of the computer more like 'the' instrument rather than 'an' instrument. The digital instrument is somehow fundamentally different than the analog version, to Risset at least. Chagas reflects, "Risset used a computer because of his interest, as he put it 'in composing sounds as well as composing *with* sounds."[42] To Risset, says Chagas, the recipe of synthesis plays the role of a score, and the score is realized by the computer program or system. This means "digital systems operate as calculation machines with a much higher precision and control factor than analog systems; the calculating power introduces a new kind of creativity based on the possibilities of *combination* and *mutation*. Yet digital systems operate as simulating machines attracting tendencies of *imitation* and *superficiality*."[43]

IRCAM was one of many new studios that sprang up in Europe and North America, and it would quickly establish itself as a cultural hub of electroacoustic research and performance. Meanwhile, both the GRM and WDR studios were evolving and flourishing. The first generation of composers who continued throughout these decades and worked at a

[41] Licata, *Electroacoustic Music: Analytical Perspectives*, 153.
[42] Chadabe *Electric Sound* ,127; emphasis original.
[43] Chagas, *Unsayable Music*, 120.

variety of studios, such as Iannis Xenakis and Karlheinz Stockhausen, developed their personal palettes and trained their students in their compositional processes.

With the success of *Gesang der Jünglinge*[44] and *Kontakte*[45], Stockhausen continued to develop his compositional palette in the realm of electronics. In the 1970s, he stated the three major parameters of electronic music are timbres, dynamics, and space movements. His compositions explored these parameters; but all three were still nascent practices, and composers are still exploring with trial and error.[46]

Over in North America, the East and West coasts created a friendly feud between two modular synthesizer makes: Robert Moog and Don Buchla, both releasing their first synths in 1964. Moog's big innovation was the voltage-controlled oscillator. Buchla's modules were more customizable. Both have dozens of historic composers attached to their names, from Wendy Carlos, Bebe Barron, Liz Phillips, and Éliane Radigue. Ultimately, both synthesizers would contribute to the digital era in the 1980s in terms of digital workspace user interface design. When using DAW documentation for analysis, it is helpful to remember the roots of the interface's design.

Institutions in California were hubs of software programming for electronic music. Leland Smith and John Chowning at the Center for Computer Research and Musical Acoustics (CCRMA) in Stanford developed Common Music. This software was an object-

[44] 1955-56; composed at WDR; uses graphic notation
[45] 1958-60; hailed as the acme of Germanic parameterization
[46] d'Escriván, *Music Technology*, 183.

oriented music composition environment that produces sound by transforming high-level representations of musical structures into a variety of control protocols for sound synthesis and display including MIDI, Csound, Common Lisp Music, Music Kit, C Mix, C Music, M4C, RT, Mix, VRML, and Common Music Notation.[47] Not only did Smith and Chowning create one of the first true digital audio workspaces, but Smith also developed the first computer program for traditional music notation. These programs for traditional notation allowed composers to work on acoustic composition on their computers, and facilitated creating compositions that use both DAWs and acoustic performers.

From such a list of protocols for sound synthesis, how could a composer possibly choose the "best" option? Their use in notation programs is one important consideration. David Cope's outline of the five advantages of using computer notation programs provides some guidance:

> 1. Readability: scores approach engraved quality; 2. Editing: simple to make corrections; 3. Flexibility: easy to rearrange measure distribution for page turns and score layout; 4. Extractions: parts can be extracted in seconds in transposition; 5. Versatility: pages can be rearranged quickly in a variety of ways for readability… Typically, musical symbols are placed on staves in one of three ways: from the standard ASCII keyboard, by use of the mouse, or by using a synthesizer keyboard…Music can also be notated by performing music on a piano-style keyboard connected to computers through MIDI interfaces. This process typically produces quite ugly results since humans are not rhythmically accurate. Quantizing is often used to round off the rhythmic complexities.[48]

[47] Cope *New Directions in Music*, 148.
[48] Cope, *New Directions in Music*, 150.

Composers creating works with both electronics and acoustic instruments could score in both programs. This set an important precedent for the works in the digital era, in 1984 and beyond, that do just that. Of the sound synthesis protocols listed above, MIDI – as Cope notes – is the default choice for interfacing multiple machines and software.

Mid-century sound in video was evolving as fast as its technology. Academic research and philosophies about audiovisual media appeared, mostly borrowing Schaefferian vocabulary. Looking back on the time, Julio d'Escriván notes three aesthetic strands developed from electronic music for moving images: 1. A 'natural' aesthetic: "acoustic music is recorded, produced and edited on digital systems and a virtual performance of the piece is arranged and mixed to suit the visuals." 2. An 'electronic' aesthetic: "music that owes its discourse to traditional musical forms but is made with electronic instruments. Works like Vangelis' music for *Blade Runner* and *Chariots of Fire*, [Wendy] Carlos' *Clockwork Orange*." 3. An 'organised sound' aesthetic (a la Edgard Varèse): "music that is structured around *sound objects*, without necessary reference to melody or harmony" such as *Forbidden Planet* by Bebe and Louis Barron.[49] These three aesthetics continued on separate paths, using the same technology but fostered from different ideologies, career practices, and cultural values. These aesthetic strands loosely relate to *musique concrete, elektronische Musik*, and synthesizer music, respectively. For all three, the composers largely forego any kind of score, but the collaboration crew working on the visuals devise some form of

[49] d'Escriván, *Music Technology*, 163; emphasis original.

documentation or scoring to denote matching up the sounds and images. I will touch on this further with Nicholas Cook's multimedia theory in chapter five.

A new notational paradigm: The Static Artifact

In many cases, a composer has a dossier of documents or artifacts that contribute to the performance, realization, and/or analysis of the composition. As Simon Emmerson frames it,

> Scores for electroacoustic music exist, of course, but have a variety of functions: for performance with instruments or over complex loudspeaker systems, or simply for reading and background information, but rarely for the re-creation of the work itself. The score moves away from prescription towards description. The emphasis is in all cases away from a reliance upon the written hieroglyph as a means to express, or at least transmit, musical utterance.[50]

I argue that it is imperative that the analyst look to these documents as a part of their analysis, understand their roles as descriptive or prescriptive models, and not only perform aural analysis.

It may help to give this dossier of varied documents a name. For this multitude and variety of descriptive as well as prescriptive items, I propose the term *static artifact*, which refers to the written documents of electronic music. I situate this term as something greater than a score, but somewhat more specific than *trace* as defined by Jean-Jacques Nattiez.[51]

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[50] Emmerson, *The Language of Electroacoustic Music*, 2.

[51] Origin: Nattiez, Jean-Jacques. *Music and Discourse: Toward a Semiology of Music*. The "material trace," coined by Nattiez and anglicized by Molino, is the neutral, objective, and autographic manifestation of a thing. For the specific case of music, the 'notational trace' [from Nicholas Cook's "Theorizing Musical Meaning"

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

The static artifact is the non-dynamic visual imprint that defines a piece and/or directly shapes its interpretation. This can include computer code, graphic written instructions to the performer, traditional or extended (or invented) notation, stage directions, spatial charts, graphs, and maps, and program notes.

I selected this pair of words carefully to distinguish the terms from their antonyms or other potential connotations. Specifying "static" explicitly omits "dynamic" scores, i.e. scores that change, are changeable, or are generated in real time. For example, the scores for aleatoric music, both electronic and not, that are altered by act of realization are not under the purview of the static artifact. Nor are scores auto-generated by a DAW or other electronic system necessarily different with each performance or realization; the inputs or systems that designed the generative process, however, could be considered static artifacts.

Furthermore, I chose "artifact" over other options, such as "object" or "product," for the specific set of connotations the word carries. For example, an artifact is stable; it is not ongoing. A composer's continually updated journal is not an artifact – but an archived journal might be. An artifact is manmade. "Found" scores, such Yoko Ono's *Sun Piece*,[52] are not artifacts. Finally, an artifact uses symbolic signs. Text scores and most types of notation

(2001) is the score "supplemented or substituted by the multiple acoustic traces of performances and recordings" (179).)]. In short, a trace is an instance of manifestation. What we call "the piece" is the aggregate of all existing traces. My term "static artifact" applies to notational traces and other visual traces, with the stipulation that they be fixed and immutable, and not dynamic or changeable like a fully aleatoric or generative score.

[52] The text she provides is certainly part of the static artifact. However, the 'found score' I describe here is the sun, Ono instructs the performer to look at the sun as the music.

fall into this category. The following table explores different kinds of materials that may be found in static artifacts, which I group into three broad categories:

Symbolic Notation	Text-based Notation	Graphic Scores / Diagrams
Traditionally notated scores (five-line staff)	Composer's journal	Spectrographic representation
Alternate notation scores (e.g. Equiton)	Program notes	Abstract drawings
Dance choreography, or other staging instructions	Academic article with self-analysis	Stage layout diagrams
Cue symbols	Computer code (could also be symbolic if a graphical programming language like Max)	Patch diagrams made in GPLs like Max (could also be text-based)
Descriptive symbols	Libretto	Digital audio workspaces (and screenshots of them)

Table 1.1 A table of kinds of documents that can constitute a static artifact. Sorted by notation-type.

These categories have a mix of descriptive and prescriptive notations, and a static artifact is most useful when it contains both. For instance, prescriptive traditional notation instructs the performer, and the analyst has an idea of what actions the performer does. In McLean's *Desert Voices*, the violinist reads the prescriptive notation to know what pitches to play and when. Descriptive symbols, separate traditional notation or added to it, like abstracted drawings of pitch bends, inform the performer and analyst what happens after the instructions are completed, and guides the ear to key into the electronic modifications. Cue markings on a score that refer to and are descriptive of Max patch charts, as seen in the McLean example.

Spectrographic representations, which are sometimes used as in or lieu of scores, are part of the static artifact if constructed by the composer, but not when constructed by an analyst. Spectrograms are symbolic insofar as they are inherently a creative visualization of

sonic data, and their purpose is to denote concrete truths and data, whereas musical notation and written language is much more abstract. In the next chapter I will discuss how spectrograms are treated by composers and theorists for composition, performance, and analysis.

Musical notation comes in many forms and is used for a variety of purposes. Musicologist Peter Winkler muses on the role of transcription:

> What exactly do I do when I make a transcription? What happens when I represent recorded sound in graphic form? What is the relation of my transcription to the actual recorded sound? What does transcription help me learn or discover? Are there things that the act of transcription obscures or minimizes? What are my motivations for making a transcription? Do the uses to which a transcription is put have deeper social and political implications?[53]

Though the act of transcription has a different purpose than compositional notation, these are a few of the same questions composers ask themselves when creating new or modified notation for their works, too.

I have these same questions as a music theorist, but for electroacoustic music with a compositional score. Whether it is an abstract graphic score or a quasi-traditionally notated score, I want to know how this helps me understand the music, and how it relates to the sounds themselves, and what this representation means on other levels. In using modern lenses intended for the analysis of electroacoustic music, does analyzing the written artifact contribute to overall analysis of the piece as a whole? I argue that the notation holds clues – if not outright solutions – to questions of formal organization, sonic transformation, and

[53] Winkler, *Keeping Score*, 170.

parametric focus. In particular, many of my case studies use psychoacoustic tricks as part of the craft, and reading the notation helps see through the fog.

The changing notation and landscape of electronic music in the late twentieth century

Trevor Wishart stated that "Western music has become too dependent on notation to the point of distorting its evolution: it has become too constrained by the two-dimensional latticework of striated pitch and rhythm."[54] This assertion would become the basis of is anti-scores, which I will discuss in depth later in this dissertation. It was also relevant to the huge technological development that caused a major shift in how composers operated at large: The Musical Instrument Digital Interface (MIDI).

What MIDI is

MIDI is a sequential data protocol, and any hardware or software that is MIDI-compatible (which is the vast majority of all hardware and software today) can communicate information. The acronym stands for "Musical Instrument Digital Interface."[55] It discretely parameterizes three sonic elements (pitch, duration, and volume) into 128 levels. Combining and sequencing MIDI data can create, transmit, synthesize, and output millions of different sounds.

[54] Wishart, *On Sonic Art*, 11.
[55] It was originally named the Universal Synthesizer Interface (USI), but they opted for a more specifically musical name in the end.

Throughout the 1970s, dozens of companies developed hardware and software for electronic music. Companies built alliances and made their products compatible with one another, while feuding companies ensured their products would never mix in a musician's set-up. In 1981, the hardware company Roland decided to begin development on a new protocol that would unify the signal that connects hardware to the sound generator regardless of manufacturer.

What has MIDI done to music?

MIDI was an important step towards the digital era, as it did not use tape and could be saved on a disk using little space. As musicologist Elizabeth Hinkle-Turner explains, "Personal computers and MIDI technology freed many composers from the need to…maintain access to extensive electroacoustic resources [like] costly equipment such as supercomputers and professional multi-track tape desks"[56] Academies and universities continued to support expensive and elaborate projects that involved such resources, but almost anyone had access to a personal computer and MIDI technology.

Before MIDI, the hardware for electronic composition was expensive and available only to a small portion of the creative population. Hinkle-Turner tells the story as such:

> Composers associated with educational and research institutions, popular artists with plenty of money to spend on studio time and equipment, and the few lucky individuals who each year received NEA funding and other grants were the only ones allowed the luxuries of time and resources to experiment with synthesized sounds. However, during the 1980s this scenario changed

[56] Hinkle-Turner, *Women Composers and Music Technology,* 119.

> dramatically with the introduction of the Apple Macintosh, Atari and Amiga personal computers and the creation of the MIDI standard for the integration and transmission of musical information between computers and electroacoustic sound modules. Both of these developments significantly decreased the expense, training requirements, maintenance and sheer size and weight of the tools for electroacoustic music generation.[57]

The clinching factors pushing computer music into the digital era were the cost-efficiency and future-proofing.[58] Artists and performers needed less redundant equipment, and MIDI-compatible personal computers were increasingly affordable and powerful each passing year. New equipment with more abilities, processing power, etc. would continue to use the MIDI protocol, so older creations could continue to be performed and worked on into the new century.[59]

1983 was an important year in electroacoustic history for a number of reasons, including first the introduction of MIDI and, secondly, the advance of the personal computer. First, the roll-out of MIDI, the new universal language for hardware and software. Creator Ikutaro Kakehashi says he was inspired by Esperanto, an invented language that was invented to be a neutral universal language for all people and cultures. This universal communication opened the door for composers and arrangers to use more tools and make more complex pieces. It was an important step for live processing and live electronics as well.

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[57] Hinkle-Turner, *Women Composers and Music Technology*, 118.
[58] Cope, *New Directions in Music*, 152.
[59] This statement remains true today. MIDI 2.0 was announced in 2019 and is rolling out slowly in 2020, but MIDI 2.0 is also backwards-compatible and the slow rollout means individuals and companies are not so rapidly scrapping the old to make room for the new.

Kakehashi attests that MIDI was the most important thing to happen to electronic music since the invention of electricity.

> With the adoption of MIDI, electronic musical instruments for the first time gained the capability to communicate with other devices. MIDI brought many benefits, including the improvement of sound and functionality through digital control… The emergence of this functionality brought an end to an era in which musical instruments were limited to the world of music.[60]

It also ushered in an era of audiovisual fusion. This statement inspired me to examine multimedia works for this dissertation. While not all the case studies fuse video and music per se, all of them fuse many kinds of art and design that would have been difficult if not impossible in the pre-MIDI era.

The MIDI protocol was equally important for academic electroacoustic music and for electronic pop music. "The tipping point in the accessibility of digital music technology came in 1983 with the release of the Yamaha DX-7, a programmable digital music synthesizer."[61] The DX-7, the first commercial synthesizer with MIDI was priced at a mere $2000, a fifty-fold difference from previous hardware with similar capacity. It was not only inexpensive; "its programmability made the possibilities of music creation quite interesting. Yamaha most likely sold 160,000 of these synthesizers between 1983 and 1988, permanently changing the world of electronic music and democratizing access to sound synthesis equipment."[62] The

[60] Kakehashi, *An Age Without Samples,* 145.
[61] Schedel 2017,"Electronic Music and the Studio," 30.
[62] Schedel, "Electronic Music and the Studio," 30.

DX-7 is often heralded as one of the most influential instruments in popular music, and it was as powerful and inexpensive as it was thanks to MIDI.[63]

Another major advantage of MIDI is that it can also interface with non-musical data; anything that can be quantized is fair game, and artists can easily add complementary equipment. Theorist Julio d'Escriván explains that the MIDI Machine Control (MMC) "appeared as a result of needing to control multitrack recorders, while MIDI Show Control (MSC) is a subset of real-time system exclusive messages for communicating show devices (lighting, video, music, pyrotechnics and animatronics can be sequenced on show-control software to coordinate them in complex cues.)"[64] From the beginning, not only could MIDI unite all the software and hardware that go into making music and sound, but also anything that makes visuals, animatronics, and so forth precisely because anything that can be parameterized in integers can be mapped to MIDI numbering and implemented in a multimedia setting.

Secondly, in the 1980s, computers became smaller, cheaper, and better – and by 1984, the personal computer became a staple for composers. Personal computers could do more and more simultaneous and robust processes. People were writing programs for computers that cut sound processing time by a large margin, and computers could perform and coordinate more and more complex tasks. Research into developing MIDI began the same year Microsoft launched their first personal computers, which opened the possibility of

[63] For more detail, theorist Megan Lavengood has published articles and book chapters on the Yamaha DX-7.
[64] d'Escriván *Music Technology,* 71.

having one central device to control and interpret signals to and from attached hardware. Microsoft and Apple adopted MIDI for sound synthesis quickly, and thus most home computers by the mid-1980s used MIDI.

By the 1990s, many homes had a home computer, and by the 2000s it was not unusual for adults to have their own laptop to take with them. For composers, this moved them away from labs and studios into their own living rooms and offices; music making became less social in this regard, but more efficient because they did not have to share. This also allowed more and more amateurs access to the same kinds of software and hardware as the professionals, and more people could compose.

Hardware and software can still be quite expensive, and composition still has a monetary barrier of entry, but it is a far less than what it used to be. Universities may also offer studio equipment and software licenses for students and professors, and therefore there has been a gradual move of composers from studios like Cologne and Paris to the university.

With the rise of home computing – and home electronic composition – came the rise of flexible analysis. Music analysts could use their programs to analyze soundwaves, and could also use the same compositional tools composers used, making the music less mysterious. Analytical tools like AudioSculpt, SPEAR, and SonicVisualiser came out of both large studios like IRCAM and private home studios like Michael Klingbeil's. Inevitably, there was philosophical cross-over for those who worked as both theorists and composers like Otto Laske and Trevor Wishart, and composers like Paulo Chagas began to adopt

theoreticians' vocabulary when writing about their music and the music of their contemporaries.

Third, in the music theory realm there was a rise in music cognition and psychoacoustics. Lerdahl and Jackendoff published *Generative Theory of Tonal Music* in 1983, and composers like James Tenney, Roger Shepard, and Peter Manning were working on aural illusions and their function. Novel and imaginative sounds and sound movements came into the limelight in the 1980s, and electronic music making became more haute and widespread than ever.

In this same vein, the 1980s saw a new rise in phenomenological study, with philosophers Husserl and Merleau-Ponty at the forefront and music theorists like Judy Lochhead and David Lewin translating their concepts into musical terms. This paradigm is particularly aurally oriented, taking Schaefferian reduced listening to a new level of analytical awareness. I will discuss this in more detail in chapter 2.

These new lenses did not provide clear focus on electroacoustic music made on home computers, however. Programs, program languages, and protocols were revamped to adopt MIDI and harness its potential processes, such Csound; others were invented after, like Max and Ableton born right in the cradle of universal electronic communication. These became the industry digital audio workspaces (DAWs) and changed the shape of electronically written scores even further from the origins of common practice notation. Each DAW features a sonological representation, and some can take music-analytical representation as

inputs (e.g., an interface resembling a piano scroll that human composers can manipulate within familiar parameters as piano composition), but these images are rarely published and difficult to translate, especially when the music employs aural illusions or novel sounds that may best be analyzed with a psychoacoustics or music cognition lens. These lenses are essential, of course, but this movement further from the purview of musical analysis as music has been detrimental to the acceptance of MIDI-mediated electroacoustic music in the eyes of academic music theory, broadly.

It is clear to see that there are numerous benefits and drawbacks of MIDI on the field of electronic music. One of my overarching research problems is that despite the universality of MIDI, that was designed to be some kind of musical Esperanto, there is no universal notation system that goes with it. In fact, there is the opposite: MIDI has exacerbated the branching evolution of musical notation and supports a wide variety of notation styles, from graphic to text, from descriptive to prescriptive. That is why I have chosen to address specifically compositional static artifacts in the MIDI era.

Composition in the Age of MIDI (1983-2020)

Without codified notation systems, analysis of electroacoustic music has adapted to using performance and recordings more than written scores or artifacts. Simon Emmerson asserts that electroacoustic music study has transitioned from score-as-object-of-study to performance analysis because “the finished work instantiates an idealized performance –

only one which did not happen at a particular time."[65] In Emmerson's paradigm, the composition is realized in a performance and frozen in a recording; any written material resembling a score is a map at best, and does not readily encapsulate or represent the composition.

Theorist Thomas DeLio agrees with Emmerson but adds that the analyst needs to make a written artifact to represent and communicate the sonic elements. He suggests spectrograms paired with detailed verbal descriptions. In this paradigm, the spectrograph is the truest possible representation of the musical work, operating under Emmerson's paradigm that the composition is realized in a performance and frozen in a recording. DeLio essentially recommends transliterating that frozen recording into an image, and doing the same kind of sound-as-object-of-study rather than score.

Composer Barry Truax remarked that

> it is these new processes [including the MIDI protocol] afforded by computer music software which are the most influential in changing the language of contemporary electroacoustic music. …A fundamental trait of the practice of electroacoustic music is that the composer composes the sound itself as well as the structure in which it appears.[66]

Truax is best known for his acousmatic soundscapes, and this statement certainly rings true for him and his colleagues. 'Composing the sound itself' is, as discussed previously, a trait of

[65] Emmerson, *Living Electronic Music*, 25.
[66] Truax, "The Aesthetics of Computer Music," 156.

electroacoustic music since before 1983, but the invention and rapid distribution of the MIDI protocol influenced how composers go about this.

The 1980s brought about a shift in musical programming languages. They moved beyond linear processing languages like MUSIC-N to object-oriented languages like C, Lisp, and Python. Max (now Max/MSP) was developed in 1985 by Miller S. Puckette at IRCAM. It was the first programming language for MIDI with a graphic interface, and reciprocatively inspired DAWs through the 1990s to today. It was also one of the first commercially available languages to enable interactive sound; rather than simply make a patch and run it, patches could be changed mid-performance, or they could be programmed to react to live inputs. To this day, Max is a standard for interactive musical programming. In 1996, Puckette released a redesign of Max he called Pure Data (Pd), which also uses graphic patches and is ideal for interactive sound.

Computer music became a more prevalent and varied style as computers themselves became more prevalent and able to perform more tasks. MIDI has been part and parcel of electronic music made on personal computers from the beginning of the personal computer era. This includes all digital audio workspaces (DAWs), which are software programs designed to emulate the modular synthesizer, the electronic studio, and the electronic instrument all rolled up into one packaged user interface. Composers working within DAWs found themselves with everything they ever worked with or wanted to work with at their disposal. Truax accurately points out that the composer of electroacoustic music composes the sound itself as well as the structure; extrapolating this one step further, the personal

computer and its MIDI-compatible software was instrumental in the rise of granular composition, spectralism, live electronics, live diffusion and spatialization, and multimedia compositions.

As discussed previously, the laptop became a key tool for electronic composers in the 1990s, especially for those incorporating real-time sound and live performance into their works. The personal computer was much smaller and more affordable than its predecessors largely thanks to microchips. On a personal computer, a composer could create effects like reverb, echo, and pitch shifting with envelope generators and filters. They could work with samples in a multichannel sequencer, effect real-time sound processing, and even design their own digital synthesizer with additive FM synthesis. They could expand the hardware by hooking up a piano-style keyboard with custom tunings and microtonality, and interactive video displays allowed the composer or performing to write and read music notation, graphic analysis, and graphic patches in a DAW. These styles will be addressed in the next chapter, and each has bearing on the case studies.

Scores, of course, changed as well, in part due to the native graphic user interface of a DAW and in part due to the new variety of music and methods of composing sound and music. The MUSIC computer language strongly influenced design in many early DAWs as much as it influenced other computer languages used for composition. Elizabeth Hinkle-Turner states,

> In many ways, MIDI software design emulated the same principles implemented by the MUSIC series of computer languages: the software provided a ‘score’ or

> instructions indicating how a synthesizer should perform a series of different stored timbres. These sequencer programs became invaluable to electroacoustic musicians for the creation of an in-person and live performance.[67]

In the context of DAWs and other computer music or music strongly reliant on a computer, the 'score' could no longer only be described as the instructions to the performer to realize the music. Rather, the score includes the instructions to the computer, or from the computer to the instrument or sound emanator. These instructions do not use a five-line staff notation but are somehow 'notated' nonetheless.

Composition at studios in the 1990s

These DAW paradigms influenced the compositional practices and output in studios across the globe in 1990s. For instance, Cologne's WDR studio adopted Pro Tools and switched to entirely digital tools in 1995. Accounts from Karlheinz Stockhausen, Paulo Chagas, Jean-Claude Eloy and Denys Bouliane describe how the switch impacted working methods, as the digital apparatuses demanded new skills from the engineers and technicians, opening a process of spatialisation that at the same time, led to a loss of the technical autonomy of those involved in the production process.[68] The new spatialization is a key element of Chagas's output in the 1990s, and will be described in detail in his case study chapter.

Paris's IRCAM, founded in 1977, took over GRM as the leading French electronic studio. There, Miller Puckette invented Max/MSP in the 1980s and Pure Data in the 1990s,

[67] Hinkle-Turner, *Women Composers and Music Technology,* 118.
[68] Chagas, *Unsayable Music,* 2014, 154.

which would become the seminal visual programming languages in the twenty-first century. Several composers at IRCAM subscribed to and continued evolving the *musique concrete* practice using these programming languages and DAWs inspired by them. I would posit that the directions these composers took in the 1980s with aural illusions and spatialized gestures are a direct evolution of that *concrete* style. Composers like Philippe Hurel used the new technology to great effect to invent novel sounds and concoct aural illusions in their pieces.

In the United States and England, electronic studios were established in universities and radio stations both in the early stages of electroacoustic music and into the end of the century. These studios contributed technological research as well as art and music. Departmental studios, like the Center for Research in Electronic Art and Technology (CREATE) at University of California Santa Barbara, fostered experimentation and blending styles. Composers like Anne Deane Berman created intertextual and interdisciplinary works (which she prefers to call “animated poetry”), as composers in a university setting have perhaps easier access to other experts and artists in different fields. In the United Kingdom, Trevor Wishart became one of the most notable English composers for his creative blending of voice and technology, creating a new kind of electronic music built around semi-semiotically coherent gibberish and notated in an anti-score. It is for these reasons I chose pieces from these composers for my case studies.

New genres, protocols, and styles for the end of the century

As I have touched on, the MIDI protocol also influenced audiovisual coordination and multimedia. Movies and television have combined visuals and audio since the 1930s, but the birth of MIDI took audiovisual composition and correlation to new levels. This appeared first in music industry studios that put out official music videos; however, personal computers were still not yet powerful enough for intense audiovisual processing. As technology progressed, however, new forms and genres of audiovisual art became possible, and older forms and genres developed in new ways.

For example, composer Robert Ashley created a new genre, opera-for-television, starting in the 1970s. He transitioned to MIDI-based instruments in 1985.[69] He began actively considering MIDI in his compositional process in 1995 when beginning to compose *Automatic Writing* (1996), one of his most famous works. The resulting television-operas are more elaborate and more synergetic than his pre-MIDI works; he notes in his book that the technological improvements after MIDI gave him more confidence that the final product would accurately match his mental picture of how the music would sound and line up with the visual and narrative elements.[70] Composer Trevor Wishart had similar feelings, which I will discuss in my case study on his theatrical composition *Scylla and Charybdis*.

[69] He transitioned after the premiere of *Perfect Lives* (1983), which he composed in 1980-82 pre-MIDI, but was broadcast on the BBC with technology that did use early MIDI. From Gann 2012.
[70] Ashley, *Outside of Time*, 120.

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

Spatialization is one of the longest-established features in electroacoustic music. Electronic playback systems allow composers to move sounds away from their sources and place them anywhere and in any number. Varèse's and Xenakis's works at the Brussels World Fair demonstrate the extent of mid-century spatialization techniques. After experiencing the impressive realization of his *Poème Électronique* at the Brussels World Fair, Varese updated his working definition of music to "the corporealization of the intelligence that is in sound."[71] Even in the 1950s at the early stages of electronic music, Varèse recognized the power of electronic spatialization in music, and adjusted his purview and vocabulary to include spatialization and diffusion as core musical elements.

MIDI was also a major influence in how electroacoustic music could be spatialized and diffused in a multichannel set-up. Live spatial movement, made possible by MIDI, is a critical component in two of my case studies (Hurel and Chagas). This advancement presented new possibilities for a number of varieties of electronic music, from pieces composed for the concert hall to the development of soundscapes and related genres that capitalize on the immersive possibilities of spatialization. Space is inherently a structural element in electroacoustic music because it comes out of speakers, and the arrangement of the speakers influences how the audience experiences the sound. For many composers,

[71] Varèse, Edgard. "The Liberation of Sound" from a lecture given at Sarah Lawrence College, 1959. He acknowledges that his definition draws from Hoëne Wronsky. Published in *Contemporary Composers on Contemporary Music* edited by Elliott Schwartz and Barney Childs, 1998.

spatial movement is a primary component of the music, as much as pitch and rhythm have been in traditional Western music.

Decades later, with the MIDI protocol, spatialization took on another layer of potential complexity with the MIDI protocol. Software like Ableton and Max can emulate spatialization in a stereo setting (e.g. headphones). Combined with physical spatialization (placement of speakers, arrangement of audience seating, etc.), the possibilities are practically endless.

Paulo Chagas identifies space as the most unique and important aspect of electroacoustic music as apart from traditional music. He writes,

> Space is the structural element of electroacoustic music. The acoustic properties of the performance hall play an important role in determining how the listener perceives the music [e.g. reverberation affects clarity, liveness, and localization]… Sound spatialisation, a crucial aspect of electroacoustic music performance, is in fact a virtual construction of sound space; the virtual space can be generated by the composition itself as with multi-channel electroacoustic music, or added as a new layer of aural experience in the performance as with acousmatic music performed with loudspeaker orchestra.[72]

In developing a language to analyze and discuss electroacoustic music in "On Spectromorphology," Denis Smalley identifies five dimensions of consideration for spatialization. These are spectral space, time as space, resonance, spatial articulation in composition, and transference of composed spatial articulation into the listening

[72] Chagas, *Unsayable Music*, 228-9.

environment.[73] Any of these on their own or combined could be a formal or structural component in composition. All four of my case studies use some combination of these five dimensions, and all four notate the space and movement in different ways.

In *Sonic Mediations: Body, Sound, Technology* (2009), Tania Riikonen proposes three concepts of spatial production based on philosopher Henri Lefebvre's spatialization theory: spatial practice "defines the relationship of local to global; the representations of this relationship; actions and signs; the trivialized spaces of everyday life," representations of space are "conceptualised space with significant authority, as the origin of various discourses and signs," and representational space is "directly lived through its associated images and symbols which overlays physical space, making symbolic use of its objects."[74]

Composer Natasha Barrett offers a list of four main compositional approaches to composed space in post-MIDI electroacoustic music. Most electronic composers, whether writing a "spatialized" piece of not, are cognizant of these types of space and how the audience may perceive them.

1. "The illusion of space or spatial location of an object created by either spatial acoustic cues, image sizes, image motions or object relationships in terms of volume, frequency colouration or relative motion velocities." [Barrett cites *Angels & Devils* (2002, Barrett) and *Argon* (1998, Horacio Vaggione) as examples].
2. "The allusion to a space or spatial location of an object created by associating the sound with, or by placing the sound within, a space that is appropriate based on its identity." Emmerson (1998) points out how soundscapes work by evoking a scene

[73] Smalley, "The Listening Imagination," 90.
[74] Riikonen, "Producing Microscopic Embodied Spaces," 145.

related to visual experience, and 'the science of acoustics cannot any longer alone explain sound phenomena and requires psychological and ecological dimensions'

3. "The simulation and recreation of three-dimensional sound fields (with ambisonics or wavefield synthesis) results in spatial clarification by doing away with ambiguous phantom imaging and allows the direct transmission, without performance interpretation, of spatial information to the listener." Hear *My Exploration Invisibilis* (Barrett, 2003) for an example.
4. "The effect of the listener's space is important to all public and private situations." Think of Lucier's *I am sitting in a room* (1970) and how it uses the acoustics of the recording/performing space *as* the composition. See also Bill Fontana's *Sculpture with Resonators* (1972-5) with microphones placed inside bottles, tubes, and seashells."[75]

All four require different kinds of notation. Parallel to spatialization, MIDI was also a major component in propelling research and development in virtual reality. David Cope wrote in 2001,

> Virtual Reality (VR) integrates visual images and music without the need for a traditional performance space (Barfield and Furness 1995). Most VR involves wearing some sort of helmet that surrounds the participants' eyes and ears encasing them in a separate sensual environment. By controlling various joysticks and levers, participants then interact with their perceived reality. VR typically involves games with various three-dimensional figures who act and react very much the way humans would. Music contributes to VR by complementing or competing with the visual images. Music can range from simple sound effects triggered by VR interactive events to complicated background music accompanying the action. Imaginative composers have extended these possibilities and have created elaborate sonic landscapes in which sound becomes the focal point, rather than the supporter of the visual imagery.[76]

[75] Barrett 2002, 313-315.
[76] Cope, *New Directions in Music*, 124.

Chapter 1: The State of Electroacoustic Analysis & The Static Artifact

VR has not fundamentally changed since 2001; only the technology has become more precise, allowing works to be realized with more fidelity to the composer's goal. VR and augmented reality (AR) have been used widely for soundscapes and soundwalks. For example, in Pauline Minevich's *Art of Immersive Soundscapes* (2013), she references several soundscapes and soundwalks from the late 1980s and 1990s for which the Max/MSP patches are the equivalent to a score, in her esteem. For many soundscape installations or other such immersive environments, especially using virtual reality gear in the 21st century, the DAW and the implementation in software fills in for a notated score most closely. The DAW reveals how sounds and sound objects are made and how they follow one another or interact with other elements.

All of these new genres are fascinating and certainly ripe for future research. Each of my case studies touch on at least one of them, and their relationships to new electronic genres are a component in choosing an appropriate framework for analysis. In the next chapter, I will discuss the general state of modern frameworks and paradigms for analyzing electroacoustic works.

Chapter 2: Electroacoustic Music Theory & Notation

Introduction

This chapter will discuss the relevant analytical methodologies for electroacoustic music and its associated notation. The last several decades have seen incredible advancements in music technology, yet there has been relatively little written on the analysis of modern electronic music and its nascent traditions. Here, I will highlight some important trends in electroacoustic analysis and twentieth-century score reading and analysis that I cite throughout the case studies.

In this discussion, I include descriptive and prescriptive notations, designed with different semiotic intentions. Put simply, descriptive notations symbolize the parameters of sounds actually heard by the listener, and are sometimes created after the music (e.g. transcriptions); prescriptive notations instruct the musician to realize a sound to certain parameters. Both can provide insights into the composer's artistic choices. Both can contribute to a static artifact for analysis. The following discussion will make use of both kinds of notation.

The focus of my dissertation is music with the following criteria: live electronics, fixed media, and live acoustic performance. The way the live electronics sound during a performance is contingent on the accuracy and timing of the human performers and their relationship to the fixed media. For this reason, it is a particularly tricky sort of composition to analyze. If the composer does not provide a score, then the analyst must rely on the

established methods of analysis for electroacoustic music that rely primarily on listening, or on spectrographic analysis. For a genre as flexible and variable as this, these analyses can only apply to the specific performance. If the composer does provide a prescriptive static artifact, then the analyst may also look to the composer's documentation to see how the elements relate and understand the potentiality of the piece. The analyst can then make a more generalized analysis that applies to the piece's range of possible realizations while using a specific performance more as an example case study. Should the analyst make a descriptive notation or visual of the piece, like a spectrogram or transcription, then their notation and analysis will be fittingly flexible to reflect the variability that may be present in performance. A static artifact that has both descriptive and prescriptive notation will provide the most support.

Therefore, I am proposing augmenting these existing analytical methods with a novel sort of score study, incorporating assessment of the static artifact with at least one other aural method to build a holistic and accurate analysis befitting this complicated electroacoustic genre. In my four case studies, the composers provide various amounts and types of prescriptive and descriptive notation. This amount of documentation and its variety is an excellent situation to start with, and it is not unusual for the genre. For each case study, I use the static artifact to decide a fitting analytical methodology, and in my analysis I use both my

aural analysis[77] and score study within the chosen paradigms to create a holistic analysis of the piece that includes its potential variation.

On Notation

Here, I summarize the history of notation to situate the issues composers faced with traditional and novel notation and analyzing with or without it. The shifting paradigm in both analysis and composition started long before the technological upheavals of the 1980s. Touching on the role of extended notation, graphic notation, and alternate notation systems pre-MIDI and after, in both composition and analysis, gives essential context to how electroacoustic analysis arrived at its current state, and how my work seeks to combine score study with the existing electroacoustic methods and models of analysis for a more holistic lens of multimedia works.

Boretz & Cone

Theorists Benjamin Boretz and Edward T. Cone have been at the forefront of notation studies for much of the latter twentieth century.[78] They have published several articles separately and as a team, and one of their greatest contributions to modern notation is their anthology *Perspectives of Notation and Performance*, published by Norton in 1976. Though this was published several years before MIDI changed the scene again, its topics are still common points of discussion even today.

[77] Though, my case study of Wishart's *Scylla and Charbydis* has no recorded performance, and I rely only on the static artifact for analysis.
[78] Boretz and Cone, *Perspectives of Notation and Performance.*

The volume contains, as the name suggests, essays on notation for electroacoustic music and extended techniques that appear throughout the latter half of the twentieth century, all of which are touched on to some extent by the case studies in this dissertation. The essays on electronic music articulate how new instruments are so difficult to notate (at least with traditional notation) and various attempts to sort things out.

One chapter, by composer Brian Fennelly, articulates the difference between acoustic notational practices and electroacoustic notational practice. One of his main findings is that "with the absence of available musical scores, the aural experience is the single point of departure for the analysis of electronic music."[79] Thus, the state of electroacoustic music analysis as of 1976 boils down to a necessary departure from score reading and into an emphasis on aural analysis and a phenomenological lens. While his purview is electroacoustic music without any sort of score from the 1960s and 70s, but the divide he notes continues, as we are aware, today. So, it is no mystery *why* analysts forgo score analysis – there is no score to examine, in many cases.

David Cline

Though he focuses on one non-electroacoustic composer, Morton Feldman (1926-1987), theorist David Cline's work[80] on graph notation sheds light on the post-WWII movement away from traditional notation and towards graph and graphic notation that would become common in DAWs by the end of the century. Cline shows how Feldman designed his

[79] Fennelly, "A Descriptive Language for the Analysis of Electronic Music," 117.
[80] Cline, *The Graph Music of Morton Feldman*.

own notation that was rooted in the conventions of traditional Western notation, but made modifications to better support the musical elements he wanted to highlight or use as primary parameters.

Feldman's symbols typically refer to musical events (e.g. sound objects) or the actions and gestures that resulted in musical events rather than the pitch and rhythm of traditional notation. His scores were intended to be prescriptive; musicians could read from them and play the music to his specifications. It was a different enough notation that many musicians, even today, balk at performing Feldman's scores because performing his works accurately requires extra study to learn his unique notation.

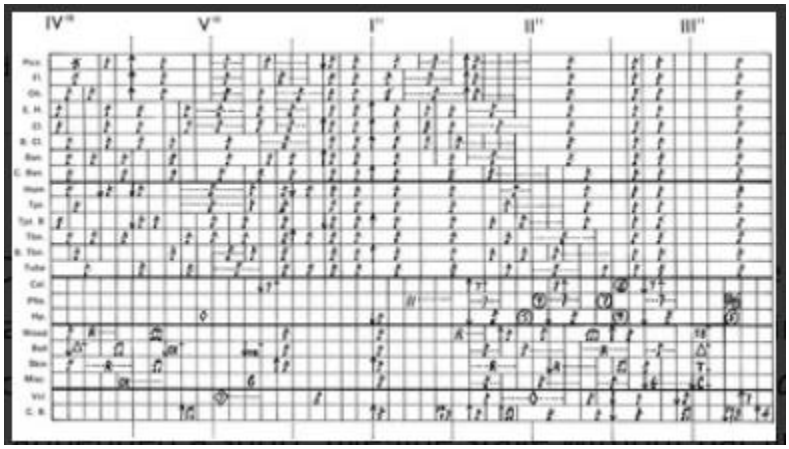


Figure 2.1 Excerpt of Morton Feldman's *In Search of an Orchestration* (1967)

That being said, Feldman's brand of graphic scores carried into modern-day DAWs – even though human performers struggled with the notation, it is easily legible for a computer. Modern DAWs use skeuomorphic[81] user interfaces that resemble analog synthesizers, and the

[81] *Skeuomorphism* is the practice of designing something to resemble its real-world or analog counterpart. It often carries connotations of 'outdated' and 'retro.'

visual output that supplants the score resembles a piano roll in some cases, and a Feldman graph in other cases.

The main difference between traditional notation or Feldman's graphs and the DAW visuals is that DAWs make descriptive notations, while the former options are prescriptive. This role shift has compounded the struggle for performers and analysts to read and understand the static artifact of electroacoustic music – it is not for them anymore. Thus, I take Cline's contribution to the field of notation as a case for the shift in prescriptive to descriptive notation in post-WWII music and more specifically electroacoustic music.

Kurt Stone

Kurt Stone's chapter "Problems and Methods of Notation" (1976) [82] and his book *Music Notation in the Twentieth-Century* (1980) [83] seek to address the hodgepodge of systems composers have concocted to express new styles of composition in the twentieth-century; I will focus on his description of electroacoustic notation. In his chapter "Problems and Methods," he remarks, "The chief trends of this development run in two very different directions: 1) toward uncompromising exactitude and predictability; 2) toward chance."[84] In other words, composers seem to either leave more to the performer or even to fate, or they exactly delineate parameters and sounds within a tenth of a decibel or a fraction of a Hertz. Some composers use modified or new symbols on a traditional five-line staff, but many abandon common-practice notation altogether. Stone proposes a number of notation systems

[82] Stone, "Problems and Methods of Notation."
[83] Stone, *Music Notation in the Twentieth-Century*.
[84] Stone, "Problems and Methods of Notation)," 9.

that he believes would facilitate what composers evidently desire. For instance, Stone recommends, at least for pitch-based music, that composers would find what they seek in Rodney Fawcett's invented notation Equiton, which removes the need for accidentals and permits unorthodox microtonality and rhythmic segmentation.

Throughout his chapter and book Stone finds or invents symbols and systems that he believes support what he has observed composers need. He never suggests one method over all others; he acknowledges that composers have different goals and focus on different parameters, and there is likely no one-size-fits-all system of notation. However, that does not mean there should not be a few codified and standardized systems that composers can choose from that analysts can readily understand.

Kurt Stone's major contributions were written in the 1970s before the MIDI protocol was even drafted, but his concerns with electroacoustic notation and the composer's intentions ring true in the MIDI era as well. Through the 1980s, when electronics and music made large evolutionary strides due to the global adoption of MIDI and the rise of the personal computer, theorists began to imagine new frameworks more broadly.

Trevor Wishart

It is difficult and currently futile to pinpoint a model or selection of models for a static artifact outside of the traditionally notation score. But they all relate in that they are composers' individual reactions to their personal trials with scores. To compare what is and is not a score, Wishart illustrates the difference in a *Greimas square*. In a Greimas square, they are all scores and not-scores. What other option is there, beyond things that are scores and things that are not-scores?

White / Scores	Not White / Not Scores
Not Black / Not Antiscores	Black / Antiscores

Table 2.1 A Greimas square with his famous white-black dichotomy, paired with the concept of Wishart's score-antiscore dichotomy.

According to composer-theorist Trevor Wishart the answer is, the *antiscore*. Wishart is one of the few who was acutely aware of this reactionary essence of score versus not-score, and so named his artifacts *antiscores* to distinguish them. [85]

It took Wishart twenty years to solidify the concept. Wishart was bothered by the emphasis on notation of two-dimensional "lattices" – especially those that centered exclusively around pitch and time. On a surface level, this is achieved by dividing musical elements and dimensions into several "sections," manifesting as graphics or text.

[85] See Wishart, *Audible Design* and *Sonic Art.*

Chapter 2: Electroacoustic Music Theory & Notation

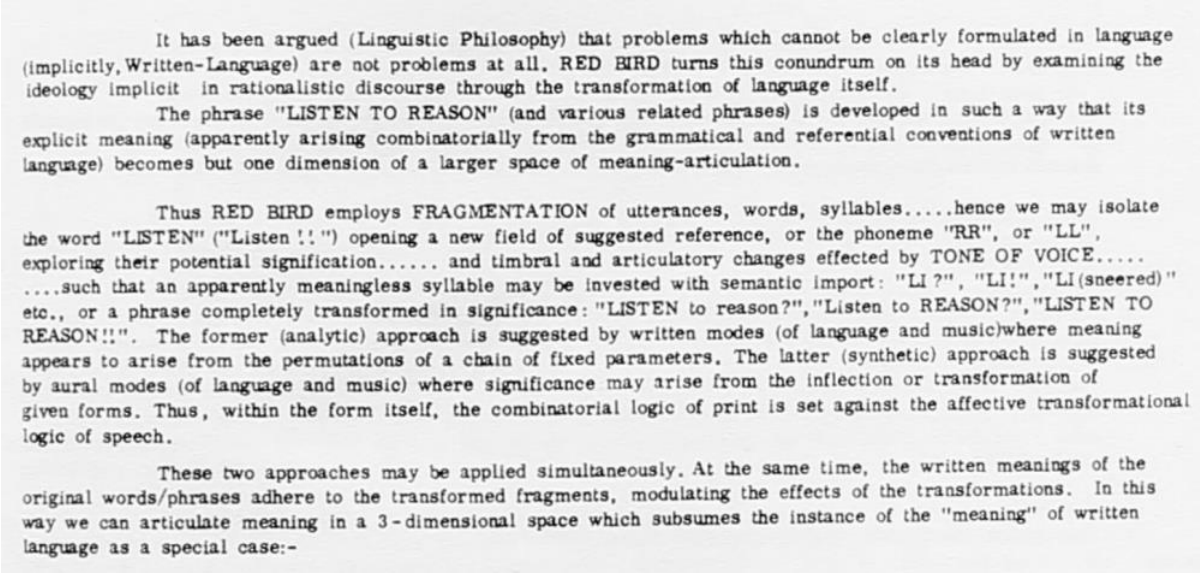
Between 1973, with his first antiscore *Journey into Space,* and 1996, with his book *On Sonic Art,* Wishart's style of antiscores evolved. In Wishart's first antiscore, his "travelogue" of *Journey-into-Space* (1973-5), he explains that an antiscore describes the process of creating an instance of sonic art with the express purpose of replacing the score for performance.[86] The antiscore of *Journey* reads like a journal of exploration in developing the piece. For this, the document is perhaps the most literal take on the definition of antiscore that he provides – sections of the antiscore resemble program notes or synthesizer patch diagrams, but never a *score*.

Journey illustrates another inherent quality of an antiscore: the sections are organized chronometrically, but only in reference to the creative process, not about or within the sonic art. While an analyst engaging with a score will analyze its pitch and rhythmic content primarily, an analyst with an antiscore can analyze a multitude of dimensions through reading a process, a series of rules, and a transformation of a sonic idea. With Wishart's homogenization of elements, the elements' contexts and functions are clear. He uses a number of charts, which are similar to scores in that they contain a number of elements in conjunction with one another. However, Wishart meticulously avoids having only two dimensions, instead focusing on one dimension at a time. Other than charts, *Journey* relies on text, which is mostly philosophical story telling.

Compared to *Journey,* the antiscore for Wishart's famous *Red Bird* (1973-1977) increases the sense of multidimensionality by continually recontextualizing sections in two-

[86] Wishart, *Journey-into-Space*.

or three-dimensional sections. This antiscore moves away from a one-dimension at a time, journal-style document but is still flush with philosophical writing. In *Red Bird*, Wishart emphasizes to the analyst that form is the most important element, writing, "the musical process is something which arises from the organisation of sounds (via notes on paper in the



It has been argued (Linguistic Philosophy) that problems which cannot be clearly formulated in language (implicitly, Written-Language) are not problems at all. RED BIRD turns this conundrum on its head by examining the ideology implicit in rationalistic discourse through the transformation of language itself.

The phrase "LISTEN TO REASON" (and various related phrases) is developed in such a way that its explicit meaning (apparently arising combinatorially from the grammatical and referential conventions of written language) becomes but one dimension of a larger space of meaning-articulation.

Thus RED BIRD employs FRAGMENTATION of utterances, words, syllables.....hence we may isolate the word "LISTEN" ("Listen !! ") opening a new field of suggested reference, or the phoneme "RR", or "LL", exploring their potential signification..... and timbral and articulatory changes effected by TONE OF VOICE..... ....such that an apparently meaningless syllable may be invested with semantic import: "LI ?", "LI!","LI(sneered)" etc., or a phrase completely transformed in significance: "LISTEN to reason?","Listen to REASON?","LISTEN TO REASON!!". The former (analytic) approach is suggested by written modes (of language and music)where meaning appears to arise from the permutations of a chain of fixed parameters. The latter (synthetic) approach is suggested by aural modes (of language and music) where significance may arise from the inflection or transformation of given forms. Thus, within the form itself, the combinatorial logic of print is set against the affective transformational logic of speech.

These two approaches may be applied simultaneously. At the same time, the written meanings of the original words/phrases adhere to the transformed fragments, modulating the effects of the transformations. In this way we can articulate meaning in a 3-dimensional space which subsumes the instance of the "meaning" of written language as a special case:-

Figure 2.2 A sample of Wishart's philosophizing, in a section on alinguistic philosophy in his *Red Bird* antiscore.

case of scored music)."[87] He also remarks that his antiscore is a document intended to "indicate certain routes towards an appreciation of [the dynamic aural] experience [that is music]," and that he does not explain the music but only shares the structure and philosophical dealings.[88] Analysts obsess over the speech transformation and spectral effects that Wishart used, but the antiscore he wrote is just as intriguing as it reveals a greater purpose to the electronics, and that his own analytical thoughts around the piece are centered

[87] "A Document" in Wishart's antiscore for *Red Bird.*
[88] "A Document" in Wishart's antiscore for *Red Bird.*

around its form. In the antiscore sections, Wishart continually recontextualizes the musical form with the other dimensions, not-so-subtly suggesting to an analyst that form is the most important element. Decades later, in his book *On Sonic Art*, Wishart would use sections of *Red Bird*'s antiscore for examples in various topics of form, of schema, and of metaphor.

All of this is to say that Wishart's concept of an antiscore is no mere hypothetical imagining, but rather a thought-out and finessed idea with very real applications. While the majority of electroacoustic composers argue over details about DAWs and create their personal notations, Wishart tackled the problem of electroacoustic notation head-on by creating the antiscore. I admire Wishart's creativity and excellent work. In my case study chapter on his dramatic work *Scylla and Charybdis*, I will further explore the antiscore and where it may be situated with my idea of the static artifact, and the analytical act of 'score analysis.'

Christian Dimpker

An example of the culmination of post-MIDI thought comes from Christian Dimpker,[89] who published a treatise on extended notation in 2013. The first half sought to compile and explain the new trends in notation for acoustic instruments in the twentieth and twenty-first centuries, such as codified symbols for microtones or percussive strikes. The second half is his treatise of the development of a coherent notation system for processes in electroacoustic music; like the first half, most of the content is cataloging more or less codified systems, but in this section he also proposes novel or hybridized systems based on

[89] Dimpker, *Extended Notation.*

his assessment of the systems in place today. He notes in the introduction to this second section that the lack of widespread notation in electroacoustic music is perhaps part of the reason notation has not become more codified, and that many notation systems come from an analytical point of view in order to study score-less electronic music, such as Stockhausen's famous realization score of *Telemusik* (1969).

Like Stone he does not imagine one global Esperanto of notation, but he does suggest much broader offerings. He offers three separate families of notation systems. The first corresponds to the production of sound materials; code, audio signal charts,[90] parameters of frequency etc. described in decibels or volts, and so forth. This is the most "scientific" and objective system, but it does not treat the music as *music* but rather as unmeaningful organized sound. The second system corresponds to the steps of editing and mixing, to elements like temporal organization and spatialization. This second system is based on Stockhausen's *Telemusik* realization score. It focuses on the composer's intent and the musicality the composer applies to the electronic sounds. The third system "is used to organise the diffusion of an electroacoustic work, e.g. in concerts. It consists mainly of a graphic representation of the score, as used in the secondary system."[91] This third system pertains more to performance and realization than the composer's process or intention. Dimpker suggests that analysis may be done on any of the three systems, and I argue that it would be ideal to perform a combination analysis using two or all three where possible.

[90] Such as Luigi Nono's *A Pierre* (1996).
[91] Dimpker, *Extended Notation,* 210.

Dimpker's treatise has contributed to the codification and cataloging of systems and methods of electroacoustic notation, which is an important step towards understanding these systems from a theoretical standpoint and implementing them in analysis. Between the four case studies in this dissertation all three of Dimpker's system types are implemented, and there are often two at a time. The various analytical methods I apply lean on different notation systems, and it important to identify the kind of notation system the composition uses before diving into analysis.

Attempts to establish a language of analysis

By the 1980s, academics and composers had not settled on a codified, standardized way of talking about electroacoustic music despite its decades of progress. Indeed, to this day they still have not, largely because there are so many different styles, practices, and schools of thought surrounding electroacoustic music composition and performance. But after so many decades of disparate research and practice, theorists began to propose frameworks specifically for the new medium.

Many believe, and I agree, that it is crucial that electroacoustic music develop its own words separate from acoustic music. As theorist David Keane says in his chapter on aesthetics and electroacoustic musical language, "if electroacoustic music is a language, or at least if music and natural language have sufficient features in common to justify the metaphor, we might be able to apply what we know of language to reveal otherwise obscure

information about the relatively young field of technological music."[92] Yet, while language has both "competence" ("the tacit knowledge possessed by a native speaker of all [and only] well-formed sentences of his own language"[93]) and "passability" (understandability of poorly-formed sentences), music does not rely on the same kind of competence.[94]

I would go against Keane's assumption that electroacoustic music is a language primarily on the basis of structure. To quote linguist Manfred Bierwisch, "the functional organization of music is different from language… Music is to be determined by gestural form, which corresponds and contrasts to the semantic form of linguistic meaning."[95] However, I acknowledge that when we speak of electroacoustic music and how it works we end up borrowing a lot of linguistic terms, and it is important that we recognize that these are metaphorical and not literal.

Denis Smalley

In light of the technological developments of the 1980s and 1990s, namely the widespread adoption of the MIDI protocol and the rise of the personal computer and music software, new vocabulary needed to be invented for the new types of music. Denis Smalley and Trevor Wishart, theorists and composers both, focused on developing texts that merged the attitudes of pure electroacoustic music, acousmatic music, and commercial music. Denis Smalley's work in the 1980s and 1990s focused on naming concepts unique to a few types of

[92] Keane, "At the Threshold of an Aesthetic."
[93] Keane, "At the Threshold of an Aesthetic," 102.
[94] Keane Keane, "At the Threshold of an Aesthetic,"102-103.
[95] Bierwisch, "Completeness and Limitaiton of Natural Languages," 815-816.

electroacoustic music. He drew from mid-century theorists and composers, particularly Pierre Schaeffer's concept of reduced listening. In his works articulating the concept of spectromorphology,[96] Composer Darren Copeland explains, "Smalley's concept of spectro-morphology offered a listening model that incorporated the social dimension of environmental and other sounds along with an analysis of their basic acoustic structures."[97]

Smalley gives definitions and labels to sonic traits and gestures commonly observed in electroacoustic music that befit spectral qualities rather than musical notes, and varieties of motion rather than metrical time, and sounds with mysterious or distant sources electronically removed.[98] In other words, "spectromorphology is concerned with perceiving and thinking in terms of spectral energies and shapes in space, their behaviour, their motion and growth processes, and their relative functions in a musical context."[99] It is applicable to many musics, but especially framed for electroacoustic music that so direly needed its own theoretical vernacular and frameworks.

Smalley's theories did account for the scores that many theorists omit in their expansions. Smalley identified three types of scores in electroacoustic music that might contain perceptually relevant information. The first is the graphic transcription score that may be used by the performer. This can include traditional notation, modified or novel notation akin to Feldman's gridlines, or abstract shapes and lines, like Hans-Christoph

[96] Smalley, "Spectro-morphology and Structuring Processes"; "On Spectromorphology."
[97] Copeland, "Toward a Wider Immersion in Sound Art," 180.
[98] Smalley, "On Spectromorphology," 109.
[99] Smalley, "On Spectromorphology," 125.

Steiner's *Solitude* (2001). The second type of score is the technical realization score that presents the composers' form-plans and sonic representations. This can include synthesizer patch charts, staging instructions that chart the cable flow from patch bay to speaker, or lines of code, such as Salvatore Sciarrino's static artifact for *Perseo e Andromeda* (1992) that includes his complete code documentation. The third type of score is the diffusion score, i.e. a free, sketchy, graphic representation of the sounding context produced primarily as a timing and memory aid for the person diffusing a work in concert. "This third type…is usually concerned with spectromorphological information: events and textures are given shapes whose vertical dimension represents spectral space, while the horizontal plane shows change over time."[100]

Based on Smalley's descriptions, the first and third scores may look similar, but their purposes are different – the first type is for the performer to make or instigate sounds, and the third type is for the diffuser to move and modify the sounds. Electroacoustic music, especially acousmatic music, inextricably links the compositional process to the realization of the work. However, electroacoustic music, unlike acoustic music, divorces sound-making from perception of sound. Acoustic music has no analogy for the diffuser; they are a novel component of electroacoustic performance/rendering and play an essential role in how the listener will perceive the music.

Smalley inspired new waves of phenomenological thought situated around technological and reduced listening. For example, Simon Emmerson and Leigh Landy also

[100] Smalley, "On Spectromorphology," 108.

use Smalley's concepts for their theories of categorizing electronic music into appropriate genres for analysis and for their own versions of reduced listening that inform their proposed template of analysis.[101] These are brand new theories and modes of thought designed for electroacoustic analysis,[102] and they derive heavily from Smalley's contributions.

Judith Lochhead

Though Smalley hoped it would be a widely adopted ideology for a broad spectrum of electronic works, spectromorphology is not the final word on electroacoustic music theory. For example, theorist Judith Lochhead's contemporary writings on phenomenology and post-phenomenology propose a brand of reduced listening as an important element in her theory of analyzing the structure of modern music apart from its written form.[103] Reduced listening of this sort is a logical and excellent method of analysis for electronic works that exist only as a static, *sonic* artifact, i.e. a rendering.[104]

Lochhead's approach addresses the scores of the works she discusses, but balances this with other forms of descriptive analytical notation while engaging "the multiple perspectives of creators, performers, and listeners."[105] She primarily puts the onus on a sole

[101] Landy, *Understanding the Art of Sound Organization,* 2007; Emmerson and Landy, "The Analysis of Electroacoustic Music."
[102] Smalley, "On Spectromorphology"; Emmerson, *The Language of Electroacoustic Music*; Landy, "Reviewing the Musicology of Electroacoustic Music"; Simoni et al., "A Theoretical Framework for Electro-Acoustic Music."
[103] Lochhead, *Reconceiving Structure in Contemporary Music.*
[104] I am using "rendering" here instead of "recording" to distinguish the methods of creation. Recordings make a live performance fixed, but this is not quite what happens with electronically devised and performance music. Rather, fixed media music is rendered by the machine that created it, and there is no other performance to be had, much less record.
[105] Lochhead, *Reconceiving Structure in Contemporary Music,* 4.

performance and the listener's reception. This has become a common practice for the analysis of electroacoustic music. Again, this makes a lot of sense for music that lacks a static artifact, and exists *as* a single rendering, as many acousmatic works do. While Lochhead does use the available notation in her analyses, she settles for excerpting the score as a suitable index for an event or time mark in the composition. She does not engage with the notation itself and its relationship to the sonic realization, which is what I argue should happen in analysis.

Leigh Landy

Leigh Landy is a composer and musicologist who specializes in acousmatic composition and analysis.[106] His work in the 1990s and 2000s explores the budding terminologies in electroacoustic music and analysis and contributes authoritative definitions for the different electronic genres, of the elements that make up the electronic genres, and an authoritative genealogy of the genres. The genealogy is composed of three historical musical paradigms: an oral tradition, written (e.g. has a score, composed score-first, requires interpretation of a medium), and electroacoustic (e.g. music recorded on a fixed medium is embedded in the medium and requires no interpretation).[107] This establishes an important distinction between music with scores and music without and accepts that electroacoustic music rarely has a score.

[106] Landy, *The Art of Organised Sound*.
[107] Landy, *The Art of Organised Sound*, 178.

However, he also notes that electroacoustic music is transdisciplinary and multidisciplinary, often integrating music, video, digital animation, robotics, performance, etc. There is a broader kind of 'technological music,' which he borrows from Francois Delalande, "which includes mixed music, interactive music, and music with live electronics."[108] As such, electroacoustic music is not *necessarily* without a score or other kind of written document. The sounds and realizations themselves may not necessitate interpretation the same way acoustic music with human musicians does, but electroacoustic music that incorporates interactivity, or live electronics, or coordination with live performers is a hybrid of 'written' and 'electroacoustic' music. Acousmatic music, like the kind Landy composes and analyses, is firmly in the purely electroacoustic category, which I suppose is why Landy does not continue his exploration into mixed media and interactive scores.

The concept of a static artifact may be the key to accepting hybrid written-electroacoustic works as valid and approachable for analysis. The documentation is often unfamiliar and does not always resemble a traditional score but is no less important to read and understand than a notated score for common practice era music. The case studies in this dissertation all fall into the hybrid written-electroacoustic category.

Synthesis

The contributions from these theorists illustrates one core reason there is yet to be one codified system of analysis for electronic music, and perhaps why there never will be. Electroacoustic music comes in many forms, some of them fixed and some of them

[108] Landy, *The Art of Organised Sound*, 178

performable and transformable, some of them with useful static artifacts and some without. Landy has put forward helpful definitions and delineations but does not offer anything for the hybrid categories that he acknowledges exist. Smalley and Dimpker at least acknowledge the static artifacts and offer some useful definitions for the types of scores, but these also fall short of helping the performer or analyst parse them.

Modern theories related to electroacoustic music (1990s, 2000s)

Barry Truax

Barry Truax[i]s primarily known as a composer of acousmatic music. He remarks, as many have before, that "a fundamental trait of the practice of electroacoustic music is that the composer composes the sound itself as well as the structure in which it appears."[109] He cites this as the primary factor that liberates both composer and music theorist from the visible "musical artifact [that] represents a structure separated from the sound through which it will be realized."[110] To Truax, the score had always been an analytical crutch, and now that electroacoustic music is all but entirely free of that crutch, then the act of music analysis can be reborn.

Truax theorizes the problem as such:

> Western music theory, having followed composition in its path toward increasing abstraction and the primacy of pitch relationships, finds itself powerless to deal with the largely unpitched material of environmental sound. A concern for timbre might have developed, and indeed, in isolated instances has been proposed (Erickson, 1975; Wishart, 1985; Young, 1991), but

[109] Truax, "Computer Music Language Design," 156.
[110] Truax, "Computer Music Language Design," 160.

> progress has been slow and generally relegated to the periphery of music theory. The lack of notation and the necessity to rely on aural judgement seem to present the most serious initial problems.[111]

Other areas that attempt to understand environmental sound composition include psychoacoustics and sound analysis (e.g. Fourier transforms and spectrograms), but Truax suggests these are not the right approaches because of their parameter-based, reductionist properties.

Truax's approach, while not fully engaging with interdisciplinary studies of timbre, does include some kind of composer-generated score. Between the time of his article publication and now, timbral studies have come a long way, and many theorists acknowledge it as the core musical element of electroacoustic music, as I will discuss in the following pages. They also have no issue with using the static artifact, though they are careful to use it as a tool and take subjectivity and objectivity into account. For example, many composers and theorists support making spectrograms for analysis, while remaining wary of the constraints of a two-parameter graph for something as complex as timbre. Truax's cautions are not forgotten in the 21st-century, though many (myself included) would argue that the score is not the problem.

Mary Simoni

Mary Simoni[112] has taken similar approaches to analyzing electroacoustic music as her colleagues Leigh Landy and Simon Emmerson, and her writings from the turn of the

[111] Truax, "Soundscape, Acoustic Communication," 49-50.
[112] Simoni et al., "A Theoretical Framework of Electro-Acoustic Music;" Simoni, *Analytical Methods of Electroacoustic Music.;* "The Analysis of Electronic Music."

millennium tackle the symbiosis between technology and the music composers make with it. A major part of understanding this relationship – and knowing what to do with it – is accepting that electroacoustic music does not emphasize pitch and rhythm the way acoustic music does, and instead is primarily concerned with timbre. Rather than discussing pitches or motifs, Simoni proposes we should use Smalley's language of spectromorphology and discuss sound objects and time scales.

By extension, this emphasis on timbre means that scores do not denote pitch and rhythm in a familiar way but are something else entirely. There are two different kinds of scores one may find (and find useful) for a piece of electroacoustic music: the code or graphics written by the composer, and the spectrogram created by the analyst. Simoni largely supports a listening-based phenomenological lens for electroacoustic analysis, but like Thomas DeLio and myself she wholeheartedly supports using analytical visualizations and composer-made artifacts as well – with a caveat.

Simoni warns that "historically, music theorists are concerned with the objective analysis of a musical artefact, usually some fixed form like a musical score or recording…But in electronic music, the cultural milieu of rapidly changing technologies in a fast-changing global culture is a factor in the creation and performance of the music."[113] Because technologies like DAWs and code change so quickly (remember, even the first musical programming language MUSIC went through five overhauls in eight years), it does not make sense to treat them as a fixed object the way we can treat a traditionally notated

[113] Simoni, *Analytical Methods of Electroacoustic Music*, 275.

score. Spectrographs are essential to analyzing a timbre objectively, and "many composers use timbre as compositional material following Schaefferian theory."[114] She prefers that the analyst use spectrographic software like *Sonic Visualiser* to tap into an unbiased way to visualize the music.

The rapid pace of technology is a double-edged sword for plenty of reasons, and Simoni points to electroacoustic analysis as one. Updates to DAWs and code makes it difficult if not impossible to access the static artifact exactly as the composer wrote it. For instance, Simoni rues that "if we had access to the DAW in which Westerkamp created [*Kits Beach Soundwalk* (1989)], we could selectively listen and analyse components by muting sound tracks, filtering sounds to enhance spectral components of the sound, or extract sounds and create spectrograms."[115] Without the precise version of the 1989 DAW, and the hardware Westerkamp ran it on, the analyst cannot accurately do the actions listed above. Some modern composers are good at self-archiving, taking screenshots and documenting things like software and hardware versions, but like all pictures and documentation these cannot be used to perform the manipulations necessary for selective analysis.

The other edge of the sword, Simoni notes, is that we are able to recover and recontextualize electroacoustic music with modern software and hardware. For instance, composer Paul Lansky used punch cards to code *Mild und leise* (1973).[116] It "would have

[114] Simoni, *Analytical Methods of Electroacoustic Music*, 278.
[115] Simoni, *Analytical Methods of Electroacoustic Music*, 285.
[116] *Mild und leise* (1973) is based on the harmonic inversions of the Tristan chord, and is only loosely connected to the Wagner aria of the same title.

become an historical artefact representative of the third computer generation had it not been discovered by the British alternative rock band Radiohead, who extracted the first phrase of Lansky's piece and used the sample as an ostinato for *Idioteque* on their album *Kid A* (2000)."[117] Radiohead used a contemporary DAW, Logic Pro X, to intercut the sample with the rest of the track and create an ostinato. Their documentation, which consisted of screenshots and stems and so forth, make it easy for the analyst to see the rhythmic timing down to the millisecond, and see in the spectrogram the spectral effects Radiohead evokes to the decihertz, which is important for timbral and spectral analysis. Simoni was able to analyze *Mild und leise* even more accurately than when she only had the spectrogram based on the punch-code, not only because improved technology allows for closer measurement, but because Radiohead's recontextualization allowed Simoni to hear (and cross-check in the visualization) certain spectral affects that Lansky created that were more difficult to pinpoint and analyze alone.

John Young

Theorist John Young has identified three musical forms typical in electroacoustic music: moment form, morphic form, and narrative form. Moment form was coined by Karlheinz Stockhausen and is a common form he and his colleagues use. Moment form is "when certain characteristics remain constant for a while – in musical terms, when sounds occupy a particular region, a certain register, or stay within a particular dynamic or maintain

[117] Simoni, *Analytical Methods of Electroacoustic Music*, 283; Simoni also notes that this sampling was done with Lansky's permission.

a certain average speed – then a moment is going on."[118] The polar opposite is morphic form, coined by Trevor Wishart and typical in Wishart's and his accolades' music. Morphic form entails ongoing transformation, especially between 'real' or recognizable sounds and 'imaginary' or novel ones. Young's description of narrative form draws from Roland Barthes and Walter Benjamin. [119] From Barthes: "the view of narrative…starts with the capacity for sound recording to function as a mirror held up to lived experience."[120] Pivoting to Benjamin, Young specifies that it carries an aura of experience, documented or alluded to in a composition. The criteria Young establishes some criteria for the narrative, such as world-building with characters and actions, the world undergoes changes of state, and the text, if there is any, constructs an interpretative network of goals, plans, causal relations, and motivations around the events.[121]

Young does not recommend any particular method to assess these forms, whether aural or visual. I would argue – and I demonstrate in my following case studies – that the composer's documentation in the static artifact is essential to identifying these forms at different time strata and keying into the elements within. For example, Philippe Hurel labels his sound objects and marks the moments of his moment form in his score; Anne Deane Berman aligns the relative timings for the performer and fixed media to the narrative

[118] Young, "Interactive and Generative Music", 64.
[119] There are plenty of theorists working on narrative approaches for acoustic music as well, such as Robert Hatten and Byron Almén, to name just two. Young primarily cites Hatten and Almén. The composer for my fourth case study, Paulo Chagas, also cites Hatten's theories as inspiration. The primary difference between Young and the others is in the intention, in that Young only cites electroacoustic music and the others are focused on acoustic music.
[120] Young, "Interactive and Generative Music," 72.
[121] Young, "Interactive and Generative Music," 73.

exposition. All in all, Young's contributions to formal analysis are a logical and important step in the right direction for electroacoustic analysis, and incorporating any and all methods applicable – whether Schaefferian reduced listening, analyst-created spectrograms, or score study of the static artifact – will support this foundation.

Discussions on descriptive notation scores

These theories cover a lot of ground and hold water in their own ways. A trait they all share is a general disregard for the static artifact. Even though they do not incorporate traditional notation into their frameworks, each theorist has their stance on ideal and actual roles for notation. These range from the roles described by Smalley and Dimpker; in other words, notation is 'for' the composers themselves, or for the performers to interpret, or for an analyst.

Comments on Spectrograms

Spectrograms came into use with the work of Robert Cogan in the 1980s, and during this period may have been theoretically regarded as a solution to the lack of score in many electronic works. In lieu of other documentation, at least they may visualize acoustic properties or other musical parameters like form and register. However, Smalley asserts spectrograms cannot replace the score. They do not *represent* the music as perceived by the human ear. He places more emphasis and confidence in his three score-types for analysis as well as realization.

Many composers and scholars share Smalley's sentiments, that spectrograms are at least useful for acoustic analysis, which is arguably critical for a lot of electronic.[122] Others tout the spectrogram as an analyst's catch-all solution for timbral and spectral analysis. Spectrographs are good at representing the musical energy and fluctuation of energy in a piece, but poor at representing the aurally perceived musical surface. They do not represent what the listener actually hears.

Thomas DeLio, in his chapter "*Diamorphoses* by Iannis Xenakis" in Licata's *Electroacoustic Music*, suggests that the period of common practice in Western composition ended at the turn of the twentieth century. What followed remains relatively unexplored, he claims, and the new focus on musical aspects like rhythm, space, and timbre remain unanalyzed. Instead, he asserts that these are not new concepts. He props up a hypothetical strawman: Beethoven begins the Eroica symphony on a tonic triad, but why does he articulate it, space it, orchestrate it, and repeat it the way he does? No, these are not new concepts at all, but they are perhaps having their first time in the spotlight, on a different stage than before.

> In electronic music, frequency, time, tone color, and space become inextricably fused. Such music challenges us to discover new ways to think about composition and forces us to examine each piece from a new theoretical perspective" and develop new theories for examining these compositional styles and traits.[123]

[122] For instance, much of algorithmic music and sonification sound art, which are effectively aural representations of data, a formula, a pattern, etc.
[123] DeLio, "*Diamorphoses* by Iannis Xenakis," 56.

In his chapter, DeLio uses spectrograms to show the pitches and timbres of sound at different time points. While phenomenologists downplayed written scores and Smalley expresses dissatisfaction with the spectrogram's ability to represent music, DeLio offered another way of using spectrograms to do signify music. He writes,

> In dealing with any electronic work, we must consider the question of how to go about analyzing its sonic events. Typically, there is no score, and each work uses sounds that may be wholly unfamiliar, at least in the world of traditional instrumental/vocal music – a rather narrowly defined sonic environment. With an instrumental work, we study the score, knowing that tis notations represent sound. However, in order to deal with an electronic work…we must develop some way to represent its sonic elements that reveals the nature of these elements, as well as their combinations and transformations, in some useful way.[124]

DeLio's method for formal analysis is to pair spectrograms with detailed verbal description. He acknowledges the same drawbacks as Smalley and others do, such as missing the symbolic link between written and sounding music, yet without a composer-generated score, it can suffice as an analyst's aid.

Comments on non-symbolically related scores

Not all scores or static artifacts have a symbolic link to the sounds, either. In the twentieth century, artists dabbled in graphic scores and 'eye' scores[125] that are intended for looking but not listening. At best, they correspond to the realized sounds more like how

[124] DeLio, "*Diamorphoses* by Iannis Xenakis," 43.
[125] Shaw-Miller, *Eye Scores* Two popular examples of eye scores are Baude Cordier's heart-shaped score for his "Belle, bonne, sage" from the Renaissance era; another is George Crumb's crucifix-shaped score for *Black Angels* (1970) These examples can be performed as music. Many eye scores are intended purely as visual art and cannot be used to follow music in any straightforward way, even if they are intended for performance in some way, like Roman Haubenstock-Ramati's graphic scores.

dance corresponds to music, or museum lighting to a painting; the two elements are certainly influenced by one another, and might be 'less' without the other (though this effect may be unbalanced), but it is much less of a direct symbolic relationship than score to music.

Konrad Boehmer's case study on Gottfried Koenig's *Essay*[126] (1960) explores the subjective factors and aesthetic relevance of written documents and electronic music. Koenig wrote a document after the composition that he intended to sell as a companion score, but it was apparently more symbolic and self-analytical than was useful for a realization score. Boehmer notes, "The 'Score and Instructions for Realization' of *Essay* was originally published by Vienna Universal Edition. As it was not fit for reading while listening and thus does not offer a graphic representation of the music, it was difficult to sell to amateurs interested in modern music."[127][128] In short, the companion score was unmarketable, and unfortunately set a bad precedent for electronic music scores.

Essay was an early electroacoustic piece, and like many electronic composers, Koenig was still testing the waters for both the sound palette and the notational style. Boehmer proclaims:

> Electroacoustic compositions that are chiefly based on these (subjective) factors [associations or remembrances, aesthetic relevance] may, at best, be useful for psycho-acoustic listening tests. Their aesthetic value is rather dubious… Composers who would like to make use of the 'new' sounds for the mere reason that they seem *to them* to be interesting or 'original' dodge the central problem of composition, which is the problem of an *intratextual* mediation – the prerequisite of any structural organization on an aesthetic

[126] Boehmer, "Koenig – Sound Composition – *Essay.*"
[127] Boehmer, "Koenig," 71.
[128] The realization score for essay is owned by PFAU-Verlag in Darmstadt, Germany.

> level. *Sound composition* cannot rely on a kind of mimesis of mechanically produced or 'natural' sounds, not can it start from the fiction of 'yet unheard' *virtual* sounds. The essence of Western art music of the past 1,000 years has rested on the fact that it has generated artifacts that differ in a substantial way from 'nature,' from the earliest Saint-Martial motets to the era of electroacoustic music… What made their integration into a musical context so 'new' was their *structural function* [or process].[129]

A problem with electroacoustic composition, Boehmer believes, is the exciting but disorienting departure from the natural sounds that composers have connected to their music and notation for thousands of years. I add that a common side effect of this new focus is the loss of a semiotically accurate score. Koenig tried to produce a decent realization score with *Essay*. It failed on the market, his piece was not performed widely until recently, and he stopped trying. The story became part of the mythos of scoreless electroacoustic culture: when a score did exist for an electroacoustic piece, performers did not find it useful nor worth the money, and so scores for electronic pieces fell out of common practice from early on.

Comments on DAWs

In his recent book *Dawn of the DAW,* Adam Bell tackles similar questions concerning electroacoustic music. How do composers literally write their scores when using DAW technologies? How has MIDI changed composition, and the act of writing compositions? How does it tie into the documented changing relationship between musicians, recording professionals, and composers?

[129] Boehmer, "Koenig," 60-61.

Bell examines these questions as a music education specialist and thus focuses his analysis on different areas and electronic music genres. He frames his responses on and for the DIY communities and pop music scenes, while I am focused on a narrow sub-genre originating from the more academic electroacoustic studios. Yet Bell's main arguments on MIDI's effects on composition and the studio culture are just as relevant in my area of study, including his question: in what ways is the democratized technology used, and by whom? How has MIDI affected composers' multimedia paradigms, and how do they use it and document it?

The answer to the first question is that "the majority of digital systems emulate the key aspects of an analog tape machine's user interface in order to make the user feel more comfortable,"[130] intending to smooth the learning curve. This reliance on skeuomorphic interfaces was practical as well as comfortable. Pro Tools, the industry standard of digital recording since the late 1990s, was initially used in tandem with analog mixing consoles, generally supplanting the tape recorder as a storage medium.[131] By 2007, "the DAW went from augmenting the recording studio to reconstructing it," and most pop music and nearly all of hip-hop, R&B, and dance music were mixed in a DAW like Pro Tools only.[132] This also answers Bell's second question; commercial music moved from analog-primary to digital-primary or digital-only recording in a scant decade. DIY, home-brew, garage-band, etc. communities followed the same pattern.

[130] Bell, *Dawn of the DAW,* 28, quoting Taylor, *Strange Sounds*, 6.
[131] Bell, *Dawn of the DAW,* 28.
[132] Bell, *Dawn of the DAW,* 28.

Chapter 2: Electroacoustic Music Theory & Notation

If asked what the score of the music is, many creators of commercial and DIY music would point to the open session of Pro Tools on their computer. That is where the music is composed directly, where it finds its primary representation as a visual image, and also what generates the tones. According to John Richards in his chapter on twenty-first-century DIY composition tools,

> there are very few traditional-type scores or notation for music emerging from this [DIY] scene. Where scores or notation are needed, the mainly sound- and noise-based nature of much DIY music making lends itself to event scores or text descriptions, as well as graphic scores…Diagrams of signal routings and system configurations are often more appropriate as scores within a DIY music-making context.[133]

The role of performance instructions is not gone, only the who and the how have changed.

In my case studies chosen for this dissertation, all written in the mid-1990s, the composers generally treat the DAW as a supplemental tool and not *the* tool, as described above. There is still some element of analog composing and recording, and the computer is another (unique and flexible) cog in the wheel. This is perhaps the overriding reason why the static artifacts I have analyzed contain so many parts and such a variety of symbols and components, ranging from five-line staves to graphic scores to paragraphs in plain English. Yet, the computer is essential for the multimedia aspects, and this produces new kinds of documentation and notation.

[133] Richards, "DIY and Maker Communities in Electronic Music," 249.

Conclusion and Moving Forward

Taking all of this into account, from the challenges of imperfect notation to the different forms of reduced listening, I aim to offer an analytical approach that involves parsing the static artifact to contribute to a fully fleshed-out analysis. The subgenre I have chosen, that is, music that uses live electronics, fixed electronics (a "tape track"), and live acoustic performance, is singularly difficult to analyze with only one method because of its inherently changeable performance and multiple intercorrelated parts that influence or are influenced by the performance. I propose a method that includes examining the static artifact and combining these essential observations with aural and visual analysis to substantiate a thorough and holistic analysis of the works. [134]

[134] Two case studies also feature visual components, so a multi-pronged and multi-sensory approach is already necessary.

Chapter 3: Philippe Hurel, Leçon de Choses *(1993)*

Introduction

A significant difference between acoustic instruments and electronic instruments is the ease of application for new performance techniques, such as microtonality, complex rhythms or arrhythmic time, new timbres, and stochastic or random choice/chance. Electroacoustic music takes advantage of these new skills, but composers and analysts have not yet codified ways to notate it or write about it. With these new capacities came new challenges in creating a static artifact that fulfills the traditional purpose of an acoustic score, and more.

Furthermore, because there are many modes of performing and hearing, music can be multimodal and multimedia unto itself. Contrary to common assumptions, "multimedia" does not necessarily mean "audiovisual." I use David Cope's definitions for mixed-media and multimedia throughout this dissertation, which he describes like so:

> 1. Multimedia is a loose structure in which the various media do not depend on each other for meaning. Happenings represent excellent examples of multimedia in that each element can stand on its own merits. [loosely knit composite forms; includes happenings, collage, theatre pieces, ballet, light-show].
> 2. Mixed media tends toward equalization of elements, though any hierarchical order is possible. Environments fit this media form in that, though the elements depend on one another, they are mixed, but not truly integrated.

> [more integrated, with varying degrees of importance of elements; includes opera, film and TV, kinetic theatre.][135]

Multimedia music, in this sense, includes pieces that are generative, interactive, live-process, reactive, and so on.[136] For example, Philippe Hurel's *Leçon de choses* (1993) combines fixed and unfixed media, acoustic instruments, synthesized instruments, and live-processed instrumental reactive MIDI (through Max patches).

In this chapter, I analyze the scores of *Leçon* using theories and methods from modern theorists such as John Young, Gary Kendall, and Michael Young. These analyses will explore, through notation, musical form, meaning, fixed and unfixed media, and digital sampling. I begin with Hurel and his quasi-traditionally notated score for *Leçon de choses,* examining the form on multiple levels, the purpose and use of electronic media, and sampling techniques.

Case study introduction: Hurel's Leçon de choses *(1993)*

French composer Philippe Hurel's mixed media masterpiece *Leçon de choses* (1993) embodies many of the new possibilities afforded to composers by advances in technology like MIDI and multi-purpose digital audio workspaces. The twelve-minute work for large ensemble includes acoustic instruments (symphonic complement of winds, strings, percussion, and harp) and electronic instruments (MIDI piano, MIDI synthesizer, and fixed

[135] Cope, *New Directions in Music*, 115.
[136] Interactive music: Music built via and reacting to the "relationship between performer, composer (if any) and software designer" (Michael Young, "Interactive and Generative Music, 91). Generative music: "in its pure form, is concerned with how we make, not perform, music; it is a computational, algorithmic process. There is no composer in a conventional sense, rather, there is a sonification of computation" (82).

electronics played from a laptop). The piece begins with the pre-recorded clang of a tart pan that expands, erupts, and evolves through MIDI-based technology and acoustic imitations in the live instruments. The piece presents the modern analyst with a challenge of new sound material, sound generation, and organization. For this case study, I will demonstrate new methods for analyzing form, motifs, and meaning on the piece as presented in the score.

It is necessary to understand three different sources of inspiration surrounding the conception and execution of this piece. The title *Leçon de choses* originates from a novel of the same name by French author Claude Simon (b. 1913). According to his online biography, Simon "does not deal in time sequences or successive events," but instead approaches narratives thematically and simultaneously.[137] His convoluted plot structure is somewhat akin to David Foster Wallace's famous novel *Infinite Jest*; there are several plots, some of which relate and others which do not, and the timeline zigzags and ultimately ends roughly where the story began. Simon used what he called "visions of life in microcosm."[138] These "microcosmic visions" directly correlate to Hurel's sound objects, or what he terms "situations;"[139] the kernel and driving force throughout the piece is the metallic clank of an everyday object. From the tart pan, Hurel designs seven sound objects, which continually evolve throughout the piece, are replaced by traditional polyphonic counterpoint, and gradually reemerge as variations, much like Simon's narrative threads. In writing a piece

[137] "Claude Simon Biography" eNotes.com, accessed July 15, 2017.
[138] "Claude Simon Biography."
[139] Hurel, "The Lesson of Things."

built on sound objects and electronic morphing, Hurel plays on both sides of the title pun: this is a lesson (leçon) on things, and it is the sound (le son) of things.

Hurel was also inspired by spectralism. In Paris in the early 1980s, he studied musical computer science under Tristan Murail, and in 1986 secured a position at IRCAM as a researcher. The IRCAM environment introduced him to spectralist composers like Jonathan Harvey, Jean-Claude Risset, and Gérard Grisey. Between Murail's instruction and Grisey's friendship, Hurel came to admire spectralism's philosophy and aural effects. His connections to Murail, Grisey, Harvey, and Risset often leads musicologists to group him in with the spectralists, but he and the composers mentioned above deem his style more contrapuntal than spectral.[140] Hurel was less interested in the actual mechanics involved than the psychoacoustic effects and aesthetics composers like Grisey and Risset could generate. The correlation of Hurel's work to spectralism comes from the prominence of timbre over pitches and evolution over rhythm, but the purpose and psychoacoustic effect are not the same. As Hurel explains in his essay "Le phénomène sonore, un modèle pour la composition," he draws from spectralists like Grisey but has a different personal approach to the harmonic spectrum as a palette. His sound objects are akin to *musique concrète* objects à la Pierre Schaeffer. It is art music with morphing objects or "situations."[141] Several of Hurel's works use and twist the harmonic spectrum to create a tromp l'oeil for the ear – a tromp l'oreille, if you will.

[140] Lelong, "Philippe Hurel Biography."
[141] Tognan, "*Leçon des choses:* analyse"

For instance, Hurel's earlier *Six miniatures en trompe-l' oeil* (1990-1) demonstrates a musical form built from half-heard sonic events. *Six miniatures* is written for an ensemble of 10-25 instruments and consists of six correlated movements. The ensemble has two options for the order of the movements. As biographer Guy Lelong explains, "The initial order – from 1 to 6 – makes one hear six autonomous pieces separated by a brief silence, followed in very marked oppositions (tension/relaxation or quick/slow). The second order – 1 4 2 5 3 6 – proposes instead a work in a single movement, the six pieces following one another without interruption."[142] Performances may use either order or both in succession.[143]

Each movement is composed around two central "objects" or "musical situations" characterized by aggregates of pitches, timbres, and rhythmic cells. Once the first situation is established of each movement, which takes only a few seconds, the ensemble spends the duration of the piece procedurally morphing into the second situation, which also lasts only a few seconds. Thus, the majority of the music exists in the intermediate zones, the processual spaces in which Hurel morphs one musical situation into the next.

Each instrument has a different distance to its second situation. Therefore, they move at different speeds in order to reach their destinations as a group. Perceptually, the major change is often the oscillation between holistic timbre and separate polyphony as instruments occasionally synchronize rhythm, timbre, or pitch, only to phase out again. [144] Alone, the

[142] Lelong, 1995 *"Six Miniatures in tromp l'oeil"* paraphrased and translated. Translation mine.
[143] I watched four performances on YouTube on July 2, 2018. One used the initial order. Two used the second order. One did both, with the initial order first and the second order second.
[144] Lelong, *"Six Miniatures in tromp l'oeil."*

instruments might appear to have reasonably standard musical lines. Together, the sound mass waxes and wanes as it morphs.[145] Using liminality and ambiguity as the artistic form merits the name *trompe l'oeil*, as it parallels morphic visual art like M.C. Escher's *Sky and Water* (1938). This is how Hurel operates adjacent to spectralism.

Hurel's third significant influence for *Leçon* was Éric Daubresse. Daubresse is Hurel's close friend and colleague to whom the piece is dedicated. He became the musical assistant at IRCAM in 1992 and accompanied Hurel in the IRCAM studios on many occasions. Hurel wrote the electronics parts for *Leçon* with Daubresse's synthesizer skills in mind. The synthesizer part of *Leçon* is separate from the fixed tape media and requires a skillful performer to blend the acoustic and electronic sounds in real-time.

From the convergence of these three influences, *Leçon* showcases spectral analysis, textural transformation, and a novel musical form. Furthermore, Hurel intended it to confuse the listener. When experienced only sonically, it is almost impossible to get the whole picture and understand the intricate form, mostly due to the changing Max patches and the spinning spatialization the audience experiences.

However, the score is straightforward. For the acoustic instruments, Hurel provides traditional notation with conventional extended techniques, including microtones and pitch bends. For the electronics, he gives charts of the speaker arrangement, details for creating and implementing the Max patches, and quasi-graphic notation representing the tape part.

[145] For a simplified version of this effect, listen to the THX earcon at the beginning of many Hollywood films.

Hurel goes so far as to print the form into the score itself. He labels each sound object and section break. These notations are of great use to the analyst and correlate well with the experience of listening to different recordings and performances of the piece. They are particularly useful for following the complex evolutions and recombinations of the different sound objects; by sound alone, the task would be nearly impossible because of how Hurel obfuscates, twists, and disguises sounds. However, Hurel had a clear plan in mind, and his score allows the analyst to follow that plan.

For the analysis, I draw from several theorists to illustrate ways to demystify the phenomena within this composition and show how a better understanding of the score and composer's environment helps solve some of the mysteries of the piece. First, I examine the form of the piece. Then I assess the types of electronics and spectral techniques that Hurel uses in the piece, and how these create the form and meaning in the piece. These analytical methods are products of 21st-century philosophy surrounding what music means and *is*.

The Analytical Models

To address a multimedia musical piece with as many moving and interweaving parts as *Leçon de choses*, I borrow from several analytical models from Gary Kendall, John Young, Michael Young, and Simon Waters. The first three of these models are recent

additions to electroacoustic music theory; in this dissertation, I use the versions published in Emmerson and Landy[146] and Emmerson.[147]

I use these models because they are quite new to the field of music theory, or are newly recontextualized for electroacoustic music analysis. They are perfectly designed for analyzing pieces like Hurel's. However, none explicitly incorporate the static artifact into their framework (except for Kendall's, which implicitly supports multi-level reading by virtue of sponsoring analysis of historical context in addition to sounds and musical forms).

Kendall's five layers

Electroacoustic music can be difficult to describe through listening. As Gary Kendall says, "amidst the novel timbres and spatial landscapes, the raw electronics, and clashing juxtapositions, the electroacoustic listener is instantly making sense of auditory sensations and experiencing meaning."[148] Kendall designs a five-layer model of meaning to help the listener parse and organize their understanding: Sensations, Gist, Locus, Contexts, and Domains. These five layers feed back into one another sensory stimulation and internal representation.

Kendall summarizes the five layers like so, in order of the smallest layer to the largest:

[146] Emmerson and Landy, eds. *Expanding the Horizon of Electroacoustic Music Analysis*.
[147] Simon Emmerson, ed. *Music, Electronic Media, and Culture*.
[148] Kendall, "Listening and Meaning," 31.

> Layer 1. *Sensations* – Perceptual organization and constancy of immediate sensation.
>
> Layer 2. *Gist* – Framework of things and space extended over several seconds enabling sustained awareness in the short term.
>
> Layer 3. *Locus* – Self-governing actions in response to situations in the 'perceptual present' and slightly beyond.
>
> Layer 4. *Contexts* – Framework for enlisting and assessing medium- and long-term, event-oriented schemas and expectations over an extended time frame.
>
> Layer 5. *Domains* – Frameworks of background knowledge providing long-term constancy.[149]

Putting the five in context together, "*Domains* delimits the schemas that are appropriate to *Contexts*. *Context*'s schemas determine what medium-term governance is prioritized in *Locus. Locus* causes the *Gist*'s organization to shift in response and thus trigger Sensations to retune to sensory attributes."[150] All of this is equally true in the reverse order – it is flexible as to top-down or bottom-up orientation.

John Young's formal analysis

Continuing with structure, music theorist John Young addresses the novel forms electroacoustic music (and contemporary music at large) take on. [151] Young posits that form is much more than the amalgamation of organizational levels, which roughly describes the notion of Baroque and Classical forms. Drawing from twentieth-century composers like Earle Brown and Roger Reynolds, Young asserts that form "is not simply the arrangement of

[149] Kendall, "The Feeling Blend," 195.
[150] Kendall, "Listening and Meaning," 37.
[151] J. Young, "Forming Form."

materials (whether fixed or transient) but a metaphorical expression of the interaction of sonic structures employed."[152]

Young has begun to codify three forms typical of electroacoustic music. All three have some bearing on *Leçon de choses,* as I will discuss later on. The forms are: *moment* form, *morphic* form, and *narrative* form. Stephen McAdams notes that moment and morphic forms seem most popular among spectral composers. Young points out these forms are endemic specifically to electroacoustic music, too.[153] Given that Hurel was so influenced by spectralism, it makes sense that he would subscribe to the forms typical of the practice.

Moment form is based on Karlheinz Stockhausen's works, *morphic* form off of Trevor Wishart's, and *narrative* form is a musical adaptation of ideas in Roland Barthes's theoretical writings. Moment and morphic form describe different formal levels of *Leçon*, and I can apply narrative form to the overall setting of the piece as it was inspired by Claude Simon's eponymous novel.

To briefly describe moment form, it is "when certain characteristics remain constant for a while – in musical terms, when sounds occupy a particular region, a certain register, or stay within a particular dynamic or maintain a certain average speed – then a moment is going on."[154] This description is a paraphrase of Stockhausen's description in his 1991 essay compilation *Stockhausen on Music*. Young references Ray Guilette's *Hommage a Pollock*

[152] J. Young, "Forming Form," 59.
[153] J. Young, "Forming Form," 59; McAdams, "Psychological Constraints on Form-bearing Dimensions in Music," 181.
[154] J. Young, "Forming Form," 64.

No. 2 (1999; comp. [1991]) as a prime example of moment form, citing its gestural elements punctuated by irregular silences coalescing into "individual lines, dots and pools congeal[ing] into an intended structure."[155]

Trevor Wishart's morphic form "extends from the potential of electroacoustic music to develop materials through processes of continuous transformation of sound identity and timbre," placing transformation and the act of transition at the foundation of form rather than a statement of objects.[156] The prime example Wishart gives is his *Tongues of Fire* (1994), in which the piece is identifiable through its changes and transformations (pitch and timbral) rather than any static objects.

Finally, the third form, narrative, references Barthes's (1977) view of narratives as a "mirror held up to lived experience."[157] He draws from Marie-Laure Ryan (2004) for three criteria for narrative:

1. Narrative creates a world, populated with characters and actions.
2. The world inhabited will undergo changes of state, through events that may or may not be imposed through human action – creating a temporal dimension.[158]
3. The text allows reconstruction of an interpretative network of 'goals, plans, causal relations, and psychological motivations around the narrated events.[159]

[155] J. Young, "Forming Form," 66; Guillette, 1999.
[156] J. Young, "Forming Form," 66-67.
[157] J. Young, "Forming Form," 72.
[158] Byron Almén and Fred Maus also discuss world-building in music and musical form. I might argue that Young's concept of narrative form is not unique to electroacoustic music, though his details are specific to electroacoustic music.
[159] J. Young, "Forming Form," 73.

Barthes's components listed here are used widely in music theory for narrative-based works beyond electroacoustic music as well. Young's specific take on electroacoustic narrative form focuses on electronically generated gestures as characters and transformations as plot beats.

All in all, John Young's codification of electroacoustic forms benefits music theorists examining pieces in both the twentieth- and twenty-first centuries. Many electroacoustic pieces fit fairly well into one of these three forms. As I will discuss with Hurel's work, applying Young's forms on each of Kendall's layers can make for a compelling analysis as well, and may necessitate cross-referencing the static artifact for signposts from the composer.

Michael Young on interactive and generative music

Hurel is one of many composers in the late 20th century creating music with computer assistance. Since the '90s "there has been an explosion of music-making in which computers are not just in evidence but can be acknowledged as co-progenitors. Computers are embedded in the act of music creation so profoundly they become not just facilitators but quasi-creators."[160] What with the prevalence of DAWs and other software that essentially digitizes the entire recording studio, many composers have elected to take on a new, enigmatic role. They put the musical realization in the hands of the software in interactive and generative pieces and remove themselves from the final product. The listener cannot

[160] M. Young, "Interactive and Generative Music," 80.

pinpoint the sound's source, designer, or ownership. For the analyst, this leaves us with a frustrating paradox. Michael Young explains:

> The computational element, however important in the construction of the work, might in fact be dependent on unrelated creative decisions, including assumptions about music in general (instrumentation, synthesis method, musical style). A very common assumption in generative music is that music naturally consists of a series of symbols, that is, notes of fixed pitch, duration and timbre, and that the note choice should be constrained (e.g. to take the form of a diatonic scale). The work may be infinite in length (e.g. when presented in an installation format), so what constitutes a representative experience? The music might appear novel, and be accepted as an enrichment of our very idea of musical aesthetics. But this might be problematic because there is no reference point to judge its expressive, structural or aesthetic value, and no composer to ask, potentially. Some forms of generative music might compare to established styles or idioms, historical or contemporary, inviting either a negative or positive comparison.[161]

John Robert Ferguson, another contributor in *Expanding the Horizon*, posits that "in regard to…new instruments and technology, I believe that analysis should focus as much on the interactive activities of music-making as the audio documentation of the activity."[162] Alongside John Young's forms, and applicable to Ferguson's desire for acknowledging the interactive, Michael Young identifies categories of generative and interactive music.

Young's first category is generative music, which, "in its pure form, is concerned with how we make, not perform, music; it is a computational, algorithmic process."[163] This involves creating a program or patch, either on a synthesizer or in a DAW. It is the musical

[161] M. Young, "Interactive and Generative Music," 83.
[162] Ferguson, "Michael Waisvisz," 262.
[163] M. Young, "Interactive and Generative Music," 82.

equivalent of "plug-and-play." In interactive music, on the other hand, "the performer engages in real-time with a computer system, through a conventional instrument, user interface or control device. The audience appreciates this interaction, depending on how accessible the controlling actions might be to an observer."[164] The two categories may use the same computational techniques, but interactive music uses real-time processing in reaction to a performer, while generative music plays out in its own division.

Michael Young describes many ways these categories can manifest and offers analytical approaches for each. For *Leçon,* I am most interested in his interactive genre "instrumental-reactive." Instrumental-reactive encompasses real-time Max patches and much, much more. M. Young says,

> There is a challenging and creative contradiction in this category: the performance system as a whole is acting in proxy for the composer/designer, enabling and encouraging the expressive and structural possibilities that are designed into the system. At the same time, such systems might seem over-engineered if performers do not enjoy a satisfying degree of improvisational freedom in their actions, to learn the range of possibilities offered.[165]

M. Young is concerned more with improvisation with electronic reaction, yet Hurel's piece has a notated score. There is no room for the orchestral instruments to improvise in a performance of *Leçon*; any alterations are a side effect of human imperfection. However, in writing *Leçon,* Hurel incorporated Daubresse's performative and improvisational skills with live sound shaping and synthesizing. Any permissible improvisation can only come from the

[164] M. Young, "Interactive and Generative Music," 82.
[165]M. Young, "Interactive and Generative Music," 92-93.

audio engineer. So, *Leçon* sits squarely in the uncomfortable area that M. Young describes as the "performance system…is acting in proxy for the composer/designer," yet the performers do not enjoy much improvisational freedom in their actions. The improvisation came beforehand. The computer reaction to instruments comes during a performance. This means every performance will be different – an important note for an analyst to bear in mind.

Waters and sampling

Simon Waters says that "sampling can be regarded as the ultimate time-manipulation tool, the ultimate musical tool of repetition and therefore of recontextualization."[166] Recontextualization is a major component of manipulation, transformation, and juxtaposition of sounds within a piece or a piece within a genre, giving rise to widespread "morphing" techniques.[167]

Morphing techniques hybridize and juxtapose realities, turning everyday objects and situations into magical or impossible ones.[168] Iconic pieces of this morphing technique include Trevor Wishart's *Vox 5* (1994) and Alejandro Viñao's *Chant d'ailleurs* (1994)[169], as well as Jonathan Harvey's *Mortuos Plango, Vivos Vico* (1980) to a lesser extent.

In *Leçon,* Hurel uses samples in the fixed media part to create hyper-real[170] sounds. He also uses live sampling in the Max patch to morph the performance in real-time, creating

[166] Waters, "Beyond the Acousmatic," 71.
[167] Waters, "Beyond the Acousmatic," 64.
[168] Waters, "Beyond the Acousmatic," 64.
[169] Waters, "Beyond the Acousmatic," 45.
[170] From Baudrillard 1994, "hyper-real" means reality and simulation of reality are indistinguishable. In music, synthesized sounds that seem like perfect reproductions of the original are hyper-real.

and manipulating a "faux orchestra."[171] This faux orchestra plays a major part in *Leçon* and is a lynchpin in understanding the piece. The juxtaposition between the real orchestra and the faux orchestra, and the electronic fixed media and the hyper-real sounds of the live-processed faux orchestra, are the foundation of the piece's formal structure as well as its narrative.

The Piece: An Overview

Leçon de choses stems from the spectra of a single sound event from which all material evolves. The event, the clang of a metal tart pan against a kitchen counter, is established in the introduction. Hurel electronically adjusts harmonics and granules selectively, emphasizing different aspects of the complex original sound to create six other sounds. for a total of seven sound objects. These objects are realized electronically, acoustically, or as a combination, and their evolutions throughout the piece entail tweaking the balance of electronics and acoustic instruments. After the introduction, the first established order of these objects is *ABCDEFGBADCF*, which I will refer to as "the original series" throughout this chapter.

These objects are short. They are not to be confused with motives; however, a combination of sound objects may be observed as a motif. Indeed, throughout the piece, some objects are permanently conjoined while others only occasionally pair off or join groupings. Hurel labels the sound objects with letters, *ABCDEFG*. He places these labels

[171] Tognan; "*Leçon des choses*: analyse."; Hurel, *Leçon des choses.*

consistently throughout the notated score, which is a great boon to understanding the form. Just how important this act is will be made clear in the coming pages.

There are three main sections of the piece, each of which is further divided into a number of subsections. Throughout the piece, through pitch and rhythmic development as well as changing Max patches, the sound objects "melt" and "refreeze."[172] In Section I, Hurel establishes the objects, and the different subsections present the objects in different combinations and with slight pitch variations. In Section II, the objects dissolve as Hurel morphs the spectrum and uses the Max patch in the live electronics to create a faux orchestra. Hurel uses the quadrophonic spatialization of the faux orchestra to 'rotate' around the audience and create a spectral and timbral whirlpool. In section II' (the second half of Section II), the spectrum narrows again. Gradually, the push and pull between the real and faux orchestras resolve into one cohesive ensemble upon entering Section III. In the final section, Hurel recomposes the original objects bit by bit, like an image buffering on a screen. After the original series is reestablished, the real orchestra and live electronics terminate, leaving the tape track to play out a coda toying with object *A*.

The Piece: A Thorough Reading

Leçon de choses has a relatively traditional written score, plus a diagram for placing loudspeakers for the best spatialization and timbral rotation "halo" effect, and a manual for

Table 3.1 The form of the Introduction section.

[172] Tognan, "*Leçon des choses*: analyse."

creating the Max patches for the MIDI line. Throughout the piece, Hurel obscures and disguises instruments through treating and spatializing samples, making sonic analysis difficult. Reading the score illuminates that which is hard to hear.

Of course, the analyst would miss the complexity of the acoustic/electronic interactions by just reading the score. The graphic contours would suggest points of interest, but the point of the piece is the aural illusions, which are only signposted by the visual guide and not fully described. Without the static artifact, the analyst would not be able to untangle the web of illusions and fully appreciate parse the live/fixed or electronic/real interactions. Without listening to the performance, the analyst would not be able to incorporate the important phenomenological framework that a piece of this sort requires. We need both the listening and reading components to analyze Hurel's work.

In the piece's introduction, Hurel immediately begins muddying the waters (see Table 3.1). The first clang in the introduction is Hurel's first modified version of the sound. The second occurrence is the "raw" sound, accompanied by instruments imitating the spectra. Hurel identifies these objects in his notated score. This self-referencing is enlightening for the analyst, as many iterations of the objects would be unrecognizable based on sound alone due to their substantial transformations. In these first few seconds, the analyst already

Introduction: *A' A*

receives a glimpse of the tricks Hurel uses. At different levels of formal structuring, Hurel creates different paths and relationships between the objects and also different kinds of

transformations and presentation of the objects themselves. This fractal-like layering will be discussed in the following section, on Gary Kendall's layers.

Chapter 3: Philippe Hurel, Leçon de Choses (1993)

Object *A* (Figure 3.1) is a resynthesis of two everyday items: a tart pan and a magnetic tape casing, struck by a mallet. As theorist Catherine Tognan puts it, the result is

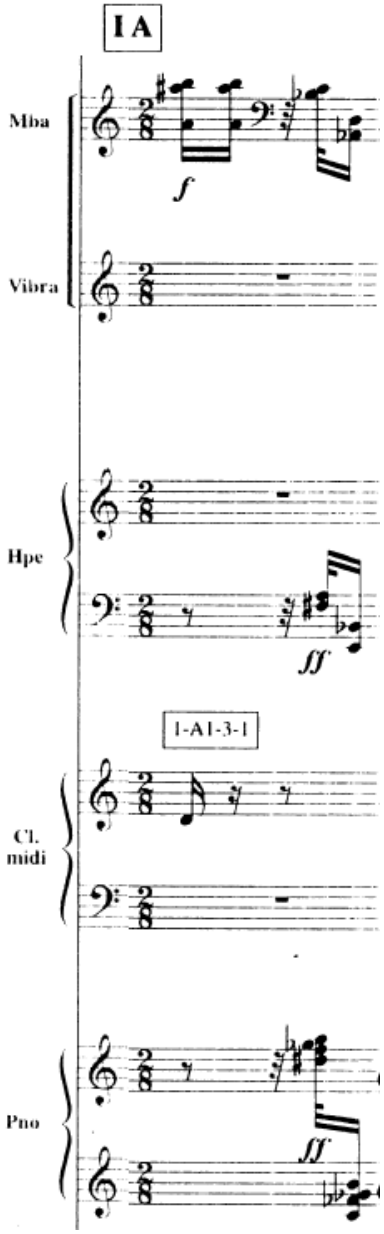


Figure 3.1 Score excerpt showing the salient features of the first iteration of Object A.

"perceived simultaneously as a concrete sound and a synthesized timbre."[173] When the listener is first exposed to Object A, the pure version is the second episode, not the first. By the time the introduction ends and Section I begins, Object *A* has already transformed.

Object	Description
A	percussive, homophonic rhythm, tart pan spectrum, resynthesis
B	scalar, harp sample as exciter, accelerando or decelerando
C	percussive, chordal aggregate, vibraphone & sampled marimba, microtonality
D	attack-resonance horn sample+horn+additive synthesizer
E	'avalanche' of descending sextuplets, orchestral accents, glockenspiel sample
F	super phase vocoder-treated double bass sample spectrum – the vyoop you hear
G	percussion sample & reco-reco with treble doubling on G5

Table 3.2 Brief descriptions of the major attributes of each sonic object.

Section IA, which introduces the basic pattern, spans mm. 12-26 after the short introduction described above. Hurel introduces the objects in their pure forms and the original series, *ABCDEFGBADCF*. Each object's identity is a composite of various sonic parameters and motions (see Table 3.2). For instance, for *Object A* the acoustic orchestra plays the contour of the tart pan's spectrum, and the electronics play the resulting synthesis of the tape casing excited by the tart pan (see Figure 3.1). *Object B* is a scalar musical situation, often linked to a harp sample that serves as an exciter, combined with acceleration or deceleration or both (Figure 3.2). The aggregate chords that make *Object C* use

[173] Tognan, "*Leçon des choses*: analyse."

microtintervals and are always doubled by the vibraphone and sampled marimba (Figure 3.3). *Object D* is identifiable by its attack-resonance, represented by a horn sample, a real

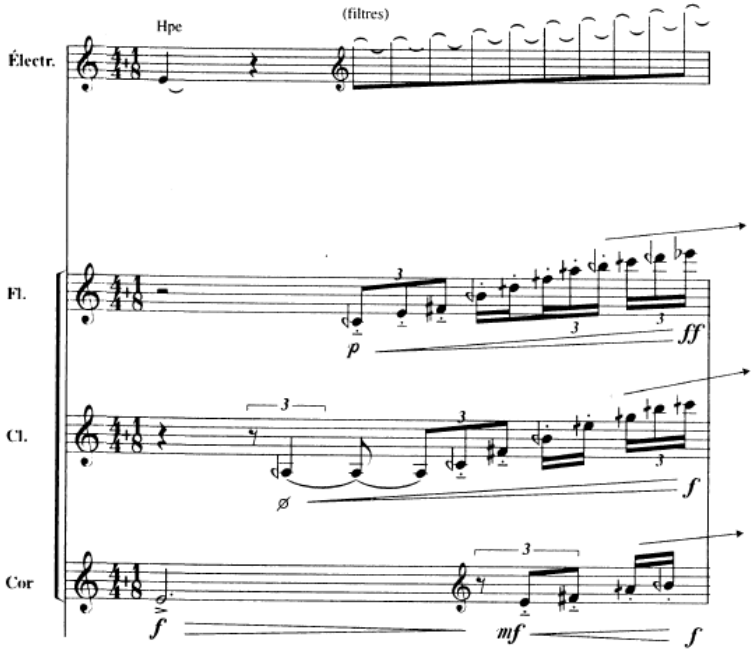


Figure 3.2 Score excerpt of the salient features of the first iteration of Object B. (above)

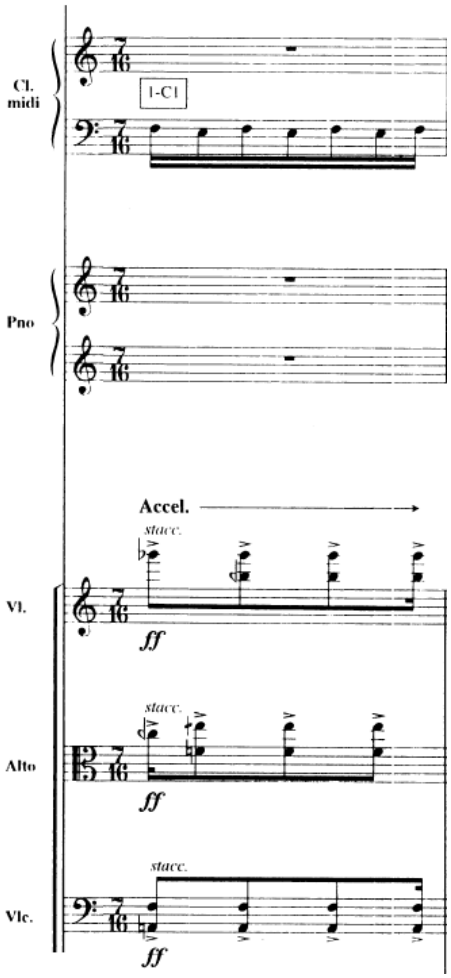


Figure 3.3 Score excerpt of the salient features of the first iteration of Object C.

horn, and additive synthesis, and the sample controlled by the pianist on the MIDI keyboard

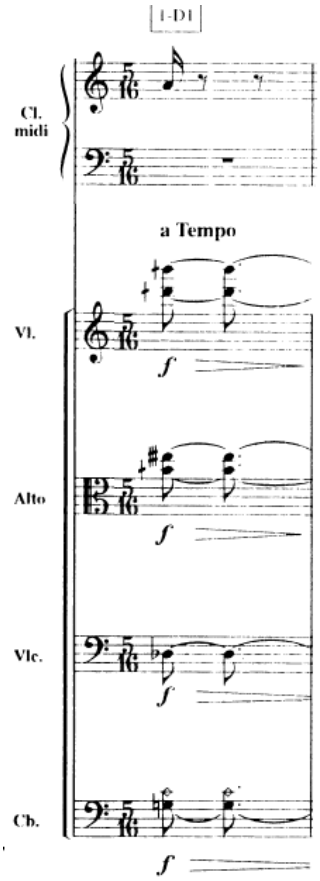


Figure 3.4 Score excerpt of the salient features of the first iteration of Object D.

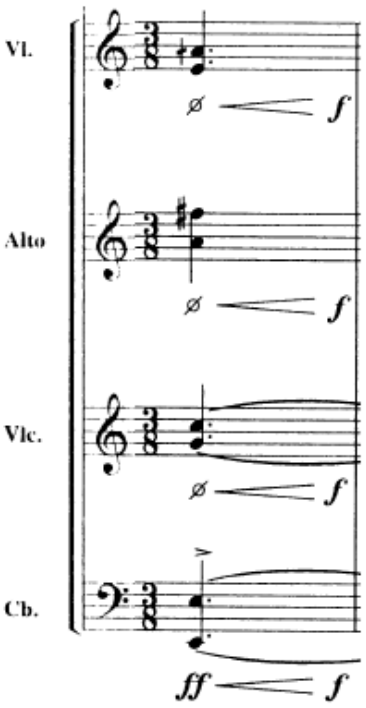


Figure 3.6 Score excerpt of the salient features of the first iteration of Object F.

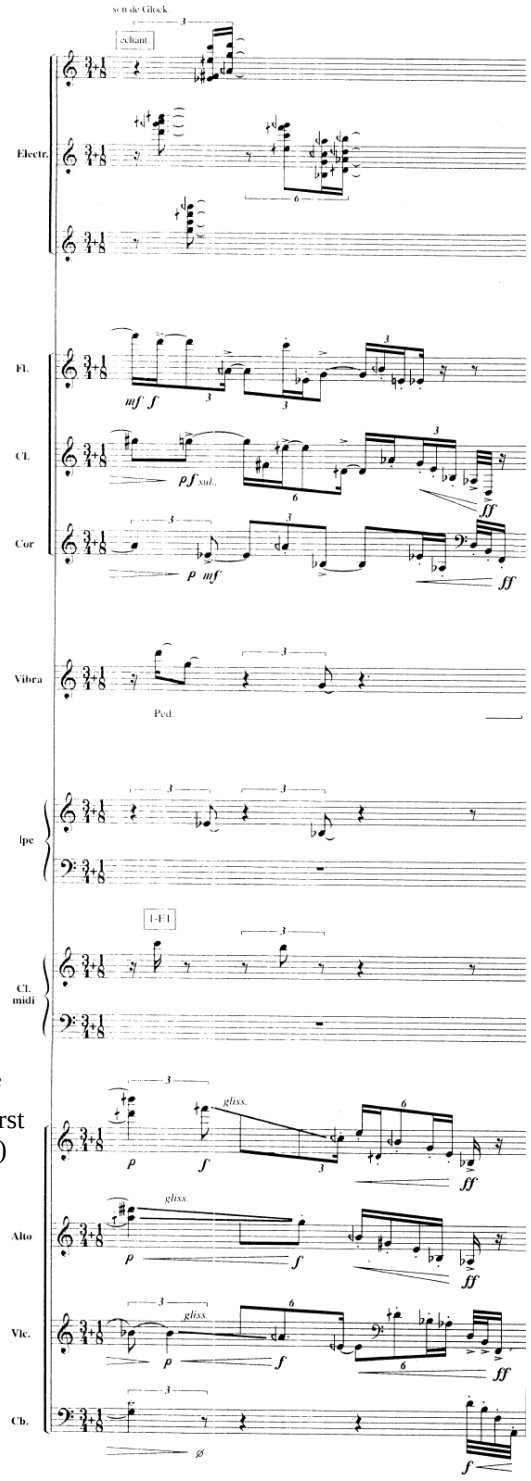


Figure 3.5 Score excerpt of the salient features of the first iteration of Object E. (right)

(Figure 3.4). *Object E* is the "avalanche" made up of two aggregates (descending motion in

sextuplets; Figure 3.5) which leads into *Object F* (Figure 3.6)

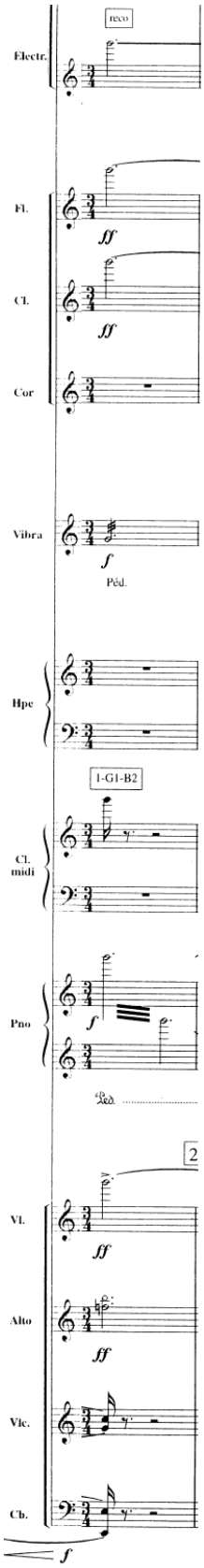


Figure 3.7 Score excerpt of the salient features of the first iteration of Object G. (right)

It is also characterized by accents in the orchestra which seem to trigger the synthesis, though this is an illusion and the synthesized sounds (glockenspiel samples) are triggered only by the MIDI keyboard. *Object F* is a double bass sample treated with a superphase vocoder (SVP) featuring the harmonic spectrum on note E0. The SVP treatment is a signature musical situation of Hurel's, and the choice of E0 spectrum is an homage to Grisey's *Partiels*. It is on this held sound of the double bass that the instrumental part of *Leçon de choses* ends. Finally, Object G is a stretched sample of a percussion instrument, the reco-reco, doubled by the flute, violin, viola, clarinet, and glockenspiel on the note G5 (Figure 3.7).[174]

These seven sound objects weave a web of connections. *Objects G* and *B* share a high note in the MIDI piano part, allowing Hurel to overlap them. Hurel modifies *Objects C, D,* and *F* to affect their character through variation. *Object A* changes rhythm continually but retains the harmony and synthesis. Swung rhythms and compression/dilation of the orchestra's spectrum affect the objects as a whole; some are affected more than others, depending on their identity parameters and the specific change. *Object A* is also the detonator of the 'little bang,' the moment that marks the piece's reversal of entropy from Section II' to the end.

The electronic sounds from the MIDI keyboard are crucial to the sound objects' identities and the form of the piece. There are three types of electronic sounds: synthesized sounds (all three sections); treatment (all three sections); and non-treated instrumental

[174] Tognan, "*Leçon des choses*: analyse."

samples (sections II' and III). Each treatment coupled with acoustic sounds plays a structural function. In each reappearance, there is a drift of the aggregate, and the sonic result differs. When the double bass performs and the spectral components are transformed by the aggregate, the result is a timbral fusion that mimics the full orchestra coming from the double bass.[175] The electric sound that unites *Objects B* and *G* is as fundamentally important as the rhythms and spectra of the other objects.

In Section I (shown in Table 3.3), the original series establishes itself once and then repeats six times with small variations. The Max patch changes in Section IC at m. 52, but the changes it causes are very gradual. Within Section IE at m. 84, Hurel begins to create more noticeable changes. In my listenings, I found the clearest moment of change at m. 96, in which *Objects E* and *F* elide. At that point, each acoustic instruments' range narrows and progresses towards a single note of arrival at m. 111.[176] Though the pitch was not a major

Table 3.3 The formal outline of Section I by the linear occurrences of sound objects within its six subsections.

IA m. 5-25: *A B C D E F G B A D C F*
IB m. 26-42: *A B C D F E GB A A D C F*
IC m. 43-58: *A B C D E F GB* (program change) *A A D C F*
ID m. 59-74: *AB C D E F GB A A D C F*
IE m. 75-88: *A C D E F GB A A D C F*
IF m. 89-111: *A AB C D G A D C F A C D G A*

[175] Tognan, "*Leçon des choses*: analyse."
[176] Think of the THX sound, but backward – starting at polyphony and ending at unison

musical parameter at the beginning of the section, Hurel uses it here to unite and collapse together the instruments to denote the beginning of a new section.

This arrival point at m. 111 marks the start of Section II. The object series morphs and homogenizes all objects into *A*. Hurel chooses their placement arbitrarily to further cloud the direction of the music. The first series is *ABCDEAGBADAF*, and it progresses to *ABAAEAGAADAA, ABAAAAGAAACA, ABAAAAABAAA*, and finally *AAAAAAAA*[177]. These five rows make up the five subsections of Section II (shown in Table 3.4).

In Section II, the driving forces are polyphony and timbre. The ensemble's spectrum expands, and the registers of each instrument expand as well. Hurel assigns each pitch a rank number that correlates to the place they occupy in each aggregate, not unlike order positions in twelve-tone theory. The aggregates begin with high-ranking

IIA m.111: *A B C D E A G B A D A F*
IIB m. 126: *A B A A E A G A A D A A*
IIC m. 134: *A B A A A A A G A A A C A*
IID m. 143: *A B A A A A A B A A A*
IIE m. 150: *A A A A A A A A A*

Table 3.4 Formal outline of section II and its five subsections.

numbers and progressively add lower ranks, plunging until the total aggregate appears.

[177] Tognan, "*Leçon des choses*: analyse," 5.

During this dive, Hurel pairs "dry" and "wet" instruments, like piano and undamped harp.[178] Through pairings, he associates some instruments with others: piano, flute, and clarinet in one pool, and harp, strings, and horn in another. The percussive instruments provide the core of the music. The winds and strings, in rapid polyphony, create a 'halo' around the percussion.[179] In this sound example, one hears the electronically sampled instruments morph from one into another in a timbral rotation.

In Section II, the relationship between the instruments and the electronics comes to the fore. Electronics have two roles in this section. First, the instrumental-reactive Max patches create sounds unrealizable by the acoustic instruments. Second, the MIDI piano reproduces the sound of real instruments with uncanny fidelity to create a second, faux orchestra. This is another key *trompe l'oreille* Hurel likes to use.

Moving forward into Section II' (shown in Table 3.5), Hurel spatializes sound via electronics and the four loudspeakers arranged around the hall. He opens the spectrum, enlarges intervals, accelerates the rhythm, and broadens registers. The sound objects have completely dissolved and mixed, replaced by quasi-traditional polyphonic writing. The artificial orchestra passes over the real orchestra, and polyphony expands for the first time in the piece. The sampled orchestra becomes three-dimensional through spatialization, thickening the sound and thus furthering the tension.

[178] Hurel does not define dry versus wet himself, but Catherine Tognan clarifies that it has to do with the length of decay, or sounds with reverberation (wet) and without (dry).
[179] Tognan, "*Leçon des choses*: analyse," 11.

II'A: *A' B' C' D' E' F' G' B' A' D' C' F'*
II'B: *A' B' C' D' E' F' G' B' A' D' C' F'*
II'C: *A' B' C' D' E' F'*

Table 3.5 Formal outline of Section II' and its three subsections.

Hurel writes in his essay that at the climax of the piece that "the listener seems at first to perceive two ensembles simultaneously – the 'real' instruments and the sample sequence – and then, little by little, hybrid instruments generated by computer manipulations."[180] The faux orchestra seems to rotate through the concert space. At the beginning of section II', loudspeaker 1 emits flute/viola, loudspeaker 2 emits violin/horn, loudspeaker 3 emits clarinet/cello, and loudspeaker 4 carries the double bass.

Through the loudspeakers, the instruments circle from one loudspeaker to another and Hurel accomplishes this not by moving the signal to another loudspeaker but rather by transforming the timbre. The flute, clarinet, and violin transition into one another (in that order), playing rapid staccato notes in counterpoint with one another, and the horn, cello, and viola have discrete transformation loops, moving at a slower yet inconsistent speed.[181] Only the double bass is not modified. It is an essential timbre holding over from section II and continues its role in Section II'.

While instruments seem to spin around the room in Section II', the overall spectrum narrows. As before in section II, the harmonic treatments "are subject to a process of

[180] Hurel, "Le phénomène sonore, un modèle pour la composition." – translation mine
[181] The rhythm moves between eighth notes, triplet eights, and septuplet quarters.

compression/dilation between two limits moving in contrary motion and of which the trajectory in time is regulated by the pattern."[182] There are three distinct processes of transformation: narrowing of intervals and range, rhythmic slowing, and the push and pull between the real and faux orchestra. Based on these processes, Section II' may be divided into three subsections. II'A and II'B both contain the original series; on the score, one can see this clearly, though in listening to the battle of the orchestras and the halo effect, it is difficult to identify any of the objects. II'C presents the shortened *ABCDEF*. Hurel wipes clean the slate of melodic progress, emphasizing only the sound objects.

Tognan explains, "several times; the melodies are distributed between several instruments and synthesis, to lessen their perceptibility. Issuing from psychoacoustic research on the perception of musical streams, this technique of writing is often employed in other works of Hurel."[183] By deceiving our ears, Hurel sonically defies our expectations of musical form while maintaining a simple form on paper. The familiar melodies reappear in II'C and predominate III, but their absence is marked in II'A and II'B. In the last subsection, the pattern's truncation suggests an interruption before moving on to section III. While this technique is not unique to Hurel nor music in general, the casual listener will likely fail to recognize the formal function due to how Hurel expands and contracts the harmony and rhythm and spatializes and transforms the faux orchestra.

[182] Tognan, "*Leçon des choses*: analyse,"15.
[183] Tognan, "*Leçon des choses*: analyse," 18.

In Section III (see Table 3.6), Hurel recomposes the original objects bit by bit. He begins with seven-voice polyphony in the acoustic instruments. The faux orchestra complements the real. The rhythmic matrix is simple, and the electronic samples and live instruments complement

IIIA m. 172: polyphony; no objects identified
IIIB m. 180: [sound object notation returns to the score] *A D C A C D E F GB A D C F*
IIIC m. 197: *AB C D E F GB F B D*
IIID m. 212: *A C F E GB A D C F A A B C D E F GB A C F*
Coda: pre-written electronic sequence. *A" A''' A''''...*

Table 3.6 Formal outline of Section III with road-map descriptions to follow the resolidification of the objects and the original series.

each other's accents. Throughout these few measures, he abandons the counterpoint and gradually returns the sound objects to the score, almost as they were in the beginning.

While he reinstates the objects, he obscures the rhythm and meter. Previously, time signatures and rhythms had been complex, but now it is almost completely beatless. In the score, Hurel resumes marking objects at measure 180, but to the ear, they are still rather amorphous. Around m. 214, sound objects regain recognizable identities. In the final section, the original objects are fully reformed. However, the original series never returns. When the pattern concludes the second time, there is a fixed-media coda virtuosically stretching the originally tart pan spectrum for over a minute.

The coda is not notated; likely, it is a recording of Daubresse the virtuoso performing variations on the sound objects. It is curious, however, that Hurel would not even attempt to list the sound objects referenced, which he had done so meticulously throughout the static artifact. This suggests that the coda is a separate concept altogether, truly a postscript to the piece's narrative and a totally separate Stockhausen-like "moment,"[184] like the dot on an exclamation point.

Applying the Analytical Models

The piece can be boiled down to the dissolution and resolidification of both the sound objects and their patterns. Musical motion hinges largely on shifting the spectral width, via acoustic instruments, electronics, or a combination of both. Emmerson and Landy note that the reason the order is important is that "the interesting challenge here is that the majority of formalized electroacoustic works are based on algorithmic methods that are not readily deciphered aurally."[185] Though Hurel's works are neither spectral nor algorithmic, which is what this quote refers to, his compositional style is openly inspired by both. I have already discussed his relationship with spectralism. As for algorithmic styles, Hurel uses ordered quasi-algorithms to obfuscate the instruments and electronics, and a fine distinction of spectra rather than timbre. These sonic illusions make *Leçon de choses* hard to decipher, in the way that Emmerson and Landy state. The spatialization in sections II and II', and how the

[184] Here I use "moment" as in Stockhausen's moment form, which I will explore more deeply later in this chapter as Hurel applies it to *Leçon de choses*.
[185] Emmerson & Landy, "The Analysis of Electroacoustic Music: The Differing Needs of Its Genres and Categories," 15.

faux instruments rotate, add to the quandary theorists may face. Some modern theories, however, may shed some light on the organization.

Kendall's and Young's forms

I begin with Gary Kendall's five-layer model of meaning. This model works well with a phenomenological composition like *Leçon de choses*. These five layers of meaning are designed for the listener. Starting at the top, the *Domain* is somewhere between spectralism and *musique concrete*, which may also prime us to expect moment or morphic forms (more on this in the next section). As addressed before, Hurel is often included with spectral composers, though he emphasizes his philosophical approach to harmonic spectra different enough to warrant a separate label. He composes with sound objects, which are akin to *musique concrète* objects à la Pierre Schaeffer. It is art music with morphing objects or 'situations.'[186] An appropriate schema for the Context focuses on the evolution and gradual reappearance of the objects and the original series. Locus, then, is the changes in the sound objects and patterns of the sound objects. The Gist is the relationship between the series of objects and the patterns of those series. Finally, the Sensations are the auditory attributes, within parameters, of the patterns.

[186] Tognan, "*Leçon des choses*: analyse."

Chapter 3: Philippe Hurel, Leçon de Choses (1993)

Kendall's model for meaning sheds light on the construction of the piece by viewing both the top-down and the bottom-up. *Leçon de choses* seems to work in both directions. On one level, the piece employs traits of spectralism and *concrète* music, and the interplay between real and sampled instruments as well as the unique spin Hurel puts on spectral composition are the foundation of the piece. On the other level, everything stems from the synthesis of a tart pan clanking against a magnetic tape casing. The sound is the little bang that explodes into the twelve-minute long piece of music which contains the little bang again as the climactic turning point in the piece, and it is also the grandeur of spectralism and electronics that distill down into the twelve-second long clank of a tart pan.

The piece offers a fascinating fractalized symmetry – each layer features a similar sort of dissolution and reconstitution. It begins where it ends; the tart pan sound is both the intro and the coda, and the opening measures and closing measures exhibit the Gist, the original series *ABCDEFGBADCF*. Hurel makes it feel like each layer informs another; the dissolution and reemergence within the Gist layer form the Loci, which in turn confirms the Context. As a result, the form seems to reflect itself transforming into something

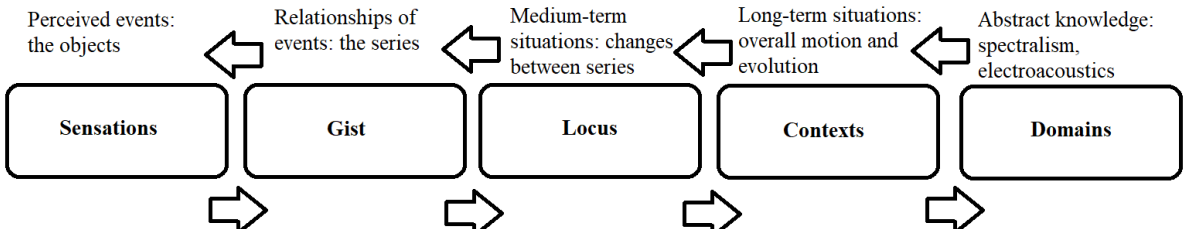


Figure 3.8: Kendall's layers, briefly applied to Hurel's piece. Smallest to largest from left to right.

unrecognizable, swirling in a whirlpool of acoustic and electronic pieces, and then leveling

out again. These elemental contrasts come from timbre, spectra, and electronics, not only melodic and rhythmic elements.

Hurel's score supplements this understanding with a clear roadmap. Every object, series, and section is labeled in the score. On a basic level, guiding listening is a task that analysts readily expect scores to do, this is precisely what makes *Leçon* interesting. As I have established, one of the common issues in electroacoustic music theory is the inaccessibility of the score, should one exist. Hurel has not only provided a score, but it is one that is close to traditional notation, making for easy reading and a well-detailed chart of the form. Hearing and understanding the progress of the piece is greatly aided by the score. Analyzing the piece in terms of Kendall's five layers is made easier by having the composer's delineations right there. It is not flawless; even the static artifact does not explain the exact results of the electronic processes creating transformations, only the processes themselves. Knowing the Max patch creates timbral distortion, for example, is only part of the essential knowledge, and the other part is hearing how that transforms the sound objects and what overall effect has occurred at each layer.

With the perceptual structure established, I turn to John Young's electroacoustic forms. *Leçon de choses* is built from objects, but the moments of transition may be the most interesting. At each of Kendall's layers, *Leçon* functions either within moment or morphic paradigms.

Chapter 3: Philippe Hurel, Leçon de Choses (1993)

In *Leçon de choses*, each sound object has a distinct set of features, and they evolve uniquely. There are no repeats, and the objects are never precisely the same as their previous iterations. Since these sound objects are the driving force of the work and the source for every change is the tempestuous tart pan, the overall form, or macroform at the Context level, fits the morphic bill.

On the Locus and Gist levels, however, the changes in the object series seem blur together like a moment. The objects and series they belong to liquefy into a morass of timbres, pitches, and rhythms without direction yet at a consistent pace. These changes are noticeable between series. For example, Section II removes the sense of time, and the series gradually removes objects until only *A* remains. Each new series (IIA->IIB, IIB->IIC, etc.) marks a new level of change to both the objects and series. So, at the middle level or mesoform, we can determine *Leçon* is comprised of moments.

At the Sensation level, objects are brief and in constant flux. Shifting instrumentation, electronic synthesis, and growing and shrinking spectra ensure the objects constantly change their identity. Over the course of the piece, they melt and resolidify. Unlike a piece of music with an exact repeat or refrain, the components of *Leçon* continuously shift and roil; thus, at this lowest level, *Leçon* employs morphic form.

In a way, morphic form and moment form are different sides of the same coin; one is constant change, and the other is episodic, respectively, but both rely on consistency. In section II, the timbres of sampled instruments rotate and become one another. This is a prime

example of the morphic form. On the highest level of form, the piece is quasi-symmetrical. Section I establishes the pattern and reestablishes it a few times over, section II dissolves into turmoil, and then II' employs counterpoint techniques to reinstate the sound objects gradually, and section III restores the pattern of the sound objects. On the lower levels, too, Hurel morphs the sound objects into one another and overlaps them to mask various aspects. Just as Wishart says is typical of morphic form, *Leçon de choses* deconstructs and fuses sonic elements, and cross-fertilizes the instrumental and electroacoustic domains. This cross-fertilization is most evident in section II when the MIDI part samples the instruments and creates a competing faux orchestra.

In the end, morphic form best describes the macroform, the scaffolding of the piece, because it examines each part as a variety of elements rather than new and contrasting elements, and it factors in the near symmetry of the form as a movement out and back. Moment form is useful for the middle- and lower-level of formal analysis. Each section may be read as a moment, and their static qualities, such as timbre or the Max patch in use, contrasting with the fluctuating elements make Hurel's changes and transitions clear.

As for the narrative form, here we must recall the origins of the composition. Hurel was inspired by a novelist, and in many ways emulates Simon's confounding techniques. The piece follows seven objects, which are introduced, transformed, influence one another and are influenced by external events, and return to the beginning recognizable but a little bit different. On an elementary level, the objects of the piece correspond to characters in a narrative, according to Hurel.

> Like [the Simon novel], this piece is composed to elements or 'situations' heterogeneous and contrasting that 'contaminate' gradually. While in the book, the different situations occur in the same place at different times. Here, the 'musical situations' played by the ensemble and electronics follow each other and become progressively contaminated and give rise to a more traditional polyphonic writing.[187]

Thus, *Leçon* fits each of the three criteria. The character of the tart pan moves through seven "situations" in a "world" and changes slightly with each iteration. The world undergoes changes of state via the changing Max patches and moments, and there is a network of causal relations and motivations around the events, particularly with the instrumental-reactive Max patches that create a feedback loop of object transformation in the faux orchestra.

This narrative reading is only possible through the static artifact's inclusion of signposts for transformations that would be too convoluted to follow by ear. Hurel's emphasis on sleight of hand transformations and aural illusion can be picked up by ear but makes tracing the narrative nearly impossible. Hurel's clear notation of sections, sound objects, and Max patch triggers offers crucial guidance. The static artifact also enlightens the analyst to Domain-level knowledge that Hurel based on the piece on a novel, which lends credence to using the narrative lens.

Understanding the electronic instruments' role(s)

Next, I draw on Michael Young's chapter, "Interactive and generative music: a quagmire for the musical analyst," which engages with pieces with interactive and generative

[187] Hurel "The Lesson of Things," translation mine.

technology. Hurel's notated components include an exhaustive list of hardware and a set-up diagram in the pre-score notes, and a line on the five-line staff for electronics with rather unique notation symbols that border graphic notation, as shown in Figure 3.9.

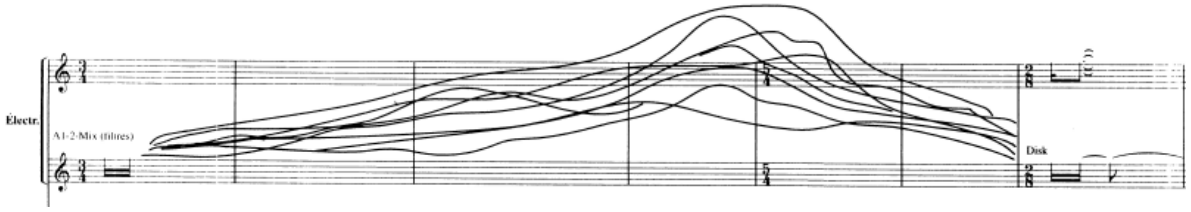


Figure 3.9 Measures 6-12 of the electronics line in the score for *Leçon.*

The form of the piece is set by Hurel's score and fixed media, but the live electronics, which react to the live performers, are the most flexible and variable part of the piece. This is where one should look for major differences between performances, and also an area where the static artifact aids analysis.

Michael Young's interactive music categories that are most applicable to *Leçon* are: (Un)fixed media, Instrumental-reactive, and Live algorithms (which are both interactive and generative). *Leçon*, for the better part, falls under the categories of instrumental-reactive and live algorithm, with a few seconds of fixed media composition in the coda.

(Un)fixed media refers to what is colloquially called "the tape track/part." In many cases, it is an indeed fixed media: all sounds are pre-recorded, and the performance involves pressing play on a playback device. In the 1980s, studios starting using unfixed media.[188] It is a continuation of fixed media, but with live manipulation. This technique entails an audio

[188] M. Young, "Interactive and Generative Music," 91.

engineer adjusting sound levels and other parameters while the tape plays back during performance, in a manner more significant than adjusting mic and speaker levels. The audio engineer in *Leçon* has the role of changing Max patches and creating the spatialized 'halo' effect, which I assert qualifies as unfixed media.

More specifically, Hurel's work uses sampling and MIDI controllers to compress, dilate, stretch, synthesize, and morph samples from live, real instruments into sounds both familiar and unfamiliar. The instrumental-reaction part, the Max patch(es), respond to the sounds from the live orchestra. Assuming the real instruments play what is written, then the faux electronic instruments will sound as Hurel intended. The fixed media portion has already undergone the obligatory changes, and lines up with the performance.

In conclusion, the notes on the page for performers are precise and non-aleatoric and non-improvisatory because he needs the live instruments to behave just so in order to manufacture the correct electronic sound. The synthesizer performer uses notation resembling the traditional five-line staff to facilitate aligning with the other live performers,

but the sonic outcome of their part is reliant on the other performers playing accurately.

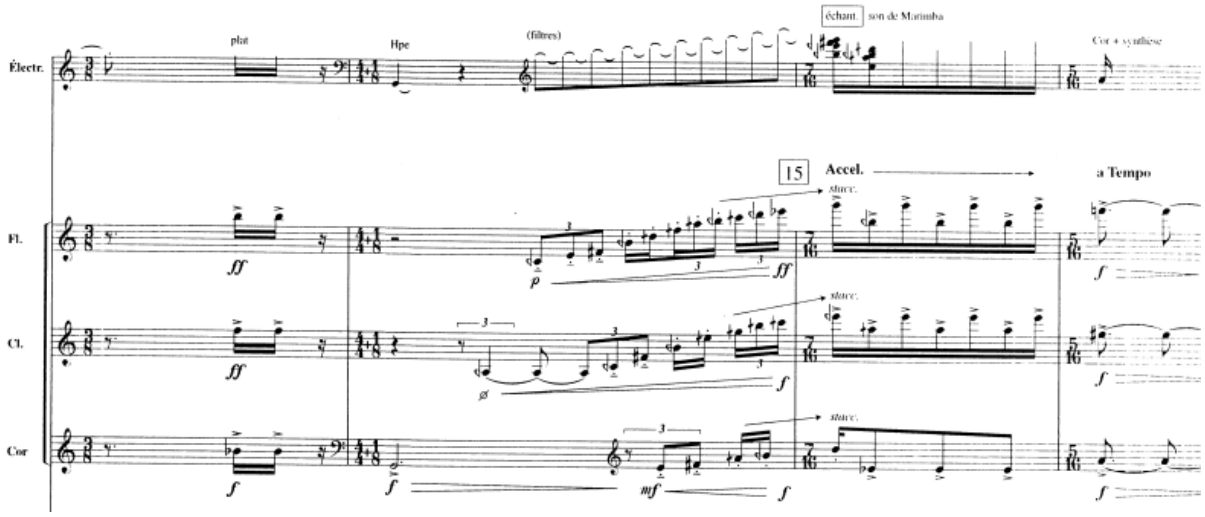


Figure 3.10 Measures 13-16 showing the electronics line with its rhythmic notation, sound descriptors, and synthesizer cues, alongside the traditional and precise notation of the three highest wind instruments.

Though Hurel meticulously designed sound objects from the original clang, he made space for aleatoricism and variation. The way he arranged it, the instruments serve the electronics, not the other way around. Without the instruments performing precise intervals and rhythms, the harmonic spectra would not be adequately ripe for stretching and compressing, for example.

Waters' Samples

Hurel's key compositional elements, rather than pitches or spectra, are sound objects, which come from samples and transforming those samples. The overall form of *Leçon de choses* is morphic, but the sections are moments. The distinction lies in the use of electronic sampling. The tart pan is the driving sound, but the sampling and modification of samples are the driving process for the entire piece.

The Max patch changes at five points, as shown in the chart below. The first program begins at measure 1, the introductory tart pan synthesis. The second program starts at m. 52, the inception of the pattern's decay in section I, and the third program is at m. 83 where the pattern completely dissolves before entering section II. The fourth program is at m. 151 in Section IIF, the last strand of musical morass before section II' prompts the duel between the real and faux instruments. The fifth and final program takes over at m. 205 in the middle of section IIIC. The programs do not line up with the section breaks themselves but instead act as the necessary impetus for the subsequent change. Each significant change slowly arises after the program change. As Waters claims, samples are the ultimate time-manipulation tool,

Patch no.	Duration
1	m. 1-51 (IA-IC)
2	m. 52-82 (IC-IE)
3	m. 83-150 (IE-IIE)
4	m. 151-204 (IIE-IIIC)
5	m. 205-end (IIIC-end)

Table 3.7 Timing and position of the Max patch changes in *Leçon de choses*.

and in this case, the Max patches take time to unfold and shift to the next section. So the MIDI not only participates in electronic evolution but creates a form at several levels.

Now the purpose of sampling is becoming more evident. Observing the piece from a top-down approach, the acoustic instruments, plus the tart pan, are the driving forces of the piece, and the electronics act primarily as accompaniment or decoration. However, if we

consider a bottom-up approach, the instruments exist to provide samples for the electronics, which create artificial sounds through spectral compression and dilation, and spatialized 'halo.' The smallest object, the sensation of the tart pan and its modifications, spin out a piece in a similar form with stretching and decay, starting and ending in almost the same sound but not quite.

Leçon de choses Conclusion

Putting it all together, Hurel's *Leçon de choses* is indeed a fascinating work of electroacoustic sounds and organization, and is exemplary for many modern techniques for analysis. This multi-pronged approach of close examination of the sound objects, the narrative background, and of the interactive electronic elements provide the necessary context for analysis. Electronics through MIDI are the driving force, but the piece requires live, real instruments. The original series' dissolution consists of moments within a morphic form. The samples and MIDI programs are the driving forces behind the form as well as the sound objects – the sound of things – that give the piece its identity. With the analytical methods offered by Gary Kendall, John Young, Michael Young, and Simon Waters, the modern analyst has several approaches at their disposal to understand live electronic, interactive, and multimedia works.

Chapter 3: Philippe Hurel, Leçon de Choses (1993)

In a post-MIDI world, the composer has a variety of options for composition. Hurel's scores use largely traditional notation, but also graphic or indexical[189] notation where he deems it necessary. Reading the notated score is, at times, more enlightening than listening to the recording thanks to this clear signposting. Even though the sound of the piece is riddled with aural illusions, the visual portion is straightforward. Hurel's score defines formal lines that are otherwise blurry. Furthermore, it indicates the role of the various electronic elements, which is also may be unclear from listening alone.

[189] For instance, the quasi-waveform of the tart pan spectrum in the introduction, and the meticulous labelling of objects and sections.

Chapter 4: Trevor Wishart, Scylla and Charybdis *(1992)*

The curious case of the antiscore

Trevor Wishart's strong beliefs about scores and notation make him an interesting case study. He finds abstract notation restrictive for the type of music he makes, which he situates under the broader umbrella term of "sonic art."[190] He summarizes the problem of notation– from providing instructions and being perceived as a representation of the music to becoming viewed as the music itself – as a shift in ideology that defeats the purpose of sonic art. At best, it represents an imbalance in power. He claims, "Ever since the ancient Egyptians developed pictures into a viable form of hieroglyphic notation, our world has been dominated by a class of scribes, capable of mastering and hence capable, or deemed capable, of controlling what was to be written down and stored in the historical record."[191] Literacy has been a dangerous skill since its invention.[192] Only the men of God were allowed to learn neumes when they were invented, and the knowledge remained within the walls of churches for a very long time. Nowadays, any trained musician can read music, but large portions of the general population can only recognize it as notation, not read it. What repercussions could this have on composers, the musically literate, and casual audiences?

While many emphasize the similarities between writing and musical notation, Wishart finds the differences to be too great to bear. He states:

[190] For sections of this dissertation concerning Wishart, I use the terms 'sonic art' and 'music' interchangeably.
[191] Wishart, *On Sonic Art*, 12.
[192] Ibid.

> With language, the actual medium may not be of special significance; it may be spoken (sound), written (visual), touched (Braille) and so forth. In a certain sense, a significant part of the message transcends the immediate concrete experience of the medium which carries it. Music, however, cannot be divorced from the medium of sound and enters into our experience as part of an immediate concrete reality."[193]

To Wishart, musical notation is a poor metaphor for a medium that cannot and should not be silent. Especially now that recording technology has come so far, it seems ridiculous to go to the effort of transcribing it.[194] Writing gets away with it, he says, because language is not confined to a single medium, but music, or sonic art, is. One might argue back that notation is no different from writing insofar as the abstract representation causes the reader to imagine the sound – but that is, admittedly, a different experience than having the sonic art performed out loud.

The age of scoreless Western music in the twentieth century is localized to a few kinds of music, as I have discussed in the first two chapters. Electroacoustic composers largely forego a traditional score because common practice notation has little relationship with the musical parameters of electroacoustic music. Wishart wanted to notate his sonic art for performers and analysts but was against notation in the way it existed. So, he reinvented it, and created the "antiscore."

In the notes for his 1973-5 work *Journey into Space*, Wishart explains his new term. Wishart draws the distinction that a "score" is written/drawn material that describes the

[193] Wishart, *On Sonic Art*, 16.
[194] And inevitably transcribing it poorly, as referenced above in the problem of metaphorical notation.

music after the fact, whereas an 'antiscore' is an umbrella term for concretized written/drawn material that describes the process that went into creating the specific instance of sonic art with the express purpose of replacing the score for performance.

Wishart labels *Journey* a "travelogue." *Journey* "consciously seeks to relinquish as much visualisable form as possible, making the piece virtually incapable of 'analysis' in the visual-structural sense which dominates current thought about music."[195] He continually punches this point home, stating, "*Journey-into-Space* as an aural experience could not be reconstituted from any written instructions, no matter how detailed,"[196] and "[the structure and content] can only be discovered in the experience of the listening journey."[197]

While some of Wishart's points are, perhaps, debatable, Wishart believes traditional or even extended or quasi-traditional notation is inadequate for contemporary music. Thus he does away with traditional notation altogether. His basic issues with traditional notation are that it is abstract and juggles two dimensions at once, rhythm and pitch, like an x and y axis on a graph.[198] Wishart's antiscores, on the other hand, aim for concrete depictions of one dimension at a time. Scores and antiscores and anything in between are useful artifacts to more fully understand a piece of music. Notation may be indexical (in the Peircean sense of the word) and it may range from metaphorical (Wishart's word) to concrete,[199] but its

[195] Wishart, *Journey-into-Space*, 1.
[196] Ibid.
[197] Ibid.
[198] Continuing the graph metaphor, additional information may be added with labels, colors, and other special symbols to represent change and status in volume, timbre (open string versus fingered string), and phrasing (staccato versus legato, where to take a breath, etc.).
[199] More on the latter side when it comes to Wishart specifically.

manifestation as a metaphor also reveals clues for analysis. Antiscores can seem more poetic, but tend towards the iconic (again, in the Peircean sense).

In *On Sonic Art*, Wishart further points out that notation is a finite, discrete, two-dimensional lattice. He defines "lattice sonics" as conventional music theories dealing with the "organisation of pitch in finite sets, rhythms using summative notation and most usually in fixed tempi, and sets of instruments grouped into clearly differentiated timbre classes."[200] A pitch-and-rhythm lattice is functional for isorhythmic, tonal, or serial music. However, once a composer employs a third dimension with equal weight or focuses on a less traditional element like timbre, an aspect Wishart often emphasizes, the lattice is inadequate to contribute information to performers or analysts.

Wishart's other book from the same decade, *Audible Design*, features his philosophy of timbre and composing sound art that features timbre. In the book, he describes twenty distinct properties of timbre. The list includes individual elements, like spectral envelope and sustain/decay curve, and byproducts of emanation, such as jitter and vibrato. He expands on each property and gives examples how he uses each element in his various compositions, especially his magnum opuses *Red Bird* and *Imago*.

As for notation, Wishart's compositions tend to surpass two dimensions as well as focusing on non-traditionally notated elements. Besides timbre, he also notates physical movement and spatialization. Thus, he deems lattice notation to be insufficient. Instead, he

[200] Wishart, *On Sonic Art*, 8.

opts for his one-dimension-at-a-time antiscore as the static artifact. As for the usefulness of notation in analysis, Wishart again cites his argument that Western music is too constrained by the two-dimensional lattice of pitch and rhythm.[201] Music contains more than two dimensions, and analysis should not be constrained to two dimensions.

Indeed, it rarely is. Many musical analyses delve into dimensions of literature and narrative form, both extramusical and within the music, and timbre, motives, transformations, gestures, and so on. But these are not often immediately apparent in the score. The analyst learns to glean information from the two-dimensional lattice before them, as well as other documents and static artifacts that make up the 'trace.'

Wishart's sonic art contains several dimensions, and he breaks down pieces into their component elements in the antiscore. By doing so, he gives each dimension the full amount of attention he feels it needs without constricting it within a lattice and having to pair it with another element arbitrarily. For example, in *Journey* he dedicates pages to musicmontage,[202] landscape, literature, movement, improvisation, drama, electronics, symbolism, and several quasi-graphic transcriptions of performed versions of the piece. Each section stands on its own. There is no real rhyme or reason to the order. There are no transitions between sections because the score is not meant to be read in real time from left to right, but rather read and internalized ahead of time, and put together in the act of performance.

[201] Wishart, *On Sonic Art*.
[202] The relative-pitch gestures with relational rhythms

Chapter 4: Trevor Wishart, Scylla and Charybdis (1992)

Wishart's decisions on what constitutes a unique musical element and deserves its own section in an antiscore are informed by several parameters, like pitch and timbre, but not all of them based on sound parameters and they are not always objective. A sample of dimensions he establishes are landscape (in *Journey*), algorithms (in *Tongues of Fire*), and political insults (in *Scylla and Charybdis*). These creative and more subjective elements he adds to the antiscore are more culturally informed, like the political insults, or more generally artistic than just musical, like the landscape. This sort of creativity and subjectivity amid equally weighted objective dimensions in the antiscore demonstrates Wishart's philosophy that a composition is necessarily "of its time," and that traditional notation, which has served many genres of music for several generations of composers, is barely a skeleton for the composition's body. The antiscore is a much more robust depiction of the composition and its cultural situation.

Wishart's most famous work is "a political prisoner's dream," *Red Bird* (1977). His antiscore presents, among other things, poetry, alinguistic philosophy,[203] contemporary myth,[204] technical origins,[205] a catalog of sound and vocal sources, context, and the musical form. Curiously, he returns to the issue of form several times, each time focusing on

[203] "It has been argued (Linguistic Philosophy) that problems which cannot be clearly formulated in language (implicitly, Written-Language) are not problems at all. *Red Bird* turns this conundrum on its head by examining the ideology implicit in rationalistic discourse through the transformation of language itself." -Wishart, from the antiscore of "Red Bird." This section on "alinguistic philosophy" explains Wishart's use of fragmented language as an undefined middle ground between tone-of-voice (inflection, etc.) and written meaning.
[204] Wishart calls Red Bird a myth-structure in which all things may be interpreted as the same thing because they transform fluidly into one another and have no 'real' boundaries.
[205] In this section, Wishart tells the reader how and why sounds and dramatic moments play out the way they do, and how technology supplements the symbolism and drama. Wishart situates these practices as "post-Webern" reductionism cum unity in which the piece *is* the process of making the piece.

something slightly different: links in a narrative, blocks of movements, blocks of sounds from the catalogue, and so on. Even within a given dimension, Wishart reveals facets of the piece and its construction that performers and analysts may find crucial.

Another of Wishart's compositions, *Tongues of Fire* (1994) is a multidimensional musical work created for and on the computer. The computer's signal-processing power metamorphoses sound material, "thereby making audible connections between different kinds of sounds and enabling a musical structure to be developed in the sonic domain."[206] The whole piece stems from a single starting sound, which Wishart metamorphoses into several related sounds. He repeats this process to build a 'tree' with nodes and branches. He admits in his article "Sonic Composition of *Tongues of Fire*" that he chose certain nodes and branches over others for their aesthetic qualities. Some are only intended as perceptual bridges. So the piece is not completely generated by an algorithm, but an algorithm spawns the possibilities from which Wishart picks and chooses.

The two major dimensions at play in *Tongues* are that of metamorphosis and transformation. He defines metamorphosis as "sonic manipulation of a sound to produce related sounds," and transformation "refers to a process of sonic development through time; that is, the use of sonic relationships to build musical structures in time."[207]

[206] Wishart, "Sonic Composition in *Tongues of Fire*," 22.
[207] Wishart, "Sonic Composition of *Tongues of Fire*," 22.

Chapter 4: Trevor Wishart, Scylla and Charybdis (1992)

Tongues was the first piece Wishart wrote that uses nothing but a computer. This pushes him even further into rethinking how he formulates his static artifact. In the antiscore, he goes through his usual steps to describe the mechanics of sound modeling and mixing. But he does not inform the analyst which DAW he used. Whether he used code like Max, a commercial DAW like Ableton, or external synth hardware patched through to the computer, we cannot know. However, Wishart goes to lengths to ensure this missing piece of knowledge does not hinder the reader. His descriptions are clear yet general enough to be interpreted on any software with the right capacity, allowing anyone with a decent computer to reproduce the sounds.

Furthermore, Wishart's aforementioned article is essentially the companion to the more barebones antiscore he created in 1994. In the article, he describes the generative processes for each phase. He frequently cites his own books, so an analyst can read up on exactly what he means by certain terms or processes.

Second, like Hurel's *Leçon de choses*, *Tongues of Fire* begins with a single sound moment and spin forth from that sound's transformation. Wishart admits that "*Tongues of Fire* does not differ from a traditionally conceived instrumental work that proceeds by the metamorphosis and development of notated pitch motives."[208] Quite unlike *Leçon*, Wishart has only the one sonic object that spawns the rest like a process of evolution, and there is no return to the beginning. Thus, *Tongues* is entirely morphic form. This is clear to anyone

[208] Wishart, "Sonic Composition of *Tongues of Fire*," 23.

listening or reading the static artifact, and Wishart openly states that he hopes listeners will be able to hear and appreciate the formal and dramatic structure.[209]

In consideration of the (anti)score along these lines, in Joel Chadabe's book, *Electric Sound*, Wishart comments that *Tongues of Fire* would have been impossible to imagine, much less actually compose, without a computer because of the different mode of compositional thought that it offers. He says, "You can now treat sound in the same logical way that we treated pitch before,"[210] and that means considering each self-contained sound, whether it be an utterance, water drip, or firework explosion, as an object. Traditional notation is designed for pitch, but not sound objects, and therefore notation has to change. Wishart and many electroacoustic composers in the late twentieth century, including all my case studies, operate in a post-pitch mindset. Hurel and Wishart think in terms of sound objects; Berman and Chagas focus on transformations and interactions, as I will explore in the next two chapters. Wishart chose to reinvent notation and make antiscores; the other composers of case studies in this dissertation chose to make hybrid notations, and fleshed out their static artifacts with essays and analyses.

By reading Wishart's books and other writings, we understand his stance on scores and the problem with scores. At the core, his complaints about music's obsession with score study and the flaws inherent in traditional scores are not unique. Trevor Wishart is in good company with mid-century theorists like Gardner Read who articulate how traditional

[209] Wishart, "Sonic Composition of *Tongues of Fire*," 22, 23.
[210] Chadabe, *Electric Sound,* 136.

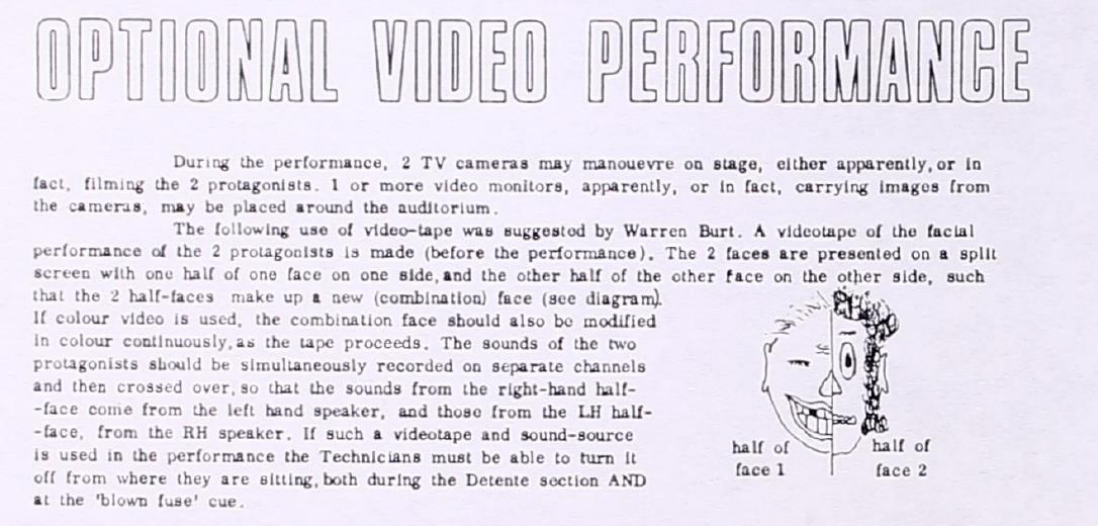
notation cannot support contemporary composition, and late-20th century theorists focused more on electronic and multimedia music like Louise Gariepy and Christian Dimpker, who identify new ways of supporting contemporary composition through new notation and transcription techniques.

Finally, by briefly reviewing Wishart's antiscore documents, we get an idea of his priorities. Wishart composes like a jeweler cuts a diamond, creating and polishing facets individually but in relation to the other facets. He prefers to give each dimension its own section of the antiscore, thus giving each dimension more or less equal weight. Wishart does use lattices but with caution, as we will see in the case study.

Introducing the case study

The score I will focus on is *Scylla and Charybdis* (1992). Wishart started it in 1976, and there was one performance at the University of La Trobe, Melbourne in September, 1976. The piece is a partially aleatoric multimedia work commenting on politicians posturing and performing their political and social ideologies. The piece incorporates fixed media, live modulation of said fixed media, live performers, lighting design, and unwitting audience participation.

The 1992 version, which is the focus here, is "based on an event [the original performance] from 1976."[211] The 1976 version used cassette tapes, and Wishart has maintained the terminology in the 1992 document. The newer version has more features, like live mixing on the computer and optional live video broadcast (see Figure 4.1), and



OPTIONAL VIDEO PERFORMANCE

During the performance, 2 TV cameras may manouevre on stage, either apparently, or in fact, filming the 2 protagonists. 1 or more video monitors, apparently, or in fact, carrying images from the cameras, may be placed around the auditorium.

The following use of video-tape was suggested by Warren Burt. A videotape of the facial performance of the 2 protagonists is made (before the performance). The 2 faces are presented on a split screen with one half of one face on one side, and the other half of the other face on the other side, such that the 2 half-faces make up a new (combination) face (see diagram). If colour video is used, the combination face should also be modified in colour continuously, as the tape proceeds. The sounds of the two protagonists should be simultaneously recorded on separate channels and then crossed over, so that the sounds from the right-hand half--face come from the left hand speaker, and those from the LH half--face, from the RH speaker. If such a videotape and sound-source is used in the performance the Technicians must be able to turn it off from where they are sitting, both during the Detente section AND at the 'blown fuse' cue.

Figure 4.1 Wishart's antiscore section on the optional video portion of *Scylla*.

technology is updated to CDs and MIDI-based technology instead of cassette tapes.

Wishart calls this piece's document a "power structure."[212] The document contains what, in the 1990s, was standard fare for a Wishart antiscore. The complete list of dimensions is in Table 4.1 below (continued on the following page).

Dimension	*Brief description*
Set	Physical arrangement of stage and audience, all to be done secretly
Outline & Resume	Describes the plot and the general idea for its manifestation

[211] Wishart, *Scylla and Charbydis*, 1.
[212] This term sounds Foucaultian, but Wishart never cites or even mentions Foucault in his writings and I am reluctant to draw the connection between the two.

Score	Two-dimensional lattice of event timing and characters
Sound diagram	Signal-flow diagram of tapes to mixer to speakers
Entrance	How the piece begins, with audience sitting and motorcycles roaring
Audience briefing	What the Protagonists should do during audience briefing (see Cheerleader notes)
Vocal duel	List of sound objects to choose from, general musical considerations, and relative volume levels
Détente	The cues to start and end, the sound objects, the acting rules, and what the tape will be doing
Denouement	Sudden stop, cued by flash of light
Technicians; electronics	Brief descriptions of props, costumes, acting, and sounds
Cheerleaders and audience manipulations	A list of lines for the Cheerleaders to say generally and during specific sections
Tapes, tape texts, tape recorders	Who corresponds to each tape, and how to manipulate the tape sound live
World problems cassette	List of characteristics
Lighting	Skeletal outline of light characteristics and cues
Optional video performance	How to incorporate live video feed
Ideals texts	The USA Bill of Rights, and the Communist Manifesto
World problems texts	A script detailing world problems
Political obscenities list	[Just what it sounds like]

Table 4.1 List of dimensions in *Scylla and Charybdis* (1992).

The first thing to address is that Wishart includes a section titled "Score." It resembles the Musical Form boxes from *Red Bird*. Within this one section, the analyst gets a feel for the entire piece. Like a traditional score that orders instruments from top to bottom, Wishart prints lines for each 'character'[213] with event timings. From this, we can infer that

[213] These 'characters' range from actors' roles to instruments to the set and lighting. The full list, in order from top to bottom: protagonists, technicians, tapes, cheerleaders, audience, lighting, (minimum lighting), and world problems cassette.

Chapter 4: Trevor Wishart, Scylla and Charybdis (1992)

Wishart acknowledges an appropriate time and place for a two-dimensional-lattice score. In this case, the coordination of characters and formal timings are the backbone of the musical structure and realization of the piece.

Scylla features actors (two protagonists and several cheerleaders) with flexible lines, audience participation, a lighting technician, and an audio technician who manages the (un)fixed media. The piece technically begins before the audience is seated, with the protagonists revving motorcycle engines in the distance. The protagonists zoom onstage on their motorcycles and duel by yelling insults and ideological quips at each other. The cheerleaders get the audience to join in. There is a lever in the middle of the stage, and the more fervently the audience participates and shows support for ideological sides, the actors move the lever to one side. The lights and audio tracks contribute to the mood and meaning – harsh blue lighting with the world problems track at mid-point, soft orange lighting and

silence from the fixed media during the cool-down. The piece ends as the vocal duel hits its climax and everything goes dark and silent, imitating a fuse short causing a blackout.

Scylla: the analysis

The first analysis to make is why Wishart chose the name he did. The names Scylla and Charybdis refer to the sea monster and whirlpool, respectively, of Greek myth. In stories,

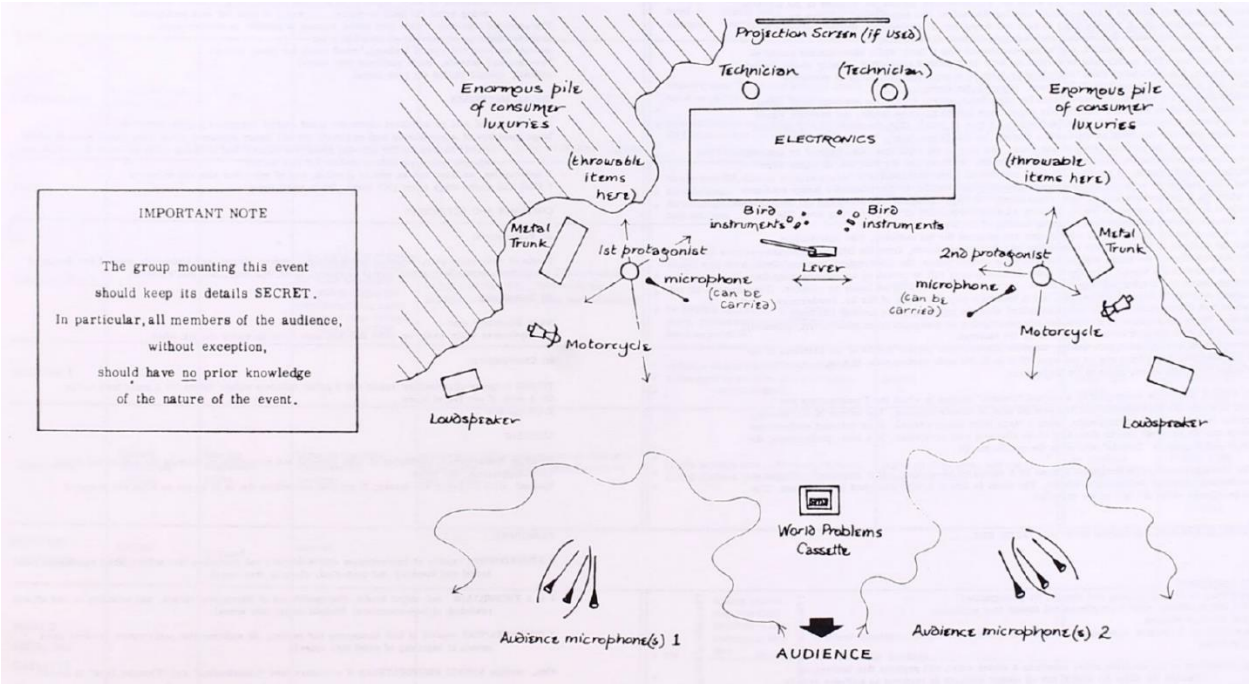
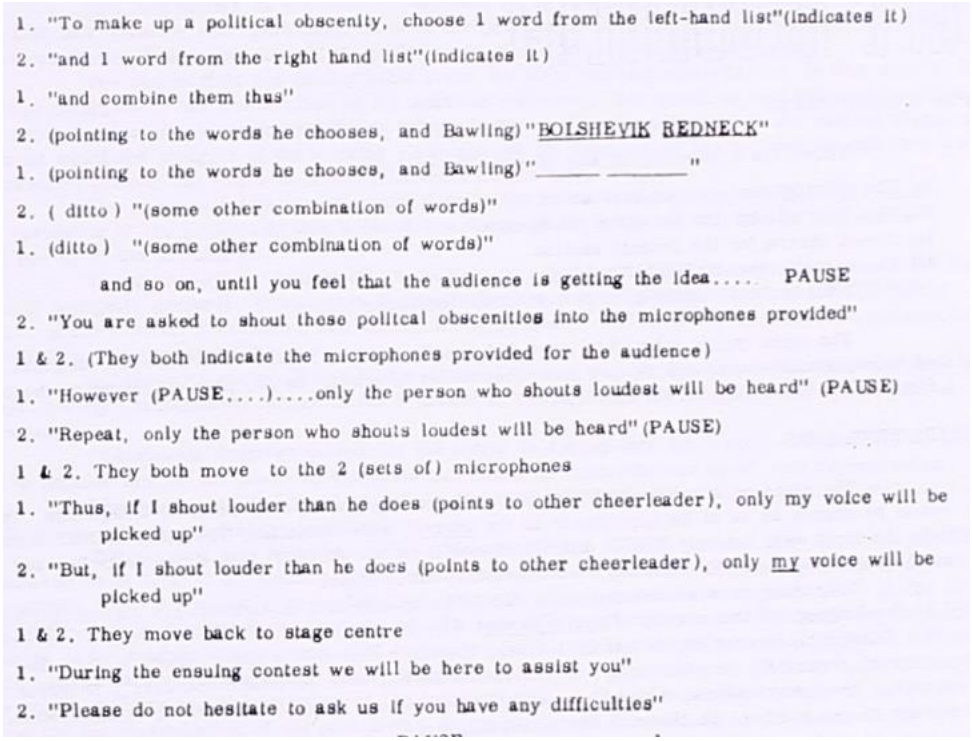


Figure 4.2 Stage set-up for *Scylla*.

like *The Odyssey*, to pass a safe distance from one is to pass too close to the other. In reality, Scylla and Charybdis are a rock shoal and a whirlpool off the coast of Sicily. The phrase "between Scylla and Charybdis" is the origin of the more common modern formulation, "between a rock and a hard place."

Chapter 4: Trevor Wishart, Scylla and Charybdis (1992)

The so-called rock and hard place in Wishart's *Scylla* are two Protagonists who enter the stage on motorcycles and proceed to throw metal objects at each other and the metal



1. "To make up a political obscenity, choose 1 word from the left-hand list"(indicates it)
2. "and 1 word from the right hand list"(indicates it)
1. "and combine them thus"
2. (pointing to the words he chooses, and Bawling)"BOLSHEVIK REDNECK"
1. (pointing to the words he chooses, and Bawling)"_____ _____"
2. (ditto) "(some other combination of words)"
1. (ditto) "(some other combination of words)"

and so on, until you feel that the audience is getting the idea.... PAUSE

2. "You are asked to shout these political obscenities into the microphones provided"
1 & 2. (They both indicate the microphones provided for the audience)
1. "However (PAUSE....)....only the person who shouts loudest will be heard" (PAUSE)
2. "Repeat, only the person who shouts loudest will be heard" (PAUSE)
1 & 2. They both move to the 2 (sets of) microphones
1. "Thus, if I shout louder than he does (points to other cheerleader), only my voice will be picked up"
2. "But, if I shout louder than he does (points to other cheerleader), only my voice will be picked up"
1 & 2. They move back to stage centre
1. "During the ensuing contest we will be here to assist you"
2. "Please do not hesitate to ask us if you have any difficulties"

Figure 4.3 Lines for the cheerleaders.

chests behind them. Hitting the metal chest triggers the contact microphones to turn on or off tape tracks of the Bill of Rights on one side and the Communist Manifesto on the other. One side stands for capitalism and democracy, and the other stands for communism. Each member of the audience picks a side and offers vocal support to their chosen Protagonist. The Cheerleaders mediate the crowd and tell them when to cheer. In this virtual setting, the audience becomes divided and act as citizens of two imagined nations. By the time the vocal duel comes along, the audience is caught up in the fervor of an imaginary war.

Chapter 4: Trevor Wishart, Scylla and Charybdis (1992)

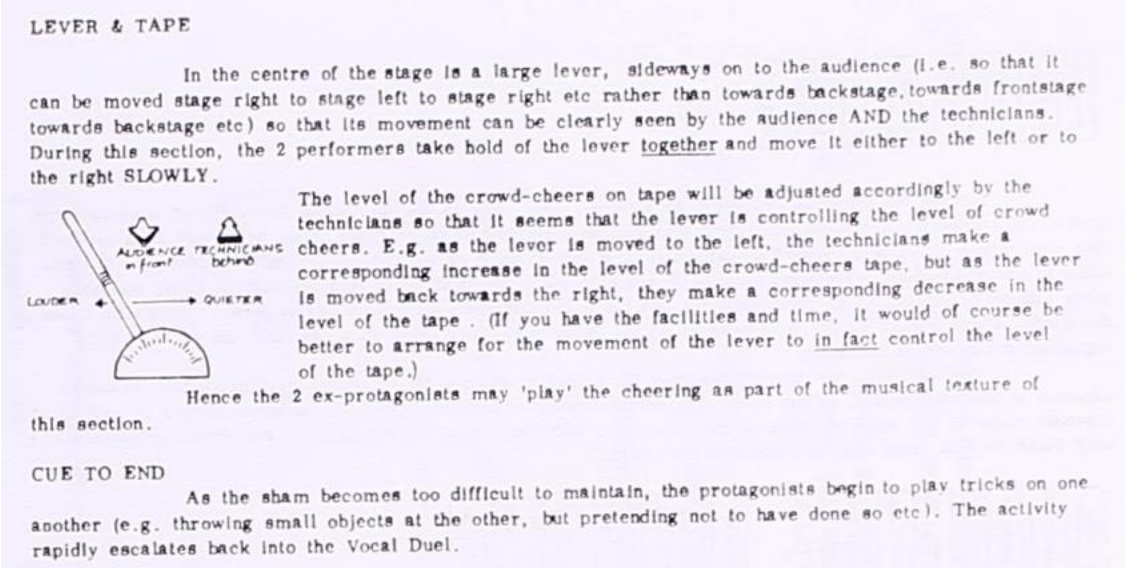
The list of political obscenities belongs to the audience alone – neither the composer nor the performers know what will be said or how strongly either side will proclaim them. Wishart only provides the foundation for political unrest. Anything crude or treasonous that is said during the performance comes straight from the audience participants.

Tale as old as time

Since *Scylla* is text-based and reflects real world politics, it is possible to analyze it via John Young's narrative form. Recall the three criteria: narrative creates a world populated with characters and actions, the world undergoes changes of state (temporal dimension), and the text allows reconstruction of an interpretative network of goals, plans, etc. To meet the first criteria, *Scylla* builds a world based on two very real factions of reality. Second, this world undergoes changes – the audience develops as a holistic character, the dramatic lighting shifts to indicate narrative beats, and the Protagonists react to the audience's cheers. Finally, *Scylla* is a commentary on world politics, and Wishart seeks to impart some self-awareness on the audience through their unwitting participation.

Scylla's form is more closely related to "moment" than "morphic" form. Wishart's works are often touted as the perfect examples of morphic form; the expert on electroacoustic forms, John Young, cites Trevor Wishart as the major influence on codifying "morphic form." However, *Scylla* is different from most of Wishart's corpus and does not fall under that category. For starters, in his antiscore he demarcates discrete sections of the macro-form (introduction, détente, etc.), which lends credence to each section having its own identity and

boundaries. Each temporal section has a number of events that happen, such as driving



LEVER & TAPE

In the centre of the stage is a large lever, sideways on to the audience (i.e. so that it can be moved stage right to stage left to stage right etc rather than towards backstage, towards frontstage towards backstage etc) so that its movement can be clearly seen by the audience AND the technicians. During this section, the 2 performers take hold of the lever together and move it either to the left or to the right SLOWLY.

The level of the crowd-cheers on tape will be adjusted accordingly by the technicians so that it seems that the lever is controlling the level of crowd cheers. E.g. as the lever is moved to the left, the technicians make a corresponding increase in the level of the crowd-cheers tape, but as the lever is moved back towards the right, they make a corresponding decrease in the level of the tape . (If you have the facilities and time, it would of course be better to arrange for the movement of the lever to in fact control the level of the tape.)

Hence the 2 ex-protagonists may 'play' the cheering as part of the musical texture of this section.

CUE TO END

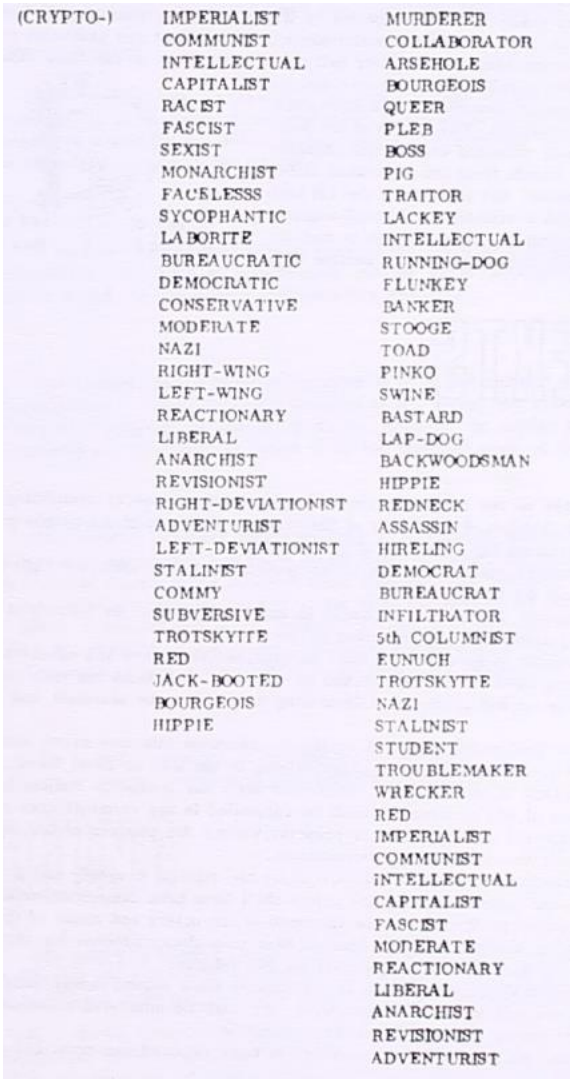
As the sham becomes too difficult to maintain, the protagonists begin to play tricks on one another (e.g. throwing small objects at the other, but pretending not to have done so etc). The activity rapidly escalates back into the Vocal Duel.

Figure 4.4 Lever and fixed media section in Wishart's antiscore for *Scylla*.

motorcycles on stage or pulling levers to change Max patches and the sonic atmosphere (see Figure 4.4), and each section is clearly distinct.

The meso-form, or the actions within these sections, is also discrete, and suggest narrative form. The content is largely aleatoric, but political insults do not morph from one into another, for example. The technician(s) performs live mixing on the tape parts, but the sounds do not take on new identities when they shift. Rather, the sounds vie for importance, and the technicians and protagonists determine which ones are heard and understood more

than others. Additionally, during the vocal duels, the audience cheers for one side or another, and the actors move the lever of the stage according to the intensity of the cheers. The technicians adjust volumes and effects according to the direction of the lever. This is why



(CRYPTO-)		
	IMPERIALIST	MURDERER
	COMMUNIST	COLLABORATOR
	INTELLECTUAL	ARSEHOLE
	CAPITALIST	BOURGEOIS
	RACIST	QUEER
	FASCIST	PLEB
	SEXIST	BOSS
	MONARCHIST	PIG
	FACELESSS	TRAITOR
	SYCOPHANTIC	LACKEY
	LABORITE	INTELLECTUAL
	BUREAUCRATIC	RUNNING-DOG
	DEMOCRATIC	FLUNKEY
	CONSERVATIVE	BANKER
	MODERATE	STOOGE
	NAZI	TOAD
	RIGHT-WING	PINKO
	LEFT-WING	SWINE
	REACTIONARY	BASTARD
	LIBERAL	LAP-DOG
	ANARCHIST	BACKWOODSMAN
	REVISIONIST	HIPPIE
	RIGHT-DEVIATIONIST	REDNECK
	ADVENTURIST	ASSASSIN
	LEFT-DEVIATIONIST	HIRELING
	STALINIST	DEMOCRAT
	COMMY	BUREAUCRAT
	SUBVERSIVE	INFILTRATOR
	TROTSKYITE	5th COLUMNIST
	RED	EUNUCH
	JACK-BOOTED	TROTSKYITE
	BOURGEOIS	NAZI
	HIPPIE	STALINIST
		STUDENT
		TROUBLEMAKER
		WRECKER
		RED
		IMPERIALIST
		COMMUNIST
		INTELLECTUAL
		CAPITALIST
		FASCIST
		MODERATE
		REACTIONARY
		LIBERAL
		ANARCHIST
		REVISIONIST
		ADVENTURIST

Figure 4.5 List of political insults for the performance of *Scylla and Charybdis*.

Wishart calls the piece a "power structure"– the piece is more about claiming and flaunting identity than it is about shifting identity, and triggering change but not molding change organically. Thus, *Scylla* is best read as a narrative form with many moment-like elements.

Section	*Key players & changes*
Preset	Protagonists on motorbikes; technicians ready; audience enters
Preentry	Protagonists approach; lighting dims
Entrance	Protagonists bike on stage; cheerleaders rush the stage
Introduction	Protagonists "sport selves up"; cheerleaders deliver speech; spotlight on cheerleaders
Vocal Duel	Protagonists trigger 'tapes'; technicians roll tracks; cheerleaders turn on "world-problems cassette" (CD in '92) and mingle with audience; audience shouts political obscenities; lights are blue with strong shadows & strobes
Détente	Protagonists bird-whistle; technicians turn on cheering track and urn off sound system; lights are orange with soft edges
Vocal Duel	Protagonists continue; lights flash
Denouement	Protagonists silence on flash but continue acting; technicians turn off all sound; cheerleaders usher audience out of auditorium

Table 4.2: Overview of the macro-form of *Scylla*.

Between fixed and media

Michael Young's categories of interactive and generative electroacoustic forms are also applicable to *Scylla*. These forms were intended for more DAW-based pieces, but anything using live electronic media in a meaningful way can borrow them.[214] *Scylla* uses (un)fixed media – the tape part is pre-recorded and fixed, but its playback involves live processing from the technician to boost its volume or affect its clarity through effects like reverb. The spatialization associated with the stage and microphone arrangements are also important elements of the (un)fixed media. Wishart's antiscore has a section dedicated to

[214] For this work, Wishart's workflow does not take place in a DAW. The only meaningful use of a computer in this work is playing the tape part, and its (un)fixed modifications.

these arrangements, which is useful to the analyst's understanding of how far sound travels from its source as well as how much modification it undergoes.

Young states "the analyst is free to disregard the interactive element beyond what is

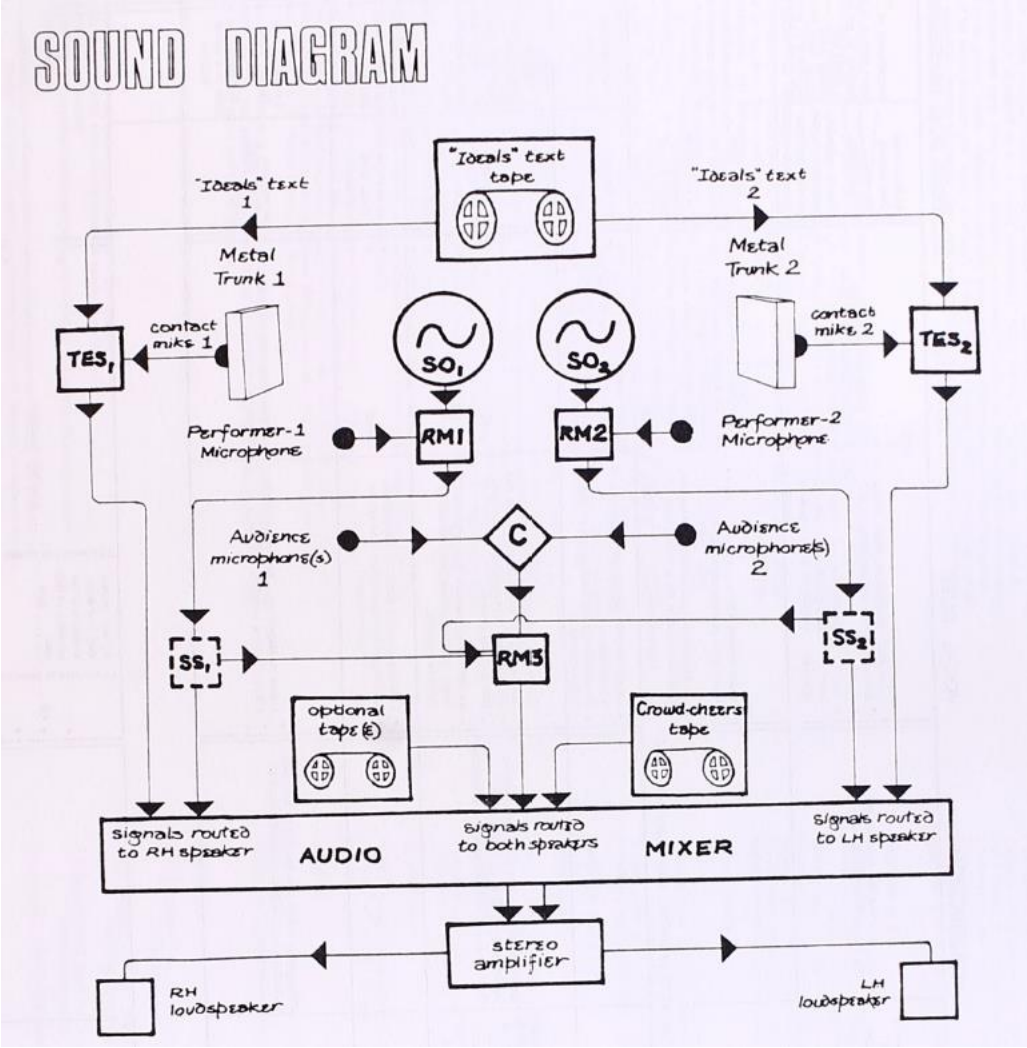


Figure 4.6 Sound chart for realization in *Scylla and Charybdis.*

clearly perceivable in sound: it is the musical materials themselves that interact, irrespective of their cause or ownership, demonstrating 'aesthetic liveness'."[215] The eloquent speeches

[215] Young, M., "Interactive and Generative Music," 92.

and hurled obscenities come from both fixed media and live actors, and it may be difficult to tell the difference of their origins. The most coherent speeches are the fixed media Ideals texts – however, these lose their coherence and meaning by the performers and audience drowning them out with improvised yelling, or even by another track during the vocal duels. The audience may observe the performers pulling levels and causing other triggers, but it may not be immediately clear what they are activating.

In Wishart's antiscore, however, we get the full picture. The analyst can read every line and contrast its meaning, its timing, its historical significance, or anything else. Without the score, the text is fragmented and loses some of its meaning. This is one purpose for a(n) (anti)score: clarity, especially when looking back. This is what Young calls a black-box approach: "a musical analysis must focus on whatever structural elements can be inferred from a recording or notated score alone, illustrating the effective nature of the work… A single instance – a performance or realisation – is likely to be only a partial manifestation of any given system."[216] Indeed, I have already brought up the aleatoric nature of the work due to the audience's participation and the performers' reactions.

In these cases of inherent incompleteness, Young recommends comparative analysis of performances. However, for this piece it is impossible. The 1976 version has only one recording that is not widely available,[217] and the 1992 version does not seem to have a

[216] M. Young, "Interactive and Generative Music," 95-6.
[217] I was unable to access it despite the University of California's robust interlibrary loan service because it is classified as "rare," and I was unable to travel to Australia to search the archives.

recording at all. As it is, *Scylla* (1992) only exists in antiscore form.[218] The only thing *to* analyze is the static artifact. There is some irony in this, given Wishart's comments about the limitations of music notation as being a silent medium. At the same time, this limitation gives us infinite space to imagine what performances could be like, and there is no "most accurate" or "best" recording or performance. In this particular case, the analyst must identify the breadth of possibility based on which sections have aleatoric or interactive elements, and consider the potential outcomes.

Michael Young next suggests evaluating process, and then the outcome. The analyst should start by picking apart elements and analyzing them one by one, or in pairs as is applicable. Wishart's antiscore is perfect for this process. Each element has already been identified and segregated. Wishart's application of subjective and cultural delineations rather than objective and physical ones, i.e. the way he defines dimensions based on artistry rather than quantitative limits, guides the analyst to focus on what Wishart deems artistically important. Interestingly, in *Scylla* there is exactly one two-dimensional lattice. As for evaluating the outcome, this is where notation-based analysis fails because outcome means performance or realization. Even without a recording of *Scylla*, thanks to the static artifact I can perform the bulk of the analysis on elements like form, lyrics, and interactivity.

Wishart's detailed antiscore gives us a lot to consider about *Scylla*, Wishart's style and intent, and, most broadly, the role and use of notation in general. If anything, the clarity

[218] Much to Wishart's chagrin, no doubt.

within his antiscore reveals more than a single performance could. The static artifact negates the need for comparative performance analyses. It also lays bare the form and meaning, regardless of the time it takes to realize, or the required success of the performers to engage the audience as prescribed.

Admittedly, Wishart's antiscores resemble event scores, like the kinds of text scores from Fluxus or Cage's "Happening" style pieces. The core difference is that event scores describe or instruct a more holistic event, whereas Wishart's antiscores parse each element into its own dimension and moment. Event scores might even be notated on a lattice; antiscores must not. Had Wishart been constrained to a lattice, the imagined piece would be rather incomplete. If the Score section were the only part, the Ideals text and the content of the other tapes would be missing, the lines for the Cheerleaders and audience would be absent, and the dramatic lighting would be bland. By creating a "power structure" document, he ensures analysts and potential performers alike have the whole picture in front of them. Wishart's antiscore offers every possible outcome at once, making comparative performance analysis unnecessary.

Scylla and Charybdis Conclusion

Electroacoustic music is a wide genre with a variety of ways it can manifest. Recent research and theories are shedding new light on approaches theorists might take to analyze these types of composition. Thus far, the static artifact is often overlooked or put in a

secondary position.[219] The two case studies provided here demonstrate that the static artifact, however close or far it is to a traditionally notated score, can be essential to understanding and analysis.

Wishart's antiscores also suit the needs of the orchestration and the allowances the performers are afforded. Pitch and rhythm are not primary parameters in *Scylla*, and so he leaves them out entirely. The major realms and parameters are the words, drama, and lighting, for which he gives explicit instructions in the antiscore. The work has several aleatoric sections and interactive electronics and can only be analyzed by imagination, and Wishart's detailed static artifact gives the analyst plenty to work with. Michael Young and other modern theorists of electroacoustic music provide us with theories and methods for analyzing pieces like Wishart's, that incorporate staging, drama, audience interaction, interactive electronics, and so forth.

Across the spectrum of multimedia electroacoustic pieces, the static artifact is a major piece in the puzzle of analysis. The phenomenological experience of electroacoustic music is difficult to parse; but, combining listening with some kind of score can illuminate what is happening in the piece, and therefore we may understand the composer's meaning. Even without a realization of the piece the analyst can reliably imagine how the piece can play out and discern meaning from the possibilities there. Wishart's case study has touched on some

[219] To be fair, sometimes a composer will choose not to make any kind of score. It may be possible to acquire screenshots or data files of their work, which qualify as static artifacts. The cases that have absolutely no static artifact accessible, which may be the case in *musique concrete*, soundwalks, and some soundscapes, are not covered in this dissertation.

other multimedia elements as well, of drama and language, which I explore further in the next two case studies.

Chapter 5: Anne Deane Berman, Positive Thinking *(1993)*

Introduction & a Brief History

The electronic age also ushered in the age of cinema and the marriage between audio and video. There is a fascinating and robust history of cinema and film scoring that has been covered in a number of books, articles, and dissertations.[220] In this chapter, I will focus on a truly audiovisual composition – not only videos with sound or compositions with video, but works in which the two elements co-exist and operate in tandem for a multimodal experience.

Despite the M in its name, MIDI is capable of much more than only musical interfacing. Audiovisual projects began well before 1983, but the invention of MIDI allowed many kinds of hardware and software, not just for sound but for visuals as well, to collaborate seamlessly. MIDI is useful in an audiovisual context for two reasons: first, because it can connect and synchronize visual data and programs just as it can connect and synchronize audio data and programs, and second, because it can visualize any data, including performance data, for the user.

Avant-garde composers, pop musicians, film-makers, and broadcast stations adopted MIDI almost overnight in 1983, and for the first time, it was possible[221] to link together audio

[220] Some notable sources include Claudia Gorbman's *Unheard Melodies: Narrative in Film Music* (1987), Michel Chion's *Audio-Vision* (Gorbman's English translation: 1990), David Neumeyer's *Meaning and Interpretation of Music in Cinema* (2015), and James Buhler's *Theories of the Soundtrack* (2019),
[221] At the very least, substantially easier

engineering hardware and software – and video hardware and software – made by any brand. By 1985, MIDI was an industry standard for music across western Europe and North America, including projects with video components.[222]

It is clear to see how MIDI enables multimedia composition. For instances of multimedia that use media other than audio, such as music videos, MIDI is an even more critical unifying feature. The way MIDI communicates pitch, volume, timbre, rhythm, and so forth is adaptable to elements of digital video data.[223] The electronic Esperanto, as Kakehashi calls it, was intended to unite sound-making and -interpreting software, and but it also positively influenced video-making and -interpreting software. In many instances of multimedia, the video portion may be examined as a portion of fixed media and as a segment of the static artifact. This is the case whenever the sounds/music take frontstage over the video.

The piece chosen for this chapter use videos and scores in different ways. Written in 1993, Anne Deane Berman's flute and voice duet with electronics centers around a poetic recitation of a narrator heartbreakingly informing his partner that he tested positive for AIDS. *Positive Thinking* has a relatively traditional score, and the visual element (possibly a video, possibly a live projection) supports and punctuates the poetry and its narrative. *Positive Thinking* demonstrates Berman's typical techniques and style, blending electronics and

[222] Kakehashi, *An Age Without Samples.*
[223] Ibid.

storytelling for an immersive "animated poetry" experience.[224] I chose this work for my case study because of its intricately woven layers and for the composer's creative use of the materials at hand; it contains an excellent example of MIDI-era extended notation worth picking apart, and also it is an emotionally powerful cohesive work of sound, music, narrative, and images. Though the original realization of this work does not tap into MIDI's audiovisual coordination ability, Berman provided several options and suggestions for implementing and coordinating the video. She did this to future-proof her static artifact – she understood that technology will move forward and her tools will become obsolete quickly, but as long as the MIDI protocol is available then future performers can find suitable ways to show the video. I will discuss this in more detail towards the end of the chapter.

Borrowing Film Theory for Audiovisual Multimedia

To explore film theory via notation and score would itself be a separate dissertation or two. For the purposes of this chapter, I draw on theorist Nicholas Cook, whose theory for audiovisual analysis also applies to electroacoustic multimedia works with a little reframing. The electronic visual component of *Positive Thinking* (1993) is a projection of live, moving cells in petri dishes. The original performance projected actual petri dishes under a microscope in the performance hall. Subsequent performances have used a pre-recorded video of similar petri dishes, or streamed video feed from laboratories offsite, which was a technology not available when the piece was first written.

[224] Berman, "Artist's Statement"

Chapter 5: Anne Deane Berman, Positive Thinking (1993)

I begin by addressing the work as a balanced, heterogeneous "instance of multimedia"[225] (hereafter: IMM). I draw on Nicholas Cook's multimedia approach to analyze it as such. as described in his book *Analyzing Multimedia* (1998). His formalist approach involves teasing the multimedia elements apart to assess them in bite-sized pairs and then recombine them in a holistic view at the end. For *Positive Thinking*, this entails parsing the identifiable segments (narrative, electronics, flute melody, etc.) into pairs that I can analyze together, and then combining the pairs into a holistic analysis.

[225] Nicholas Cook's umbrella term for piece/instance of multimedia art, music, performances, etc.

Cook prescribes three models to choose from for the media pairs. The three models are *conformance*, *complementation*, and *contest*. Determining which model to use involves pairing off elements of the *instance of multimedia* and running them through what he calls a similarity test and a difference test.[226] The similarity test borrows from Lakoff and Johnson's distinction between *consistent* and *coherent* metaphors. Media are consistent if their symbolic and indexical meanings are in alignment; they are coherent if their meanings are

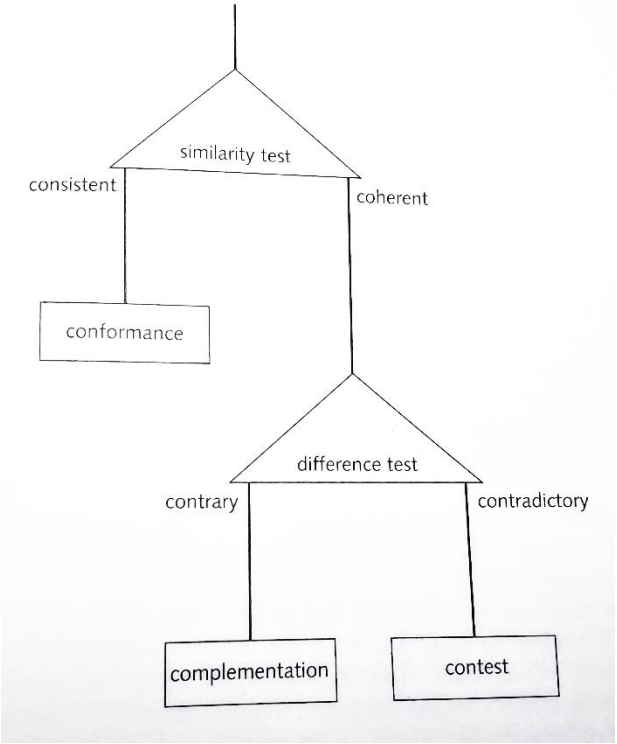


Figure 5.1 Cook's three basic models and their tests. From Nicholas Cook's *Analyzing Multimedia* (1999), p. 98.

similar but bear different connotations and symbolism.

[226] Cook, *Analysing Musical Multimedia*, 99.

If the similarity is deemed consistent, then the applicable model is conformance. As Cook explains:

> Where an IMM is conformant, or where the relations between the constituent media of an IMM are conformant, it should be possible to invert such statements without change of meaning; it makes as much sense (indeed, it makes just the same sense) to speak of the upper *luce* part in [Skriabin's] *Prometheus* projecting the music, as of the music projecting the upper *luce* part.[227]

In other words, there is an equal and symbiotic correlation – the intermedia relationship is dyadic.[228] Note that the key word is relationship; "the importance of conformance…is not so much as an overall model of multimedia, but as a model of relationship of constituent media within an IMM."[229]

If the similarity is deemed 'coherent,'[230] then the media pair passes on to the difference test. The difference test is based on Greimas's semiotic square, and the

White	Black
Not-black	Not-white

Figure 5.2 An example of a Greimas square, showing a 'consistent' pairing.

[227] Cook, *Analysing Musical Multimedia*, 100.
[228] Or, in some cases, triadic, as Kandisky suggests colour corresponds to a sound "inasmuch as both correspond to an underlying emotional or spiritual meaning" (Cook, p. 101).
[229] Cook, *Analysing Musical Multimedia*, 102.
[230] Cook, *Analysing Musical Multimedia*, 100.

relationships are contrariety and contradiction, "of which the latter…is the narrower, or 'marked', term."[231] The semiotic square works like so: two descriptions may be positive or negative, e.g. white & not white, and they may or may not bear alignment, e.g. black & not black or square & not square.

In the first example, white & not-white and black & not-black may be consistent, but white and not-square or not-white and square are coherent at best. As Cook uses the Greimas square, he considers that if the difference is deemed contrary, then the analyst should use the complementation model; if the difference is contradictory, then the contest model is in order.

Contrariety is a collision between different levels of signification.[232] An example of such disjunction is a pun. Puns use lexical similarity to mask a semantic contradiction; in one way, they are a normal sentence, and simultaneously on a different level they carry an unexpected meaning. A type of multimedia that often uses contrariety is television ads; the visual or aural hook may have nothing to do with or be in direct contrast to the linguistic message. These IMMs should be exampled under the multimedia model of *contest.*

The mid-point between these two extremes is *complementation.* This relationship exhibits neither consistency nor contradiction. Whereas consistency examines a dyadic relationship and contradiction examines disjunction and dissonance, complementation often has an unbalanced relationship. A common example of complementation is background

[231] Cook, *Analysing Musical Multimedia,* 102.
[232] Cook, *Analysing Musical Multimedia,* 103.

music in a play or televised medium. In the case of background music, the music is a "servant art"[233] to the visuals and words. Cook suggests essentializing these elements into separate spheres so one is not unfairly favored over the other, and then looking at how the relationship contributes or detracts from the media's intrinsic properties.

Cook's own analyses using his method weigh the performance against the score for confirmation. His chapter on Disney's *Fantasia* version of the *Rite of Spring* not only uses score study in the analysis: he also compares Stravinsky's original version to the edited cut for the film. The power play between the media in that instance is that the storyboard was written to follow the music, and then the music was arranged to be much more concise and suitable for essentially a music video. By describing how the 1939 version of *Rite* came to be, Cook illuminates its ambiguous situation as both the primary media and the last piece of the IMM, and the subsequent score study tracing the musical score alongside the story beats takes on a different implied dynamic. This example sets a precedent for in depth score study for analyzing IMMs.

It is not always cut-and-dry which model is the optimal choice. For example, commercial music videos often add irrelevant imagery, or the imagery does not line up to the timing or form of the music. In Cook's example of Disney's *Fantasia*, he points out the problem with addressing the issue of continuity is the successive production of the video make it subservient to the music, thus calling on the complementary model, or does the

[233] Cook, *Analysing Musical Multimedia* 104

reception of contrast and juxtaposition lean more towards contest? Here, it falls on the analyst to make and defend a choice in order to proceed.

In the case of *Positive Thinking*, the IMM consists of a fixed media track containing a poem, live alto flute performance, fixed and reactive electronics, and quasi-live visuals. The power dynamics between the four elements is as much a part of the piece as the elements are themselves, which is where Cook's methods will come in. These power dynamics are in part due to when each section was composed – as the *Fantasia* example demonstrates, an earlier part of the work would establish a precedent for a later part, but could also be edited afterwards and create a feedback loop. These specifics will be discussed in the analysis.

Introducing the Case study: Anne Deane Berman's *Positive Thinking* (1993)

The case study I have chosen for this audiovisual chapter is Anne Deane's *Positive Thinking* for alto flute, tape, poem, and slideshow (1993). I chose Anne Deane Berman for her holistic philosophy of multimedia and narrative-imbued composition. In her words: "My computer music uses story-telling and narrative to create animated poetry. This particular piece was selected for its four-way mingling of live instrument performance, fixed sonic media ('tape' part), fixed or aleatoric visual media, and live or fixed poem recitation."[234] Additionally, the work encapsulates Berman's holistic and multimedia compositional philosophy, and works well with Cook's multimedia method of analysis.

[234] Composer's note in *Positive Thinking* (1993)

Chapter 5: Anne Deane Berman, Positive Thinking (1993)

Positive Thinking was written as separate but connected components. The first component to have been created was the poem, written by professor of composition Fred Chance at UCSB. The text describes his anguish not knowing if he inadvertently infected his partner with HIV. The second component, and the first one that Berman herself created, is the fixed media component. Berman created this using Linear Predictive Coding (LPC) on a NeXT computer to stretch and mutate Chance's recorded recitation into the fixed media ("tape part"). Simultaneously and separately, Berman designed the alto flute part with two goals. The first was as a wordless character in conversation with the poem. It "speaks" in musical gestures, and eventually the flutist begins to speak the words of the text through the flute, creating a liminal musical/textual IMM. The secondary goal was to support and accentuate certain parts of the poem.[235] Finally, Berman assembled slides of live human cells from the Microtubule and Pharmacology Lab at UCSB for projection on a 15-foot screen. This was necessarily the last step actually realized before the premiere because the cells were alive and changing; that being said, Berman designed the slideshow as soon as she finalized the tape part, and her notes may be used to recreate the slides. Additionally, the official video Berman has posted on YouTube may be used during performances as a fixed media.

As a whole, the piece explores telling a story through quasi-interactive art elements. The flute 'learns to speak' from the words uttered in the poem – over the course of the piece, the flutist gradually enunciates and vocalizes syllables like "sss" after having heard them in

[235] Personal correspondence with Anne Deane Berman. May 31, 2020.

the poem. The flute's musical gestures evoke or reflect certain emotions in the poem. The electronic effects add uncanny timbres and evoke new layers of meaning. The cells projected a million times larger than life locate and expand the soundscape.[236] Meaning and narrative are imbued in the very process of realizing the piece with technology.

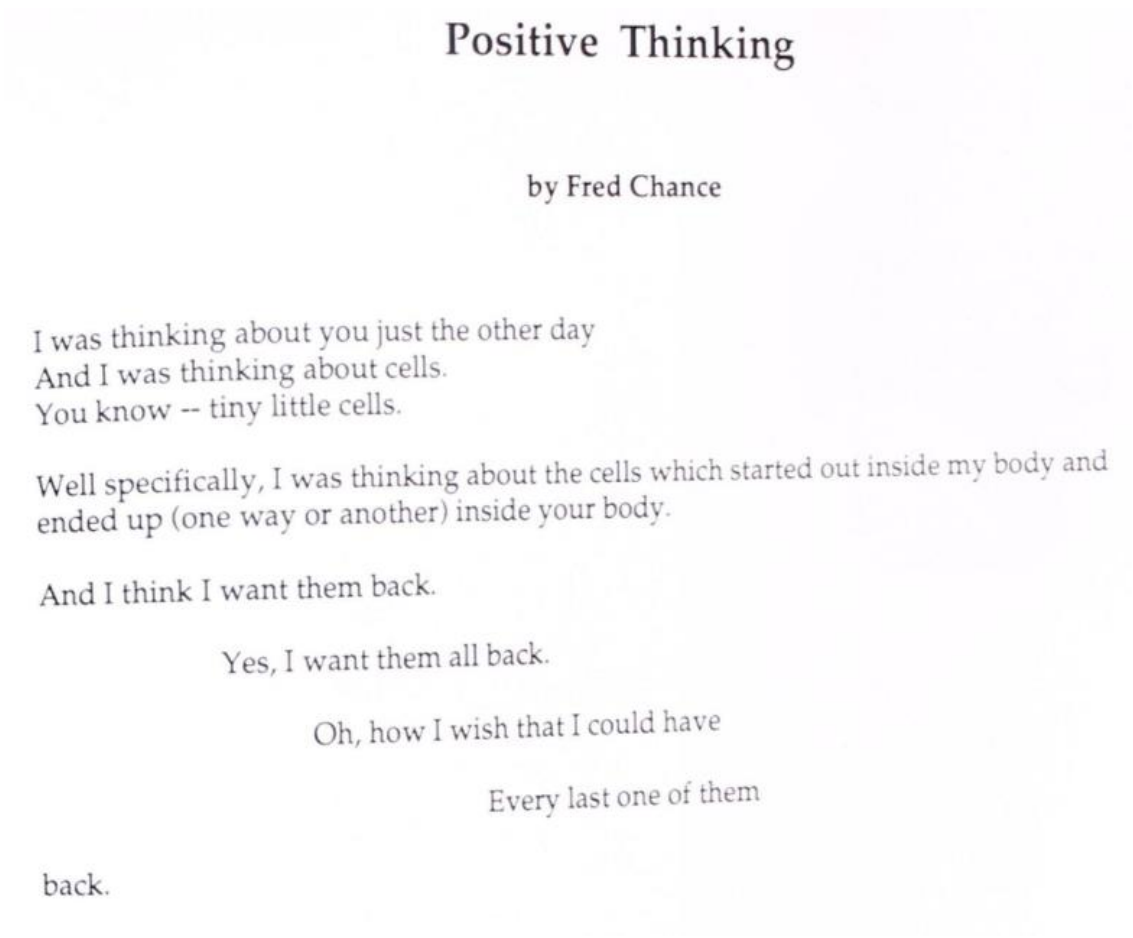
Berman describes her compositional style as "animated poetry."[237] Such a description might evoke connection to animation *à la* Disney's *Fantasia*, but Berman simply means that her works incorporate movement – animation – in a meaningful way. In the case of *Positive Thinking,* the visual elements are living blood cells projected on a screen. Some are infected with HIV; some are not. The operator fades between petri dishes to match the form of the piece. Berman allows the operator to take liberties with lighting or magnification so long as the subject is evident.

[236] Berman, Anne Deane. "Artist's Statement."
[237] Ibid.

Chapter 5: Anne Deane Berman, Positive Thinking (1993)

The score, the static artifact

The score for *Positive Thinking* was written for the analyst/audience, flute performer, and technician in charge of the fixed media. In my analysis, I consider the order in which the elements were collected or composed by Berman; knowing which elements directly influenced others and were then in turn edited or modified to match other pieces is an important task in analyzing this kind of multimedia. Thankfully, Berman remarks on this



Positive Thinking

by Fred Chance

I was thinking about you just the other day
And I was thinking about cells.
You know -- tiny little cells.

Well specifically, I was thinking about the cells which started out inside my body and ended up (one way or another) inside your body.

And I think I want them back.

Yes, I want them all back.

Oh, how I wish that I could have

Every last one of them

back.

Figure 5.3 Berman's reproduction of Fred Chance's poem "Positive Thinking" (1991).

ordering in her score and program notes, which are collectively the static artifact. She even organizes the score roughly in chronological order to guide the reader.

The first page of the score is a reproduction of Fred Chance's poem, which is used as the text, with its original formatting. This sets the scene: the poem came first, and Berman's composition followed. If the poem came first, then perhaps the composition exists to showcase the poem, to raise it to new heights.

The second page contains the program notes that one would put in the audience member's program. These notes cite the artistic sources and the sources of monetary support. They describe the first performance of the piece, which further gives future performers an idea how to set up the stage and emphasize appropriate moments. These directions include instrumentation, staging set-up, and the visual elements like projection and lighting. Certain things, like the projection, are described in a way that can be recreated or give freedom to the future performer.

Next, the performance instructions are divided into Audio and Visual. The audio list informs what kinds of flute, audio formats, and microphones are ideal or passable. The visual list describes the rules for projecting the slides (15-foot projection; use a dissolve transition), house lights (darkness, save for blue stand light for flutist), and costumes (all black). The exact visuals and timing for the visuals are not specified in Berman's score. Rather, the flutist predetermines the slides and the transition timings. For this, the static artifact encompasses the score and the fixed media, but not the projection.

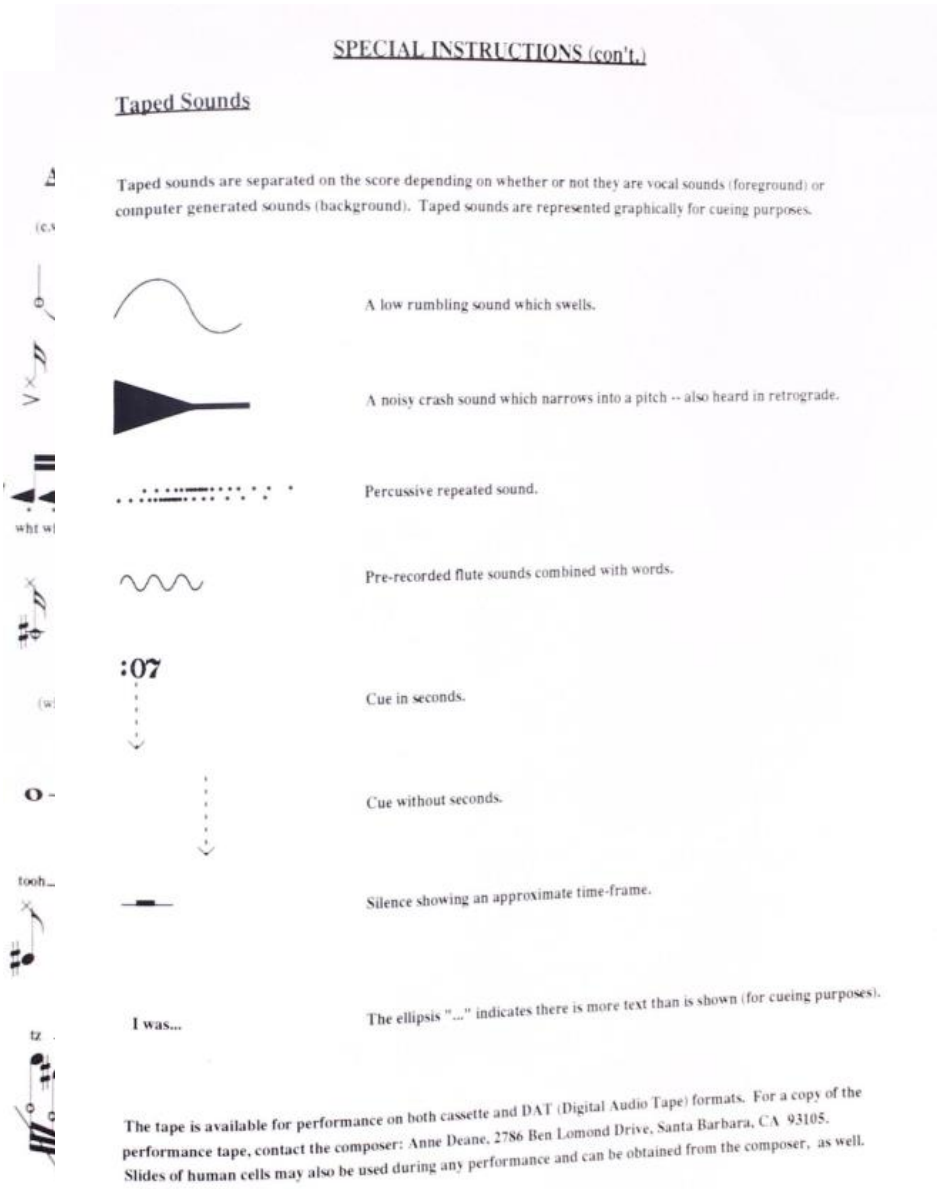


Figure 5.5 Graphic notation instructions for tape.

Figure 5.4 Graphic notation instructions for flute.

The following segment of Special Instructions, shown in Figures 5.4 and 5.5, for flute and tape respectively, are a legend for reading unfamiliar symbols in the notated score. The alto flute part is based on traditional notation, but there is a wide variety of extended

techniques. These include different kinds of key clicks, whispering, harmonics, and pitch bends.

Next, on the prerecorded audio, Berman writes, "Taped sounds are represented graphically for cueing purposes." These graphic icons denote pitch and/or timbre, both of which oscillate in various ways through the piece.

Finally, we see the notated score. There are three staves: alto flute, voice, and tape. The notation visually synchronizes them. This benefits the performing flutist, as well as the audio engineer to ensure the musical lines match up.

Positive Thinking: Overview of the Piece

I have elected to divide the piece into six sections, which I label Introduction-ABCDE. I chose the delineations based on thematic and timbral shifts that I interpret as formal movements. As I describe the sections, I will also describe the unique differences and shifts between sections.

The Introduction sets the visual mood and first sonic palette. The video enters first, showing gigantic bacteria wriggling in their petri dishes. The tape enters next, stuttering the

words "I was" barely understandably, punctuated by blasts of white noise. Finally, the alto

Section	Duration	Identifying features
Introduction	0:00-1:00	Video on; slow tape intro punctuated by blast; alto flute enters at 0:45, plays a slowing rhythm
A	1:00-2:35	Words enter, stutteringly; flute whispers gibberish
B	2:35-3:37	Section delineated by noisy swell in tape; emphasis on voice; percussion enters at 3:15
C	3:37-4:55	Flute solo, speaking the words and then only notes. D-Eb-D motif.
D	4:55-6:06	Flute solo 4:55-5:45 vocalizes gibberish, then overtones over wavering tape, then tremolo, hits high note then voice returns solo, and flute ends section on low note
E	6:06-end	Voice and tape harmonize; flute solo 6:35-end, with D-Eb-D motif at end.

flute enters, whispering at first, and slowly gaining speed but staying low and quiet.

Table 5.1 Outline and salient features of sections in *Positive Thinking*. The notated score does not have bar lines or measure numbers; all locations are given in time stamps based on Betsy Cuffel's 1994 performance.

In Section A, the narrator's voice emerges as if out of a primordial pool of sound. His words begin to form into sentences with identifiable meaning: "I was thinking about you." This marks the beginning of the poem. The flute hisses and snaps, then suddenly plays a

Figure 5.6 Double-note flute motif, ca. 2:00. (Treble clef)

double-note motif: BB, DD, C#C#, FF, B'B'. This becomes an important motif in the flute, both rhythmically and melodically. The flute concludes the second with a jarring major ninth split tone, which the tape picks up and distorts into noise as it enters section B.

The narrator's voice becomes clearer in Section B, and he manages to get out more of the poem before losing intelligibility again: "You know – tiny little cells. Well specifically, I was thinking about the cells which started out inside my body and ended up (one way or another) inside your body." Bits of these lines are repeated, as if unsure of himself. The electronic processing that obscures the words adds to this sense of insecurity and uncertainty – neither the listener nor the narrator are completely following what he is saying or wants to say. The fixed tape part thrums like an anxious heartbeat, evoking denotations of blood and biology, and connotations of love and of fear.

The flute punctuates the word "cells" and interrupts when the narrator goes on to specify *his* cells. The tape thrums like an anxious heartbeat as the narrator finishes his sentence. The flute jumps in with a solo. Rhythmically, it is a retrograde then repeat of its opening motif in the Introduction. The flutist's fingerings relate to the melodic motif in Section A, but now plays on harmonics. This high, heady range on flute requires a great amount of breath and control, something which the narrator's voice lacks as he stumbles over his words.

The alto flute 'speaks' intelligibly for the first time in Section C: "I was." As if surprised at its own ability or audacity, the flutist skips its way up to the highest pitch possible, hitting the same pitch content as its solo in Section B. It whispers again: "thinking about," then interrupts itself with high-pitched wailing on notes F#, G, C#, B. This set class (0157) and interval vector 110121 becomes the melodic motif indicating stress and fear. The flute also duplicates notes, hearkening back to the double-note motif in Section A, now more clearly connected to the narrator's stuttering voice and the connotations that carries.

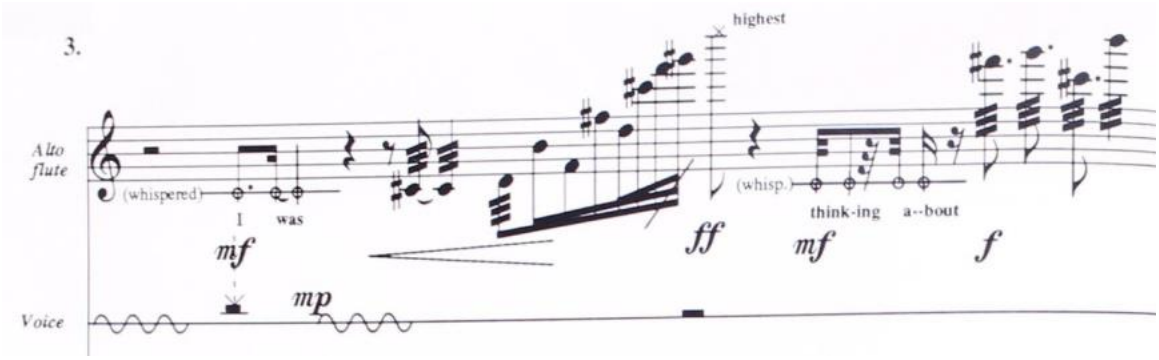


Figure 5.7 The flute speaks, panics, and wails, ca. 4:00.

The flute concludes its spoken line: "cellsssssss." There is a brief pause in all sound elements, indicated in the score by rests in the flute part and a gap in the tape part. The only thing moving are the magnified five-foot long cells lazily swimmingly across the projection. The flute finishes the section hovering around D. This final motif, D G Ab, Db, A, D, is

another manifestation of (0157). In a lower register and in a much more languid style, the affect is more like a gentle sob than a wail as before.

The tape rejoins at the beginning of Section D with white noise and warbling as the flute suddenly leaps to minor ninths from D to Eb. The pitch classes from the motif in Section C reappears, but leaping and disjunct rather than a conjunct melody. The tape picks up its anxious heartbeat sound again as the flutist riffs above. At 5:35, the middle of the

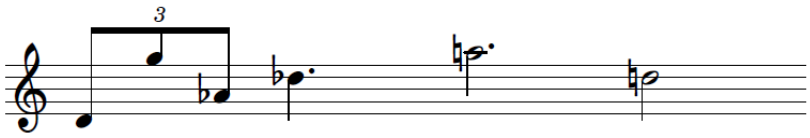


Figure 5.8 Flute motif at the end of section C in *Positive Thinking.*

section, the flute repeats its opening line a half step higher, from D# to E. The basic melodic line moves up to G#, A#, C#, constantly accelerating until it pops up to a high G.

Removing the grace notes and reducing the line to its basic melody, E, Eb, D, G#, A#,

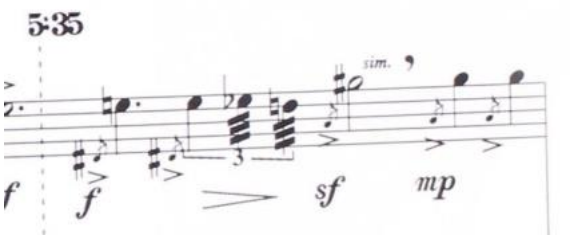


Figure 5.9 Leaping grace notes; chronologically followed by Figure 8.

C#, G result in the interclass-class sequence <116226>. This hearkens back to the intervals in Section C's wailing motif, with added stutters just like the narrator's speaking voice in Section A. These stutters are achieved through repeating notes, which itself becomes a musical motif that mirrors the computer-processing motif of stuttering. The tritone between pitches G and C# seem to have some kind of relationship here and back in Section C, after

the flute "speaks" the line, "thinking about." The flute sustains the high G while the electronic noise suddenly cuts out and the narrator's voice, clear but oddly echoing, states, "And I think, I want them back." The word "back" is duplicated; the flute replies by repeating its double-note figure from Section A, now a minor third higher. The tape (and poem) freeze as the flute finishes the section on a low note, and the projected cells slowly circle and fade out.

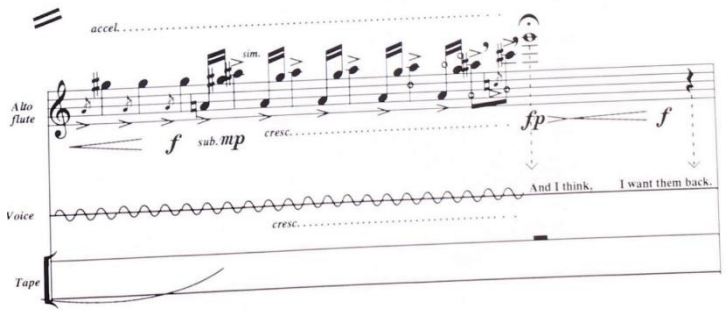


Figure 5.10 End of Section C.

In the final section, E, the narrator states, "Yes, I want them all back," and the tape part echoes and distorts his syllables. The projected cells fade in on a new petri dish. The flute quietly rejoins in a low register, and the tape part now incorporates both flute and voice

Figure 5.11 The notation for the flute performer at the final section.

in its electronically distorted sounds. The flute pauses and the narrator states, "Oh, how I wish, that I could have every last one of them back." The tape plays white noise explosions, but does not obscure the words. After that moment, the voice and tape both cut out, and the

final two petri dishes are projected; first, white blood cells, and then red blood cells. The flute plays a solo – the Section C motif, backwards. After the flute fades away, the audience is left with the red image. In the YouTube version, the image fades out and a black screen remains for an extended time.

The technology

Positive Thinking is a technologically interesting IMM because Berman future-proofed the score by permitting interpretations to use more advanced technology. A common error electroacoustic composers make is using a unique software that will become outdated in a matter of years. Berman does not attempt to imagine the technology of the future, but still leaves suggestions for future users. Part of this foundation involves trusting in the MIDI protocol.

One must bear in mind that this piece was composed 1991-1993 and uses contemporary technology; however, Berman's notes to the performers seem open to using updated technology in modern performances. The visual element, for example, uses a slideshow projector on actual petri dishes with live cell cultures, magnified onto a fifteen-foot high backdrop. In the score, Berman notes that tape part is "available on both DAT and cassette formats from the composer," which was, of course, the standard technology at the time. In 2009, however, Berman posted a video of the piece on YouTube that is intended to be the modern definitive version. This version is also available on DVD to be used as fixed media for a live performance. The video element is an animation rather than recording of

cells from an artist in 1992, when the piece was first being composed, but not the live biological version Berman envisioned in the score. The flute performance by Betsy Cuffel was recorded in 1997; there is another recording by Cuffel from 1999 that is the version from Innova Records used by Naxos and other online streaming services, but that is not the one Berman prefers for her definitive take. So, while the score necessarily describes itself in terms of early 1990s technology, Berman's artistic vision for the work overall is not limited to DAT/cassette or live video feed.

Positive Thinking presents many manifestations of this contrast between the internal and the external, the biological and the technological, and the large and the small. Some of these manifestations are in the setup of the piece itself – the huge video projection compared to a tiny microphone, the large rectangular speakers compared to a thin, curved alto flute.

The visual meaning is not tied to the specific technology used. This is part of how Berman future-proofed her score; the video portion can be created or implemented in any variety of ways, with or without cutting edge electronics. Using a slide projector on clear petri dishes was, at the time, the most effective and feasible way to have moving images of bacteria, viruses, and cells during the performance, and I might argue it would also be the most emotionally powerful. The intention behind the projected cells is to show the antagonist, larger than life, looming above the audience and performers. The video shows those tiny, deadly cells so the audience can see the monster the narrator fears, and the daunting size may impart a shade of dread similar to what Fred Chance felt when writing the poem.

The looming effect is lost when viewing YouTube on a computer; for a performance, Berman specifies, the performer should project the video onto a fifteen-foot backdrop. The visual meaning, then, is connected to the relative size of the microorganisms to the musical organisms, the flutist and the reciter.

In the realm of audio, Fred Chance recited the poem onto a tape cassette, the technology available at the time. Berman modified the tape on a NeXT machine using Linear Predictive Coding, turning it into the fixed media we hear in *Positive Thinking*. This fixed media can be acquired on DAT, cassette, DVD, or digital download – again, Berman thought ahead, and has continued to contribute to refresh the available options as technology evolves. The computerized processing can be emulated on any number of modern DAWs as of 2020 These technological facts are immutable; they are how the piece was made. The specific technology was important to the creation of the piece, but not particularly to its realization.

Applying Cook's multimedia theory

For *Positive Thinking*, I find Cook's multimedia approach the most apt. Cook's method incorporates power dynamics in the models. Pairing off the elements allows the analyst to explore complex relationships, and then assess the relationships holistically. This is a major component in *Positive Thinking* on multiple levels. The creation order of the elements is a part of the piece's meaning. The different media have different relationships and balancing acts within the piece's score and realization, which form another major portion of *Positive*'s meaning.

Chapter 5: Anne Deane Berman, Positive Thinking (1993)

Flute & words

The poem was the first element created of this piece, and Berman composed the flute part, tape part, and visual design afterwards and in that order. The lyrics have clear denotations, and like most poetry they evoke several possible connotations. The flute takes care of the non-linguistic and semi-linguistic vocalizations and sonic expressions.

The flute and the narrator's voice rarely overlap. At times they seem to be in conversation with one another, and other times the flute reflects the narrator's wordless turmoil. I interpret this to mean the flute moves between two roles: the first role is the narrator's partner hearing the news that Chance is stammering out, and the second is Chance's inner turmoil while he strains to find the right words. The piece is highly emotional, and one can parse the sections by emotion and by the flute's role.

The flute's solos represent the narrator's partner's reactions, slowed from the speed of synapses firing to a wavelength more suitable for music. The times when the flute 'speaks' is likely a part of that role as well, like words echoing in one's head. Together, the words and flute music form the complete dialog, and the division of roles is not evenly cast between the two characters, which I will address throughout this section.

Using Cook's terms, these media are coherent and complementary – their meanings are similar but express different points of view and bear differing connotations. The words and the flute have an unbalanced relationship. Chance's voice seems to be leading or informing the flute, which I interpret to be a metaphor for his partner hearing the news. Yet,

there are also some isolated moments of conformity, as the two occasionally mingle in the shared space of non-verbal vocalization.

To further demonstrate this relationship, here I will examine the sections by emotional context in the flute & voice pairings. The Introduction is the flute introducing himself to the audience, making his presence known. In Section A, the narrator says, "I was thinking about you, and I was thinking about cells." As soon as he says cells, the audience hears the flute make hissing and popping noises. According to the score, the flutist is instructed to voice "wht" and "teu" into the flute to achieve these sounds. These look and sound like the flutist asking, "What?" These are also close to the phonemes used in the word "was," which comes up in Section B; a "t" sound is a similar tongue shape as an "s." After the "wht" s comes the first time the flute plays the double-note pattern. It concludes with the dissonant C against D (major ninth) split tone, which I interpret represents a man's voice breaking when trying to speak.

In Section B, the narrator gathers his strength and specifies, "the cells which started outside my body and ended up…inside your body." The only time in the piece the flute overlaps with him is when he says "tiny little cells," and the flutist repeats back the word "was" into the flute. After the narrator finishes his thought and pauses, the flute replies with a mournful low A, first held and then repeating at an increasing pace. The solo at the end of the section uses percussive extended techniques: key slaps, buzzing and dissonant harmonics, and flutter tongue. This emotes frustration. The "tz" on descending harmonics sounds like a pained sigh. Transitioning to Section C, the flute finds its voice, literally. It repeats back, "I

was," and rushes up to the highest note possible – a squawk of terror, or indignation, at the sudden realization of what the narrator is trying to say. The flute whispers, "thinking about," and follows the utterance with the wailing motif, and finally it says, "cells."

Considering the flute as the recipient's point of view, we hear the emotional reaction.

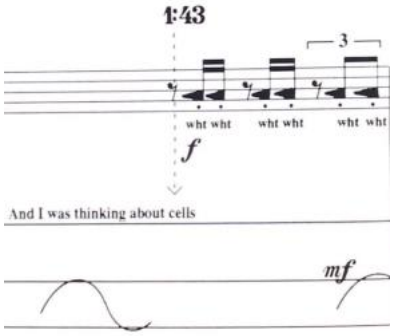


Figure 5.12 The flute (on a treble clef) stammering in response to Chance's disclosure.

The score assists by making it clear what the flute is intending to say or evoke ("wht" and "teuh" meaning "what" or "was"), though the precise sound is lost in translation by being performed on a flute. The score confirms the words that the flutist is saying, but the sounds are distorted by the flute and the words come across as scattered phonemes. As listeners, the best guess one can make is that the flute is attempting to parrot back the narrator's words. Taking the notation into account, however, it seems more likely that the flute is responding, not repeating.

The end of Section D, and into Section E, the flute solos over white noise. But the score reveals that the white noise is not from the fixed media tape part, but rather the secondary live processing of the voice and flute. The narrator's partner is processing swirling emotions, and the narrator's voice becomes noise for the flute to riff over. At the end of

Section E, the narrator's voice comes out from the noise and states, "And I think, I want them back." And all the sound freezes. After a pause, the flute replies with its double-note figure a major tenth below the original motif. In Section A and here, it acts as a question, a sort of "What are you saying?" Whereas in Section A the question was innocently curious and confused, in Section E the question is worried and filled with dread.

The way Section E emphasizes the flute and turns the voice into background noise suggests that the whole piece is a narrative told from the point of view of the flute, and therefore from the perspective of the partner hearing the news. The poem and flute line are a dialogue, though neither is fully lingual. The narrator's stuttering and the flute's double-note motif evoke the emotional motifs of hesitancy and fear. The flute effects emotions more than words – after all, what can one say when learning their partner's affliction, and that they might have it, too?

Throughout the piece, the flute part and the words of the poem fall in with one another by being two halves of a whole dialogue, but their relationship is not quite dyadic. The complete message cannot be understood with only words or only flute, but they are also playing separate roles for the most part. The flute responds to the narrator's voice, and the narrator responds to the flute's affective melodies.

Tape part & words

Fred Chance wrote the poem in 1991. Berman requested he record himself reciting it for *Positive Thinking*. Berman used that recording as musique concrete to process in a DAW.

She also used recorded flute samples for the tape part. The end result is a poem recitation with mild effects, like reverb and repetition, and an abstract tape part composed of four main strands: the mildly altered voice, the abstracted voice, the recognizable flute, and the abstracted flute. The four strands build a sound palette of white noise, drones, and uncanny vocalese and flute-like sounds.

The narrator exists within the fixed media; however, the linguistic content is one element, and the electronic timbres, processes, and modifications are another, and that is why I assess them separately. The fixed media and the poem have a complicated relationship because they share a sound source *and* sound producer. The abstract tape part uses sound particles taken from Fred Chance's recitation, manipulated to enact white noise, an anxious pattering, and a throbbing drone. The tape also uses flute samples, as discussed before. In performance, the tech operator manages both, because they are on the same tape (or CD or digital file, as is the modern case). However, in the score, they are notated separately; Berman indicates that they are "separated on the score depending on whether or not they are vocal sounds (foreground) or computer-generated sounds (background)." So, it is clear that Berman intends the words and the tape part that hosts the words as separate entities.

The score accurately represents performance because there is no room for change or error. For clarity, I will refer to the voice and tape part by their separate names to distinguish them, and I will refer to their combination as "the fixed media." In the two paragraphs that follow, I will describe the particularly salient moments of the tape part and words being

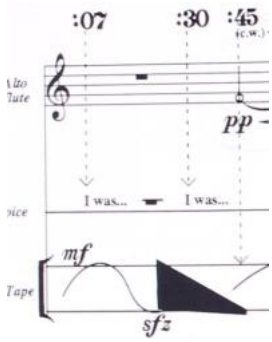
juxtaposed in sound and in notation, demonstrating how the elements are wedded in their medium but individual in their characters.

Because the two elements coexist on the medium, they will always have the same timing, unlike the live performance from the flutist and projector. The poem was composed first and the tape part is a mutation of Chance's recitation, putting the words in a position of dominance over the tape part. Their relationship is primarily a complementary one, as the messages and meanings are coherent and one seems to drive the other. The abstracted elements in the tape part sound rarely if ever at odds with the words, but serve to emphasize the emotional states of fear, anxiety, and shame.

In the Introduction, the score shows the voice part saying "I was" at least twice. In listening, the tape part is the only sonic element in the first seven seconds. Where the voice is supposed to enter at 0:07, instead we hear electronically modified flute sounds from the tape. This is notated as a curving line. The *sfz* explosion is notated as a thick, black triangle in the shape of the amplitude of the waveform. The following sound in the tape track is a quiet echo of the explosion that filters out into an almost clean tone, followed by a pattering rhythm. It

Figure 5.13 Where Chance says "I was" over the span of 23 seconds, paired with a white noise explosion.

seems as though there are two sonic lines happening simultaneously. One of them is the narrator's voice saying, "I was." It is notated quite clearly in the score. Yet it is slowed down



to the span of a 23 seconds, judging by the temporal notation. At such a slow speed it is unintelligible as words but better understood as the abstracted voice strand of the tape part. The tape notation is a wave, which Berman defines as "a low rumbling sound which swells."

This particular sound, the elongated “I was,” returns throughout the piece. At first it is paired with the voice saying the words "I was," its inception. It reappears at the beginning of Section B, but no longer accompanying the narrator. However, it still carries the associated meaning, hearkening back to Chance’s stuttering and the electronic explosion.

Flute & tape part

As described above, the tape part of the work hosts the recitation and modified vocal samples of that recitation. Often, the words are obfuscated by electronic modification, and so can only be analyzed as sounds rather than words. The tape also contains electronically altered samples of the alto flute. The only readily recognizable flute sounds in the tape part are in the very beginning of the piece. After the flute enters, all flute-like timbres belong to the flute proper, though the tape and the flute sometimes quote or imitate one another. The

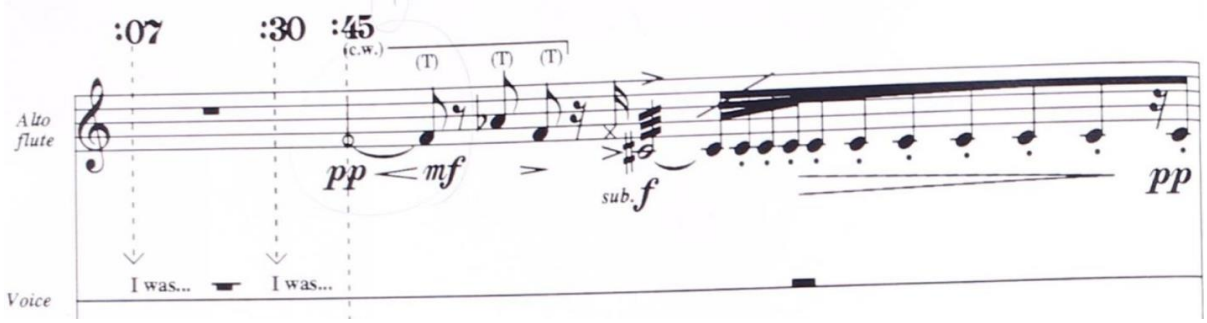


Figure 5.14 The flute's entrance in *Positive Thinking*.

relationship between the flute and the tape part is complicated because of the many sub-parts the fixed media contains. I have already discussed the flute's relationship to the words, which may be understood as a part of the tape part, and established that it is primarily complementary. The abstract electronic sounds, however, have more of a contested relationship with the flute.

The fixed media enters brazenly before the flute. As mentioned before, in the beginning it uses a flute timbre in its sound palette, and later leaves the flute sounds to the flutist. The tape and flute rarely overlap, and when they do, they are often on the same pitch with starkly different timbres. Besides the beginning of the piece, the tape part seems to react to the flute like an echo, though with its own sonic identity. It is not terribly dissimilar to the idea of a canon. These elements are under the multimedia model of complementation. When they overlap vertically (at the same time), they contrast greatly, but horizontally they are quite similar, just out of phase with one another.

When the live flute enters at 0:45, it enters on a diffuse harmonic, disguising its liveness for a moment. A listener may be uncertain whether this flute sound stems from the fixed media or from the live flute. From 0:50 to 1:00, the flute flutter-tongues on a low C#

and gradually slows down to eighth notes, at which point is becomes clear to the listener that that is indeed a flute coming into focus. The score confirms that the flute is the only sound other than a low noise band with a gradual attack reminiscent of the earlier explosion in slow motion.

This separation seems less an intentional separation of flute and fixed media and has more to do with the separate relationships the flute and tape part have with the spoken poem. This is logical because the poem was written first, even though the fixed media part was finished after the flute part was composed. The fixed media *is* a synthesized morphing of the spoken words, and often accompanies or punctuates the narrator's words. This is evident in the static artifact, as Berman labels sections of tape with the syllable or word it is producing.

On the other hand, the flute seems to reply to the narrator, and they rarely overlap. I interpret this to mean the flute represents the narrator's lover hearing this news and his mental reactions in slow-motion. Unlike the flute and poem, which have a complementary relationship by way of a dialogue and imitation, the tape part seems at odds with the flute. If the flute is meant to represent the humans, perhaps the electronics represent the disease, or the cells that Chance so desperately wants to take back that are projected larger than life on the screen. We hear this in the dissonance, and we see this in the swirling lines on the staff in the static artifact.

Flute & visuals

This brings us to the visuals. The concept behind the visuals in *Positive Thinking* is one simple idea: project live video of a microscopic feed of human cells, some infected with HIV and some without. Berman procured the cells and equipment through the biology department at UC Santa Barbara for the premier performance and hired a colleague to work the projector. This is all documented in the static artifact, and the steps can be reproduced.

However, the instructions call for several slides and transitions between them, but the transitions in the visuals are not marked in the score. The performance instructions instruct that the order of the slides is up to the performer. The score does not indicate the exact number of slides/dishes to use. There are no prescribed times to switch slides. It seems unlikely Berman would overlook such important details, and so the aleatoric aspect must be intentional; but there is no way to confirm it in the score.

That said, the times indicated in the score, which primarily function as section breaks and synchronization points, could double as indications to change slides. Perhaps Berman did not write timing instructions and the like on the page marked "Visuals" because the timings are elsewhere in the score and are applicable to many elements. One argument against this hope is that the 2008 YouTube video version of the piece does not align the visuals with these time markings. However, it could go either way. The performer in charge of the visuals could use a DAW to align the slide transitions and effects with the fixed media or the live electronics, as Berman suggests; or they could make the transitions manually, and decide

whether or not to align timings with the audio fixed media. It is an occupational hazard of permitting such flexibility, one which is arguably outweighed by making the piece performable *despite* technological advancements.

It is important to note that the "performer" the notes reference is the flutist, and not the projector operator. I would argue that the flutist is the primary agent in the piece as a whole. The flute engages in dialogue with Chance's voice and provides the majority of the sonic material overall. According to the score, the projections are determined by the flutist beforehand, and the operator only performs the flutist's selections. For all these reasons, the multimedia relationship model here is complementation, where the visuals are at best a supporting character in the grand scheme of the IMM.

Tape part & visuals; words & visuals

The score offers practically nothing in terms of comparing the visuals to any of the other parts because the visuals are not represented in the score. They are only described in Berman’s words on the page marked “Visuals.” In performance, there does not seem to be any correlation between visual transitions and change in the tape part, nor visual transitions and spoken change.

The connection between the text and projections are that the projections are of microbial beings, and the poem describes such microorganisms. The subject of the poem is cells, while the slides show a range of microorganisms including but not limited to cells.

The slides support the poem's message, and also suggest more depth. By using projected live video of living cells, some with and some without the virus, the audience is confronted with the thing the narrator fears. The narrator speaks about his cells ending up in his partner's body; when the projectionist changes slides, one might imagine the focus shift from one body to another. Without the narrator saying so explicitly, the visuals solemnly reveal the monster at the heart of the poem.

For all these reasons, the words & visuals fit best in the complementation multimedia model. As with the flute, the visuals are a 'servant art,' though the power discrepancy is not as extreme. The poem came before the visuals, and takes precedence, but the narrator did not choose the images of cells looming over the audience.

The tape part and the visuals do not have a clear enough relationship to assign any multimedia model. A lack of relationship means there is no clear synchronicity, and therefore is grounds enough to assign them a contest model. Furthermore, because the tape part and poem have a contest relationship, one may be tempted to default to assigning the inverted relationship poem and visuals have to the tape and visuals.

Positive Thinking Conclusion

The first thing one notices in a performance of *Positive Thinking* is the projection of cells. The discrete media enter one by one: second is tape, then flute, and finally the voice. This is the reverse order of their creation. Each media plays a unique role, and the relationships build the piece, and almost all of these relationships are complementary in some

way or another. To summarize, the poem recited by Fred Chance plays the role of Chance himself. The flute plays the role of his partner and the emotional responses. The tape part may best be understood as a representation of their relationship, and the visuals portray the images floating through the men's heads during the conversation.

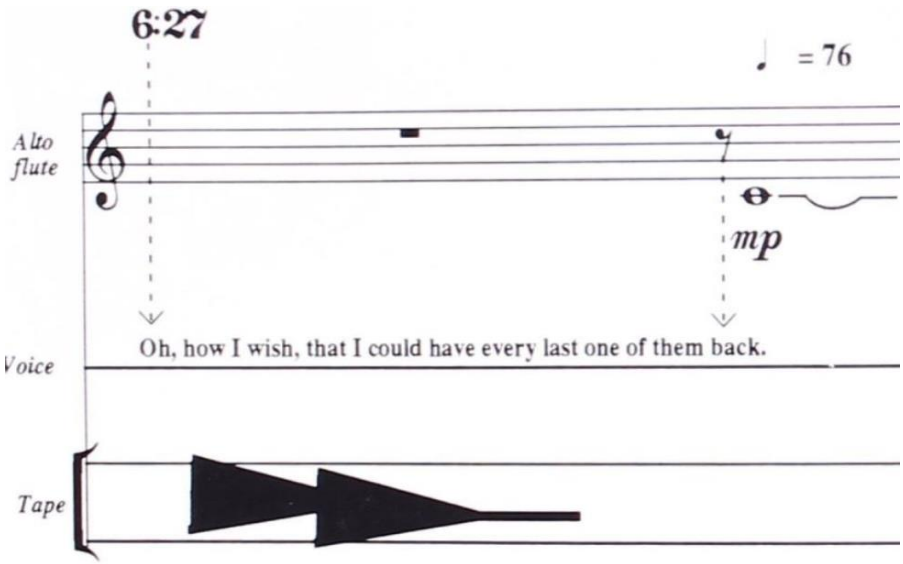


Figure 5.15 An example of Berman's dotted lines timing notation.

To solidify these readings, I turn to the score. There is one symbol in particular that Berman employs to suggest a ‘reaction’ in the flute, and that is the dotted cue line. Many of the cue lines are labeled with time stamps. These stamps help the live performers – both the flutist and the projectionist – line up with the timing of the electronics. The most emotionally poignant moments, however, do not have time stamps, and the flutist must instead react to Chance’s words and play at the appropriate time based on his phrasing.

Given this freedom, each performance has the potential for dramatic variety; the flutist may choose to add a dramatic pause for effect or enter suddenly immediately after the

painful blow Chance delivers. The projectionist may also use these cues to change slides, accentuating the news and the flutist's sonic reaction. In the Betsy Cuffel performance on YouTube, the projectionist changes slides as the abstract tape part concludes, and the flutist does take a dramatic pause after Chance's last line. In this one performance, it is a powerful moment; in examining the score, one realizes the dramatic potential Berman built in, and that these select few moments near the end of the piece when the gravity of the situation would be sinking in to Chance's partner have a great potential for emotional liveness that a single performance cannot quite convey.

Berman captured a heartbreaking moment of the AIDS epidemic in an electronic piece and she did it using a MIDI-accessible DAW and a blend of traditional, unique, and electronic-based notations. She also looked to the future and noted in her static artifact that certain elements could change; the narration, for example, could be performed live and the tape part could only play the abstract noises.[238] Berman's static artifact, which includes her score, her notes and instructions, and writings she added online, indicate a willingness to adapt to rapidly-changing technology, as long as the moment the piece presents has the same poignancy. She made an effort to future-proof her score by trusting in the MIDI protocol; though the original performance and ideation do not use MIDI to line up the audio and visual components, she writes in her score preface and in her artist's statement that she wants performers to use whatever technology is available. She even suggests generating abstract

[238] Part of the emotional affect comes from Chance's voice becoming distorted; however, this effect can be achieved in the twenty-first century with live electronic manipulation.

images in place of live cells – a technique that would most likely use MIDI. The computerized processing can be emulated on any number of modern DAWs as of 2020. In practice, the tape part has been digitized, and is available on CD or digital download from Berman's website store. The specific technology she used in the early 1990s was important to the creation of the piece, but not to its realization, which she leaves open to the performer and the technology of the future.

Chapter 6: Paulo Chagas, Migration *(1995-7)*

Introduction

Electroacoustic music, more than traditional acoustic music by virtue of its technology, has the curious and unique capacity for liberating sound emanation from its point of origin. The term for this is "schizophonia," coined by R. Murray Schafer to describe sounds that emanate from a mediated source rather than from their producer.[239] Sounds of any kind can be moved from their origins and placed anywhere a loudspeaker can rest. This allows composers to create psychoacoustic illusions that can be perceived as sound moving in three-dimensional space. Arranging sound emanators just-so can create, reflect, change, or affect the perception of space. Many electroacoustic composers use this phenomenon within performance (or other audition setting like a recording studio, which also has another layer of mediation) as a primary musical feature alongside (or instead of) pitch, rhythm, timbre, and so on.

In this chapter of the dissertation, I examine multi-channel spatialized music and how the composers notate space in the static artifact. As I will discuss, the movement to MIDI and digital equipment was a boon to spatializing sounds thanks to uniting the myriad software and hardware available. However, it also meant composers had less to write down, which can leave gaps in the static artifact.

[239] Schafer, *The Music of the Environment*.

Chapter 6: Paulo Chagas, Migration (1995-7)

The case study I have chosen is Paulo Chagas's piece *Migration* (1995-7), for live and fixed electronics and live orchestra. My main focus is on the notation of Chagas's physical spatialization around the listener, abstract and physical spatialization of the musical themes, and abstract and metaphorical spatialization of migrants as Chagas represents them in the work, and the overall virtual space Chagas creates. Chagas states in his book on electronic music at the end of the millennium, *Unsayable Music* (2014), that he wanted to push the limits of the available technology in the WDR studio and create a multitude of spaces and realism of space.[240] I look to Chagas's performance score and libretto as well as the companion article, "Composing in Circular Sound Space,"[241] which he published after the fact in which he describes his process of composition and writing, and documentation of his Max patches and AudioSculpt processes. In his article, he provides his own analysis of the work in the context of other works cut from a similar cloth. *Migration* features so many interconnected and intermedial gestures examining only the score is insufficient. The rest of the components of the static artifact, in addition to listening to a recording or performance, are essential for a full understanding and analysis of the piece.

A brief history of electronically spatialized music in Cologne

Electronic speakers created new ways of moving sound and creating space with sound, and it did not take long for composers to explore and exploit this new capacity. The most recognized name in early spatialized electronic music for concert space is Karlheinz

[240] Chagas, *Unsayable Music.*
[241] Chagas, "Composing in Circular Sound Space."

Stockhausen, who has become something of a figurehead for the German school of *elektronische Musik*. His piece *Gesang der Jünglinge* (1955-56) is one of the seminal works of electronic music to come out of the WDR studio in Cologne and also an important historical work in spatialization for a concert space.

The original version of *Gesang* was designed for five loudspeakers. Nowadays, it is most often heard in recordings in its reduced quadrophonic or stereo versions. Not only was it an impressive feat to spatialize on five speakers in the 1950s—and one that was an important precedent for composers working with more than four channels—but mixing versions for fewer speakers was also an accomplishment, in that producing the same spatialization effects was an additional challenge.

When creating spatialized works, Stockhausen meticulously notated and diagramed speakers, mixer levels, and voltages.[242] This documentation is critical to the performance and analysis of the work because it is, for all intents and purposes, the design and performance score for the performer sitting at the mixer.[243] Many composers following Stockhausen's footsteps after *Gesang* made similar documentation for electronic and multimedia works. However, such diagrams and markings are only suitable for analog machines with fixed ranges and finite options.

[242] Chagas, "Composition in Circular Sound Space," 189.
[243] Especially if the analyst does not have access to a five-channel setup and must use some level of imagination

For this reason, according to Paulo Chagas, Stockhausen's documentation and compositional breadth suffered when the WDR studio switched to digital mixers in the late 1980s when it moved locations.[244] Stockhausen could no longer draw diagrams and mark knob directions because the settings were no longer fixed. He could write out directions to future performers, but these require some degree of interpretation, and as technology continues to evolve certain settings and directions may become harder to decipher.

With the help of Chagas and other composers at WDR, in 1992 Stockhausen completed the 8-channel tour de force *Octophonie*. This work was conceived as a successor to *Kontakte* (1958-60), which Stockhausen composed for four channels on the *Rotationtische* at WDR. *Octophonie* takes the quadrophonic geometry and multiplies it to create a spherical of sound with a cube of speakers.[245] The synchronous rotation of the six "sides of the cube" was coordinated, Chagas stipulated, by "two four-track spatialization systems, each one requiring a specific MIDI sequencer, a digital mixer, and a MIDI fader, [all] used simultaneously."[246] This work inspired composers in Cologne, and in Europe at large, to expand their horizons to multi-channel dynamic three-dimensional space with MIDI-based technologies.

The technology to create and adjust sound at the WDR studio Stockhausen worked in is all MIDI-based: a MIDI-sequencer (C-Lab, Atari), a MIDI controlled digital mixer

[244] Chagas, "Composition in Circular Sound Space," 191.
[245] Chagas, "Composition in Circular Sound Space," 191.
[246] Ibid.

(Yamaha DMP7) and a MIDI-fader (JL Cooper)."[247] These new machines, and the software they ran, could emulate the *Rotationtische* and take spatialization to new heights with movement and shapes. The problem for Stockhausen was that the digital equipment used variable ranges and channels, and Stockhausen was unable to notate mix levels and alterations with tape, markers, and paper.[248] His problem was seen as a benefit for other composers, however, who felt liberated of the finite scope of the analog machines and free to compose or program events on new levels of range and breadth. On this point, in his article about the WDR studios and *Migration*, Chagas proudly writes,

> The new digital tools and the enormous multi-track mixing capabilities of the WDR studio expanded the boundaries of sound space composition and introduced a higher level of control and precision. The flexible and modular concept, which integrated analogue and digital design, stimulated a new kind of *hybrid* creativity. Rather than being anchored in a specific technology or aesthetics, it instigated the creative dialogue between art, technique and handcraft. This is fertile ground for generating new ideas.[249]

Paulo Chagas and Volker Müller led the overhaul at WDR to all-new digital, MIDI-based technology in the studios. Chagas assisted Stockhausen and other composers in transitioning to the new technology while also exploring it for himself. The leap forward into the digital age, both in Cologne specifically and in studios across the world, opened a thousand new doors in creativity and ability that had been closed before.

[247] Ibid.
[248] Chagas, "Composition in Circular Sound Space," 192.
[249] Chagas, "Composition in Circular Sound Space," 192, emphasis in the original.

Chapter 6: Paulo Chagas, Migration (1995-7)

MIDI provided the ability to move sound in a live, spatialized construct much more easily. In the analog era, spatialization and movement required preparation. This usually entailed cutting the tapes of many reels to create cross-fades. An audio technician sitting at a mixing board could use sliders and knobs to adjust sound levels in various speakers and manually move sound, but these movements were mostly to fine-tune the rolling tapes, and were limited by how well the technician could multitask. Consequently, this spatialization was generally limited to four speakers and basic changes. With MIDI-based digital audio workspaces that could automate movement and spatialization, composers could have an enormous number of speakers, many movements, numerous overlapping movement speeds, and other sonic transformations while flying sounds around the room. Chagas takes a two-fold approach by both implementing pre-set events on triggers and having an audio technician run the remaining parts of the composition live.

Chagas and Modern Sound Philosophy

Chagas cites four key elements of modern listening in the 20th and 21st centuries—schizophonia, repetition, noise, and sound objects—as his four primary considerations when writing a piece. Whether creating twelve-channel spatialization or an acoustic solo work, he considers how these listening elements are enculturated into every twenty-first century person's listening habits.

Ever since the invention of the wax cylinder in the late-19th century, schizophonia has been a reality. For contemporary society, Chagas suggests,

> Music is accumulated in the form of digital information organized as commercial databases such as iTunes. The files are transmitted and decoded as sounds by mobile apparatuses, which reconstruct the structures for individual listening. Headphones shut out the environment, which is one form of suppressing ambient noise. On the other hand, amplified music becomes background noise in spaces such as cars, airplanes, offices, elevators, and many other public spaces."[250]

Schizophonia not only means sounds and music can be moved from their point of emanation, but also that they can be selectively highlighted or ignored by the listener. Listening becomes a more individual activity rather than a shared experience because of this individualized choice of "blocking out" or focusing on certain sounds.[251]

Chagas acknowledges that reproducibility is a fundamental musical trait for the repetition and connectivity of sound, in rhythms, melodies, harmonies, and sound objects.[252] One notable example of reproducibility and repetition in this context is the technique of the "loop." Loop techniques "emerged with the turntables of the earlier days of the *musique concrete* and became popular with apparatuses such as the *drum machine* and the *sequencer*, is an example of how the integration of *automaticity* and *repetition* in analog and digital machines impacts musical ideas."[253] Digital integration mostly facilitates repetition, though the looping technique has also been useful in shrinking the digital storage required for a piece of music. This has had many benefits, especially in the 1980s and 1990s, when digital storage was finite and costly. Looping allowed composers to avoid compressing too much data on

[250] Chagas, *Unsayable Music*, 93.
[251] This audile technique is championed by Canadian ethnomusicologist R. Murray Schafer.
[252] Chagas, *Unsayable Music*, 94.
[253] Chagas, *Unsayable Music*, 94. Emphasis original.

CDs and tapes. It allowed them to run more complex code in a DAW and store and generate more sounds. This also afforded them creative space to explore other artistic and aesthetic areas for the same reason.

Next, Chagas states modern music and listening is concerned with noise. Chagas defines noise as the opposite of music, that music is the marked (organized) space (form) and noise is the unmarked (unorganized) space.[254] To summarize the early twentieth-century futurist Luigi Russolo, noise is a part of modern life, so we may as well embrace it. However, Chagas seems tepid towards noise in his own works. In his article, he expresses confusion about why modern composers seem obsessed with noisy sound palettes:

> A work of music begins with something that we identify as noise and concludes by returning to noise. We can call this musical pattern emergence from noise and disappearance into noise. How often works of contemporary music follow this pattern? How oft have we heard acoustic or electroacoustic pieces beginning with some kind of rumor – rumbling, whispering, buzz, mumbling, drone, sound clouds, etc. – from which the music builds up and after some time, dwindles, shrinks, or fades into some indiscernible or nebulous noisy state. Or, which is the same in effect, how many works of music fade in from silence and fade out into silence? Why does this form seem to be so attractive for today's composers?[255]

Chagas acknowledges that noise has become a major element in modern composition, and savvy listeners are attuned to the various "rumbling, whispering, buzz, mumbling, drone, sound clouds" in the modern palette. He has some personal misgivings about the state of the noise usage, but asserts nonetheless that it is a recognizable and important element of

[254] Chagas, *Unsayable Music*, 90.
[255] Chagas, *Unsayable Music*, 96.

composition and for listeners. He does not use what he considers noise. His notation in the static artifact reflects that he always intends his music, no matter how dissonant or unfamiliar, is *music* in his personal paradigm.

Finally, Chagas discusses sound objects in two ways: "sound object" as an element of composition like pitch or rhythm; and also "sound *as* object" as a standard and/or codified recording or realization of a work. The former definition comes from the tradition of Pierre Schaeffer's *musique concrète*. The latter is a cultural observance that electroacoustic music composition, performance, and engagement was moving away from the long-standing tradition of score as the object of study, and instead focuses on the sound as object. And he was not alone in this assessment; this opinion was shared by several analysts and composers, including theorist Simon Emmerson. Chagas says for the most part "composers of electroacoustic music do all the composition as performance, and freeze it in a recording, not a score."[256] Thus, the finished work instantiates an idealized performance – only one which did not happen at a particular time.

This "frozen" sound as object is made possible by schizophonia. In 2020, listeners can choose to attend a concert, play a recording via software, or stream music recorded in the past or live from a smartphone or dedicated device. And indeed, some composers, from academic IRCAM artists to deejays, make sounds "directly" to the recording device. In such cases, a written mediation may not exist at all—at most, only traces *à la* Nattiez.

[256] Chagas, *Unsayable Music*, 130.

Chapter 6: Paulo Chagas, Migration (1995-7)

All of this brings us back to Chagas and spatialized electroacoustic music. Nowadays, composers have the option to address any of his four elements of modern listening. Chagas posits that after MIDI was released in 1983, composition tools on computers became even better and composition, allowing composers to take those four key elements to a new level of intricacy and complexity. At the WDR Studio for Electronic Music in the 1990s, composers Jean-Claude Eloy, Denys Bouliane, Karlheinz Stockhausen, and Chagas himself learned to use MIDI sampler and sequencer software. Each of these composers pursued different strategies:

> Eloy used the new technology for the realization of an electroacoustic music recorded on tape, which is the basic layer for the live performance of a soloist. Bouliane explored the new possibilities of samplers and MIDI controllers and created a work of live electronics with musicians and no tape."[257]

These composers found the new MIDI-based DAWs robust and varied enough to permit these numerous and diverse explorations. As Chagas poetically puts it, "Real time or no real time, live electronics or audio tape, game or automation – these oppositions bring us back to the heart of the universe of apparatuses and their programs."[258]

Introduction to *Migration*

In terms of these compositional strategies, Chagas explores both live and pre-recorded electronics. *Migration* (1995-7) is a prime example of Chagas's style with live electronics. It is written for MIDI-piano, ensemble, and live electronics. The main software is

[257] Chagas, *Unsayable Music*, 168-9.
[258] Chagas, *Unsayable Music*, 169.

Max which is also the software typically used by composers at IRCAM. Recall that Hurel also used it. The movement of spatial elements is programmed in another IRCAM software, AudioSculpt, that was first published in 1996. Chagas's anecdotes in *Unsayable Music* about writing the programs for *Migration* suggest that he tried a few other options in the early years of composing the piece, but it was AudioSculpt that did everything he wanted, and was the final lynchpin for the composition. In other words, when he began his work the available technology was not yet sufficient to realize his art. The MIDI protocol and its implementation in AudioSculpt changed that, and he was able to finish his piece to satisfaction.

Migration (1995-7) uses a live ensemble with winds and strings as well as multiple keyboards, fixed media, live sound manipulation, and 12-channel spatialization that he rendered in the WDR studio in Cologne. The piece is about moving from one home to another, and the accompanying strange disorientation and re-orientation that comes with the (new) territory.

The piece contains autobiographical elements. Chagas grew up in Salvador, Brazil and was schooled in São Paulo. He left Brazil after being tortured by the military, an experience that has informed his compositional processes and intent for the rest of his life. He found himself in Liege, Belgium and chose to study under the mentorship of Henri Pousseur. He ultimately received his doctorate in Cologne in the 1990s and then moved to the United States in 2004 to advance his career. As a professor of composition at UC Riverside, he constantly pushes the boundaries of electronic music and audiovisual media "to

illuminate human thinking and emotion."[259] In the 1990s as an established yet still young composer, Chagas composed *Migration* to tell the typical story of a migrant. Chagas represents the disorientation and the trials of acclimating to a foreign land through vocal sampling techniques, consonance and dissonance, and visceral experiences through sound spatialization.

Chagas proudly claims that *Migration* "was the first 12-channel electronic music produced in the WDR studio as well as the first based on ProTools and hard disk recording."[260] The studio had updated to MIDI when it changed locations in 1987. In 1995, Pro Tools entered the studio, which introduced adjustable interfaces and parameters. In *Unsayable Music*, Chagas writes, "With the introduction of the first Pro Tools system in 1995, digital technology replaced tape recorders as a platform for multi-channel music production. It also impacted working methods, as the digital apparatuses demanded new skills from the engineers and technicians, opening a process of spatialisation that at the same time, led to a loss of the technical autonomy of those involved in the production process."[261]

[259] From the mission stated on Chagas's website: "My compositional philosophy is driven by the belief that a major transformation is occurring in the way we create and experience art and music in today's digital world. Aside from writing for traditional acoustic media, my work makes extensive use of electronic sound and audiovisual media while developing a critical approach to technology in order to achieve transparency and illuminate human thinking and emotion. I hold that art has an ethical mission to provide people the opportunity to observe the world from the outside. Now more than ever, the arts offer myriad possibilities for transcendence while critically engaging with human and social issues."

[260] Chagas, *Unsayable Music*, 180. It was no doubt the first to use AudioSculpt, too.
[261] Chagas, *Unsayable Music*, 154.

The MIDI-mediated studio also hosted a suspended ring of 12 loudspeakers that composers could use for circular space. There are two principles of sound spatialization: static sound spaces (separation and distribution in various shapes, fields, sizes, etc.) and dynamic sound spaces (movement of sound and changing shapes, fields, etc.). Chagas notes that both of these principles are used in *Migration*, and that he used "a method of sound space composition rooted in the history of the WDR Electronic Studio."[262]

Chagas chose not to notate these electronic and spatial innovations in the score. The notated score is intended only for the live performers: the instrumentalists, the keyboardist, and the conductor. Chagas relegates the information about electronics to a simple page of instructions, and the 12-channel spatialization is only hinted at by the set-up chart in the score's introduction. The only written documentation of the electronics and spatialization is found in articles and book chapters Chagas published afterwards.

But I am concerned with analysis from the score, not just analysis from a performance or a recording. The fixed media presents multilingual excerpts (German, English, French, Latin, and Spanish) from Argentinian author Jorge Luis Borges's short story "The Library of Babel," and generates additional sound objects and sound structures via fast Fourier transformation (FFT) in the IRCAM software AudioSculpt. The lyrics are not specially notated. The transformations are not notated per se, but their timing and alignment with other acoustic and electronic instruments are. The software Patchwork generates

[262] Chagas, *Unsayable Music*, 186.

temporal processes that are critical for spatial dynamism, but is not notated in the score. Chagas used Pro Tools to preset rotational patterns and arrangements, and Max patches to implement algorithms and changes, but these are also not in the score. Chagas created the patches and algorithms himself. To perform the piece, one only needs the files and an audio technician besides the acoustic instrumentalists. Thus, the score by itself is insufficient for score analysis. Chagas's writings, like his article "Composing in Circular Sound Space," and his book *Unsayable Music*, are therefore additional parts of the larger static artifact.

The MIDI connection is critical for Chagas in *Migration* because all the programs he employed to compose and perform it used MIDI. With the exception of EMS Synthi 100, which Chagas and Volker Müller developed for this work, all of the software had been previously established and updated for several years from different creators and licenses.

Chagas designed *Migration* for 12 channels of spatialization through 24 speakers and two subwoofers. This arrangement of 12 channels with 24 speakers was ideal in Cologne, but Chagas recognized that many concert halls outside of electronic music hubs like Cologne, Karlsruhe, and Paris might not be equipped for the sheer number of electronic devices he requires. To accommodate concert halls elsewhere, he mixed 8-channel, 5.1-surround, and stereo versions.[263] The stereo version might have been impossible before the Pro Tools plug-in "Proton," which uses a psychoacoustic algorithm to emulate the spectral characteristics of 12-channel music.

[263] Chagas, *Unsayable Music*, 182.

Chapter 6: Paulo Chagas, Migration (1995-7)

The Piece

By identifying large moments, I analyze *Migration* as having five body sections that include the live orchestra, plus a fixed media prelude and a postlude that feature recited lines from the Borges story. The acoustic ensemble sits on stage in front of the audience with the piano soloist between the ensemble and the audience. In an ideal setup, the audience is surrounded by twenty-four speakers and bookended by two subwoofers. The electronic and recorded sounds are spatialized via twelve channels placed equidistantly at angles of 30 degrees. The static artifact of the work consists of the notated score, the Max patches, the spatial charts Chagas drew, and his article on circular space and his relevant chapter in his book that act as a compositional journal.

The piece showcases spatialization of many levels and types. In the physical sense, the twelve speakers create a sense of circular space which Chagas partitions into various shapes and fields of various sizes. These shapes shift and move as well, creating a sense of movement within and between spaces. In the narrative sense, Chagas writes, the text of "The Library of Babel is about journeying, foreign lands, texts, and the world at large."[264] It is also inspired by his own journey as a migrant across three continents. In a semiotic sense, the spoken words are in four different languages (German, English, French, Latin, and Spanish), moving the listener through cultural and linguistic spaces. Chagas uses effects like time stretching and band pass filters to affect the fixed media, generate new electronic sounds live,

[264] Chagas, *Unsayable Music*, 180.

and spatially and spectrally modify the several keyboard instruments playing with the acoustic ensemble.

In the score, the form is sectionalized by arrangements of instrumentation, electronic happenings (e.g. rotational motion, different Max patches, etc.), and gestures. Chagas builds on Hatten's definition of gestures as "significant energetic shaping of sound thorough [sic] time,"[265] such as unique rhythmic traits and spectral effects, and used this in his works at the turn of the millennium. Gestures found in the acoustic instrumentation – such as building harmonic textures and rhythms – are visible in the score. However, the gestures that are linked to technology and spatialization, like triggering new Max patches or changing static spaces into dynamic spaces, are harder to discern in the score because Chagas chose not to notate them, yet they are clearly audible. All of these effects and changes are examples of gestures Chagas repeats and layers throughout the piece, which in turn reflects and reveals the form of the piece – yet another type of space.

The Score

These static and dynamic sound spaces are not explicitly marked in the notated score. However, the score itself presents an interesting space. The acoustic instruments use traditional notation, but the keyboard instruments are both acoustic and electronic. In the instructions and specifications Chagas explains, "The MIDI-piano is most of the time played by a computer. The pianist controls the action of the computer by playing notes on a MIDI-

[265] Chagas, "Composition in Circular Sound Space," 194.

master keyboard or on the MIDI-piano itself… only the control notes and the rhythms played by the pianist are written in the score, not the resulting notes on the MIDI-piano." There is only the one pianist, but there are in fact five different keyboard instruments including the MIDI-fader that the pianist can control.

The Piano

There is only one pianist covering the acoustic piano parts and MIDI-keyboard parts, and must read up to five staves at a time. Chagas distinguishes one staff for the MIDI-piano, for which key strikes are electronic triggers, from a double grand staff for the piano that the

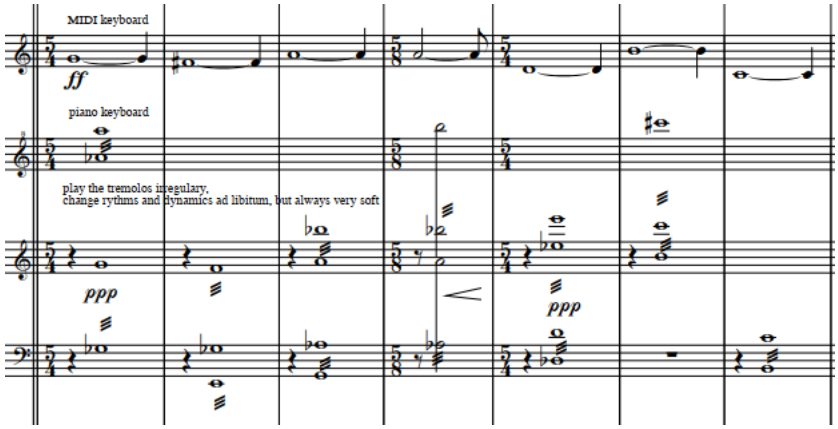


Figure 6.1 Excerpt of the four piano lines, starting at m.3 in *Migration*.

pianist plays. In the introduction at m.3 , these are labelled clearly. However, as the piece goes on, staves drop out and Chagas does not always relabel or reassign lines. One cannot assume the default is MIDI-piano on top, either; at m.27, the start of section B, the MIDI-piano staff moves to the second piano line. Chagas does occasionally relabel lines, but there is much to be inferred and assumed. Again, the notation is intended for the performers, and

Chagas only notates what they need to see in order to perform. Staves appearing, disappearing, or being left blank is simply Chagas's method of efficient notation.

Chagas uses beams and stems across huge expanses of the keyboard. Where the piano part is indeed written for piano (whether acoustic or piano sound on keyboard), the music is pointillistic to the extreme, and moves so quickly that it becomes a more of a timbral or spectral gesture than anything pitch-related. For the majority of the piece, the pianist is also

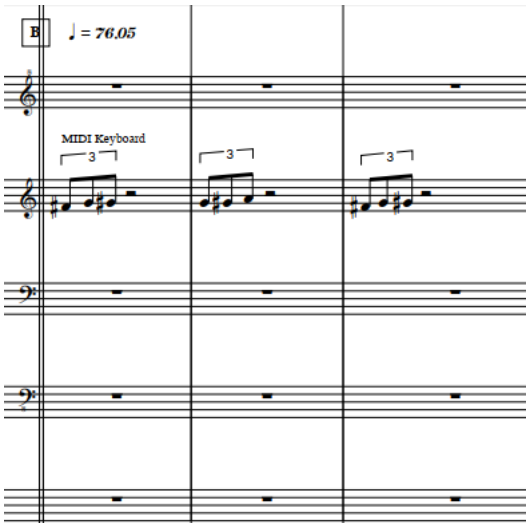


Figure 6.2 The keyboard triplets at section B.

tasked with reaching over to the MIDI-piano to strike a key to trigger events. For example, at section BB, m. 305, there is a piano solo by the human performer at the piano. Seamlessly, Chagas has the pianist move to the MIDI piano at m. 362, playing the same rhythmic

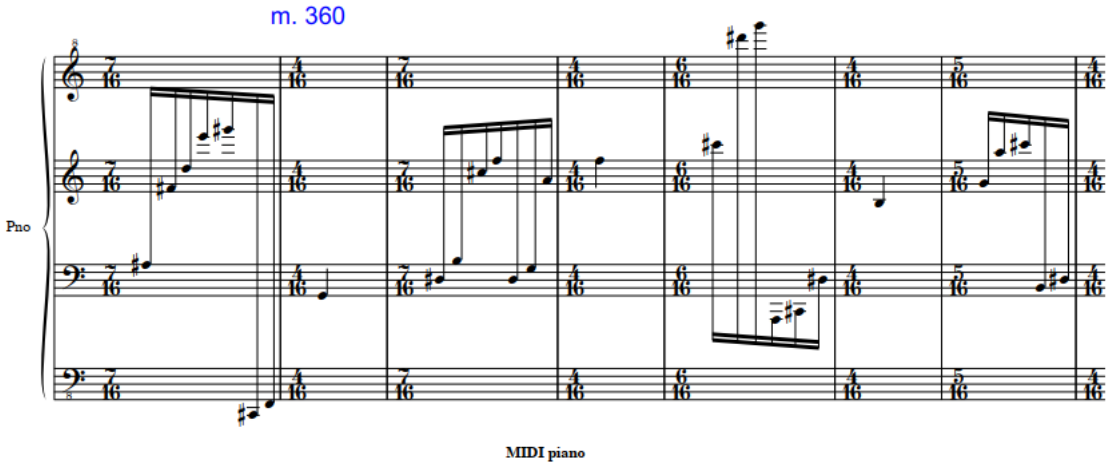


Figure 6.3 The piano parts, mm. 359-365.

gestures without missing a beat but with a fundamentally different sound and effect. Similarly, at the beginning of Section 5 at m.374, the computer fully takes over the MIDI keyboard from the human, and the fixed media takes over the sounding piano parts.

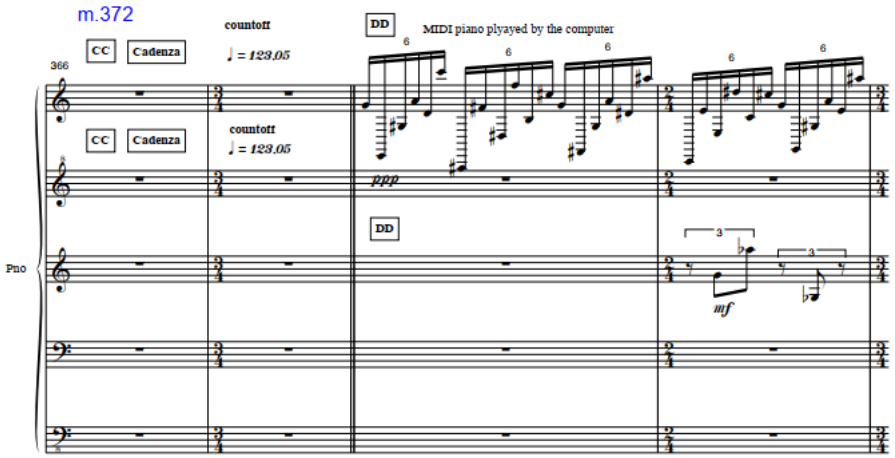


Figure 6.4 The piano parts, mm. 372-375.

Gestures

Chagas's work is built out of several gestures. Chagas, using Hatten's definition of gestures as "significant energetic shaping of sound thorough [sic] time," writes that "in *Migration*, the spectral qualities of the material, particularly spoken text and piano, are interpreted as three kinds of gesture: vocal, instrumental, and technological."[266] He also identifies several parametrical gestures, such as attack and resonance (a mainstay in *Migration*), temporal expansion (another prolific gesture), circularity, reversing, and crescendo-stopping-suddenly (a common cadential gesture in the piece), to name just a few. These can be a part of the larger categories of gestures or can unite two or three of the larger gestures before separating them again.

This unification and subsequent separation of musical realms is, I argue, yet another type of space Chagas plays with in *Migration*. By setting up three foundational sonic realms (vocal, instrumental, and technological) and finding ways of moving between them and overlapping them, he transports the listener between and through these sonic realms, taking them on another kind of journey as the piece unfolds.

Gestures are notated where relevant. Gestures that exist in the instrumental realm, or have to do with traditional musical elements like pitch and rhythm, are clearly notated in the score; ones that exist in the technological realm are unsurprisingly evident only in the

[266] Chagas, "Composition in Circular Sound Space," 194.

electronic processes. Access to these different elements of the static artifact are what contribute to a fully formed analysis.

Instrumental gestures: spectralism and time

The instrumental gestures signify the unending liminal spaces of a migrant. They represent the unfamiliar and at times uncomfortable transitions between spaces and perspectives, drawn from Chagas' personal experiences.[267] In this class of gestures, Chagas mostly employs acoustic spectral techniques and rhythmic motifs. For instance, in his article on the electroacoustic practice at the WDR, "Composition in Circular Sound Space," he claims that each acoustic piano chord "articulates a slow, accentuated rhythm. Each chord has a strong attack and a long resonance processed by time stretching that gives the sound a granular texture. The *gesture of attack and resonance* is here combined with the *gesture of time stretching*."[268] Each time the piano plays, its wide harmony – often spanning the entire width of the piano – evokes a spectral ringing. The upper notes serve to emphasize the high harmonics of the lower notes. This is one example of the gesture of attack and resonance. Combined with some subtle time stretching processes in a Max patch, i.e. the gesture of time stretching (which is one instance of overlap between acoustic and technological gestures), the spectral swirl resonates much longer than is natural.

The slow harmonic rhythm is apparent in the notated score, but the electronic processes – which come from a Max patch – are nowhere to be found on the page, not even

[267] Chagas, "Composition in Circular Sound Space," 192-193.
[268] Chagas, "Composition in Circular Sound Space," 196.

as a cue to start the patch. The unnatural duration of the piano notes gives the music an echoing, displaced feeling – but there is no way to know this from the score alone. The static artifact, however, includes the Max patches and other electronic processes. If the analyst can obtain the program, or at least documentation of it, then the analyst can imagine how the piano notes could be modified, and how they could vary from one recording or performance to the next.

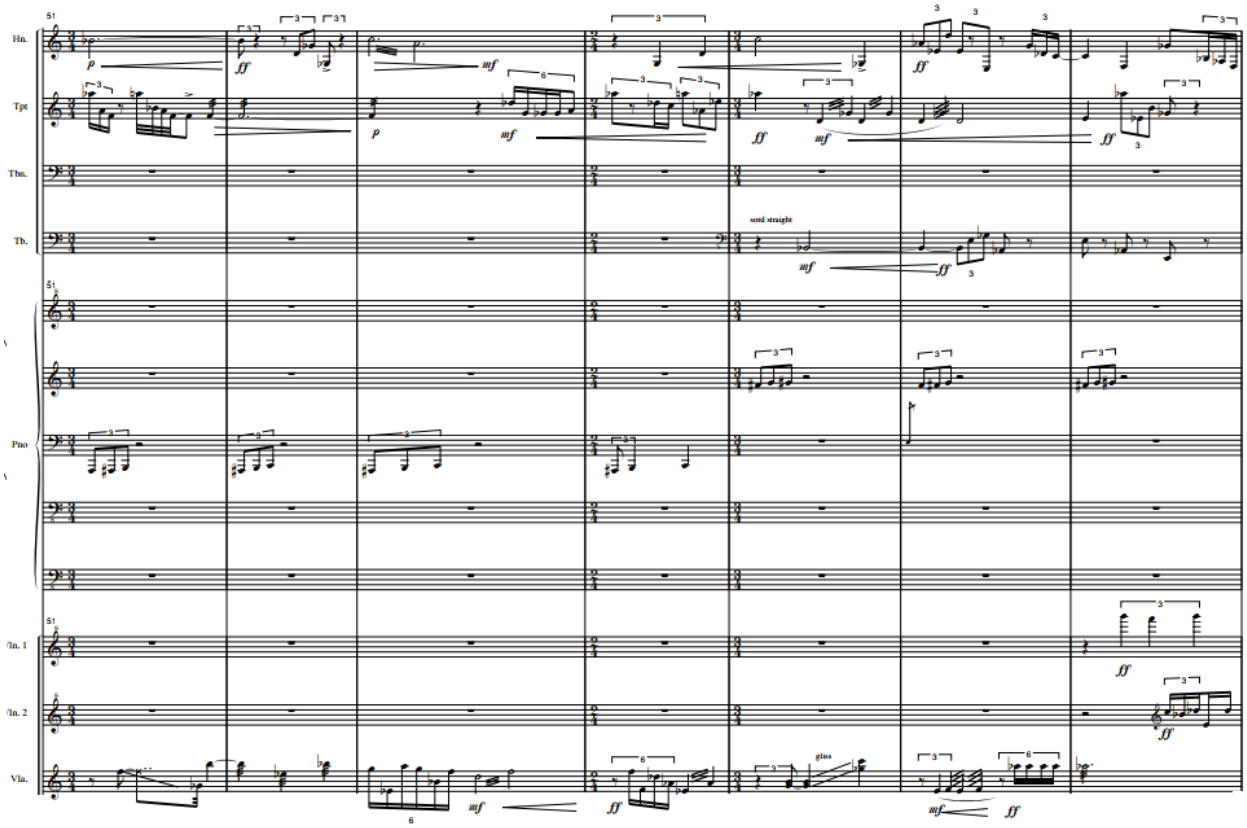


Figure 6.5 The instruments at mm. 51-57.

The combination of two gestures within the instrumental gesture category creates series of sound objects. For example, in Section D, mm. 51-61, the acoustic instruments play attack and resonance gestures out of phase with one another. The piano keeps a steady motif

of rising triplets on the downbeat of the bar. Meanwhile, the viola alternates between sixteenth note sextuplets and longer tremolo intervals. Simultaneously, the horn and trumpet trade off tremolos and triplets of varying durations. The overall effect is a cascade of attack and resonance gestures of different timbres. The individual notes move by too quickly to be heard as melodic lines or proper polyphony, but rather waves of harsh and smooth resonances.

Chagas asserts that the acoustic instruments are at once embodied and objectified. "An instrumental gesture requires a synchronised action between body and object. Both vocal and instrumental gestures are tight couplings on the acoustic medium; they are perceived as ritualisation of myths."[269] In *Migration*, the instrumentalists stay in place on stage, but create movement through these phased gestures. They also move the piece from section to section – almost every small section concludes on a climax of a crescendo-stopping-suddenly gesture. This gesture is perhaps the most clearly visible in the score because it is purely instrumental and does not rely on technological processing or interaction with vocal or electronic gestures to be heard or read.

Vocal gestures – words spoken and words altered through time and space

Chagas's description of vocal gestures draws explicitly on Eero Tarasti's interpretation of Hegel: "A vocal gesture consists of a physical and metaphysical effort, a

[269] Chagas, "Composition in Circular Sound Space," 194; as opposed to ritualisation of programs, which is how he describes the technological gestures.

projection of an identity (*Dasein*) in some other context."[270] The realm of vocal gestures evokes the human cultural spaces the eponymous migrant moves through, marked by different languages and tones of voice. The work uses recordings of voices that speak different languages and with different accents, which are electronically transformed through various processes. These human speakers represent the migrants and their journeys to new homes and trying to acclimate to new spaces and cultures.

Though the voices are all human, they are separated from their sounding bodies. Dissociating voices, or ventriloquism by recording, is a compositional technique as old as recording technology. There is an uncanniness and power to a voice with no bodily source. Musicologist Tom Gunning writes on dissociated voices: "Separated both from its human bodily source and the moment of its origin, the recorded voice becomes an alien entity, free-floating and replay-able, belong in effect to no one, or perhaps clinging to whoever hears it."[271] Ethnomusicologist Steven Connor writes in *Dumbstruck* that voice "requires and requisitions space" and can act outside of the body that created it. [272] Chagas's use of voice in this composition takes Connor's theory to new heights, using human voice and also technologically altered voice to manifest cultural spaces in *Migration,* and represent the bodily movement through geographical and cultural space, alongside the psychological spaces effected by spatialized sound.

[270] Chagas, "Composition in Circular Sound Space," quoting Tarasti, *Signs of Music*.
[271] Gunning "A Voice That is Not Mine."
[272] Connor, *Dumbstruck,* 5.

Using recorded voices rather than live performers allows Chagas to alter their tone and the words' meaning with technological processes.[273] The most common gestures for the voices are time stretching, reversing, and modulation (via amplitude modulation with the EMS Synthi 100), which make the vocalizations aphasic. These musical gestures combine the vocal gesture with the technological gesture.

Luis Borges switches languages throughout the text. For instance, the opening line of *Migration* moves from English to Latin mid-sentence: "First axiom, the library exists ab aeterno." Chagas adds additional lingual confusion through editing and combining lines of text and recordings. For instance, the chorus of voices may unify in one language, or shout against one another in all four. There is a lead female voice who sometimes takes center stage (somewhat literally, by being panned to speaker 12). It also seems as though she cues the section changes and electronic changes – some Max patch triggers are attuned to her voice, even though she is a fixed recording and the triggers could just as well have been on timers.

There is a gesture of call and response at 6'43" (rehearsal K, beginning at m.61) that invokes all four musical traits of schizophonia, repetition, noise, and sound objectivity. The lead narrating female voice bellows in Spanish and the other voices echo her meekly, and the instruments also seem to echo in a confused yet spirited tone. The voices are put in conversation with each other, but in different languages, reflecting a particular kind of

[273] Logistically, these processes would have been incredibly difficult if not impossible to do in a live performance in the 1990s, though nowadays with MIDI 2.0 they might be feasible.

schizophonia. The woman repeats herself, and the piano plays and rephrases its rhythmic motif in several different ways, playing with repetition. The mass of instruments, almost the full orchestra, plus the piano and voice and electronic effects creates disorienting noise.

Also, the electronic processes gradually evolve. For example, an utterance that was slowed down may have only the attack and sustain speed up to regular speed while the release and decay remain slow, creating a curious distortion that causes the utterance to cease sounding like a human voice at all until the release and decay catch up around 7'.

However, Chagas does not notate any of this, nor does he provide a libretto to follow. One can find Borges's text and translate it into the four languages and map the text to the recitation, but that is outside the realm of the static artifact. Chagas may be interested in the gestures he creates, but the analyst will find no sign of it in the score besides vague references to "voice" and "tape."

Gestures of technology – diffusion and movement

If the instruments are at once embodied and objectified, and the voices are in emigratory limbo, then the technological gestures are the movement and reconstitution of sound. I have already discussed ways in which technological processes emphasize and amplify the disorientating effects of the instrumental and vocal gestures, but the technological gestures alone have a rather different role. In *Migration,* technology represents the spaces that migrants move through and inhabit, often shifting and always liminal. Chagas states the "technological gestures make the body invisible and underline the

recontextualization of embodied experience"[274] The unique gestures under the umbrella of "technology" are two types of diffusion and movement of sound, using the twelve channels to create static and dynamic spaces.

The first type of diffusion is pre-set with the computer and creates static spaces via the fixed tape track voices that emanate from various angles. Chagas assigns channels to different groups; for example, channels 1 & 2 might be a pair while 3 & 4 are another pair, or channels 1, 2, 3, & 4 are grouped against 5, 6, 7, & 8, and so forth. The groupings create shapes – triangles, squares, hexagons, etc. – that surround, tessellate, or overlap one another.

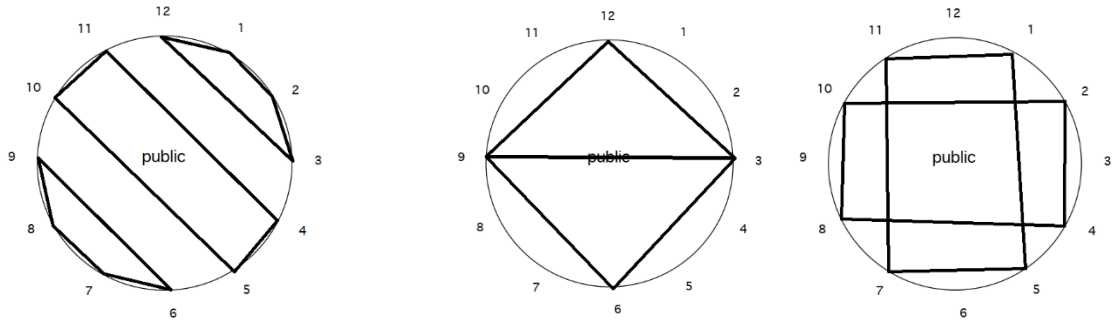


Figure 6.6 Examples of static spaces and arrangements, superimposed on Chagas's diagram of the 12-channel speaker arrangement. Drawn by author.

These groupings change to create new static spaces. Sometimes the groups are reassigned and rearranged instantly and in line with other moments of musical transition or repose. Other times, their adjustment creates a queasy kind of movement. For instance, group 4A in channels 1234 and group 4B in channels 5678 merge and exchange. At one point, both

[274] Chagas, "Composition in Circular Sound Space," 194.

groups are clustered cacophonously in channels 3456 and eventually tease themselves apart to recognizable groups again in their new arrangements.

Chagas set up these static spaces in Max, but the original stems were difficult to locate.[275] To perform the piece, one may request the appropriate fixed Max patch with everything preset; the stereo, surround, 5.1, and 12-channel versions are available as separate files. Seeing the spatialization in the Max patch is the only sure way to analyze this work, even if only via screenshots, because it is incredibly difficult to keep up with parsing the 12 channels' spatialized shapes and how they move, especially in moments of intentional disorientation. The DAW itself, or at least images of the DAW and its stems, are therefore critical contributions to the static artifact.

The second diffusion is live movement of dynamic spaces. As described above, dynamic spaces are created when static spaces morph and move into different speakers and arrangements. Like the middle section of Hurel's *Leçon*, Chagas's piece swirls sound from speaker to speaker, creating the sensation of rotation within the space or movement through the space even though the audience is stationary. The movements reflect the movement of the immigrant and may align with or oppose the voices speaking in the "tape" track.

Combining the gestures

In the realm of electronic effects and gestures, the electronics create transmedial couplings that emerge and fade away. Chagas created these juxtapositions intentionally. The

[275] I was able to procure the stems for the stereo version of the piece.

trifecta of gesture categories – having to do with speech, live instruments, and spatialized/spatializing electronics – is a form of migration, too. In Chagas's words, "sound migrations occurring between speech and piano as opposite sonic poles circularly organise the form of the piece. Variations of rotations connecting either all 12 or only six loudspeakers shape the circular sound space."[276] Electronic technology always works in tandem with other types of gestures. Either the electronics are live-processing an instrumental sound, hosting and processing vocal sounds, or they are triggered by an instrumentalist (the pianist or the audio technician). The specific vocal gestures have to do with the reciter's cadences and use of language, and the gestures are amplified or modified by the electronics. The electronic gestures, then, are the modifications like time-stretching and moving sound around the circular space.

As discussed in the vocal section, word lengths are extended by time stretching and the spectral information of speech is remapped to a large time scale. The variations of pitch and timbre become much slower than in ordinary language, and creates both melody and spectral variation. Chagas uses this to create a feedback loop – certain pitches and timbres in the fixed media track cue other tones and effects to trigger on the live processing of the piano and other instruments. As long as the Max patch is active, it will continue to monitor tonal, temporal, and timbral inputs and process or instigate processes on those sounds, creating yet more varied sounds.

[276] Chagas, "Composition in Circular Sound Space," 195.

Migration Conclusion

Migration portrays and creates spaces in such a multitude of ways. It tells the story of the migrant by evoking and creating disorienting and shifting spaces in the concert hall. Chagas describes the space generally as circular and cites his inspiration as the circular set-up in the WDR studio in Cologne. In truth, however, there are very few circles in *Migration* – the circular arrangement of speakers allows for many other shapes. *Migration* features sonic polygons that transform and move around one another and bump into each other, like people in a train station, or like a refugee passing through country after country until finding a new place to call home. The distortion and reorganization of familiar materials and gestures is another parallel to the immigrant experience. Languages and perspectives change as a person moves through geographical space; similarly, speech and spatial orientations change in the audience's perspective.

In this chapter, I have discussed space and music through Paulo Chagas, a composer at WDR who aided in in the transition to a new studio space and new innovative technology in the 1980s, and strove to push that technology to its limits in the 1990s. *Migration* the largest work that Chagas completed at WDR in the 1990s, and its musical, technological, and philosophical layers and complexities make it a fascinating case study for multimedia spatialized electroacoustic music. Moreover, Chagas made very thorough documentation of the piece, albeit many of the important documents he published over a decade later. The static artifact for *Migration* consists of the score, the article "Circular Sound" (2008), the

chapter on WDR and spatialized music in *Unsayable Music* (2014), and any images of the Max patches, ProTools presets, AudioSculpt processes, or other workings within a DAW.

I applied Hatten's theory of musical gestures in conjunction with Chagas's personal brand of theory and musical philosophies to analyze *Migration* and assess its static artifact. The static artifact reveals this potentiality. While comparing performances and recordings can hint at possible variations, the best way to understand the full scope of realization deviation comes from reading the score alongside views of the DAWs and informed by Chagas's essays.

Concluding Thoughts

In this dissertation, I analyzed four case studies of static artifacts of electroacoustic multimedia music from the 1990s, each using methodologies specific to the type of music plus "score study" based on their static artifacts. In chapters 1 and 2, I gave a brief history of the technological advances that changed composers' methods of composition and notation, and theorists' styles and modes of analysis. In chapter 3, I analyzed Philippe Hurel's *Leçon de choses*, and demonstrated how to use the static artifact in conjunction with phenomenological styles of analysis, untangling aspects of form and morphology that were not apparent from listening alone. In chapter 4, I performed a static artifact-only analysis on Trevor Wishart's *Scylla and Charybdis*, which has no recording or live performances to use in analysis, but is well documented through its antiscore. In chapter 5, I recontextualized Nicholas Cook's analytical method intended for film – or, more broadly, audiovisual multimedia – to perform a static artifact-based analysis on the media elements in Anne Deane Berman's *Positive Thinking*. Finally, in chapter 6, I combined the many modes of examination and analysis as well as reworking Robert Hatten's gestures to apply to Paulo Chagas's *Migration*. Through this history and these four disparate case studies, I have continually asked the questions: How can music analysts use a static artifact? And what benefit does it serve us?

To answer the first question, I remind the reader of the context I designed for my case studies. All four composers of the case studies worked in different countries, artistic societies, and studios. What they have in common is that they creatively addressed a similar

problem with notation and documentation, and used technology with the young, universal protocol: MIDI. The resulting static artifacts are not so dissimilar on the surface, not even Wishart's antiscore. All used elements as outlined in Table 1.1 (p. 34) and had a mix of descriptive and prescriptive notation. Each case study's static artifact consists of some notation for live performers (symbolic notation), electronics diagrams for audio technicians (graphical notation), and prose documenting their thought process in composing (text-based notation). One finds diversity in the individual components themselves; for instance, the text components had a particularly wide range, from Chagas's academic articles, to Berman's layman-accessible program notes, to Wishart's philosophical antiscore segments. The variety of these components itself is an important component of analysis, too, because the composers reveal their artistic priorities (be they sonic, visual, dramatic, or lexical) in what they choose to emphasize through their documentation.

Each composer of these case studies cited the MIDI protocol as an important factor in their ability to create multimedia art; in the cases of Wishart and Berman, they also incorporated visuals, and they and Chagas use drama as well. One issue with MIDI and this new capacity for multimedia interaction – rather, an exacerbation of a growing issue with electronic music and art generally – is the lack of traditional notation. Even where some familiar music notation exists for an instrumentalist, it barely scratches the surface of the composer's artistic intent for the IMM as a whole and it is not a sufficiently useful tool for analysis. This is where my concept of a static artifact, the amalgamation of all the available composer-generated notation comes into play, whether that be score notation, text or graphic

scores, diagrams, DAWs or images of DAWs, code, self-analysis, or other relevant documentation.

Each of these four composers used a combination of fixed media, live electronics, and live acoustic performers to make IMMs. This multimedia genre of electroacoustic music lends itself to a wide variety of realizations as the interactivity and live components will no doubt have differences between performances. It is therefore unreasonable to analyze a single recording or performance, but instead the analyst must take the variety – imagined or real – into account. For the last few decades, theorists like Nicholas Cook, Michael Young, John Young, and Gary Kendall, to name a few, have developed theories and models for analyzing electroacoustic music, especially music that has these interactive and live components.

Beginning with these frameworks, I contributed my "score study" of the static artifact to devise what I assert is a more thorough analysis. Here is the answer to how we use the static artifact and what benefit it provides: By taking the static artifact into account, I was able to trace sound object transformations, gestures, and multimedia interactions and dynamics with greater fidelity than with my ears alone.

To begin to show the benefits of analysis based on a broader concept of static artifact, I have offered these four case studies. In *Leçon de choses,* Hurel intentionally created aural illusions with spectral techniques, and threaded together seven sound objects as if weaving narratives, as he was inspired by the eponymous novel by Claude Simon. Listening to the piece, it is difficult to parse these changes – but they are so core to the piece that without understanding them, it is nearly impossible to analyze the piece. Theorists like Gary Kendall and John Young offer helpful methods for analyzing multimedia electroacoustic music like

Hurel's, but these formal frameworks alone cannot analyze the electronic processing. For that, clues in the score and the accompanying written documentation of the static artifact are necessary to follow this central dynamic of the piece.

Wishart's *Scylla and Charybdis* lacks a recording and has only been performed once on record, so the static artifact is the only option for analysis. This is also an incomplete analysis without having a realization on which to anchor one's claims. That being said, Wishart's antiscore reveals important insight into every facet that he considered, no matter how insignificant in the grand scheme. From the position of the lever on stage to the motorcycle choreography, the static artifact provides extensive detail into the sonic art, visual spectacle, and political drama. It also reveals which sections have chance or improvisatory elements to the analyst, and the range of imagined or future performances that it could engender.

Positive Thinking is the smallest-scale work of the four case studies but is no less intricate. Berman weaves an emotional narrative between the text itself, the electronic modification of the narrator's voice, and the live flute motifs and live electronic effects applied to the flute. In Berman's case, the static artifact is particularly useful in understanding what order the media were composed and therefore what inherent power balance they have with one another. Berman's future-proofing is also only apparent in the static artifact, though recognizable in all subsequent realizations of the piece. As with *Scylla*, analyzing *Positive Thinking* necessitates considering a spectrum of potential performances.

Finally, on this point, Chagas's static artifact for *Migration* combines many of the same elements as the three others. He uses spatialization and spectral effects to obfuscate the

instruments and create gestures like Hurel, which the static artifact helps to parse. The Max patch triggers and acoustic space design are invisible to the eye and hard to track with the ear, but like Wishart's antiscore sections the static artifact reveals how the two components work and interact with one another. As with Berman, the use of electronic gestures butting into the vocal space mirrors *Positive Thinking*, and the written documentation – articles from Chagas, program notes from Berman – describes how the media are balanced.

Furthermore, each composer and theorist has their own philosophy on the state of music composition and music theory, which informs their compositional and analytical decisions. Here again, I assert these are not so different in the big picture. For example, there is a not-insignificant correlation between Wishart, who points out that music as art by itself contains many dimensions and elements, all of which deserve to be recognized in analysis, and Nicholas Cook, whose method for analyzing multimedia works involves pairing elements and systematically analyzing the dyads. Hurel is influenced by contemporary spectralists as well as the older generation of *musique concrète* composers, yet with sound objects based on narratives. Chagas is directly inspired by Hatten's theory of gestures, considering them as parts of "realms." – but the gestures are often shared in two realms, such as voice and technology, and the intersections may be understood as dimensions themselves.

Chagas's notion of separate media realms and their intersections is like Berman's philosophy in her composition, which she calls a "multimedia experience" of "animated poetry,"[277] and Berman's media elements also cannot help but to overlap in the same ways.

[277] "Artist's Statement." Annedeaneberman.com. Accessed June 19, 2020.

Concluding Thoughts

In both composers' works, vocal and instrumental gestures occur both live and mediated by the live electronics, and there are also technological gestures that can happen *to* them or *with* them. Tracing these gestures is made much simpler with a static artifact to consult.

Different kinds of multimedia might require the collaboration of different types of performers, and therefore need to communicate in different ways through different types of notation. In terms of scores and static artifacts, the first two case studies, Hurel's *Leçon de choses* and Wishart's *Scylla and Charybdis*, represent seemingly opposite ends of the spectrum of multimedia musical scores. The former is most related to traditional notation and traditional performance practice, but with the added elements of electronic media that make it something entirely new. The latter takes a novel approach to both notation, with its one-dimensional primarily text-based antiscore segments, and performance practice, with a unique mix of drama, audience participation, and live electronics. The Hurel analysis demonstrates how extended traditional notation can serve a piece effectively, even when unconventional forces are used. *Leçon* requires precise rhythms and pitches for the instrumental-reactive Max patches to work as intended, for which traditional notation is the ideal choice. The supplementary notation for the fixed media and Max patches falls on the side of graphic descriptive notation and meets the needs of the performers (and analysts).

My case studies on Berman and Chagas rest in the middle of that spectrum between traditional and novel descriptive notation. In Berman's *Positive Thinking* (1993), the bulk of the score consists of extended traditional notation for the flutist to perform from. The descriptive writings for the visual components are similar to Wishart's antiscore writings.

Concluding Thoughts

Berman does not specify certain things with notation because she intentionally future-proofed her score, and instead chose to accept and trust that technology will advance and there will be many new, unimaginable ways to create the visuals for *Positive Thinking*. The final case study, *Migration*, has a score with notation strikingly similar to *Leçon de choses*, including the separate acoustic and MIDI piano lines, but with more robust compositional journaling in the larger static artifact. The static artifact of *Migration* consists of the notated score, the Max patches, the spatial charts Chagas drew, and his article on circular space and his relevant chapter in his book that act as a compositional journal. The compositional journal component is similar to Wishart's journals in his antiscores. The primary difference is what the two composers did with the documentation. Wishart kept his as a part of the antiscore, literally bound in the same document as the rest of the static artifact materials and contextualized only within the work itself – the Context, to use Kendall's term. Chagas published his writings in academic journals and a book, and thus situated the material amid other works from the same studio (e.g. Stockhausen's *Octophonie*) and within Chagas's own oeuvre – in other words, the Domain. To be sure, Hurel and Berman also have components that resemble Wishart's and Chagas's journaling. Hurel's published self-analysis has provided one theorist, Catherine Tognan, with material for her own study. While not published as an article, Berman's website has useful writings for most of her oeuvre. By bringing together these materials from different sources under the umbrella term of static artifact, I hope to stress their underlying similarities and the benefits they can bring to analytical study.

Concluding Thoughts

The different layers of context do not fundamentally change the analysis of the static artifact, but they are worth taking into account to understand where the documentation comes from and why it takes the form it does. Analyzing electronic mixed media and interactive media like these requires a fairly novel paradigm in music theory, and new models have been devised since the turn of the millennium. The next step is incorporating disparate documentation like compositional journaling and unique notation into a new kind of score: the static artifact. My contribution has been to take a close look at a variety of static artifacts of pieces in this genre and demonstrate ways to incorporate a new kind of score study into analysis. Looking forward, I hope to continue to refine this toolkit, and observe how other theorists engage with the static artifacts of electroacoustic music.

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