

Fall 2010

Morton Subotnick's Ghost Scores: Interaction and Performance with Music Technology

Jeffrey Hanson
San Jose State University

Follow this and additional works at: https://scholarworks.sjsu.edu/etd_theses

Recommended Citation

Hanson, Jeffrey, "Morton Subotnick's Ghost Scores: Interaction and Performance with Music Technology" (2010). *Master's Theses*. 3864.
DOI: <https://doi.org/10.31979/etd.h6cw-5qkx>
https://scholarworks.sjsu.edu/etd_theses/3864

This Thesis is brought to you for free and open access by the Master's Theses and Graduate Research at SJSU ScholarWorks. It has been accepted for inclusion in Master's Theses by an authorized administrator of SJSU ScholarWorks. For more information, please contact scholarworks@sjsu.edu.

MORTON SUBOTNICK'S GHOST SCORES:
INTERACTION AND PERFORMANCE WITH MUSIC TECHNOLOGY

A Thesis

Presented to

The Faculty of the School of Music and Dance

San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Jeffrey S. Hanson

December 2010

© 2010

Jeffrey S. Hanson

ALL RIGHTS RESERVED

The Designated Thesis Committee Approves the Thesis Titled

MORTON SUBOTNICK'S GHOST SCORES:
INTERACTION AND PERFORMANCE WITH MUSIC TECHNOLOGY

by

Jeffrey S. Hanson

APPROVED FOR THE SCHOOL OF MUSIC AND DANCE

SAN JOSÉ STATE UNIVERSITY

December 2010

Dr. Brian Belet	School of Music and Dance
-----------------	---------------------------

Dr. Pablo E. Furman	School of Music and Dance
---------------------	---------------------------

Dr. Daniel N. Wyman	School of Music and Dance
---------------------	---------------------------

ABSTRACT

MORTON SUBOTNICK'S GHOST SCORES: INTERACTION AND PERFORMANCE WITH MUSIC TECHNOLOGY

by Jeffrey S. Hanson

This thesis investigates the ghost works of Morton Subotnick and their contribution to the world of sound art and electronic music technologies. Subotnick's work in this area is an integral part of his outstanding achievements, on which there is little collected research. The discussion focuses on the development of Subotnick's designs and techniques that he applied to the construction of the ghost works. Through an exploration of earlier background details, it is shown that tape recording, voltage-controlled technologies, and the analog sequencer provided Subotnick with the means to follow his vision and begin creating "music as studio art." An examination of these technologies and the creative manner in which he applied them reveal how Subotnick established a vehicle for his life's work in the early sixties, from which he created notable electronic works. An assessment of Subotnick's work from the early seventies shows that the composer's methods progressed using a variety of compositional elements, including electronics and traditional acoustic orchestral instruments, the culmination of which resulted in the creation of the ghost compositions in the mid-seventies. The evaluation of these works reveals Subotnick's aptitude with real-time analog signal processing and his standing as a significant American composer.

ACKNOWLEDGEMENTS

Thanks are due to the following people for their assistance, encouragement, and patience in the completion of this masters thesis document: Dr. Daniel Wyman for his mentoring, encouragement, and generosity in sharing his knowledge, time, and insights into the world of analog and digital electronic music technologies, as well as his general wisdom, sense of humor, and perspectives on the nature of academia; Dr. Pablo Furman for his guidance, fortitude, and persistence in maintaining high standards of academic excellence, as well as his willingness to share his vast knowledge of music; Dr. Brian Belet for his support, attention to details, and willingness to share his knowledge of music systems; Elizabeth Sava, for her knowledge of word processing issues and steadfast assistance with editing details, as well as her encouragement and inspiration; Bob and Carol Daniels, and Dorothy Hanson, for their optimism and support through this process; Drs. Robert Jones and Becky Roberts, and Professors Ronald Dunn and Erik Turkman, for their discerning input and advice on academic writing.

TABLE OF CONTENTS

List of Figures	viii
List of Tables	ix
Introduction.....	1
Chapter One: Morton Subotnick.....	5
Early Development (1940 – 1958).....	5
Career Development (1958 – 1961).....	6
Chapter Two: Ghost Development	11
The San Francisco Tape Music Center (1962 – 1966).....	13
New York City (1966 – 1969)	20
Pre-Ghost Techniques (1969 – 1976)	24
Chapter Three: The Sound of a Ghost (1976 – 1983).....	32
Sound Source: Acoustic Instruments	34
Sound Processing: Ghost Box.....	38
Control Source: Ghost Score.....	44
Sound Management: Audio System.....	48
Chapter Four: Ghost Works (1976 – 1983)	53
<i>Two Life Histories</i>	54
<i>Liquid Strata</i>	56
<i>The Wild Beasts</i>	59
<i>Passages of the Beast</i>	61
<i>Parallel Lines</i>	62

<i>The Last Dream of the Beast</i>	64
<i>After the Butterfly</i>	66
<i>The First Dream of Light</i>	68
<i>Axolotl</i>	69
<i>A Fluttering of Wings</i>	71
<i>An Arsenal of Defense</i>	73
<i>Trembling</i>	73
Conclusion	76
Appendix A: List and Details of Ghost Works	82
Appendix B: Available Ghost Works and Recordings	83
Bibliography	84

LIST OF FIGURES

Figure 1. The Buchla 200 Series Electronic Music Box.....	18
Figure 2. Buchla Touch Plate Interface	25
Figure 3. Ghost System Performance	33
Figure 4. Music Score Elements	35
Figure 5. Music Notation with Ghost Score Performance Notes.....	36
Figure 6. Electronic Ghost Score Part.....	38
Figure 7. Original Ghost Box Signal Routing	40
Figure 8. Electronic Ghost Score Notation of Signal Modulation.....	43
Figure 9. Electronic Ghost Score: Preparation	45

LIST OF TABLES

Table 1. Evolution of Techniques	12
--	----

INTRODUCTION

My urge is to create an expressive art with the technology of our time.
*Subotnick*¹

American composer Morton Subotnick (b. 1933) has cultivated unique musical ideas and innovative instrument designs by assimilating diverse genres of music, theatre, and dance into his music compositions. Although Subotnick has written and performed contemporary compositions for acoustic chamber groups and large ensembles, the majority of his compositions involve the use of electronics and computers. Subotnick's musical journey with electronics began in the late 1950s when he found work scoring for theatre and television in San Francisco. Rather than score for traditional orchestral instruments, a more common practice at the time, he worked with tape music, and created recordings of acoustic sounds produced from traditional and homemade instruments.

In the early 1960s, Subotnick became associated with avant-garde performance art: a live, performance-oriented art form involving multiple disciplines and new postwar technologies, where it was common for the performers to “break the fourth wall” and interact directly with members of the audience. Subotnick embraced aspects of performance art, including narrative, set design, choreography, lighting, and the use of cutting-edge audio and visual electronic technologies and incorporated them into his own works. These early associations with performance art and electronic technologies formed the basis of Subotnick's artistic sensibilities for much of his career and are evident in his life's work.

¹ Curtis Roads, “Interview with Morton Subotnick,” *Computer Music Journal* 12, no. 1 (Spring, 1988): 14.

Subotnick saw that with the aid of electronics, he could combine his composition and performance skills in the creation of “sound art.” While in pursuit of this vision in the early sixties, Subotnick collaborated with Don Buchla in the design of one of the first voltage-controlled synthesizers, a technology that greatly facilitated Subotnick’s production of sound art. The voltage-controlled synthesizer is an assembly of electronic audio components into a single unit, which employs voltages to control the various electronic components. These systems revolutionized electronic music in the late sixties and led the way to contemporary electronic music production accessible to a larger community of composers and performers. Subotnick developed a unique set of technical skills and aesthetics using the voltage-controlled synthesizer, and with it, produced notable electronic works, including his *ghost* compositions beginning in 1977, the subject of this paper.

Subotnick’s ghost compositions provided the electronic music genre with new models for performance interaction with electronics, making them a significant contribution to the history of American art music in the latter part of the twentieth-century. These works combined voltage-controlled analog electronics together with acoustic instruments, in which musicians interact with the electronics during live performance. Subotnick used the voltage-controlled electronic sound-producing modules of the synthesizer to both generate sound and to manipulate external sounds together with acoustic instruments. The application of real-time control to acoustic signals in performance was innovative, and foreshadowed the development of later MIDI-based electronics (musical instrument digital interface). When musicians interacted with

Subotnick's ghost electronics during performance, the resulting effects on the sound of the acoustic instruments were clearly evident, yet the electronics alone made no sound of their own. This led Subotnick to apply the term "ghost" to the process. This thesis will focus on Morton Subotnick's noteworthy interactive designs and techniques as applied to the construction and creation of the ghost works, an integral part of the composer's outstanding achievements, on which there is little collected research.

Chapter One will briefly describe the details of Morton Subotnick's primary musical foundations, followed by a discussion of his early career development where he began integrating electronic audio technologies with live stage productions in San Francisco between 1958 and 1961.

Chapter Two will discuss important influences in the development of Subotnick's ghost compositions, beginning with his experiences at the San Francisco Tape Music Center (Tape Center), including avant-garde performance art and the inception of the voltage-controlled synthesizer. The chapter focus shifts to Subotnick's artistic explorations in New York City where he improved his skills with voltage-controlled synthesis, produced notable electronic compositions, and further developed his multimedia performance art. Finally, there will be a brief discussion of several "pre-ghost" works in which Subotnick began to employ various designs and techniques ultimately applied to the production of his ghost pieces.

Chapter Three looks at specific details of the ghost electronics, which are Subotnick's programmable systems that combine magnetic tape and analog electronic sound processing components. The ghost electronics will be divided into four

fundamental subject areas: sound source, sound processing, control source, and sound reinforcement. *Sound source* pertains to acoustic instrumental performance, and will look at Subotnick's traditional music scores, intricate performance notes, and special ghost notation. *Sound processing* involves the ghost box audio processing components and will examine their contents and function. *Control source* entails several programmable electronic systems and will discuss the programming process and follow the evolution of the (ghost) technology over time. *Sound reinforcement* refers to a common sound amplification system and will be addressed as it pertains to the performance of the ghost works.

Chapter Four chronicles the twelve original ghost compositions as Morton Subotnick composed and produced them from 1976 to 1983. A detailed account of each work is given, citing relevant information about each piece. Each account covers pertinent details of instrumental scores, including the completion date, orchestration, and any text or concept that may have been associated with that particular work. Next, details regarding the particular electronics that Subotnick used in the preparation of each work are presented along with the performance (running) time of each piece. This information is followed by details of the premiere performance and covers dates, locations, venues, events, commissions, featured artists, conductors, recordings, and listener reviews.

CHAPTER ONE MORTON SUBOTNICK

Early Development (1940 – 1958)

Morton Subotnick's musical endeavors began in Los Angeles with clarinet lessons at age seven, which were then augmented with studies in harmony and composition at age twelve. By the time Subotnick finished high school in 1950, he had become an accomplished performer on the clarinet and had cultivated a high level of proficiency with harmony and composition skills. Immediately after high school, Subotnick attended the University of Southern California. He passed the USC music placement exams, allowing him to enter the music department at an accelerated level. Before finishing his first year of school, he was recruited to perform in the Denver symphony at age seventeen.

Subotnick moved to Denver in the summer of 1951 where he attended the University of Denver, majoring in English literature, while working as a professional musician. In Denver, Subotnick became acquainted with composer James Tenney and experimental filmmakers Stan Brakhage and Larry Jordan. He began to develop his compositional sensibilities through his interactions with these influential creators. Subotnick recalls that they "were all getting out of school around the same time. We hung out together and learned what was going on in the various arts. That was sort of the beginning of my avant-garde side."² Upon completing a BA in English at Denver, Subotnick was drafted into the military and subsequently stationed in San Francisco.

² Cole Gagne, *Soundpieces 2: Interviews With American Composers* (Metuchen, NJ: Scarecrow Press, 1993), 340.

After his military duties were over, Subotnick studied music composition with renowned composers Darius Milhaud and Leon Kirchner at Mills College in Oakland, California.

Career Development (1958 – 1961)

Between 1958 and 1961, Subotnick found work composing for live stage productions with the Actor's Workshop and the Ann Halprin Dance Company in San Francisco. These were avant-garde companies that presented progressive material, which inspired Subotnick to provide them with a progressive score, something more than “incidental” or background music. He became intrigued with the capabilities of the tape recorder as an effective means for creating the audio component to the live action on stage.

In 1959, after graduating from Mills, Subotnick performed professionally as a clarinetist with chamber groups and with the San Francisco Symphony. He maintained his involvement with electronics and avant-garde stage productions, but the clash of these diverse sensibilities left him torn between the two artistic areas of his life.³ Subotnick soon realized that the capabilities of the tape media could allow him to function both as a composer *and* a performer. With the use of the tape recorder, he was able to flesh-out musical ideas, rehearse, perform, record, and then listen back to the recorded performance as an all-in-one process that required no intermediary to realize the final piece. This powerful new tool became a catalyst for Subotnick, motivating him to pursue a personal vision of creating of sound as art.⁴

³ Roads, “Interview with Morton Subotnick,” 9.

⁴ Ibid., 13.

In 1959, Subotnick was hired by San Francisco public television station KQED to score a six-part film for National Educational Television called *The Computer and The Mind of Man*.⁵ Subotnick felt that traditional orchestral instruments would not be able to offer the timbres or tone colors necessary to support the content, so he turned to tape music to expand his palate of sounds. He acquired a tape deck and applied the studio techniques of *musique concrète* to construct electronic audio scores for the films, which premiered in 1960. Subotnick completed the work in his own studio built in the basement of his San Francisco apartment. He experimented with “non-traditional” sounds and made recordings of broken musical instruments, used car parts, a Wurlitzer electric piano, and a set of old coil springs from a San Francisco trolley car. In an interview with Cole Gagne, Subotnick stated:

I had a broken-down piano and other things and I hung them through the basement. I made a path for myself with a microphone at one end, and I would rehearse these action pieces: I would fly through the space, hitting this and that, and then turn the tape recorder off at the other end. Then, I'd figure out another pass. . . I made \$200 a score, so I had \$600 after the first three and I bought my first oscillators. I did the next score with the oscillators and then they called me and said, “This is nice, but it's not really ‘computer-like,’ like your first ones!” And it's true, because those oscillators sounded like a bad oboe! So I ended up having to do all of those scores on that [acoustic] equipment.⁶

Subotnick continued scoring with tape music on a production of *King Lear* for the Actor's Workshop. He recorded the voices of cast members, and then edited the sounds

⁵ Richard Moore, *The Computer And The Mind Of Man: Logic By Machine* (National Educational Television, 1960), 13:58, Prelinger Archives, MPEG4 video, Accessed February 8, 2010, http://www.archive.org/details/logic_by_machine_1.

⁶ Gagne, *Soundpieces* 2, 338.

into a supporting audio piece, which premiered in May of 1961. The unconventional electronic tape music score for *King Lear* was successful, but also controversial. In an interview with Curtis Roads, Subotnick recalls:

The tape music was actually fairly well accepted because it had been codified by Europe and by the work being done at the Columbia-Princeton Electronic Music Studio. But I was doing things that were electronic and also theatrical. The combination of the electronic and the theatrical caused the most furor. We were literally kicked out of the San Francisco Conservatory.⁷

Subotnick's early inroads with electronic music technologies often involved *musique concrète* techniques where he applied his own, low-cost, homemade acoustic sounds, as described above. In addition to his excursions with tape, Subotnick explored electronic sound synthesis with oscillators, an electronic device that generates select frequencies of electric signals, which are converted into sound when amplified through loudspeakers. Electronic synthesis was difficult to produce in the late fifties due to the high cost of electronic components. Subotnick explains:

Everything you used was basically test equipment; there was no consumer market for it, so everything was just enormously expensive. In the late '50s, an oscillator—Hewlett Packard was the main oscillator—was \$400 or \$500. That's one oscillator to make one sound. . . To build a simple studio that would have maybe two tape recorders and three or four oscillators and whatever minimal mixing would have been about \$40,000—in 1950s money.⁸

A pivotal point in Subotnick's career came in September of 1961 with his first original multimedia theatre work, *Sound Blocks: An Heroic Vision*. "Working on that

⁷ Roads, "Interview With Morton Subotnick," 9–10.

⁸ Gagne, *Soundpieces* 2, 337.

piece,” Subotnick recalls, “altered my musical perception. It was a large, full evening work that used lighting, an actor, several musicians, and tape music playing on two tape recorders. It was the process of working on it, the relationship with the audience, and the performance aspects, which completely molded my vision up through my present work.”⁹

Sound Blocks was a very successful production for Subotnick, which motivated him to break away from writing music exclusively for traditional instruments and commit himself to following his vision of creating studio art music. In the interview with Bernstein and Payne, Subotnick stated:

What I really wanted to do was to develop a whole new form of media. This piece [*Sound Blocks*] was my first attempt to do this. . . It was really the work with *King Lear* that made me understand that I could combine my performing ability with my composing and put together a new concept, which I called “music as studio art” where one could be the composer and the audience all at the same time. . . I felt that I had a natural affinity immediately . . . I had a sense of the theater from day one and was not really writing music for the theater. I was creating sound. It’s what became known as “sound design.”¹⁰

Continuing from the above interview, Subotnick explains that his process of scoring with tape is a studio art, “similar to the studio art of the painter, where one can produce a finished work in a studio environment. When the work leaves the studio, it is the completed work, no reinterpretation is necessary.” Subotnick was attracted to the hands-on aspect of working with the tape media. “With tape composition,” he says, “one deals

⁹ Roads, “Interview With Morton Subotnick,” 10.

¹⁰ David W. Bernstein and Maggi Payne, “Morton Subotnick,” in *The San Francisco Tape Music Center: 1960’s Counterculture and the Avant-Garde*, ed. David W. Bernstein (Berkeley: University of California Press, 2008), 120.

directly with the sound material. There is a kind of physicality in working with tape music.”¹¹

Subotnick produced a subsequent original theatre work, *A Theater Piece After Sonnet Number 47 of Petrarch* in 1963, which was orchestrated for recorded spoken word, electronics, mimes, piano, viola, light production, and set design. With *Sound Blocks* and the *Petrarch* piece, Subotnick was beginning to create sonic art. Pioneered primarily by John Cage,¹² sonic art refers to the creative organization of sound as a work of art, in and of itself. As his techniques with tape and electronic composition progressed, Subotnick began to create unique concrete and electronic timbres in his compositions, reminiscent of Cage, which were each able to stand alone as independent works of sonic art.

Morton Subotnick’s foray into electronics that began in 1958 led him to a point three years later where he had adapted electro-acoustic studio techniques into his work and combined them with elements of theatre in the development of his own, unique set of skills: that of a *sonic artist*, beginning with his original electro-acoustic works in 1961. Subotnick continued to explore the emerging elements of avant-garde expression at the Tape Center, where he integrated his musicianship with multiple disciplines in the pursuit of his career as a sonic artist.

¹¹ Ibid., 117–120.

¹² Tony Gibbs, *The Fundamentals of Sonic Art & Sound Design* (Lausanne, Switzerland: AVA, 2007), 36.

CHAPTER TWO GHOST DEVELOPMENT

I have always thought of my work with electronic sounds and tape recorders as “sculpting” with sound in time and space: placing sound into an imaginary “space canvas” in front of me . . . molding the color of the sound . . . transforming the harmonic content . . . to begin to shape it like the beginnings of some strange visceral language . . . shaping the sounds into contours of pitch . . . bending, pulsating points along an imaginary time line . . . increasing and decreasing their occurrences . . . like elastic bands stretching to their limits and either gently brought back to their original form or let go to snap into a chaotic pattern like a balloon full of air suddenly released.

*Subotnick, from Until Spring recording liner notes, 1976*¹³

In 1976, Morton Subotnick began producing his series of ghost compositions. He applied techniques using voltage-controlled synthesis and magnetic tape recording that had evolved in his work over the previous fifteen years. Table 1 below illustrates the evolution of Subotnick’s electronic composition techniques relevant to the ghost compositions in select works from 1960 to 1976.

¹³ Morton Subotnick, *Until Spring*, liner notes, Odyssey Records, 1976, LP record. Quote taken verbatim, including ellipses, from original source.

Table 1. Evolution of Techniques

Work	Application	Techniques	Significance
<i>The Computer and The Mind of Man (1960)</i>	Film	Musique concrète, film scoring	Proficiency with tape
<i>King Lear (1961)</i>	Theatre	Musique concrète, sound design	Live stage experience
<i>Sound Blocks (1961)</i> <i>Petrarch Piece (1963)</i>	Performance art	Music scoring, musique concrète, set design, lighting, choreography, “4th-wall” interaction	Formation of work ethic and personal vision with “studio art” techniques
<i>Silver Apples (1967)</i> <i>Wild Bull (1968)</i>	Electronic composition, LP recording	Voltage-controlled synthesis	Proficiency with Buchla voltage-controlled synthesis
<i>Touch (1969)</i>	Electronic composition, LP recording	Voltage-controlled synthesis programming: “energy shape” gestures	Formation of primary programming technique
<i>Sidewinder (1971)</i>	Electronic composition, LP recording	Recording of energy shape programming gestures to magnetic tape	Application of magnetic tape as a rewritable storage medium
<i>Four Butterflies (1973)</i>	Electronic composition, LP recording	Recording of energy shape programming gestures to magnetic tape	Automation of analog signal processing
<i>Two Butterflies (1974)</i> <i>Before the Butterfly (1975)</i>	Electro-acoustic works for orchestra	Live “ghosting” of an orchestra	Real-time control over VCAs in live performance
<i>Until Spring (1976)</i>	Electronic composition, LP recording	Consolidated multitrack tape for audio and control data	Analog programming of synth patches, a precursor to MIDI
<i>Two Life Histories (1976)</i>	Electro-acoustic works for chamber ensemble	Ghost system	Real-time signal processing applied to live, acoustic instruments

From 1962 to 1976, Morton Subotnick designed and applied voltage-controlled technologies in the creation of electronic recordings, performance art, and electro-acoustic works. Out of these endeavors came the designs and processes that Subotnick applied to the ghost pieces. The first aspect of his development was the influential events that took place at the Tape Center from 1962 to 1966, which provided a backdrop for Subotnick to experiment and develop his craft. The second aspect of development discussed was Subotnick's work in New York City from 1966 to 1969, where he honed his skills with voltage-controlled synthesis and created notable electronic works. The third aspect of Subotnick's ghost works development centered around what might be called pre-ghost techniques that Subotnick applied in works from 1969 to 1976, which outline a progression of techniques leading directly to the first constructions for the ghost pieces.

The San Francisco Tape Music Center (1962 – 1966)

Morton Subotnick formed The San Francisco Tape Music Center in the summer of 1962 with Ramon Sender and Pauline Oliveros after the three of them were banished from using the San Francisco Music Conservatory for their avant-garde productions. Subotnick and the Tape Center members sought to develop new forms of creative expression, and in doing so, turned away from established trends in art and academia and pushed their artistic envelope. "The mutual thread between us," says Subotnick, "was a distinct break from the post-Webern serial tradition as we saw it at that time." This disposition led Subotnick to explore the nature of performance interaction with

electronics and live stage productions, an aspect that he continued to explore throughout his career.¹⁴

There was an emerging avant-garde art scene in San Francisco in the early-sixties, and the Tape Center was one of several venues in San Francisco at this time that provided an open environment for artistic experimentation with multiple disciplines. Performances at the Tape Center often included new electronic technologies for audio and visual productions. During the Tape Center period, Subotnick's work developed into an amalgamation of art and technology as he applied additional increasingly available techniques of electro-acoustic music to live theatre, music, and dance. From these performances, Subotnick honed his skill at recording concrete sounds to magnetic tape and connecting them to events in the production, which are techniques that became the cornerstone of Subotnick's early career. His command of the tape medium progressed from here to the ghost compositions where he applied tape as a control source.

Subotnick and the Tape Center members encountered an emerging popularity of performance art "happenings" in San Francisco during the sixties. Happenings emerged in the late fifties, in part predicated on the work of John Cage: in particular, Cage's untitled piece performed at Black Mountain College, North Carolina in 1952. This was a live performance of random events, which integrated film and image projections, recorded audio, spoken word, painting, music and dance.¹⁵ The happenings to which Subotnick was exposed in San Francisco were highly interactive, live performances

¹⁴ Roads, "Interview With Morton Subotnick," 9–10.

¹⁵ William Fetterman, *John Cage's Theatre Pieces: Notations and Public Performances* (Amsterdam: Harwood Academic, 1996), 97–105.

involving paint, film, light projections, electronics, theatre, music, and dance.

Happenings were dependent upon the spontaneity of the performers and the engagement of the audience.

Morton Subotnick occupied his own artistic space between classical music traditions, pop culture aesthetics, and avant-garde sensibilities. “I was aiming towards theatre and music,” says Subotnick, “as a big, single thing [combined], not just theatre with music.”¹⁶ Subotnick maintained this artistic trajectory through *Sound Blocks*, the *Petrarch* piece, sound designs for installations and live stage, electronic recordings, and electro-acoustic works. Technology finally caught up with Morton Subotnick three decades later, and he was able to produce interactive multimedia works on CD-ROM.

On March 9, 1963, Subotnick’s colleague, Ramon Sender, viewed a “liquid” light show performed by visual artist Elias Romero as part of *City Scale*, an all night happening event. “It was my first view of a light show with liquid projections,” Sender recalls, “and when I saw that, I said, ‘*That’s* what we need [at the Tape Center].’ Because the more we did electronic music, the more it was obvious that there was this visual aspect to a concert which was really missing—I mean there is nobody to look at playing an instrument and it was a real lack of dimension.”¹⁷ To remedy this lack of dimension, Romero and later, Anthony Martin, began producing live-motion visual projections to compliment Subotnick’s as well as other Tape Center electronic music performances. The image projections became popular and led Tape Center Lighting Designer Tony Martin to produce visual works for famous rock acts at the Fillmore West

¹⁶ Gagne, *Soundpieces* 2, 345.

¹⁷ Bernstein and Payne, “Ramon Sender and William Maginnis,” in *Tape Music Center*, 64–65.

venue in San Francisco, in which Subotnick and other Tape Center members occasionally participated. In his essay, *The Evolution of the Projected Image Light Show in San Francisco*, arts curator Robert Riley tied the projected image to electronic music: “In addition to its role within the counterculture, the poetic and determined operation of machinery and image-projections technologies of the multimedia movements formed a union of revolutionary artistic ambitions that inexorably corresponds with advances in sound amplification, magnetic tape recording, and electronic music composition.”¹⁸

As Subotnick began to broaden his compositions to include sound and lighting, he felt the need to develop new methods in technology that would allow him to compose more effectively. Subotnick was generally using the tedious process of *musique concrète* studio techniques in his works at this time. These techniques involved the labor-intensive job of splicing different recorded sounds on tape, and then recombining them in various ways to produce a final result. Subotnick also used electronic audio test components when they were available, which while interesting for their focused tone generation, were expensive and cumbersome to use. Subotnick and other electronic musicians in the early sixties searched for ways to streamline these processes. Within a few years, engineers Robert Moog (1934 – 2005) and Donald Buchla (b. 1937) mitigated this dilemma by each creating electronic music production systems using voltage-controlled technologies. Subotnick was directly responsible for working with Buchla on this new system.

Subotnick and Sender recruited engineer Donald Buchla to implement a design that would streamline the old electronic technologies and facilitate their artistic

¹⁸ Robert R. Riley, “The Evolution of the Projected Image Light Show in San Francisco,” in *Tape Music Center*, 21–23.

productions. These three men collaborated on the details of the new device.¹⁹ Buchla presented the first incarnation of the revolutionary Buchla 100 Series Modular Electronic Music System. The new Buchla systems integrated traditional electronic audio components into one convenient system and employed voltages to control the various sound-producing and sound-processing modules of the system. The Buchla components were easily patched together with a set of interchangeable cables, allowing the composer easy access to all devices from a central location. This was a far more efficient method for producing electronic compositions than with previous electronic systems. In his description of the Buchla, Subotnick writes, “I view the Buchla electronic music synthesizer as a set of flexible building blocks rather than as a musical instrument. The closest analogue to this is the symphony orchestra . . . out of which the composer would construct any group of instruments he needs, and then perform each together in order to realize his composition.”²⁰ The photo in Figure 1 shows a Buchla 200 Series Electronic Music Box.

¹⁹ Morton Subotnick, “Music As Studio Art,” in *Tape Music Center*, 114–16.

²⁰ “AES E-Library: The Use Of The Buchla Synthesizer In Musical Composition,” Morton Subotnick, AES.org, 2010, accessed May 4, 2009, <http://www.aes.org/e-lib/browse.cfm?elib=1303>.

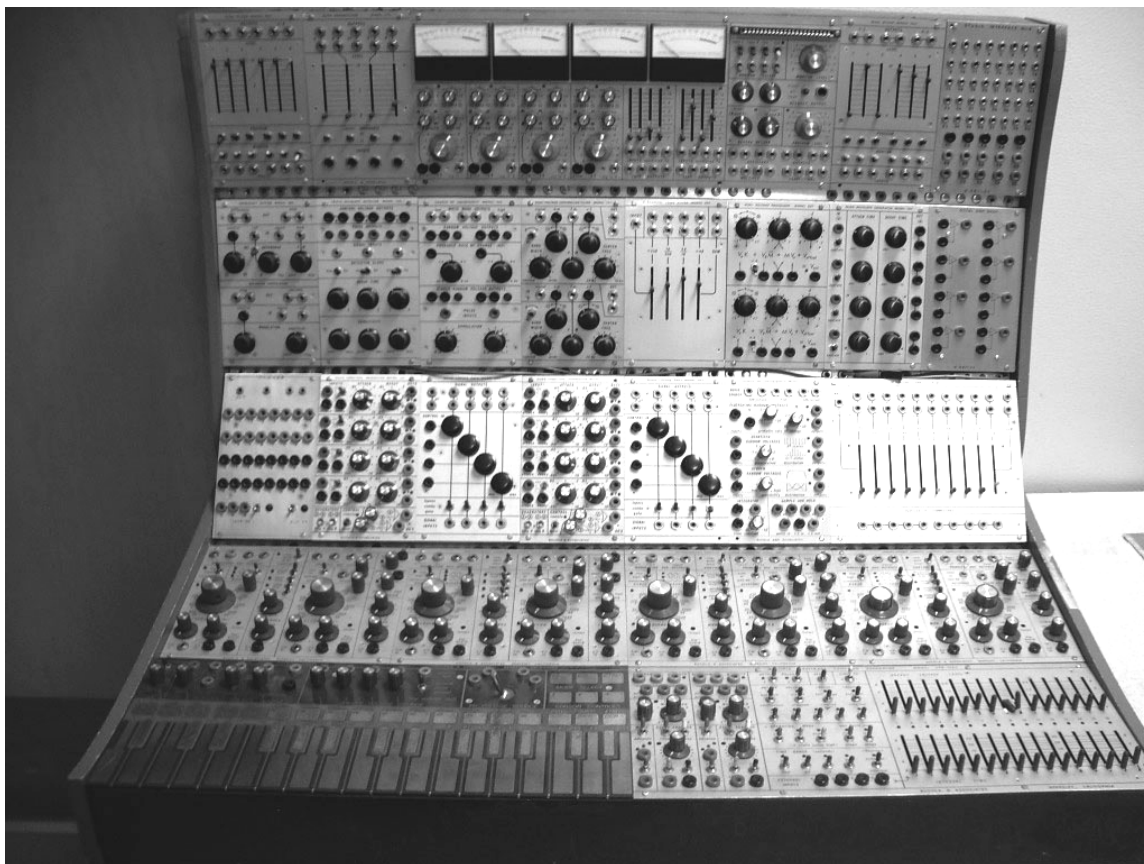


Figure 1. The Buchla 200 Series Electronic Music Box
(Photo by author. Buchla courtesy of San José State University, School of Music and Dance)

Subotnick, Sender, and Buchla were all determined to find an alternative to the tedious, time consuming work of splicing tape to produce a musical phrase of electronic tones, and Buchla's sequencer was the answer. The sequencer was a unique, groundbreaking feature of the Buchla synthesizer, which was capable of remembering an ordered sequence of control-voltages. Subotnick explains, "I thought of the sequencer as a way to rapidly assemble a series of predetermined pitches and avoid a number of tape splices."²¹ The sequencer provided Subotnick with a way to control both sound

²¹ Mark Vail, "Gallery of Vintage Gear: Buchla's First Modular System," *Keyboard Magazine* 18, no. 10 (1992): 50.

processing and electronic tone production events, which could be programmed into the sequencer, triggered according to timed events, and then heard. The Buchla 100 Series Modular Electronic Music System became the first synthesizer to incorporate sequencing capabilities. “You wouldn’t have to splice sixteen pieces of tape together if you wanted a sequence of sixteen notes,” says Buchla. “You could simply take my sequencer and set the time and the pitch for each interval. So that required, of course, a voltage-controlled oscillator and sequencer, and from then it led to a bunch of other ideas.”²² The sequencer was an important development in the history of electronic music, as it became a standard feature on all synthesizers, MIDI systems and, DAWs used today.²³

The Buchla 100 Series Modular Electronic Music System was a significant building block in the progression of Morton Subotnick’s career and greatly facilitated his work by making his studio composition process far more efficient than earlier classical electronic studio methods. Richard Friedman was a young computer engineer in the mid-sixties who became associated with Subotnick and who spent a fair amount of time working on the Buchla in Subotnick’s studio. Friedman makes the following observations:

With Don Buchla’s equipment, you just turn it on and start the sequencer, and what came out of it was incredible. You can use the sequencer for things other than note sequencing, and Mort was a master at that . . . He would create these long sequences, 10–15 minutes long . . . In contrast [to the Buchla], to make music using mainframe computers back then, you first had to conceive what you

²² Trevor Pinch and Frank Trocco, *Analog Days: The Invention And Impact Of The Moog Synthesizer* (Harvard University Press: Cambridge, MA: 2002), 39–40.

²³ Allen Strange, *Electronic Music: Systems, Techniques, And Controls* (Dubuque, IA: Brown Co., 1983), 70.

were doing in silence, then develop this device and create this type of instrument, type out the score, take the output punch-card deck to Princeton and have them run it, listen to it, and then realize maybe only two minutes of it. And they had to pay for all those computer runs, which cost thousands of dollars for just a couple of minutes of music.²⁴

Subotnick eventually cultivated a great technical proficiency on the Buchla and produced a series of notable electronic compositions in the late sixties and early seventies. The basic components of the Buchla and the techniques that he developed with this technology later became the technical underpinnings of Subotnick's ghost electronics in the seventies.

New York City (1966 – 1969)

In 1965, the San Francisco Actors Workshop moved from San Francisco to New York City to become the first resident company for the Vivian Beaumont Theatre at Lincoln Center in Manhattan. Subotnick accompanied them and became the first musical director for the theatre, a post that he held for several years. Subotnick commuted between San Francisco and New York until moving there in 1966. The majority of Subotnick's creative output in New York was an extension of his work in San Francisco with voltage-controlled synthesis, performance art, and sound design.

In 1966, Subotnick became an artist-in-residence at the Tisch School of the Arts at New York University. At NYU, Subotnick taught clarinet and was involved with their Intermedia arts program. His residency provided him with a studio workspace that included a Buchla 100 Modular Electronic Music System. Subotnick worked long hours

²⁴ Bob Gluck, "Richard Friedman" (unpublished manuscript, November 21, 2008), PDF document, 2.

in this studio creating material for what became his first two recordings of purely electronic works, *Silver Apples of the Moon* (1967) and *Wild Bull* (1968).²⁵

While Subotnick was progressing with voltage-control synthesis on the Buchla at his NYU studio, graduate music student Walter Carlos (who later became Wendy Carlos in 1972) was advancing with voltage-controlled synthesis on the Moog at Columbia University. Carlos was also disillusioned, as was Subotnick, with the emphasis on serialism prevalent in academia at that time.²⁶ Subotnick and Carlos pursued their own artistic agendas and each produced the first notable works using voltage-controlled synthesis: Subotnick's *Silver Apples of The Moon* (1967) and Carlos' *Switched-On Bach* (1968). For Subotnick, this accomplishment led to notoriety in the art music community and subsequent recording contracts for his electronics works *Wild Bull* (1968) and *Touch* (1969). "This series of [Subotnick's] compositions," states author and composer Curtis Roads, "commissioned by major recording companies, established a foothold for advanced electronic music within an otherwise conservative musical culture."²⁷ Performances with the Buchla and Moog synthesizers at major rock concert events bolstered this foothold. The Buchla was featured at the Trips Festival, January 1966, and the Moog at the Monterey Pops Festival, June 1967. These events, followed by the successful recordings of Subotnick and Carlos, had a positive effect on the popularity of the synthesizer and electronic sound, which stimulated the future development of voltage-

²⁵ Morton Subotnick, "Music As Studio Art," in *Tape Music Center*, 115.

²⁶ Pinch and Trocco, *Analog Days*, 139.

²⁷ Curtis Roads, *Morton Subotnick: Electronic Works, Volume 2*, liner notes, (New York: Mode, 2004), DVD.

controlled synthesis.²⁸ Due in large part to the accessibility of Moog's piano keyboard interface and the public's familiarity with the work of J. S. Bach, the majority of attention went to *Switched-On Bach* and the Moog synthesizer, which both became commonly identified with early synthesizers and electronic music. *Silver Apples of the Moon*, on the other hand, was an original work of serious art music, and the Buchla, on which it was created, had new and unusual ways for a performer to address the instrument. Along with the sequencer, there was an unusual touch-plate interface. With the performer's touch, this plate of small metal pads could set off multiple events and timbres, rather than a simple pitch or series of pitches common to a Moog keyboard. Hence, the work and the instrument were unfamiliar and inaccessible to the general public, receiving far less popular attention than *Switched-On Bach* and Moog. In spite of this, both *Silver Apples* and the Buchla became underground sensations of early voltage-control synthesis.

Subotnick saw the potential of the new long-play record medium and stated that "the LP record, although it lacks the spontaneity of live performance, satisfies so many of the joint needs and desires of the audience and composer that it is as close to an ideal medium for new music as the parlor was for chamber music."²⁹ Subotnick designed a listener-interaction feature for his electronic recordings "where people would not only listen, but actually *play* with the piece. I wanted *Silver Apples* to be interactive with the record players (speeds, left/right panning) so the listener could interact and get different

²⁸ Pinch and Trocco, *Analog Days*, 131–154.

²⁹ Morton Subotnick, "Extending The Stuff Music Is Made Of," *Music Educators Journal* (November, 1968): 110.

results, but the technology was unable to support these features.”³⁰ Subotnick’s 1969 recording, *Touch*, was the first quadraphonic recording of electronic music released on vinyl, and had very successful sales. Due to technical issues, quadraphonic, which was the first surround sound format, soon dwindled, forcing Subotnick and many other artists to return to the stereo format.

While Subotnick was in New York, he became the first artistic director of the Electric Circus, an experimental performance art club in East Greenwich Village. “I was associated with the ‘downtown’ scene,” says Subotnick. “I not only felt comfortable with it, but I was a part of the whole ‘McLuhanesque’ world around the Electric Circus.” Philosopher Marshall McLuhan emphasized how artists could affect technology by bringing awareness to the way the media influences the communicated message.³¹ Subotnick and his Tape Center colleagues resonated with McLuhan’s work. The Electric Circus “was not just fine art music,” recalls Subotnick, “but it was also a feeling of integrating with the public, which is one of the hallmarks of the ‘downtown’ movement. The Electric Circus followed what we had done at the Tape Center for the Fillmore West five years earlier.”³²

The Electric Circus provided Subotnick with a venue to experiment with real-time applications of his craft. Richard Friedman, Subotnick’s technician at the Electric Circus, recalls that “Mort and I made a lot of one-minute transition pieces to fill-in the space between different acts. They were really early techno pieces! I remember being totally

³⁰ “Morton Subotnick,” *Electronic Works: Volume One*, interviewed by John Schaefer (2000; New York: Mode, 2001), DVD, 04:00.

³¹ Janine Marchessault, *Marshall McLuhan: Cosmic Media* (Thousand Oaks, CA: Sage, 2005), 20.

³² Roads, “Interview With Morton Subotnick,” 11–12.

impressed with what he did. He was pretty heavy on rhythm and these were incredible pieces.”³³ Between his time spent at the Electric Circus and his studio, Subotnick perfected his techniques with voltage-controlled synthesis on the Buchla.

Pre-Ghost Techniques (1969 – 1976)

Through the development of the Buchla, and Subotnick’s growing knowledge of sequencer and touch plate complexities, the composer increased his ability to automate and improvise with voltage controls. With mainly the Buchla synthesizer, he began to create “ghost-like” designs and techniques that controlled large-scale musical events and performance.

Subotnick’s style can be attributed in large part to the degree of control that he had over the sequencer, the control surface, and the overall ingenuity of the Buchla design. The Buchla sequencer, as described earlier, was crucial to Subotnick’s programming techniques, allowing him to assemble musical phrases and automate sound parameters with precision and in rapid succession. The Buchla programmable touch-sensitive control surface (touch-plates) produced voltages corresponding to performer input in a real-time situation, yet using pre-set connections and voltages.³⁴ The touch-plates encouraged Subotnick to explore new modes of creative expression and were an essential part of his programming into the early eighties. The Buchla touch-plates were a striking hardware feature, which set the synthesizer apart from other modular systems that used standard piano-type keyboards. Sender, who was a pianist, wanted a standard

³³ Gluck, “Richard Friedman,” 2.

³⁴ “Model 112 Touch Controlled Voltage Source,” Buchla & Associates, 2010, accessed July 14, 2010, <http://www.buchla.com/historical/b100/112-touch.html>.

piano keyboard interface, but both Subotnick and Buchla, who were attempting to disassociate their design from any preconceived notions or techniques, wanted a neutral, non-traditional interface. Buchla says, “I was never tempted to build keyboards into synthesizers. To me, that was unnatural.”³⁵ The touch-plates were a prime example of Buchla’s intent. Buchla produced several models and designs of touch-sensitive control surfaces, some of which were arranged in circles, while most of them were a series of smooth metal strips adjacent to one another. Each surface or strip was tunable and could be programmed to produce pulses, triggers, or voltages proportional to the amount of finger pressure on the plate. The touch-plate in Figure 2 is the Buchla Kinesthetic Input Port Model 221.



Figure 2. Buchla Touch Plate Interface
(Photo by author. Buchla courtesy of San José State University, School of Music and Dance)

The Model 221 touch-plate has pressure-sensitive strips arranged in the manner of a two and one-half octave chromatic keyboard.³⁶ Although arranged as a chromatic piano

³⁵ Bernstein and Payne, “Don Buchla,” in *Tape Music Center*, 166–7.

³⁶ “Buchla 200 Series,” Buchla & Associates, 2010, accessed October 14, 2010, <http://www.buchla.com/historical/b200/intro.html>.

keyboard, these touch-plates were smooth metal strips, which were stationary and did not have the action of a traditional piano keyboard.

Subotnick's method of programming "energy shapes" was a principal technique applied to his work, beginning with *Touch* in 1969. By singing and grunting into a microphone, Subotnick was able to use his voice together with the touch plates to improvise dynamic musical expressions in real-time. Subotnick writes, "What I did was to 'warble' an energy shape from loud to soft."³⁷ The microphone was patched to a Buchla envelope follower. An envelope follower is a circuit or module that produces DC (direct current) control voltages proportional to the average amplitude of an audio signal.³⁸ When Subotnick made a sonic gesture with his voice, the envelope follower *followed* the amplitude or loudness of his articulations and output corresponding changes in [control] voltage, allowing him to control the amplitude of the Buchla oscillators with his voice. Subotnick developed this method for both studio and live performance applications.³⁹

For his subsequent electronic works, Subotnick developed a new method of programming by recording his energy shape gestures onto two tracks of analog tape. The recording of the gestures resulted in corresponding "control data" that was stored on tape in the form of audio frequencies. This control data is not the same as control *voltages*, which are primarily direct currents (DC) and not recordable. Magnetic tape was used

³⁷ "Subotnick," *Electronic Works: One*, 09:00.

³⁸ Dan Wyman, *Moog Modular Owner's Manual* (Los Angeles: Sound Arts, 1981), 185.

³⁹ Subotnick, *Electronic Works: Volume One*, 09:00.

only for recording audio signals, not control voltages.⁴⁰ When the recorded control data frequencies were played back into the Buchla, the signals passed through the envelope follower, which produced corresponding DC control voltages that ran the various components of the Buchla.⁴¹ When the pre-programmed tape was played back, select modules within the Buchla became automated and reacted to the programming in real-time. This procedure automated the programming of the Buchla considerably. “Then,” Subotnick says, “I could play with that until I got exactly the right melody, make it move in space, change its timbre—do all of these things *out* of real-time, even though the original performance was done *in* real-time.”⁴² These processes will be discussed further in the following chapter.

By recording his energy shape gestures to tape, Subotnick was able to create an element of “elasticity” in his work, an additional aesthetic element which complimented the otherwise mechanical nature of the sequencers. This technique was applied to his fourth composition, *Sidewinder* (1971), and imbued his work with an element of human expression. “Electronic music for me,” he writes, “was energy, just shapes of energy, like rubber band energy with things pushing and sliding, which began to solidify with *Sidewinder*, then came to fruition in 1976 with *Until Spring*.”⁴³ Following *Sidewinder*, Subotnick continued using this method of recording his energy shape gestures and

⁴⁰ Joel Naumann and James D. Wagoner, *Analog Electronic Music Techniques: In Tape, Electronic, and Voltage-Controlled Synthesizer Studios* (New York: Schirmer, 1985), 23–24, 218–19.

⁴¹ Strange, *Electronic Music*, 53–54.

⁴² Gagne, *Soundpieces 2*, 344–45.

⁴³ “Morton Subotnick and Tony Martin,” *Electronic Works: Volume Two*, (2004; New York: Mode, 2004), DVD, 44:30.

applied it to his fifth electronic work, *Four Butterflies* (1973).⁴⁴ Subotnick also applied elements of this technique in the programming of the ghost scores.

Subotnick's next piece, *Two Butterflies* (1974), was written as an electro-acoustic work for amplified orchestra of timpani, percussion, harp, and strings. The sections were divided into smaller groups, each separately miked. The strings, consisting of twelve violins, were muted and provided with contact mics, small microphones that attach directly to the instrument. The signals from the violins were fed into a box of voltage-controlled amplifiers [VCAs], which affected the dynamics of other instruments in real-time, acting as live automation. Subotnick explains:

The violins actually controlled the amplification of the different groups, so that I could blend this group with that group, and bring another group out with a pizzicato. So there were literally two compositions going on simultaneously: the "normal" composition and the amplified version that these string players were controlling. And there was this special box that was made for it, which was full of voltage-controlled amplifiers, so that the conductor could make a downbeat and there could be one violin with a pluck on the downbeat, another one making a crescendo, another one making a decrescendo—you could have three groups amplified differently as a result.⁴⁵

The box of VCAs in this piece had similarities to components in the first of the ghost boxes. Details of the ghost box contents will be explained further in Chapter Three.

Before The Butterfly (1975) was also written as an electro-acoustic work for orchestra, including timpani, three percussion, cello, and strings and seven amplified instruments. This piece incorporated the same methods used for *Two Butterflies* (where

⁴⁴ Harold W. Whipple, "Beasts and Butterflies: Morton Subotnick's Ghost Scores," *Musical Quarterly* 69, no. 3 (Summer, 1983): 432.

⁴⁵ Gagne, *Soundpieces* 2, 348.

the instruments controlled the signal processing), but called for a slightly different orchestration. The seven amplified solo instruments that were featured are trumpet, trombone, percussion, harp, violin, viola, and cello. Twelve violins with contact mics acted as control sources, which varied the output of each solo instrument in the same manner as explained above with *Two Butterflies*.⁴⁶

Until Spring (1975) was Subotnick's sixth electronic work that employs automation commands that were pre-recorded on tape to operate the signal processing components of the Buchla. This was the same process that was applied to the ghost box during the live performance of the ghost compositions. Subotnick recalls:

In 1961, I had finished a piece called *Sound Blocks*, and that was my "breakaway piece." It was very successful, and I felt that this is what I wanted to do, so I set myself a task: At some point in the next several years, I wanted to make a piece like this, but with better control over all the media. So, I started with the electronics and worked, and it took me until 1975, when I did *Until Spring*, to get the sense that I really understood what a tape piece was. The ghost pieces and all the instrumental works that have gone since are examples of my ability to deal with instruments [in this fashion].⁴⁷

Subotnick utilized eight tracks of tape for the creation of *Until Spring*, two for control data and six for recording audio. The control tracks allocated editing capabilities so that Subotnick could add or subtract any number of sounds, replace or move any event, and synchronize any sound with any other sound. For his subsequent electronic work, *A Sky of Cloudless Sulphur* (1980), Subotnick applied the same techniques using sixteen tracks of tape. He used the control tracks in both of these works to automate each

⁴⁶ Ibid.

⁴⁷ Ibid., 352.

musical event in a similar manner to the way that MIDI works, by synchronizing when an event begins (MIDI “note-on”), when the event stops (MIDI “note-off”), at what rate an event is pulsed (“quantization”), what voltage was needed to produce pitch information (pitch value 0–127), spatial positioning (“control change” messages), and duration (“attack velocity” or “aftertouch”).⁴⁸ Subotnick’s innovative processes predate the debut of the MIDI protocol by nearly a decade.

Subotnick’s energy shape programming method granted him the ability to improvise with musical parameters and record his gestures to a re-writeable storage medium, where they could be accessed on demand at any time in the future for further editing or performance. Subotnick writes:

It had to do with the idea that things like a melodic contour could be understood in terms of energy shapes. So, I reduced everything to energy shapes. There were energy melodies, which could be in the form of crescendo/diminuendo, loudness and softness, timbral changes, the location of a sound in space, and pitch changes. It was a way to organize [my] thinking. . . . You could actually have parametric counterpoint. *Until Spring* was a piece where I sort of mastered that for myself.⁴⁹

By recording his gestures to tape, Subotnick created an extremely accurate method of analog automation, where he could listen to individual sections and edit his work without affecting the rest of the composition. “The problem that I needed to solve,” Subotnick states, “was how to be able to return to the composition at a later time and re-

⁴⁸ David M. Huber & Robert E. Runstein, “MIDI and Electronic Music Technology,” *Modern Recording Techniques*, 6th ed. (San Francisco: Focal Press, 2005), 307–10; Subotnick, *Until Spring*, liner notes, 1976.

⁴⁹ Gagne, *Soundpieces* 2, 357.

structure it from a stereo composition, to a quad composition, and finally, to a multi-media composition using light controls, live performers, and twelve speakers.”⁵⁰

Subotnick funneled these designs and processes into the creation of the first ghost compositions in 1977, and developed a unique approach focused on aspects of performance and interaction. The following chapter will demonstrate how these designs and processes were implemented.

⁵⁰ “Subotnick,” *Electronic Works: One*, 09:00.

CHAPTER THREE THE SOUND OF A GHOST (1976 – 1983)

The work was originally inspired by an exhibition of Les Fauves paintings. I was left with the impression that each subject was portrayed as “normal,” but that we were seeing this subject through a strangely prismatic atmosphere in which normal expectations of color and shape would not exist. This was the visual counterpart to my “ghost” idea, i.e., a traditional musical instrument played into an unusual, a continually transforming atmosphere, in which the normal sound expectations would no longer exist. Throughout each of the works, the environment is undergoing continuous transformation; a transformation, however, dictated by the aesthetic and compositional needs of each work.

*Subotnick, describing his ghost aesthetic, in liner notes from Wild Beasts, 1981*⁵¹

Morton Subotnick’s twelve ghost compositions included works for solo instrument, duet, quartet, and small chamber orchestras. Each work featured one or two instruments that had its sound altered by Subotnick’s ghost electronics. In the case of the larger chamber works, the “ghosted” instruments were blended with the unaltered sound of the ensemble. In all cases, the sound source for the ghost electronics was provided by the acoustic sound waves produced by the featured instrument. With the help of a common sound reinforcement system, the acoustic sound produced from the instruments were “captured” by a microphone, and then sent to a box of electronic components for processing. A pre-programmed tape controlled the electronics, resulting in an additional sound texture made audible by a simple sound reinforcement system.

Sound source (acoustic instruments), sound processing (ghost box electronics), control source (ghost score/magnetic tape), and sound reinforcement (microphones, amplifiers, loudspeakers, etc.) constituted the four functional areas of Subotnick’s ghost electronics. These four areas formed a complete, electro-acoustic sound production unit.

⁵¹ Morton Subotnick, *The Wild Beasts*, liner notes, Nonesuch Records N-78012, March 1981, LP record.

This sound production unit will be referred to as the *ghost system*. Figure 3 illustrates the basic functionality of the electronic ghost system during performance, while visually delineating the four fundamental areas.

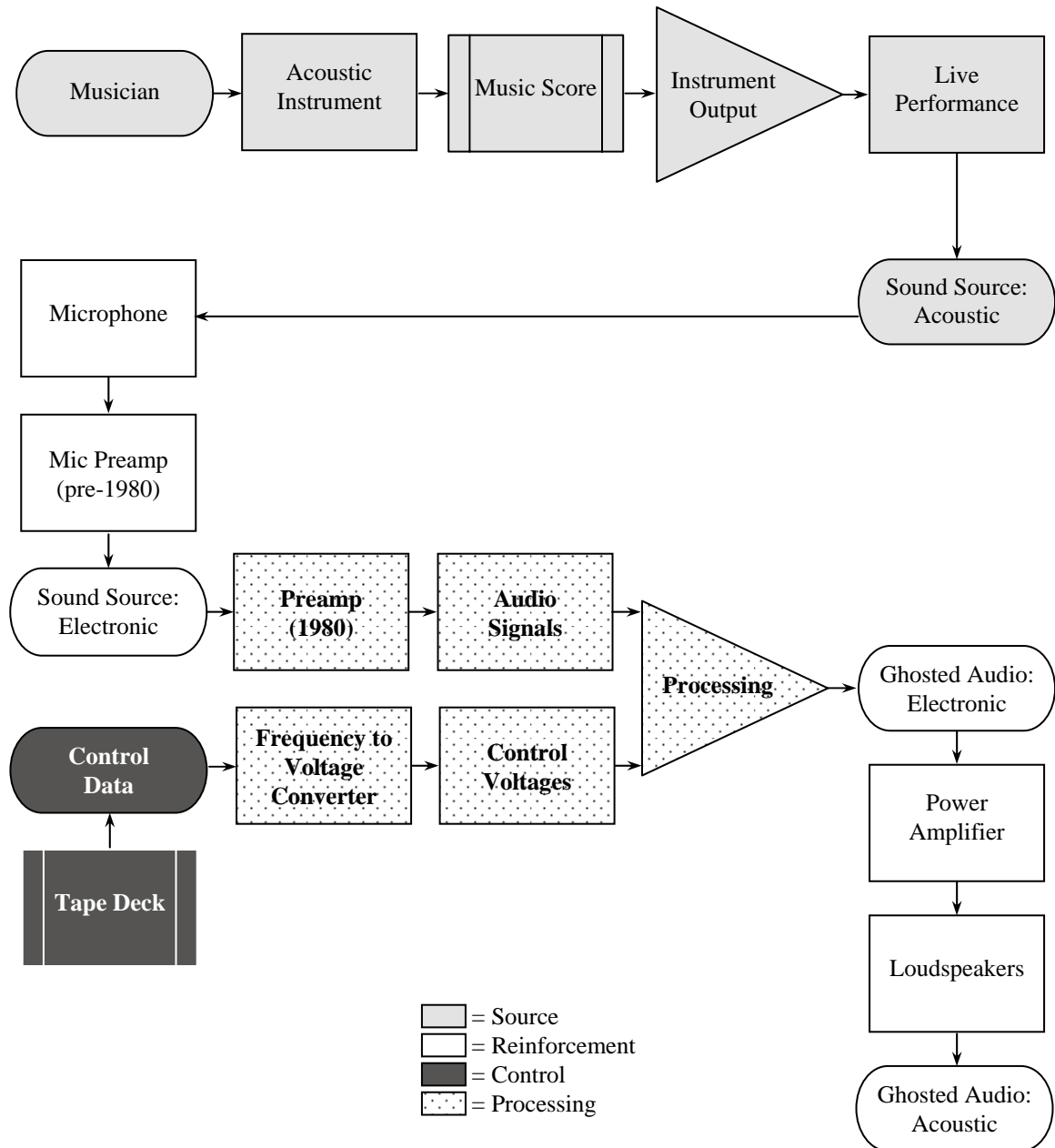


Figure 3. Ghost System Performance

Sound Source: Acoustic Instruments

The sound source for Subotnick's ghost compositions began with acoustic performance generated by acoustic musical instruments. Acoustic sound production resembles the electronic sound production systems discussed in Chapter Two, in as much as both sound production methods, electronic and acoustic, involve source, processing, control, and reinforcement, but the process of acoustic sound production is far more complex than that of electronic sound production. Elements of performer technique and capabilities, instrument design and construction, and the physical performance environment were only a few of the many details that might influence the outcome of the acoustic sound production, far too many to be covered in the scope of this discussion.⁵²

Once the acoustic sound left the instrument, as illustrated at the top of Figure 3, it was modified by the acoustics of the performance space. In the case of the ghost system, the performance space was enhanced and modified through the proximity of the instrument to the microphone. The closer the instrument was to the microphone, the less of an effect the surrounding space would have on the sound that was captured by the microphone. The type of microphone and the manner in which it was used, as discussed later in this chapter, could also color the sound that was captured.⁵³

The illustration in Figure 3 points to the acoustic musical instrument as a self-contained sound production system, an indication that the ghost works began with complex sound waves *before* they were again processed. The ghost system produced

⁵² For further information on the properties of acoustic musical instruments, see Neville Fletcher and Thomas Rossing, *The Physics of Musical Instruments* (New York: Springer, 1998).

⁵³ For further information on the physical nature of sound and acoustics, see David Huber and Robert Runstein, *Modern Recording Techniques* (San Francisco: Focal Press: 2009).

additional musical characteristics in concert with the naturally occurring complex sounds originating from the acoustic instrument. Subotnick's ghost system provided further modification and manipulation of the sound beyond the natural capabilities of the instrument and its performer.

Although the ghost works were not intended to be performed apart from their ghost electronics, each ghost piece was a stand-alone composition for acoustic instruments with traditional scores and parts using standard notation. Out of the twelve original ghost compositions, only four of these scores are available to the public. Four additional works are available from the current publisher, Schott Music Corporation, exclusively to institutions for a sliding fee.⁵⁴

Subotnick wrote custom notation for the ghost electronics directly into the music score, as if it were another instrument. He also included custom tailored performance notes to aid the musician when performing with the electronic ghost score. Figure 4 illustrates the additional elements that comprised Subotnick's music score preparation.

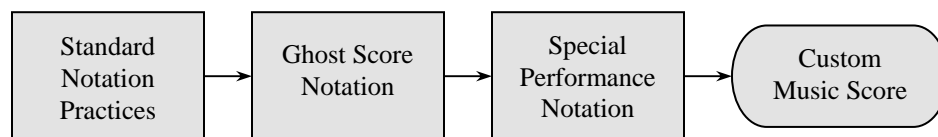


Figure 4. Music Score Elements

⁵⁴ For a complete list of currently available ghost pieces, see appendix A.

Subotnick's first four ghost compositions, *Two Life Histories*, *Liquid Strata*, *The Wild Beasts* and *Passages of the Beast* each used a simple variation of the electronic processing system indicated in Figure 3, and the same notation system shown in Figure 4. Figure 5 is an excerpt of the score for *Passages of the Beast*, written for clarinet and electronic ghost score.

Figure 5. Music Notation with Ghost Score Performance Notes
(Subotnick PASSAGES OF THE BEAST, © 1978 Schott Music Corp. All rights reserved.
Used by permission of Schott Music Corp.)

In this work, there are no key or time signatures; all accidentals are written into the part and the tempos are indicated by metronome markings at the beginning of sections. Tempo and meter were occasionally improvised in order to accommodate the rigid linear

structure of the ghost score tape. *A Fluttering of Wings*, Subotnick's tenth ghost composition, had time signatures indicated at nearly every measure, which constantly alternated between measures of nine-eight, six-eight, three-four, and four-four.

Measures were undefined and some indications may be ambiguous. Regardless, this passage shows the score with examples of Subotnick's special notation for the electronic ghost score and other instructions for the performer. Note the instructions in the middle of the second system, below the modified fermata, that indicate an F# played by the clarinet (sounding a concert E), while vocalizing a concert B into the instrument (the additional staff for voice was in treble clef). Both notes were held on one long breath, as indicated by the square fermata with an arrow, and repeated until the ghost score falls in unison with the clarinet. Similar instructions were given to the performer above the last system. These two areas allowed the performer a margin of flexibility while working with the rigid ghost score tape media, which was unforgiving as it played continuously from beginning to end. Precise ghost score timings were indicated at the beginning, below the sixth measure, and at the end of the passage. In the seventh measure, additional notes were indicated, which were produced by the electronic ghost score. Here, the clarinet and voice were in unison on a concert C-natural, while the ghost score produced a crescendo on concert A and E-natural, creating a major triad in harmony with the clarinet and voice. Additional frequency shifts in the eighth measure where the clarinet played a concert F-sharp, while the ghost score produced octave notes on concert B-natural above and below the clarinet, gradually modulating in unison with the clarinet.

Figure 6 shows the same time point in *Passages of the Beast* as seen in the music score in Figure 5, which begins at 8:15 and continues to 9:40.

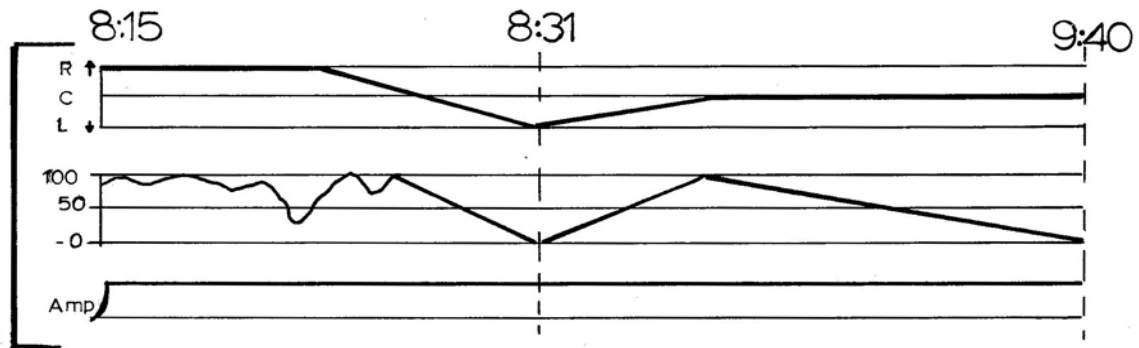


Figure 6. Electronic Ghost Score Part
(Subotnick *PASSAGES OF THE BEAST*, © 1978 Schott Music Corp. All rights reserved.
Used by permission of Schott Music Corp.)

Subotnick supplied a ghost score part for the entire piece as a guide. Subotnick explains, “I intended that this ghost score be a reference, an aid to learning, but not read during rehearsals or even during the performance.”⁵⁵ The notation for the electronic ghost score read from left to right and represented events on a timeline that indicated the timed results of signal processing events. The compositional technique demonstrated in these examples is representational of Subotnick’s notational style for all subsequent ghost compositions.

Sound Processing: Ghost Box

In the passage quoted at the beginning of this chapter, Subotnick described his aesthetic objective for the ghost works as “an unusual and continually transforming

⁵⁵ Morton Subotnick, *Passages of the Beast*, performance notes (Bryn Mawr, PA: Presser, 1978), musical score, 5.

atmosphere that affects the sound of the acoustic instruments being played and alters what the listening audience would expect to hear.”⁵⁶ During a live performance of the ghost works, this objective was realized as the audience watched musicians perform as the sound would move rapidly from side to side with unusual timbres that modulate seamlessly up and down in pitch, dynamics, or with apparently virtuosic effects.⁵⁷

The ghost boxes were designed by Donald Buchla and built by John Payne according to Subotnick’s specifications.⁵⁸ Buchla and Payne were both associated with the California Institute of the Arts, while Subotnick headed the composition department there, facilitating a close collaboration on the construction.⁵⁹ The contents of the ghost box were housed in a small black metal box measuring 4 x 8 x 16 inches with audio connections for the input and output of line-level audio signals.⁶⁰ Ghost box signal routing is indicated in Figure 7.

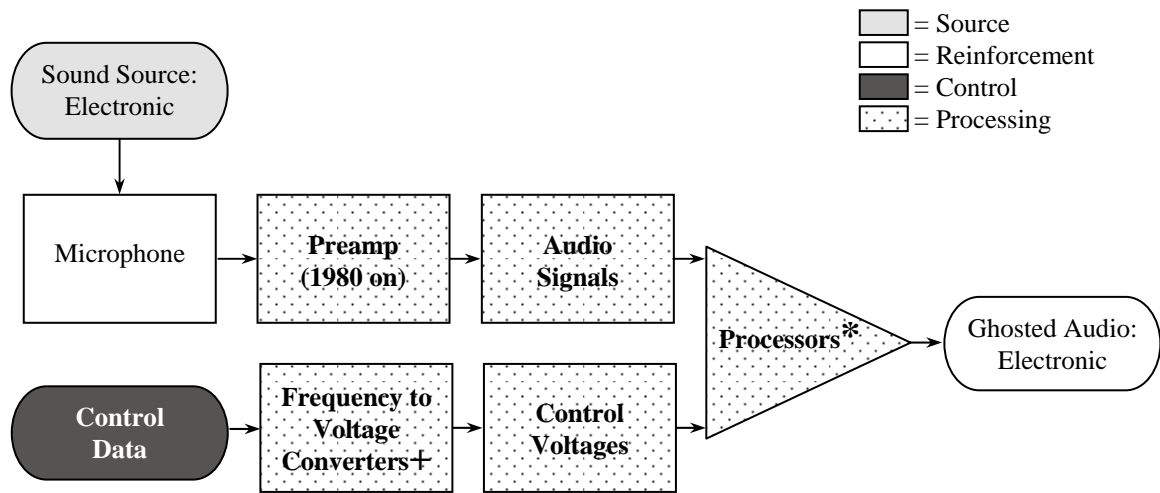
⁵⁶ Subotnick, *The Wild Beasts*.

⁵⁷ Morton Subotnick, “The Use of Computer Technology in an Interactive or ‘Real-Time’ Performance Environment,” *Contemporary Music Review* 18, part 3 (1999), 115.

⁵⁸ Morton Subotnick, *Passages of the Beast*, liner notes, Owl Recordings, Owl 30, 1978, LP record.

⁵⁹ Matrixsynth, “This Week In Synths: The First Buchla 500, Buchla 200e Rock, ARP 2500 Demo and Repair,” *Create Digital Music* (blog), May 18, 2007, <http://createdigitalmusic.com/tag/buchla/>.

⁶⁰ Subotnick, *Passages*, 5.



***PROCESSORS** (effects applied to the audible sound source audio)

- Stereo Locator: Controls the left/right spatial location
- Frequency Shifter: Creates additional frequencies above and/or below the original
- Voltage-controlled Amplifier: Controls dynamics and effects, such as tremolo

+CONVERTERS (conversion of inaudible control data audio into voltages)

- Envelope Follower: Creates corresponding voltages in response to changes in amplitude
- Frequency Follower: Creates corresponding voltages in response to changes in amplitude of prerecorded frequencies on tape

Figure 7. Original Ghost Box Signal Routing

The ghost box was modified in 1980 when microphone preamps were incorporated into the design, allowing microphones to be patched directly into the box, and omitting the need for an external preamp or mixer. The components in the ghost box worked in tandem with audio signals (control data) on tape. As mentioned, the silent “ghost” audio signals were the control data and should not be confused with the audible audio signals from the acoustic instruments. These ghost audio signals will be referred to as the *sound source*. A set of frequency-to-voltage converters inside the box translated the control data [audio] signals into voltages, so that the voltage-controlled signal processors would recognize the data. As Subotnick’s recorded gestures modulate in

volume and pitch, the followers created voltages that corresponded to these changes. Depending on how the converter units were patched, the voltages could be used to control any of the processing components.⁶¹ Once inside the ghost box, the control data and sound source audio signals worked together through the following analog sound processors: a spatial positioner, frequency shifter, and a voltage-controlled amplifier, all of which are voltage-controlled units.⁶²

The stereo location processor or spatial positioner component functioned as an automatic panning control that shifted the audio output of the ghost box between the left and right speaker channels. The example of ghost score notation shown in Figure 6 represents a panning event. The first system in this example has a bold horizontal line that indicates a modulation of the signal location that begins on the right (top of system) and shifts to the left (bottom of system) and then back to the middle (center line of system). Subotnick often used the location processor component in conjunction with the frequency shifter to produce a simultaneous change in spatial positioning and frequency. The frequency shifter component was capable of modulating the frequencies of the sound source signal up and/or down by 100 Hertz or cycles per second, producing non-harmonic tones significantly different from the original, resembling the output of a ring modulator. A ring modulator produces two frequencies that are the sum and difference of the original signal and an additional carrier frequency, while attenuating the original center frequency. If the location were to the left, the frequency would go down, and

⁶¹ Whipple, “Beasts and Butterflies,” 432–35.

⁶² To avoid confusion with the many other types of amplifiers, the ghost box amplifier component is always referred to as a *voltage-controlled* amplifier or VCA, and not simply as an “amplifier.”

conversely, when the signal was on the right, the pitch was pushed up to a higher frequency. If the location processor were set to the middle, all three tones would be produced simultaneously, the original plus the up and down shifted tones. The results of the frequency shifter and location processors are indicated by the arrows at the far left of the first system in Figure 6, which show the direction of frequency shift, either “R↑” which indicates up and to the right, or “L↓” which indicates down and to the left. The second system in Figure 6 represents the amount of frequency shift indicated by a solid horizontal line that reads from left to right and varies from zero, at the bottom of the system, to 100Hz at the top of system.

The voltage-controlled amplifier (VCA) controlled the amount of signal gain or volume that was produced by the ghost box and sent to the power amplifier and loudspeakers. This component is represented in Figure 6 by the third system labeled “Amp.” When no action was occurring with dynamics, the VCA, also known as a “gate,” opened fully to allow the full amount of the signal to pass. This process was first indicated by the quick up-turn of the bold line to the full up or open position, followed by a steady horizontal line throughout the rest of the phrase.

Fluctuations in dynamics created by the performer were usually written directly into the ghost music score and were indicated by standard dynamics markings. The excerpt of electronic ghost score notation in Figure 8 indicates an unusual control of dynamics using the voltage-controlled amplifier to produce rapid fluctuations of amplitude (volume) to create a tremolo effect.

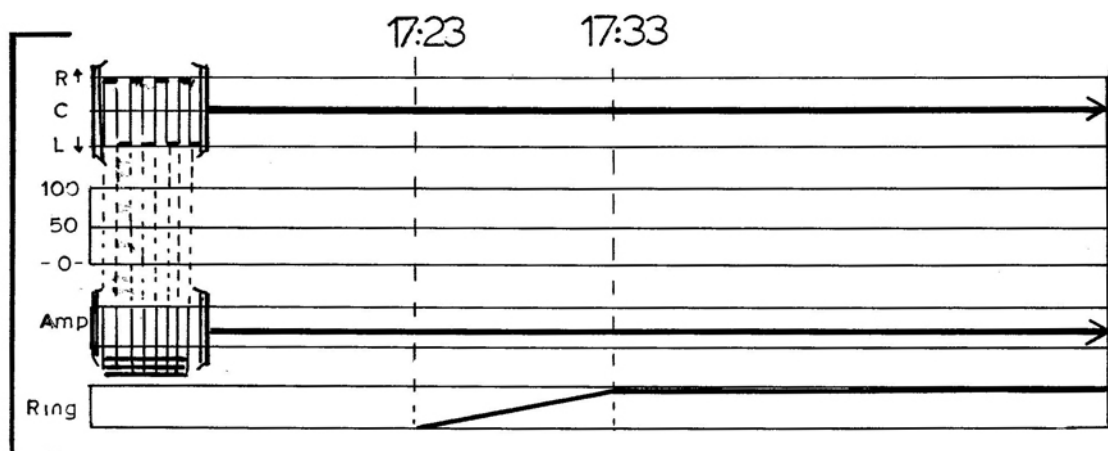


Figure 8. Electronic Ghost Score Notation of Signal Modulation
 (Subotnick PASSAGES OF THE BEAST, © 1978 Schott Music Corp. All rights reserved.
 Used by permission of Schott Music Corp.)

In this example, the top three systems indicate that the spatial positioner, frequency shifter, and voltage-controlled amplifier were working together to produce a simultaneous trio of effects with the rapid left-right shifting, frequency modulations, and on-off pulsing of volume. These actions were indicated by the grouping of 32nd notes on the far left of the third system that extended upward to include the first and second systems, the spatial positioner and frequency shifter, respectively.

The fourth system in Figure 8 labeled “Ring” represents the activity of the frequency shifter that was controlled by the voltage from the envelope follower. In this example, no action occurred until 17:23 where the upward direction of a bold line indicated the gradual activation of the frequency modulation. The “ring” effect was fully activated when the line reached the full-on position (top of fourth system) at 17:33, and then continued at that setting until the end of the phrase.

Control Source: Ghost Score

The arduous task of dealing with tape splicing and editing was an incentive for Subotnick, Sender, Buchla, as well as Robert Moog to develop the voltage-controlled synthesizer and the analog sequencer. The sequencer streamlined the sound synthesis process because it allowed for the linear ordering of electronic sonic events in time to create musical phrases. Subotnick took this idea a step further by implementing magnetic tape as a way of programming the sonic events for an entire composition. The concept of using tape for artistic purposes beyond normal playback was unusual, but not completely new. Edgard Varèse incorporated a fifteen-track tape to manipulate audio location, lighting and visual effects for the original installation of *Poème électronique* at the Brussels World's Fair of 1958.⁶³ In 1971, Subotnick used magnetic tape as a positional control source for his electronic work, *Sidewinder*, and then continued to apply the technique to his works during the next ten years, including the ghost compositions.

Subotnick's ghost score was the silent control data programmed on tape that "played" the sound processing components (see Figures 6 and 7). The preparation of the electronic ghost score tape began with Subotnick's "energy shape" gestures mentioned in Chapter Two where Subotnick used the Buchla touch-plates and also his voice, which was linked to special envelope followers, to perform musical gestures in real-time. Subotnick described his energy shape programming process as such: "Using my voice and two or three fingers on each hand, I'd end up with four or five energy shapes simultaneously. These were recorded using sine tones frequencies and filters so that

⁶³ Barry Schrader, *Introduction to Electro-Acoustic Music*, (Englewood Cliffs, NJ: Prentice Hall), 1982. 105.

they'd be different pitches on a single track of two tracks.”⁶⁴ The envelope followers were a crucial part of the ghost scoring process because they allowed Subotnick to translate the sound of his voice into control voltages. The illustration in Figure 9 depicts control track preparation.

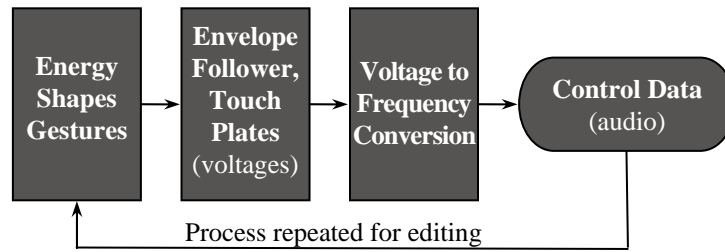


Figure 9. Electronic Ghost Score: Preparation

Notice that these gestures were not recorded directly to tape as voltages, since direct current (DC) voltages could not be represented on tape. Instead, the voltages passed through voltage-to-frequency converters, from DC to AC (alternating current), producing high frequency audio signals, which were then recorded onto a two-channel, quarter-inch magnetic tape as control data audio signals.⁶⁵ “I might have a vocal on one track,” Subotnick explains, “and then I would be controlling oscillators through a comb filter so I could get three different pitches with my three fingers using touch-plate sensors. This way, I might end up with four sets of control voltages on two tracks of tape.”⁶⁶ The “comb” filter that Subotnick mentions above is an audio filtering device that can be adjusted to filter out bands of frequencies, leaving the remainder as several narrow frequency bands graphically resembling the teeth of a comb.

⁶⁴ Gagne, *Soundpieces* 2, 345.

⁶⁵ Whipple, “Beasts and Butterflies,” *Musical Quarterly*, 433.

⁶⁶ Bill Murphy, “Morton Subotnick: Synthologist,” *Remix* 9, no. 7 (July 2007): 98.

After the initial real-time recording of his energy shape gestures, Subotnick spliced the control tape into individual phrases with blank leader tape sections inserted between each phrase so that he could listen to each gesture individually, out of real-time, and make necessary corrections and edits. As indicated above in Figure 9, Subotnick repeated this programming process with each section, until he was satisfied with the results. Once the editing was finished, the blank sections of leader tape were removed, leaving the completed work of control tracks, and the ghost score was ready for performance.⁶⁷

During performance, the control data audiotape was played on a reel-to-reel tape deck from the beginning and throughout the performance. As was described in the previous section, the line-level output signals from the tape deck were routed into frequency-to-voltage converters inside the ghost box that converted the control data audio frequencies back into voltages. The voltages ran the various voltage-controlled components and affected the incoming sound source audio signals in real-time (see Figure 7).

In the early 1980s, the ghost score process and box were updated from analog magnetic tape to a digital EPROM system. EPROM (also referred to as PROM) stands for electronic, programmable, read-only memory, which were small, two-inch square memory cards that were read by a card reader inside the ghost box. The EPROM card was capable of holding twenty-four instrument definitions, twenty-four wave-shape

⁶⁷ Subotnick, *Electronic Works: One*, 09:00.

tables, and four tuning tables.⁶⁸ When an EPROM card was inserted into the ghost box, the onboard computer would, on demand, run through the pre-programmed sequence of digital control data for that particular ghost piece. The digital control data output from the EPROM card reader was sent to internal digital-to-analog converters, which generated the voltages necessary to run the voltage-controlled processing components in the ghost box. The control data on the EPROM cards were divided into ten preset locations. This new feature improved the rehearsal process by allowing performers to step through the different sections of the work, instead of having to locate points on one continuous length of tape, which was a tedious and time-consuming process. The new EPROM system also allowed the performer to synchronize rehearsals and performances with the ghost box without the use of a stopwatch. The Buchla 400 Electronic Musical Instrument was used in the programming process of the EPROM cards.⁶⁹ The primary component of the EPROM system was the Z80 microprocessor.⁷⁰ The Z80 was an 8-bit CPU that had a relatively low cost, reliable chip for information technologies at that time.⁷¹

These updates to the ghost electronics streamlined Subotnick's programming of control data for the original set of ghost compositions composed from 1976 to 1983. After this point, Subotnick continued using the EPROM system for subsequent

⁶⁸ "Buchla 400: Electronic Musical Instrument," Buchla & Associates, 2010, accessed September 29, 2010, <http://www.buchla.com/historical/b400/>.

⁶⁹ Morton Subotnick, *Ascent Into Air/ A Fluttering of Wings*, liner notes Nonesuch 78020-1, 1981, LP record.

⁷⁰ Morton Subotnick, *A Fluttering of Wings*, technical description (Bryn Mawr, PA: Presser, 1982), musical score.

⁷¹ "Z80 Microprocessor," ToolBox.com, 1998–2010, accessed April 23, 2008, http://it.toolbox.com/wiki/index.php/Z80_Microprocessor.

performances of the ghost works until the early nineties when the ghost score process and box were updated once more from the EPROM system to the interactive music and multimedia software program MAX/MSP, which is the system Subotnick currently uses to create the ghost sound processing for his performances of the original ghost works, as well as new ghost pieces composed after 2007. MAX is an extremely flexible, adaptable graphical programming language originally designed in the mid-1980s by Miller Puckette for creating interactive compositions.⁷² MAX is currently maintained by and made commercially available from Cycling 74.⁷³

Sound Management: Audio System

Unlike traditional musical instruments that generate and amplify acoustic sounds on their own accord, electronic sound production, musical instruments, and signal processing depend on some form of amplification or reinforcement to make their sounds audible. Subotnick's ghost works were no exception as they involved electronic signal processing, the effects of which required amplification to be heard in performance. For the ghost system to function properly, it was necessary for the sound of the acoustic instruments to be captured and converted into electronic audio signals so that they may be combined with the electronics. This process was accomplished with a simple sound reinforcement system consisting of a microphone or pickup, preamp, mixer, amplifier, and loudspeakers.

⁷² Todd Winkler, *Composing Interactive Music: Techniques and Ideas Using MAX* (MIT Press: Cambridge, MA, 1998), x.

⁷³ For more information on MAX, visit Cycling 74 at: <http://cycling74.com>.

An audio system such as this is essential to electronic music production and was a necessary component at every live performance of the ghost works. For Subotnick's ghost work performances to proceed without difficulty, the issue of feedback would have to be taken into consideration. The loud, screeching sound of feedback results when an audio system amplifies audible output to the proximity of microphones to the front of the loudspeakers and is a potential problem with most audio systems, especially those that involve acoustic instruments and the use of microphones. It was imperative for Subotnick to take great care in deciding the set up and location of the acoustic instrument or instruments, as well as the placement of the microphones on the featured ghosted instrument relative to the location of the loudspeakers in order to avoid potential feedback, while also considering how musicians would be able to hear themselves and each other. Subotnick had to be aware of placing microphones, and the subjects that he was miking, behind the loudspeakers and far enough upstage to avoid potential feedback. By using proper miking techniques, Subotnick could increase the ratio of the captured sound to other unwanted sounds occurring in the performance space, reducing the possibility of feedback, and allowing for the best possible ghosting of the featured instruments.

In addition to proper arrangement of the instruments and placement of the audio equipment, microphone selection can significantly influence the quality of the captured sound and the potential for feedback. The acute sensitivity of most condenser microphones is likely to produce a more well-defined sound than the generally less sensitive dynamic microphone, but is more likely to cause feedback. A pickup is a small

device that accomplishes what a microphone does, but with a greatly reduced likelihood of feedback. Pickups are attached directly to an instrument, which frees the musician from having to maintain a close proximity of their instrument to a microphone, and it produces a consistent capture of sound. The author witnessed the use pickups at a live performance of Subotnick's ghost piece, *A Fluttering of Wings* at Mills College in Oakland, California on February 27, 2010. Each ghosted instrument of the string quartet was fitted with a pickup, while a four-speaker audio system was used to reproduce the ghosting effects of the captured audio. The performance was successful as every nuance of the ghosting effects could clearly be heard while there was absolutely no hint of feedback.

The use of space was, and still is, a critical issue for Subotnick in the performance of his works. He has experimented with various loudspeaker setups using two-to-eight speaker systems to create a sense of space. The author attended a live concert performance of *Until Spring* at Stanford University in the fall of 2005 where Subotnick used an octophonic (eight-speaker) audio system to present his piece. A typical sound reinforcement system has two loudspeakers placed at the foot of the stage, one on each side, facing the audience. For the early performances of his first ghost piece, *Two Life Histories* (1976), Subotnick used a four-speaker audio system with two additional speakers behind the audience to create a three dimensional aesthetic of sound. This configuration did not suit Subotnick's vision that he had for the ghost compositions and at some point in the early 1980s, he returned to the standard two-speaker system. Subotnick explains:

Since then, I've moved to the proscenium [two speakers] again. And it has to do with content. I would never use surround sound with a dancer on the stage, because the focus should be to the dancer and behind [them], but never behind you; that dancer should be the edge of the universe in some way. . . . With a symphony orchestra or a string quartet, the chamber group should always be the focus. I've coined the term "a theater of sound," and these people, the chamber musicians in the pieces I do for them, are the "Ophelias" on the stage. The music should never diminish them; it should always make them bigger than life, not smaller than life.⁷⁴

Another critical issue for Subotnick in the performance of the ghost scores has been his ability to maintain the proper balance between the acoustic instruments and the electronics, which proved to be acoustically and aesthetically problematic. When the featured instruments were properly miked and the ghost system electronics were functioning correctly, the ideal sound produced from the loudspeakers would be one hundred percent ghosted audio, with the exception of *Parallel Lines* and *After the Butterfly*, which called for additional non-ghosted instruments. However, this was not always the case, as Subotnick explains:

My vision of it is that we hear a single sound and that we don't know the difference. My guess, from what I've heard, is that the musicians want to be heard. They don't have the idea that they are being heard; they have the idea that they're *not* being heard as they are playing and they want to get "out front." I think that, for a while there anyway, that the electronics were acting as a backdrop, rather than as a part of the fabric; I had imagined the ghost pieces as a fabric.⁷⁵

⁷⁴ Gagne, *Soundpieces* 2, 346.

⁷⁵ *Ibid.*, 347.

The use of an audio system to blend traditional acoustic instruments with electronics, including the effective placement of musicians, microphones, and loudspeakers, is an art unto itself, which when done correctly can greatly enhance the outcome of the performance. Loudspeakers are acoustic audio devices and subject to many of the same acoustic principles that affect the sound characteristics of musical instruments, including the quality and construction of materials, as well as the characteristics of the acoustic space in which they are placed. Subotnick had to make adjustments for these principles, just as a conductor would with any ensemble, in order to create the optimal blend between instruments, electronics, and the acoustics of the performance space.

CHAPTER FOUR

GHOST WORKS (1976 – 1983)

Morton Subotnick's ghost compositions bring music composition, acoustic instruments, and analog electronic music technologies together in a live performance environment. Chapter Four identifies key elements for each composition, beginning with the full title of each piece, the approximate date the work was composed, the orchestration, and whether any text or concept is relevant to the piece. The orchestrations state the acoustic instruments for which each piece was written and identify the ghosted and non-ghosted instruments.

Finally, there is a detailed description of the premiere performance(s) of each work, which covers the known date of performance, the location, venue, and any events with which the performance may be associated. Additional information in this chapter includes any known commissions for that work, the featured artists (usually performing on the ghosted instrument), conductors, recordings, and critical reviews.

With few exceptions, the premiere performances of Subotnick's ghost compositions were fairly well received by critics. Most of these performances took place in Los Angeles and the surrounding area, with a few exceptions of performances in New York, San Francisco, and Washington, DC. As it is in most cases, the outcome of a live performance is subject to many variables and depends not only on the compositions and the performers, but also the performance environment, the programming choices, the nature of the attendees, and other factors. In reviewing the accounts of the Subotnick's ghost premieres, it is evident that these factors may have affected the performance and

review of the works. Ten of the twelve compositions were commissioned by artists or a group of artists that ultimately performed the work. Subotnick had several notable performers and conductors perform his pieces, including vocalist Joan La Barbara, the Juilliard String Quartet, and conductor Michael Tilson Thomas.

Two Life Histories

The first of Subotnick's ghost works is *Two Life Histories (A Melodrama): For Bb Clarinet and Voice with "Ghost Electronics."* Composed in 1976, it was orchestrated for Bb clarinet, tenor voice, and ghost electronics. Both the clarinet and the tenor voice were ghosted in this piece. The text included in "Life History One" took quotes from *Butterflies and Moths*, and "Life History Two" took passages from Greek mythology and the Old Testament.⁷⁶

The concept of this piece is a melodrama in which "Life History One" chronicles the development of butterflies and moths from egg to adult. "Life History Two" juxtaposes the myths of the Greek goddess Psyche and the plight of the Israelites in the Old Testament with the symbol of the butterfly emerging into the light from its dark cocoon.⁷⁷

Two Life Histories originally premiered for Cal Arts at the Vanguard on November 12, 1976, at the Theatre Vanguard in West Hollywood, California. Featured artists included Marvin Hayes, tenor voice and Morton Subotnick, clarinet. Los Angeles

⁷⁶ For more information, see *Butterflies and Moths: A Guide to the More Common American Species*, by Robert T. Mitchell and Herbert S. Zim, (New York: Golden Press, 1977).

⁷⁷ Morton Subotnick, *Two Life Histories*, performance notes (Bryn Mawr, PA: Presser, 1982), musical score.

Times staff writer Daniel Cariaga reviewed the Theater Vanguard performance of *Two Life Histories*. He writes,

Subotnick's ghost piece for clarinet is the promised first installment in a series to be called "Life Histories." Once again, the composer is concerned with the world of nature and insects and with the subtle electronic alteration of instrumental reality. The first ghost piece used textbook words spoken and intoned by the baritone Marvin Hayes, the live clarinet as played by the composer, and unpredictable tampering from the preprogrammed electronics. The effect, in 15 short minutes, is poetic and convincing.⁷⁸

Two Life Histories was subsequently performed on June 10, 1978, at USC Bing Theatre at the University of Southern California, Los Angeles. Featured artists included Marvin Hayes, tenor voice, and Morton Subotnick, clarinet. Walter Arlen of the Los Angeles Times reviewed the USC Bing Theatre performance, and writes,

These performances mark the first time the composer has performed on clarinet since deciding to forgo his involvement with performance in the mid-sixties and focus on music composition. As it turned out, he has not lost his professionalism. . . . He calls it a ghost piece because it includes a "ghost score" on tape, which controls the electronics as sound emerges from two loudspeakers. The effects on the narration (which deals with the life history of the butterfly, a Subotnick specialty) and on the clarinet (which contributes cantilena-like phrases) are often engaging. Conciseness was an added dividend.⁷⁹

⁷⁸ Daniel Cariaga, "Cal Arts Camaraderie at Vanguard," Music Review, *Los Angeles Times*, sec. IV, November 15, 1976.

⁷⁹ Walter Arlen, "Subotnick, Stein, Krosnick at USC," *Los Angeles Times*, sec. IV, June 13, 1978.

Liquid Strata

Liquid Strata: For Solo Piano and "Ghost Electronics" is the second ghost piece by Subotnick. It was commissioned by Ralph Grierson and composed in the same year as Subotnick's first ghost work. It was orchestrated for piano and ghost electronics. The text in *Liquid Strata* appears at the beginning, when the pianist recites quotes from Isaac Newton regarding motion and inertia. Subotnick writes, "Liquid Strata is a romantic, poetic response to the profound scientific insights about fundamental realities of nature as enunciated by Newton."⁸⁰

The premiere performance of *Liquid Strata* was on May 1977 during the Ojai Music Festival at the Festival Bowl in Ojai, California. Ralph Grierson was the featured artist on piano. In his article "Beasts and Butterflies," Harold Whipple discusses details of the work. Whipple writes,

Liquid Strata itself is concerned with a transition from rest to motion and of the energy expended. The first section is static, comparatively quiet, conventionally harmonic and melodic, and represents the body at rest; it also contains the Newtonian quotes and a deep, moaning sound produced by stroking the low piano strings inside the instrument. The second section is a representation of the energy expended to overcome the inertia, to set the body into motion. . . . The third section, which follows without a pause, is a virtuosic display in the Romantic tradition . . . with sections of previously heard material, forearm clusters, fanfare-like patterns, and new material. This violent climax fades into a perpetual-motion figure—delicate, regular, and tonal at first, then becoming less traditional at the end.⁸¹

⁸⁰ Whipple, "Beasts and Butterflies," 435.

⁸¹ Ibid., 435–37.

Los Angeles Times music critic, Daniel Cariaga commented on Ralph Grierson's performance of *Liquid Strata*. He writes,

Subotnick's latest "ghost" piece may be the most effective in the series. Twenty-seven minutes in length, this canvas is in three parts: a fantasy, a toccata and a postlude. Each demands from the solo pianist extreme digital control and concentration. The tape, whether one considers it distortion or enhancement—and in actuality it is both—is the strongest unifying element here, yet it is subordinate to the composer's vision of the total. The toccata—fast, furious and as exciting as a fistfight—is the focal point, but the real sonic messages of the piece are contained in the silence-dotted outer sections. Grierson, as is his habit, performed with abundant sympathy for the music, plus enormous technical efficiency. The composer was present to acknowledge a positive audience response.⁸²

The premiere performance of *Liquid Strata* at the Ojai Music Festival was recorded by Town Hall Records in 1979. David Moore, music critic for the American Record Guide, reviewed the recording of the *Liquid Strata* premiere. Moore gave a mixed, but fairly positive review citing the sense of composition within the piece between electronic "distortions" and "the actual piano sound" against which Ralph Grierson was playing. Moore writes, "The effects break up the sound in many different ways, though the result always includes the actual piano sound to play the distortions against. At 25 minutes, it gets a little slow sometimes, but there are some interesting things going on. Electronics-lovers may like this disc better than pianists, but there's a lot of food for

⁸² Daniel Cariaga, "A Quiet Elegance at Ojai," Music, Calendar, *Los Angeles Times*, June 12, 1977.

thought and the ears, though there's more grunting from the performer than is strictly desirable.”⁸³

Liquid Strata was subsequently performed on November 14, 1977, during Monday Evening Concerts at the Bing Theatre of the Los Angeles County Museum of Art in Los Angeles, California. Ralph Grierson was featured on piano. Los Angeles Times music critic Daniel Cariaga writes about the Bing Theatre performance:

Morton Subotnick's *Liquid Strata*, one of the hits of the 1977 Ojai Festival, came to town this week. . . . In Ojai last spring, on a balmy, sunny afternoon, surrounded by other sensitive souls, one savored the alternatively dramatic and meditative qualities of *Liquid Strata*. . . . But, sitting in dimly lit Bing Theater in an audience, which after 10 o'clock began to shrink rapidly, one felt that some of the thrill was gone. This is no serious reflection on either Subotnick's conception or Grierson's performance. Both remain strong and engage the listener directly for a 27-minute period, which seems brief, and both can survive surroundings that are less than festive.⁸⁴

A later performance of *Liquid Strata* was given on December 1982 for the New York League of Composers in New York City. Aleck Karis was featured on piano at this venue. In response to this performance, New York Times music critic Tim Page writes,

“The [ghost] score is an artificially generated audio environment reactive to the sounds of the piano. *Liquid Strata* is a dazzling and virtuosic workout that demands neo-Lisztian heroics from the pianist. Aleck Karis, who preceded his performance with a witty demonstration of

⁸³ David Moore, “The Demented Keyboard,” *American Record Guide* 61:5 (September-October, 1998): 259.

⁸⁴ Daniel Cariaga, “Grierson Plays Subotnick at Bing,” Music Review, *Los Angeles Times*, sec. IV, November 16, 1977.

Mr. Subotnick's extra-musical innovations, was completely convincing.⁸⁵

The Wild Beasts

Subotnick's third ghost score is entitled *The Wild Beasts: For Piano, Trombone, and "Ghost Electronics."* It was commissioned by Miles Anderson and Virko Baley and composed in 1978 for piano, trombone, and ghost electronics, as indicated in the title. Both the piano and trombone were ghosted. *The Wild Beast* is the first of a series of works incorporating the word "beasts" in the title. Subotnick's inspiration for *The Wild Beasts* came from the works of *Les Fauves* (The Wild Beasts), a small group of French painters from the early twentieth century. He draws an analogy between these paintings, as the visual component, and his piece. *The Wild Beast*, as the aural component of an altered state of perception. In this altered state, one perceives the subject not as it truly is, but with discolorations due to an unusual state of the atmosphere that alters light and sound. As a result, it is not the subject that is altered, but the observer's perception of it. Hence, the ghost electronics are providing the "aural atmosphere." This atmosphere alters one's aural perception of the traditional acoustic instrument or the unaltered subject.⁸⁶

The Wild Beasts premiered on April 4, 1978, for the Contemporary Music Festival, California Institute of the Arts at Roy O. Disney Hall in Valencia, California.

⁸⁵ Tim Page, "League of Composers Offers Electronic Concert," Music, *New York Times*, Late Edition—East Coast, sec. C, December 13, 1982.

⁸⁶ "Morton Subotnick: Program and Technical Notes," Morton Subotnick, MortonSubotnick.com, March 2010, accessed June 20, 2010, <http://www.mortonsubotnick.com/program.html>.

Miles Anderson and Virko Baley were featured on trombone and piano, respectively for this performance. Los Angeles Times writer Ara Guzelimian offers a review:

“*Wild Beasts*, scored for trombone and piano, begins with a calm enough landscape, eventually rises to extraordinary outbursts from both instruments and finally subsides as if breathless and exhausted. It is a wildly imaginative piece, full of a primal energy and pushing both players to dazzling extremes. The performance by Miles Anderson and Virko Baley was spectacularly virtuosic.”⁸⁷

The Wild Beasts was subsequently performed on February 20, 1979, at the Schoenberg Institute in Los Angeles. Miles Anderson and Virko Baley were again featured. In response to this performance, Los Angeles Times writer John Henken comments, “The [ghost] technique can produce some drastic effects, but *The Wild Beasts* suffers from gross redundancy.”⁸⁸

The Wild Beasts was recorded in March 1981 at Evergreen Studios in Burbank, California for Elektra/Asylum/Nonesuch Records, and published in 1981 on audiocassette. Miles Anderson and Virko Baley, the original artists, were again featured in this recording. Roger Mayer was the Chief Engineer, and Mike Hatcher and Steve Burger were the Assistant Engineers. In response to this recording, Subotnick writes,

Take, for example, the opening trombone solo. With the whisper mute, the trombone sounds distant and dry . . . but this sound is caught in short bursts of amplification which zigzag in an unpredictable pattern across the proscenium space of stereo speakers. If we skip to the piano cadenza towards the end of the work, we find that the atmosphere has changed . . . now the piano seems to be in a dense, undulating liquid atmosphere which caused the sound to

⁸⁷ Ara Guzelimian, “Contemporary Cal Arts Festival,” Music Review, *Los Angeles Times*, Calendar, April 4, 1978.

⁸⁸ John Henken, “Miles Anderson on the Trombone,” *Los Angeles Times*, part IV, February 22, 1979.

continually shift in pitch, first of one side of the space and then on the other.⁸⁹

Passages of the Beast

Passages of the Beast: For Solo Bb Clarinet and "Ghost Electronics" is the fourth ghost work, and was composed in 1978 for clarinet and ghost electronics.

Subotnick explains the concept of the piece:

The title, *Passages of the Beast*, refers to the rites of passage, of beast-ness to humanness, the passion of the beast and human awareness joined. The clarinet is treated as both a very old instrument (through a series of invented fingerings to get some of the non-diatonic qualities back into the technique) and a modern instrument, paralleling, more or less, the transition or passages from beast to human. The almost programmatic quality of the work is in keeping with the mainstream of my work for more than a decade. *Passages*, in particular, deals metaphorically with the evolution of the human spirit, and was one of a group of works which led up to the final (as of this writing) piece in the series, *The Double Life of Amphibians*, a ninety minute staged tone poem which received its world premiere at the 1984 Olympics Arts Festival in Los Angeles.⁹⁰

Passages of the Beast was commissioned by the International Clarinet Society and represents the first major clarinet composition commissioned by this group. Featured artist Ramon Kireilis comments,

The title, *Passages of the Beast*, refers to the recent version of the Butterfly metaphor Mr. Subotnick has been working with for several years. In the case of the beast pieces, the emergence of the butterfly is seen as the struggle of emergence of "beast-ness" and "humanness." The emergence of "beast-ness" is the emergence of passion,

⁸⁹ "Program and Technical Notes," MortonSubotnick.com, accessed June 24, 2010.

⁹⁰ Subotnick, *Passages*, liner notes.

pain, and joy. Movements are titled “Before Dawn,” “Awakening,” “Night Song,” and “Dance of Emergence.” The clarinet solo itself is in two parts: Part one is the awakening of the beast . . . starting with clicking sounds and distant echoes of calls and wails . . . this moves into a faster section which results in a loud “moan-cry.” Part two starts softly, again with a more melodic and more “musical” material than the start of the first part . . . this also moves into a fast section ending with a dance of staccato notes . . . almost mid-eastern in quality.⁹¹

Passages of the Beast premiered on August 10, 1978, for the International Clarinet Clinic at the University of Toronto. Ramon Kireilis was the featured artist on clarinet.⁹² This piece was recorded for Owl Records, and originally distributed by Starkland.

Parallel Lines

Subotnick’s fifth ghost piece is entitled *Parallel Lines: For Solo Piccolo with “Ghost Electronics” and Nine Players*. It was composed in 1978, commissioned by Lawrence Trott and the International Piccolo Society. The orchestration included piccolo and ghost electronics with a nine-piece chamber orchestra consisting of oboe, English horn, Bb clarinet, bass clarinet, C trumpet, trombone, harp, viola, cello, percussion (2): glockenspiel, vibraphone, xylophone, marimba, timpani, snare drum, sizzle cymbal, bongo, tam-tam, chimes, bass drum, and antique cymbal. The piccolo was the only ghosted instrument, and this is the first ghost work that includes additional, non-ghosted instruments. Subotnick explains the concept of this piece as such:

⁹¹ “Program and Technical Notes,” MortonSubotnick.com, accessed July 10, 2010.

⁹² Morton Subotnick also performed the clarinet part for the work on a separate occasion.

The title has to do with the way in which the ghost electronics interact with the piccolo. In previous ghost pieces, the electronics were used to produce an acoustic environment within which the solo manifested itself, but in this case the ghost score is a parallel composition to the piccolo solo. The ghost score amplifies and shifts the frequency of the original non-amplified piccolo sound. The two—ghost and original piccolo sounds—like a pair of parallel lines, can never touch, no matter how quickly or intricately they move. The work, a continuation of the butterfly-beast series, is divided into three large sections: (1) a perpetual-motion-like movement in which all parts play an equal role; (2) more visceral music, starting with the piccolo alone and leading to a pulsating “crying out,” and (3) a return to the perpetual motion activity, but sweeter.⁹³

The premiere performance of *Parallel Lines* was on April 28, 1979, for the International clarinet congress in the Roy O. Disney Hall at the California Institute of the Arts in Los Angeles. Ramon Kireilis was featured on piccolo and the orchestra was conducted by Michael Tilson Thomas.

Parallel Lines was recorded for Crystal Records in 1983, and featured Laurence Trott on piccolo. Remaining instruments were played by members of the Buffalo Philharmonic and Buffalo Creative Associates, and the piece was conducted by Michael Tilson Thomas. Professor Tom Cleman of Northern Arizona University writes in response to the recording of *Parallel Lines*,

It relies for its structural impetus on sound masses that vary in texture and color beneath the fluid piccolo part. Much of the part writing contains long repetitive configurations or lengthy sustained pitches, producing a static layering. . . . Disregarding the various caveats, this is a major work by a significant American composer—a work that is spacious, technically demanding, and . . . an aural tour de force.

⁹³ Morton Subotnick, *Parallel Lines*, liner notes, Chrysalis Records, CRI SD 458, 1979, LP record.

While it will require effort to perform and should not be tackled by those unwilling to approach it sympathetically, it certainly should be a part of a library's holdings.⁹⁴

The Last Dream of the Beast

The sixth piece of the ghost works is entitled *The Last Dream of the Beast: For Amplified Soprano and "Ghost Electronics,"* and was orchestrated for soprano voice, cello, and ghost electronics. This piece represents Subotnick's fourth ghost score written in 1978, and including his first two works, which were written in 1977, this piece is his sixth score written in only two years.

The Last Dream of the Beast is a concert version of an "aria" from Subotnick's *The Double Life of Amphibians*. In the aria, a beast man imagines a beautiful, blind woman who falls in love with him. He fantasizes that if one dies while dreaming, the dream becomes infinite and so, he arranges his death while dreaming his last and most beautiful encounter with his fantasy woman.⁹⁵

The Last Dream of the Beast premiered in February 1979 at the Hirshhorn Museum in Washington, DC. Joan La Barbara was featured on soprano voice. This composition was subsequently performed on November 5, 1979, and also March 7, 1981, at the Cal Arts, Roy O. Disney Hall in Valencia, California, and once again featured Joan La Barbara on soprano voice. Los Angeles Times writer John Henken describes the latter performance as such:

⁹⁴ Tom Cleman, "Review of *Parallel Lines*," *Music Library Association* vol. 40, no. 2 (December, 1983), 404–405.

⁹⁵ Morton Subotnick, *Parallel Lines*, liner notes, Chrysalis Records, CRI SD 458, 1979, LP record.

“Subotnick’s *The Last Dream of the Beast* . . . may be his most accessible and also most emotionally resonant work yet. It reaches the listener on the visceral level, and this proves at once attractive, but non-reactionary. Performed by singer Joan La Barbara, who met its many vocal demands with self-effacing virtuosity, it reminded us how many musical colors often remain unused by composers of today.”⁹⁶

The revised orchestration (for soprano voice, six cellos, and ghost electronics) premiered on December 6, 1982, for the Monday Evening Concerts at the Bing Theatre, Los Angeles County Museum of Art in Los Angeles. Joan La Barbara was featured on soprano voice. Terry McQuilkin of the Los Angeles Times reviewed this performance and writes, “La Barbara’s voice is continuously electronically altered. A wonderfully evocative work, *Last Dream* is full of drama and erotic sensuousness and is aptly written for voice and instruments.”⁹⁷

The Double Life of Amphibians was subsequently performed as a staged version on June 20, 1984, for the Olympics Arts Festival in Los Angeles. It was orchestrated for amplified soprano voice, two cellos, live electronic sounds, and ghost electronics.

This piece was recorded on February 10, 1984, with amplified soprano voice, two cellos, and ghost electronics at the Capitol Records studio in Los Angeles for Nonesuch Records. Stephen L. Mosko conducted the performance and the recording was engineered by Roger Mayer, Chief Engineer, and Mike Hatcher and Steve Burger, Assistant Engineers.

⁹⁶ John Henken, “New Music Fest at Cal Arts,” *Los Angeles Times*, Calendar, Sunday, March 8, 1981.

⁹⁷ Terry McQuilkin, “La Barbara at Museum Concert,” *Los Angeles Times*, part IV, December 11, 1982.

After the Butterfly

After the Butterfly: For Solo Trumpet with Ghost Electronics and Seven Players, is the seventh ghost work, and was commissioned by trumpeter Mario Guarneri. It was composed in 1979 for trumpet, ghost electronics, and a seven-piece chamber orchestra consisting of clarinet (2), trombone (2), cello (2), and percussion. The trumpet is the only ghosted instrument in this piece. This is a dynamic piece, for which Curtis Roads writes, “*After the Butterfly* is not carved into discrete sections. Rather, as Subotnick states: ‘Independent layers of increasing and decreasing intensities of sound material form the basis of the work.’ The stages of caterpillar, cocoon, and butterfly are interpreted by Subotnick and reflected in the structure of the composition.”⁹⁸

After the Butterfly premiered on October 29, 1979, for the Monday Evening Concerts at Bing Theater, Los Angeles County Museum of Art in Los Angeles. Mario Guarneri was featured on trumpet, and William Kraft conducted the piece. Daniel Cariaga reviewed the performance and writes,

The new piece appears to be more structured, more single-minded and more final than the four previous “butterfly” pieces we have heard in the past five years. . . . These 18 minutes are eventful, sequential, compacted. They begin in drowsiness, proceed to heavy and steady activity in ascending “decibility,” end in quietude and a major triad. Two clarinets, two trombones, two cellos, and a percussionist share the labors with the trumpet solo, whose showy role is rendered even more colorful by the controlling ghost electronic score. At its climax, there is an orgy of loudness completely unrelated to chaos.⁹⁹

⁹⁸ Curtis Roads, “Morton Subotnick: A Sky of Cloudless Sulphur/After the Butterfly,” *Reviews, Computer Music Journal* 5, no. 4 (Winter, 1981): 81–82.

⁹⁹ Daniel Cariaga, “New Subotnick Work in Premiere,” *Los Angeles Times*, part IV, November 1, 1979.

After the Butterfly was later performed on February 11, 1980, for the Los Angeles Philharmonic Composer's Choice Series at Schoenberg Hall, UCLA, in Los Angeles. Mario Guarneri was featured on trumpet, with members of the Los Angeles Philharmonic Orchestra. John Henken writes, "As a metaphor, a butterfly usually symbolized delicacy or the brevity of life, and *After the Butterfly* is neither brief nor delicate. As performed by members of the Los Angeles Philharmonic with Mario Guarneri on the trumpet part, it rang with cacophonous conviction."¹⁰⁰

After the Butterfly was also recorded in 1980 at The Record Plant in Los Angeles for Nonesuch Records. Mario Guarneri was featured on trumpet with The Twentieth Century Players, and Morton Subotnick conducted the performance. Professor at Massachusetts Institute of Technology, Curtis Roads writes in response to this recording,

At the center, the trumpet melody is heavily modulated, resulting in a spectrum laden with inharmonic partials. This is mixed with tapping on the body of the cellos, trills in the clarinets, and rolls on bells. The climax gives way to simple drone texture, and then a wistful, meandering melody is played on the trumpet over a murky instrumental background. The trumpet line is reminiscent of some of Miles Davis' more lyrical work . . . Guarneri's performance is outstanding. . . . The sound quality of the album is excellent . . . one senses a pragmatic craftsman who knows his materials and how they may be used. But unlike some pragmatists, Subotnick is clearly willing to explore new techniques to achieve his musical goals.¹⁰¹

¹⁰⁰ John Henken, "Morton Subotnick At UCLA," Music Reviews, *Los Angeles Times*, February 15, 1980.

¹⁰¹ Roads, "Morton Subotnick," 81–82.

The First Dream of Light

The First Dream of Light: For Tuba and Electronic Ghost Score is the eighth ghost work, and it was completed in 1980. It was orchestrated for tuba and ghost electronics and commissioned by Robert Bobo. *The First Dream of Light* premiered on February 11, 1980, for the Los Angeles Philharmonic Composer's Choice Series at Schoenberg Hall, University of California in Los Angeles. Roger Bobo was featured on tuba. John Henken writes in review of the performance,

"The First Dream of Light carried the composer's concept more clearly and compellingly [than *After the Butterfly*]. It has little beyond energy and the ghost score tricks, but that is almost enough. Ultimately though, the energy is dissipated through redundancy, and electronic flamboyance cannot completely cover the poverty of the material."¹⁰²

A recorded version of *The First Dream of Light* appears on *Rainbo-Bo: The Man with the Golden Tuba*, for Crystal Records and *Tuba Nova*, also for Crystal Records.

Roger Bobo was again featured on the tuba.

With regard to this recording, New York Times writer Allan Kozinn writes,

*"Several of these works have been released by Nonesuch over the last few years, and I find them far less attractive than Mr. Subotnick's purely electronic scores. In this case, Ralph Grierson's piano part is altered considerably more than the tuba line, and while the piano's new timbres are often scintillating, the tuba writing is mostly lethargic, and except for a brief stretch of beautiful harmonics at the end, rather bland."*¹⁰³

¹⁰² John Henken, "Subotnick at UCLA," *LA Times*, sec. 4, February 15, 1980.

¹⁰³ Allan Kozinn, "Adventurousness Spurs The Independent Labels." Late Edition—East Coast, *New York Times*, September 19, 1982.

Axolotl

The ninth ghost work is entitled *Axolotl: For Solo Cello and Electronic Ghost Score*. It was commissioned by cellist Joel Krosnick, and was completed in 1980. The original orchestration was for solo cello and electronic ghost score, and the revised orchestration included cello, electronic ghost score, and chamber orchestra consisting of percussion (2), harp, piano, cello (8), and bass (4).

In his description of the *Axolotl*, Subotnick writes,

“An Axolotl is a Mexican salamander. It is a transparent and delicate creature with two filigree wing-like appendages, extending from either side of the body, which appear to float above it. These are its lungs for the future ascent onto land . . . but the axolotl never goes through the final stage of its potential development . . . it never reaches air . . . it remains forever in water.”¹⁰⁴

Axolotl belongs to the first part of Subotnick’s three-part series called *The Double Life of Amphibians*. *Part I: Amphibians* includes two pieces, *Axolotl* and *Ascent into Air*. *Part II: Beasts* is comprised of a single piece, *The Last Dream of the Beast*, and *Part III: Angels* is also a single piece, *A Fluttering of Wings*. Although it belongs to the three-part series, Subotnick does not consider *Ascent into Air* as a ghost piece because it used a different method of applying the signal processing, which was controlled by the instruments in live performance rather than a prerecorded ghost score.¹⁰⁵

The original orchestration of *Axolotl* premiered on February 13, 1981, at the Library of Congress in Washington, DC. Joel Krosnick was featured on cello. The

¹⁰⁴ Morton Subotnick, *Axolotl*, liner notes, Nonesuch Records N-78012, 1980, LP record.

¹⁰⁵ “Morton Subotnick: Timeline,” Morton Subotnick, MortonSubotnick.com, March 2010, accessed June 20, 2010, <http://www.mortonsubotnick.com/timeline.html>.

revised orchestration of *Axolotl* premiered on February 15, 1982, for the Monday Evening Concerts at the Bing Theater, Los Angeles County Museum of Art in Los Angeles. Cellist Joel Krosnick was again featured for this performance. John Henken reviews the latter performance:

“If Subotnick’s composition reflects its namesake, then the *Axolotl*—a Mexican salamander—leads an intriguing, complex life. The ghost electronics bend and tease the sound of the solo cello, while the ensemble shimmers and shouts, both affirming and contradicting the soloist. Nicely proportioned and paced. *Axolotl* is an enigmatic drama warranting further hearing.”¹⁰⁶

The original orchestration of *Axolotl* was later performed on April 6, 1982, at The House in Santa Monica, California and featured Erika Duke on cello. Terry McQuilkin from the Los Angeles Times writes in response to this performance,

“Morton Subotnick’s *Axolotl*, represents an effective marriage between live and electronic media. Altering pitch, timbre, and intensity, the electronics enhance rather than pervert the sounds made by cellist Erika Duke. Along with the many cello effects, expertly played, these alterations work to form a satisfying, though occasionally rambling, fantasia.”¹⁰⁷

Subsequent performances of the original score of *Axolotl* took place on June 17, 1982, for the Piatigorsky Seminar at the Bing Theater, University of Southern California in Los Angeles and again on November 12, 1984, at the Juilliard Theater in New York City. Joel Krosnick was featured on cello for both performances. Los Angeles Times staff writer, Daniel Cariaga writes of the June 1982 performance, “In seriousness,

¹⁰⁶ John Henken, “Joel Krosnick at Monday Concert,” *Los Angeles Times*, sec. 4, February 17, 1982.

¹⁰⁷ Terry McQuilkin, “New Music from The E.A.R. Unit,” *Los Angeles Times*, sec. 4, April 8, 1982.

integration, and eloquence, it is typical Subotnick: It charms, provokes, entertains, and challenges simultaneously. Krosnick brought to it a vibrancy and intensity almost, but not quite, overweening.”¹⁰⁸

A Fluttering of Wings

The tenth ghost work is entitled *A Fluttering of Wings: For String Quartet and Electronic Ghost Score*. *A Fluttering of Wings* was commissioned by the National Education Association for the Juilliard String Quartet and completed in 1981. Subotnick describes this piece by writing, “*A Fluttering of Wings* is the third part of a larger work entitled *The Double Life of Amphibians*. The entire work is conceived as a staged tone poem. *A Fluttering of Wings* is for string quartet and an electronic ghost score and is in five parts played without pause: ‘One Angel Dancing, Two Angels Dancing, Three Angels Dancing, Halo, and Song of the Angel.’”¹⁰⁹

The premiere performance of *A Fluttering of Wings* was on October 14, 1982, at the Library of Congress in Washington, DC, and featured the Juilliard String Quartet. The work premiered a second time on February 3, 1983, at the Ambassador Auditorium in Pasadena, California, again with the Juilliard String Quartet. Robert Mann, the founder and, at the time, senior member of the Juilliard String Quartet was interviewed by Daniel Cariaga of the Los Angeles Times. In a discussion about this composition, Cariaga writes (quoting Mann), “‘*A Fluttering of Wings* signals almost a return to a kind

¹⁰⁸ Daniel Cariaga, “Krosnick Closes Cello Recital Series,” *Los Angeles Times*, Calendar, June 19, 1982.

¹⁰⁹ Morton Subotnick, *The Double Life of Amphibians*, liner notes, Nonesuch Records, 78020-1, 1982, LP record.

of mystic element. . . . The final section is really the song of the angel, and it's frankly,' the violinist says, wincing, 'very pretty.'"¹¹⁰

Los Angeles Times writer Terry McQuilkin writes of the Pasadena premiere, "At the beginning, we heard a flurry of activity in which individual notes became blurred, but the overall progression of ideas was completely clear. A frenzied dance, a quiescent section and a moving 'song of the Angel' followed. The ghosting added a new dimension of color to the work, which then took on a more caustic, biting character."¹¹¹

A Fluttering of Wings was subsequently performed on December 4, 1983, at the Schoenberg Institute, University of Southern California in Los Angeles and featured the Kronos Quartet. John Henken reviews this performance and writes, "The ghost score creates a kind of live *musique concrète*, though one less flamboyant than in other of Subotnick's ghost works. The expectant feeling of the opening is dissolved rather than fulfilled, with a surprisingly introverted cast to the music."¹¹²

Allan Ulrich of the Los Angeles Times writes,

"*The Double Life of Amphibians* represents Subotnick at his compelling best. The ten conventional instruments and computer-generated sonics of *Ascent into Air* create a thickly textured progression, with the brilliantly varied material—shimmering, ominous and witty in turn—tracing an evolution to ultimate clarity. . . . Both works require live performance to realize their total effect. Nevertheless, these virtuosic readings smack of the definitive."¹¹³

¹¹⁰ Daniel Cariaga, "Juilliard's Mann Still Touring," *Los Angeles Times*, part IV, February 3, 1983.

¹¹¹ Terry McQuilkin, "Subotnick With, Without Ghost," *Los Angeles Times*, sec. 4, February 5, 1983.

¹¹² John Henken, "Kronos Quartet Ends Season," *Los Angeles Times*, sec. 4, December 8, 1983.

¹¹³ Allan Ulrich, "Morton Subotnick: *Ascent into Air*; *A Fluttering of Wings*," LPs: Alla Breve, *Los Angeles Times*, part IV, December 8, 1983.

In a review of the musical score of *A Fluttering of Wings* for the Music Library Association, Daniel Ashalomov of the American String Quartet writes, “The ghost score represents progress not only in technology, but in the composer’s view of that technology’s position relative to the mortal musician.”¹¹⁴

An Arsenal of Defense

An Arsenal of Defense: For Solo Viola and Electronic Ghost Score is the eleventh ghost score and was completed in 1982. This piece was commissioned by John Graham, and premiered on November 7, 1982, at the San Francisco Conservatory of Music in San Francisco and featured John Graham on viola.

An Arsenal of Defense was later performed by John Graham along with a selection of other twentieth-century compositions on January 28, 1986, at Carnegie Hall in New York. New York Times writer Allen Hughes reviewed Graham’s performance. Hughes writes, “Except for the Subotnick item—which sounded like an adolescent’s idea of fun with a musical instrument and electronic devices—the works elicited admiration for the viola and even more of it for the performer.”¹¹⁵

Trembling

Trembling: For Violin, Piano, Tape, and Electronic Ghost Score is Subotnick’s twelfth ghost piece. The work was commissioned by the Library of Congress and orchestrated for violin, piano, spoken word, and electronic ghost score in 1983.

Subotnick describes this piece as such:

¹¹⁴ Daniel Ashalomov, “*A Fluttering of Wings*,” *Reviewed Works, Music Library Association* 42:2 (December, 1985), 405.

¹¹⁵ Allen Hughes, “Music: John Graham, Violist,” *New York Times, Arts*, January 30, 1986.

“Throughout the work, the ghost acts to heighten the shimmering and ‘trembling’ quality of the music. The word ‘tremble’ (on tape) occurs at the end. Each of the four statements contains four simultaneous utterances of the word . . . and each utterance, though starting at the same time, unfolds at a different rate . . . resulting in a ‘rose petal’ effect.”¹¹⁶

Trembling premiered on October 29, 1983, at the Library of Congress in Washington, DC. Ben Hudson was featured on violin and Alan Feinberg was featured on piano. *Trembling* was subsequently performed in New York City on November 15, 1984, for the New York New Music Ensemble’s Thursday night at Carnegie Recital Hall series at an event titled, “The ‘California School’ of Contemporary Composition at the Carnegie Recital Hall.” The performance featured the Robert Black Ensemble. John Rockwell of the New York Times writes,

The only piece on Thursday’s program that directly epitomized that spirit [of California and Minimalism], however, was Morton Subotnick’s *Trembling*. Mr. Subotnick’s scores are busier in incident than much California music. But they partake of the state’s style, nonetheless, and they certainly present the imaginative use of synthesizers and computers: his term “ghost electronics” means the electronic extension of natural sounds, and it’s ingeniously accomplished. One problem, though, is that he hasn’t apparently been able to convey to performers just how loud the electronics should be. At Joel Krosnick’s cello recital on Monday at the Juilliard Theater, another Subotnick piece in this series suffered from nearly inaudible electronics; on Thursday, the electronic effects seemed too loud, in comparison with how they’ve sounded

¹¹⁶ Morton Subotnick, *The Virtuoso in the Computer Age IV*, liner notes, Centaur Records, CRC 2170, 1993, compact disc.

on recordings and in concerts supervised by the
composer.¹¹⁷

Trembling was recorded in February 1993 at the Dallas Sound Lab for the album *The Virtuoso in the Computer Age IV* for Centaur Records. Larry Austin was featured for this recording on electronics, Adam Wodnicki on piano, Joan La Barbara, soprano voice, and Robert Davidovici, violin.

¹¹⁷ Rockwell, John. "New Music: Ensemble at Carnegie Recital Hall," Review, *New York Times*, Late Edition—East Coast, November 18, 1984.

CONCLUSION

This thesis has sought to explore the ghost works of Morton Subotnick, and their contribution to the world of sound art and electronic music technologies. It has been shown that as electronic music technologies caught up to the aspirations of composers, they were able to freely express themselves and develop new methods and art forms relevant to the times. When magnetic tape recording emerged in the late forties, Pierre Schaeffer was able to streamline his *musique concrète* studio techniques. The same recording technology allowed tape music pioneers Vladimir Ussachevsky, Otto Luening, and others in the early fifties to create notable electronic works by manipulating concrete and electronically synthesized sounds captured on tape. In the late fifties, tape technology facilitated Subotnick's creative application of *musique concrète* studio techniques to build sound designs for live theatre. Additionally, in the mid-sixties, voltage-controlled synthesis and the analog sequencer provided Subotnick with the means to assemble long phases of electronically synthesized sounds and begin fulfilling his aspirations of creating music as studio art.

Magnetic tape and voltage-controlled synthesis were major technological stepping-stones for Subotnick and the generation of artists and innovators who followed him. These technologies opened the door to innovative methods of creating music with electronic sounds and signal processing. The ghost works effectively demonstrate the fusion of these technologies with Subotnick's artistic aspirations, as they enabled him to combine his composition and performance skills with acoustic instruments and analog signal processing. Subotnick and his contemporaries, through their efforts with these

new technologies, established methods for modern electronic music production, and led the way to MIDI and the DAW. It is the intent of this thesis to look closely at these people and their works, which have contributed to modern advancements in audio art, in particular Morton Subotnick and his ghost works, and to pay respect to the benefits that music has received from his efforts.

Morton Subotnick and others have performed select works of the original ghost compositions since their inception in the late seventies. The electronic materials necessary for producing the electronic ghost score effects, which have evolved over time per the discussion in Chapter Three, have always accompanied the musical scores for the works, which been available upon request from the publisher since the ghost works were first published in the late seventies. The inclusion of the electronics has allowed others to perform the ghost works as they were originally intended, even though the performance might be outside of Subotnick's purview. As of this writing in 2010, the following five ghost pieces are currently available from the publisher for rental: *The Wild Beasts*, *Passages of the Beast*, *After the Butterfly*, *Axolotl*, and *Trembling*.¹¹⁸ Upon rental, Subotnick emails the client the necessary MAX software to reproduce the ghost score processing.

Subotnick completed his original set of ghost compositions in 1983. From 1983 to 2007, Subotnick performed these works while continuing to update his ghost electronics as the technology progressed. In 2007, using this new technology, Subotnick began creating new ghost works beginning with *The Other Piano: Version One for Solo*

¹¹⁸ "Morton Subotnick," Schott Music Corporation, Schott-Music.com, Schott Music GmbH & Co. KG, 2010, accessed July 10, 2010, <http://www.schott-music.com/shop/persons/az/18626/>.

Piano and Version Two for Piano and Live Digital Signal Processing. Version Two premiered May 1, 2007 at Zipper Concert Hall, Los Angeles and was very well received. Regarding this performance, LA Weekly columnist Alan Rich writes, “We, sitting there, floated, surrounded, inside the sound. Talk about your magic!”¹¹⁹ Subotnick has an additional new ghost composition, a trio for violin, clarinet, and piano, which premiered in August of 2008. In regards to the premiere of the trio, Subotnick comments, “It got this amazing standing ovation. People just rose to their feet and I was almost in tears—it was great. So, I’m going to keep going with this series.”¹²⁰

Electronic music technologies have progressed considerably in both art and popular music genres since Subotnick began producing his first ghost scores in the late seventies. Although analog tape is still coveted for its sonic qualities, it has been replaced, both as a recording and control medium, by digital, computer-based systems. In a similar manner, analog signal processing and audio components are revered for their impeccable sound, but have largely been replaced by digital, software-based equivalents. Substantial progress has been made in the area of digital sound production environments. KYMA is a powerful digital sound design environment used for music post-production and live applications.¹²¹ In spite of advances in these areas, Subotnick is still looking for new ways to program his dynamic musical gestures and compose interactive works in formats that meet his needs. In a 2006 interview, Subotnick commented that there were currently no programs available, other than Vortex Sound Designer by IMR (Immersive

¹¹⁹ Alan Rich, “A Lot Of Night Music: American Idolatry,” *LA Weekly*, May 16, 2007.

¹²⁰ “Interview with Morton Subotnick,” interviewed by Gino Robair, Electronic Musician TV, Penton Media, 2009, http://emusician.com/ms/namm/video/interview_morton_subotnick/.

¹²¹ “KYMA X,” Symbolic Sound Corporation, 2010, accessed October 24, 2010, <http://www.symbolicsound.com/cgi-bin/bin/view/Products/WebHome>.

Media Research), that give him complete control over compositional parameters in a surround sound format.¹²² In a 2009 interview, Subotnick lamented that there was currently no computer program available that would allow him to program his detailed “energy shape” gesture melodies as he did when programming the Buchla synthesizer for his early electronic works and ghost pieces. “I can’t just sing into it,” Subotnick says, “and keep my voice [as a gesture], so that it can control any parameter of anything I want it to.”¹²³

It is ironic, with all the advances made in audio technologies to date, that Morton Subotnick is still searching for suitable digital replacements to equal the amount of control he once had in the analog realm over forty years ago. There is, without a doubt, plenty of room for further technological developments in this area, which will facilitate the continued advancement of this unique sonic art form. In addition to the need for more specific music programming technologies, a fair amount of experimentation has yet to be accomplished by way of interactive music technologies in a live performance and the creation of new timbres and virtual instruments. There is still to be seen a composer that will continue the work of Morton Subotnick and create a musical score with the techniques that he has created; using modern computer technology to interact with live musicians to alter the music in a dynamic way and also create a new/separate instrument.

The assembly of research materials for certain aspects of this document has been rather straightforward, while other areas of research have proven to be an arduous task.

¹²² “Morton Talks About Immersive Designer,” Immersive Media Research, IM-Research.Com, Immersive Media Research, 2002-2010, Accessed May 12, 2010, <http://im-research.com/artists/>.

¹²³ “Interview with Morton Subotnick,” Penton Media.

A plentiful amount of accessible information exists on the composer's early works, as well as his more recent activities, which has facilitated a frank discussion of background details. However, there is scant information on the details of the ghost electronics, including the signal processing components, control data conversion units, and Subotnick's specific programming techniques. Other than a handful of reviews from music critics, there is also little discussion available on the works themselves. While this research has shed light on these areas, more input from the perspective of the composer and the performers would be beneficial.

It is the opinion of the author that the lack of available information on this subject may be due to the less popular status of the ghost works relative to the composer's more notable early electronic works. Beginning with *Silver Apples of the Moon* in 1967, Subotnick's early electronic works originally received attention in both art and popular music circles, and have since become underground sensations with a younger set of *Electronica* music fans and composers. The ghost works, on the other hand, did not receive this kind of attention and remain as rather obscure art music pieces. The electronic recordings were completely new and novel works of sonic art and not in direct conflict with any preconceived notions of music. However, the unusual effects of the "ghosted" acoustic instruments conflicted with the sensibilities and expectations of the traditional art music listener, making them less accessible.

Another area of difficulty encountered in the research of this subject was, the unavailability of music scores and ghost electronics. Only four of the original twelve ghost music scores (fourteen, including revisions) are available through the public library

system, including the Library of Congress, as they were in their first printed editions. These compositions are available only as music scores and not accompanied by any of the original ghost electronics. There is a need for further research in this area to uncover any scores or original ghost hardware that may be in existence. These available original music scores are as follows: *Two Life Histories*, *Passages of the Beast*, *Parallel Lines*, and *A Fluttering of Wings*. A fifth score, the original autograph manuscript of Subotnick's *Trembling*, which was his final piece of the original ghost series, is currently available for perusal at the Performing Arts Reading Room in the Library of Congress in Washington DC. A facsimile of the score may be obtained for a fee through the Library of Congress, Duplication Services.¹²⁴ The scores for three additional ghost compositions, plus two of the aforementioned works, are available from the publisher.

For over fifty years now, audio recording, electronic synthesis, and interactive multimedia technologies have been catching up with the artistic aspirations of Morton Subotnick, who has always sought to incorporate the cutting edge of technology in his works. He continues today to blaze a trail with new music technologies while maintaining a busy schedule as a lecturer, performer, and artist in residence around the world.

¹²⁴ For more information, visit the Library of Congress Duplication Services at <http://www.loc.gov/preserv/pds/>.

APPENDIX A

LIST AND DETAILS OF GHOST WORKS

Title	Date	Ghosted Instruments	Additional Instruments (unaffected)	Length Of Work ¹²⁵	Original Ghost Score Medium	Current Ghost Score Medium	Ghost Box Contents
<i>Two Life Histories</i>	1977	Clarinet, tenor voice	None	24'	Tape ¹²⁶		Early design ¹²⁷
<i>Liquid Strata</i>	1977	Piano	None	27'	Tape		Early design
<i>The Wild Beasts</i>	1978	Piano, trombone	None	30'	Tape	MAX ¹²⁸	Early design
<i>Passages of the Beast</i>	1978	Clarinet	None	18'	Tape	MAX	Early design
<i>Parallel Lines</i>	1978	Piccolo	Oboe, English horn, clarinet, bass clarinet, trumpet, trombone, harp, percussion, viola, cello	16'	Tape		Early design
<i>The Last Dream of the Beast</i>	1978	Soprano voice, cello	None ¹²⁹	17'	Tape		Early design
<i>After the Butterfly</i>	1979	Trumpet	Clarinet (2), trombone (2), cello (2), percussion	18'	Tape	MAX	Early design
<i>The First Dream of Light</i>	1980	Tuba	None	18'	EPROM		Later design ¹³⁰
<i>Axolotl</i>	1980	Cello	None ¹³¹	17'	EPROM	MAX	Later design
<i>A Fluttering of Wings</i>	1981	String quartet	None	25'	EPROM		Later design
<i>An Arsenal of Defense</i>	1982	Viola	None	15'	EPROM		Later design
<i>Trembling</i>	1983	Violin, piano, voice	None	17'	EPROM	MAX	Later design

¹²⁵ "Music of Morton Subotnick," MortonSubotnick.com, March 2010, accessed June 20, 2010, <http://www.mortonsubotnick.com/musicof.html>.

¹²⁶ The tape used for these works was an 1/4-inch, 2-track analog magnetic tape.

¹²⁷ Early design includes a stereo location processor, frequency shifter, and a voltage controlled amplifier, plus frequency-to-voltage conversion modules.

¹²⁸ MAX/MSP interactive software program. Upon rental, the composer supplies client with software.

¹²⁹ *After the Butterfly* was later revised with five additional, un-ghosted cellos.

¹³⁰ Later design includes microphone preamps, a stereo location processor, frequency shifter, and a voltage controlled amplifier, plus frequency-to-voltage conversion modules.

¹³¹ *Axolotl* was later revised to include a chamber orchestra consisting of percussion (2), harp, piano, cello (8), and bass (4).

APPENDIX B
AVAILABLE GHOST WORKS AND RECORDINGS

	Library of Congress	California Libraries	Publisher ¹³²	Recordings
<i>Two Life Histories</i>	M1624.7.S	CSU East Bay CSU Fresno		None available
<i>Liquid Strata</i>				<i>For Ralph Grierson</i> Town Hall: S-24, 1979
<i>The Wild Beasts</i>			Available	<i>Axolotl/The Wild Beasts</i> Nonesuch: N-78012, 1981
<i>Passages of the Beast</i>	M72.S.	CSU San Diego San Jose State Univ.	Available	<i>New Music for Clarinet</i> Owl: OWL-30, 1984
<i>Parallel Lines</i>	M985.S.	CSU East Bay Occidental College		<i>Parallel Lines</i> CRI: SD-458, 1983
<i>The Last Dream of the Beast</i>				<i>The Art of Joan La Barbara</i> Nonesuch: N-78029, 1985
<i>After the Butterfly</i>			Available	<i>A Sky of Cloudless Sulphur/ After the Butterfly</i> Nonesuch: N-78001, 1980
<i>The First Dream of Light</i>				<i>Rainbo-Bo</i> Crystal: CD398, 1981
<i>Axolotl</i>			Available	<i>Axolotl/The Wild Beasts</i> Nonesuch: N-78012, 1981
<i>A Fluttering of Wings</i>	M452.S932 D73	CSU East Bay CSU Fresno CSU Long Beach Occidental College		<i>Ascent Into Air</i> Nonesuch: 78020, 1984
<i>An Arsenal of Defense</i>				<i>Viola Anthology</i> CRI, 1988
<i>Trembling</i>	ML31. M24a no. 24		Available	<i>Virtuoso in the Computer Age</i> Centaur, 1993

¹³² Schott Music, <http://www.schott-music.com>.

BIBLIOGRAPHY

- Bernstein, David W., ed. *The San Francisco Tape Music Center: 1960's Counterculture and the Avant-Garde*. Berkeley: University of California Press, 2008.
- Bernstein, David W., and Maggi Payne. "Morton Subotnick." In Bernstein, *Tape Music Center*, 117–135.
- Buchla & Associates. "Model 112 Touch Controlled Voltage Source." Buchla & Associates, 2010. <http://www.buchla.com/historical/b100/112-touch.html>.
- . "Buchla 200 Series." Buchla & Associates, 2010. <http://www.buchla.com/historical/b200/intro.html>.
- . "Buchla 400: Electronic Musical Instrument." Buchla & Associates, 2010. <http://www.buchla.com/historical/b400/>.
- Cox, Christoph, and Daniel Warner. *Audio Culture: Readings In Modern Music*. New York: Continuum, 2004.
- Darter, Tom. *The Art of Electronic Music*. New York: Morrow & Co, 1984.
- Davis, Gary, and Ralph Jones, *The Sound Reinforcement Handbook*, 2nd ed. Buena Park, CA: Yamaha, 1989.
- Fetterman, William. *John Cage's Theatre Pieces: Notations and Public Performances*. Amsterdam: Harwood Academic, 1996.
- Gluck, Bob. "Richard Friedman." Unpublished manuscript, November 21, 2008. PDF document.
- Gagne, Cole. *Soundpieces 2: Interviews with American Composers*. Metuchen, NJ: Scarecrow Press, 1993.
- Gibbs, Tony. *The Fundamentals of Sonic Art & Sound Design*. Lausanne, Switzerland: AVA, 2007.
- Huber, David M. and Robert E Runstein. *Modern Recording Techniques*. 6th ed. San Francisco: Focal Press, 2005.
- Immersive Media Research. "Morton Talks About Immersive Designer." IM-Research.Com. Immersive Media Research, 2002-2010. <http://im-research.com/artists/>.
- Marchessault, Janine. *Marshall McLuhan: Cosmic Media*. Thousand Oaks, CA: Sage, 2005.

- Matrixsynth, "This Week In Synths: The First Buchla 500, Buchla 200e Rock, ARP 2500 Demo and Repair," *Create Digital Music* (blog), Creative Commons Attribution-Share Alike 3.0 Unported License. <http://createdigitalmusic.com/tag/buchla/>.
- McLarty, Peter. "Z80 Microprocessor." ToolBox.com Q&A, April 23, 2008, http://it.toolbox.com/wiki/index.php/Z80_Microprocessor.
- Moore, Richard. *The Computer and the Mind Of Man: Logic By Machine* (National Educational Television, 1960). Prelinger Internet Archives, March 10, 2001. MPEG4 video. http://www.archive.org/details/logic_by_machine_1.
- Murphy, Bill. "Morton Subotnick: Synthologist." *Remix* 9, no. 7 (July 2007): 98.
- Naumann, Joel, and James D. Wagoner. *Analog Electronic Music Techniques: In Tape, Electronic, and Voltage-Controlled Synthesizer Studios*. New York: Schirmer Books, 1985.
- Penton Media. "Interview with Morton Subotnick." Interview with Gino Robair. Electronic Musician TV, 2009. http://emusician.com/ms/namm/video/interview_morton_subotnick/.
- Phenix, Ben. "KYMA X." SymbolicSound.com. Symbolic Sound Corporation, 2010. <http://www.symbolicsound.com/cgi-bin/bin/view/Products/WebHome>.
- Pinch, Trevor, and Frank Trocco. *Analog Days: The Invention and Impact of the Moog Synthesizer*. Cambridge, MA: Harvard University Press, 2002.
- Riley, Robert R. "The Evolution of the Projected Image Light Show in San Francisco." In Bernstein, *The Tape Music Center*, 21–23.
- Roads, Curtis. "Interview with Morton Subotnick." *Computer Music Journal* 12, no. 1 (Spring, 1988): 9–18.
- . "Morton Subotnick: A Sky of Cloudless Sulphur/After the Butterfly." Reviews. *Computer Music Journal* 5, no. 4 (Winter, 1981): 80–85.
- . *Morton Subotnick: Electronic Works, Volume 2*. Liner notes. New York: Mode, 2004. DVD.
- Schrader, Barry. *Introduction to Electro-Acoustic Music*. Englewood Cliffs, NJ: Prentice Hall, 1982.
- Schott Music Corporation. "Morton Subotnick." Schott Music GmbH & Co. KG, 2010. <http://www.schott-music.com/shop/persons/az/18626/>.

- Strange, Allen. *Electronic Music: Systems, Techniques, And Controls*. Dubuque, IA: Brown Co., 1983.
- Subotnick, Morton. *A Fluttering of Wings*. Technical description. Bryn Mawr, PA: Presser, 1984. Musical score.
- . *Ascent Into Air/ A Fluttering of Wings*. Liner notes. Nonesuch 78020-1, 1981. LP record.
- . *Axolotl*. Liner notes. Nonesuch Records, N-78012. 1980. LP record.
- . *The Double Life of Amphibians*. Liner notes. Nonesuch Records, 78020-1. 1982. LP record.
- . “Extending the Stuff Music Is Made Of.” *Music Educators Journal* (November, 1968): 109–116.
- . “Morton Subotnick.” *Electronic Works: Volume One*. DVD. Interviewed by John Schaefer. New York: Mode, 2001.
- . “Morton Subotnick and Tony Martin.” *Electronic Works: Volume Two*. DVD. New York: Mode, 2004.
- . “Morton Subotnick: Program and Technical Notes.” MortonSubotnick.com, March 2010. <http://www.mortonsubotnick.com/program.html>.
- . “Morton Subotnick: Timeline.” MortonSubotnick.com, March 2010. <http://www.mortonsubotnick.com/timeline.html>.
- . “Music as Studio Art.” In Bernstein, *Tape Music Center*, 112–116.
- . “Music of Morton Subotnick.” MortonSubotnick.com, March 2010. <http://www.mortonsubotnick.com/musicof.html>.
- . *Parallel Lines*. Liner notes. Chrysalis Records, CRI SD 458, 1979. LP record.
- . *Passages of the Beast*. Liner notes. Owl Recordings, Owl 30, 1978. LP record.
- . *Passages of the Beast*. Performance notes. Bryn Mawr, PA: Presser, 1984. Musical score.
- . *Two Life Histories*. Technical notes. Bryn Mawr, PA: Presser, 1982. Musical score.
- . *Until Spring*. Liner notes. Odyssey Records, 1976. LP record.

- . “The Use of Computer Technology in an Interactive or ‘Real-Time’ Performance Environment.” *Contemporary Music Review* 18, part 3 (1999): 112–120.
- . “The Use of the Buchla Synthesizer In Musical Composition.” AES E-Library, Audio Engineering Society, 2010.
<http://www.aes.org/e-lib/browse.cfm?elib=1303>.
- . *The Virtuoso in the Computer Age IV*. Liner notes. Centaur Records, CRC 2170. 1993. Compact disc.
- . *The Wild Beasts*. Liner notes. Nonesuch Records, N-78012. March 1981. LP record.
- Vail, Mark. “Gallery of Vintage Gear: Buchla’s First Modular System.” *Keyboard Magazine* 18, no. 10 (1992): 44–53.
- Whipple, Harold W. “Beasts and Butterflies: Morton Subotnick’s Ghost Scores.” *Musical Quarterly* 69, no. 3 (Summer, 1983): 429–442.
- Winkler, Todd. *Composing Interactive Music: Techniques and Ideas Using MAX*. Cambridge, MA: MIT Press, 1998.
- Wyman, Dan. *Moog Modular Owner’s Manual*. Los Angeles: Sound Arts, 1981.