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Performing Percussion in an Electronic World: An Exploration of Electroacoustic Music with a Focus on Stockhausen's Mikrophonie I and Saariaho's Six Japanese Gardens

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Performing Percussion in an Electronic World: An Exploration of Electroacoustic Music with a Focus on Stockhausen's *Mikrophonie I* and Saariaho's *Six Japanese Gardens*

A dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Musical Arts

by

Nikolaus Adrian Keelaghan

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ABSTRACT OF THE DISSERTATION

Performing Percussion in an Electronic World: An Exploration of Electroacoustic Music with a Focus on Stockhausen's *Mikrophonie I* and Saariaho's *Six Japanese Gardens*

by

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Doctor of Musical Arts

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The origins of electroacoustic music are rooted in a long-standing tradition of non-human music making, dating back centuries to the inventions of automaton creators. The technological boom during and following the Second World War provided composers with a new wave of electronic devices that put a wealth of new, truly twentieth-century sounds at their disposal.

Percussionists, by virtue of their longstanding relationship to new sounds and their ability to decipher complex parts for a bewildering variety of instruments, have been a favored recipient of what has become known as electroacoustic music. This dissertation addresses several dimensions of this sub-genre: Chapter One provides a definition and brief history of the genres of electronic (acousmatic) and electroacoustic music. Chapter Two provides a detailed taxonomy of the genre of electroacoustic music. Chapter Three addresses the various musical and aesthetic challenges that electroacoustic music presents to the interested percussionist or observer.

The final two chapters focus more closely on one of electroacoustic music's most exquisite creations to date: Kaija Saariaho's *Six Japanese Gardens* (1994). Chapter Four assesses the complex equipment needs and offers practical advice for a successful performance. Chapter Five puts Saariaho's work in a broader context by placing an examination of it next to one of Karlheinz Stockhausen's breakthrough 1964 composition, *Mikrophonie I*.

The dissertation of Nikolaus Adrian Keelaghan is approved.

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Introduction

Electronic music in combination with other instruments—what is known broadly as "electroacoustic" music—is an exciting, evocative, and exceptionally challenging genre in performance. Composers in the West have often been intrigued by the possibilities of new sounds, and the technological advances of the twentieth century offered them plenty. Works featuring percussion arguably make up the bulk of this electroacoustic repertoire. Why?

Perhaps it begins with the vast array of instruments (and therefore sounds) that percussionists must master. This in turn helps explain percussionists' historical openness to experimentation. Percussionists also develop unrivaled skills at logistics and event execution. Or perhaps there is a correlation between the noise-like sounds created by electronic means and the unique ability of percussion instruments to emulate these sounds. Whatever the collective reasons, contemporary percussionists are afforded more opportunities to perform this special repertoire than other instrumentalists.

The first step in addressing the larger phenomenon of electroacoustic music involving percussion (as opposed to simply "electronic music") is to define it. The nomenclature behind electronic music has been held hostage by the evolution of technology. Take, for example, the genre known as "Tape Music," or "Percussion with Tape." Such works are still performed regularly, yet the heavy-duty reel-to-reel machines on which these works were created are seldom used today. Hence names of genres and subgenres, though they clearly leave their traces, are all doomed to an eventual irrelevancy. A working definition, therefore, needs to be sufficiently broad so that it encompasses works from the 1920s to the present day. In that light, we might define electroacoustic music for percussion as: a genre that combines live performance on traditional percussion instruments with either pre-recorded sounds or sounds produced electronically during the process of performance.

Even the New Grove Encyclopedia (2000) falls prey to defining electroacoustic music too narrowly. Grove states that electroacoustic music is "music in which electronic technology, now primarily computer-based, is used to access, generate, explore, and configure sound materials, and in which loudspeakers are the prime medium of transmission."[1] The term that specifically describes music composed for listening via loudspeakers without live performers is "acousmatic," which derives from the Greek *akousmatikoi*, which was used to describe Pythagoras's pupils. They received their lectures from behind a veil while sitting in silence, just as acousmatic music is generated and heard behind a "veil" of lifeless loudspeakers.

In France, Pierre Schaeffer designated this budding genre as *musique concrète*. Schaeffer defined his mission as "to collect concrete sounds, wherever they came from, and to abstract the musical values they were potentially containing."[2] The German take on the genre is based on the synthesis of electronic sounds, which they call *elektronische Musik* (more on these genres and subgenres in Chapter One).

During the heyday of reel-to-reel tape (ca. 1945-1980), most of this repertoire was simply referred to as "tape music." Some composers eventually used computers to generate, compose, and/or perform music, which developed into a new genre known as "computer music."[3] Each of these terms was invoked based on the context of the discussion. At all events, any deeper understanding depends on going well beyond the generic descriptions in reference works.

[1] Simon Emmerson and Dennis Smalley, "Electro-acoustic music," *Grove Music Online. Oxford Music Online* (Oxford University Press), accessed May 20, 2016.

[2] Jean de Reydellet, "Pierre Schaeffer, 1910-1995: The Founder of "*Musique Concrète*," *Computer Music Journal* 20, no. 2 (1996): 10.

[3] This term is itself nebulous, in that "computer music" is also understood in more recent contexts as music actually composed by computers following pre-determined protocols.

If the first step in discussing electronic music is defining it, the next step would be to uncover the particular modernist motivation for its genesis. In 1913, Luigi Russolo wrote a letter which he published three years later as a manifesto entitled "The Art of Noise." He proposed:

> "The most complicated orchestra can be reduced to four or five categories of instruments with different sound tones: rubbed string instruments, pinched string instruments, metallic wind instruments, wooden wind instruments, and percussion instruments. Music marks time in this small circle and vainly tries to create a new variety of tones. We must break at all cost from this restrictive circle of pure sounds and conquer the infinite variety of noise-sounds."[4]

With this statement Russolo became the first writer to declare that music should encompass "the infinite variety of noise-sounds." Arnold Schoenberg's *Pierrot Lunaire* and Igor Stravinsky's *The Rite of Spring* were already challenging audiences to broaden their definitions of "music." Russolo was insisting on much more. Indeed, he takes the idea to its logical conclusion, suggesting that all noise-sounds should be integrated into our musical tradition. He thus provided a manifesto for the electronic music era that followed some forty years later. There is little doubt that, had electronic sounds been available at the time of his writing, Russolo would surely have brought them under his big umbrella.

Given such a bewildering variety of both repertoire and nomenclature, this study first lays out in Chapter One the broad outlines of an electronic percussion taxonomy, including an annotated listing of the key historical repertoire. Chapter Two moves on to consider the range of performance challenges inherent within these various subcategories of music. Finally, the culmination (Chapters Three and Four) focuses on a comparison between two fundamentally different electroacousic works—*Mikrophonie I* (1964) by Karlheinz Stockhausen, and *Six Japanese Gardens* by Kaija Saariaho (1994). In doing so, I hope to both ease the way for fellow

[4] Luigi Russolo, *The Art of Noises*, trans. Barclay Brown (New York: Pendragon Press, 1986), 6.

percussionists contemplating a performance of these works, and to illuminate the cultural context in which this rich and diverse genre developed.

Chapter One:

Music without Humans

Origins

Because its origins intermingle and overlap with several of the rapid technological advances of the twentieth century, the beginnings of electronic music are difficult to pinpoint. There is considerable irony in the circumstance that the earliest known example of electrically amplified sound combined with classical acoustic instruments occurs in Ottorino Respighi's musically conservative *Pines of Rome* (*Pini di Roma*) for orchestra, composed in 1924. At the end of the third movement, accompanied by muted, *pianississimo* string trills and a single harp playing *pianissimo* harmonics, the recorded sound of a nightingale accompanies the final note of the famous clarinet solo.

Respighi might have just as easily used a nightingale whistle to evoke this common Roman bird, yet he elected to incorporate the newest technology. The recording was first played live for *Pines of Rome* on the brand-new Brunswick Panatrope, amplified electronically with its revolutionary vacuum tube technology.[5] The Panatrope was advertised to have "more than twice the sound range of the phonograph."[6] By this we should understand that the advantage of the

Fig. 1-1: 1925 Brunswick Panatrope

[5] The score specifies "*No. R. 6105 del Concert Record Gramophone: Il canto dell'usignolo.*" The nightingales for this recording were recorded in the early-1910s by Karl Reich in Bremen, Germany. The record can be found via its Victor catalog number: 45057. (Thanks to Dr. Robert Fink for tracking down this recording.) Orchestras today usually bring in their own recordings, often played over large house speakers.

[6] Advertisement for Brunswick Panatrope, *Talking Machine World*, February 15, 1926, p. 175, accessed August 10, 2016, http://memory.loc.gov/gc/amrlgs/tm1/1852014.tif.

Panotrope over its acoustic predecessors was less a matter of volume (acoustic machines could in fact play quite loudly) than frequency range—what a marketing department might refer to as a "realistic" sound.

The December 14, 1924 premiere in Rome actually took place a few months before Brunswick's commercial release.[7] We may never know the exact chain of events that brought Respighi and Brunswick together, but we do know it was a cutting-edge relationship, and Respighi was surely aware of this. In fact, when the Philharmonic Society of New York presented its first performance of the work in January of 1926 (coincidentally, also Arturo Toscanini's first concert with the orchestra), the program notes specified that "The Nightingale's Song in the third movement of Respighi's work is reproduced on a Brunswick Panatrope."[8] It is almost certain that Respighi's revolutionary usage had a strong promotional dimension. Although naively simple when compared to later developments, this earliest known example of amplified sound performing simultaneously with live acoustic instruments remains a curious landmark.

Although Western composers have often been drawn to new sounds, the pace picked up almost exponentially with the swift technological advancements in electrical amplification. The Theremin, invented by Lèon Theremin in 1920, offered the first instance where electric field

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[7] This information regarding the Brunswick Panatrope is taken from the following sources:
R.J. Wakeman, "Brunswick Panatrope," accessed June 6, 2016, http://www.pickapack.com/more.htm.
Tom McKenney, "Respighi – The Pines of Rome," *From the Canyons to the Stars*, June 9, 2015, accessed June 20, 2016, http://thunderswallow.blogspot.com/2015/06/respighi-pines-of-rome.html.

[8] "Pines of Rome," Program Notes, *The Philharmonic Society of New York*, January 14, 1929, accessed June 20, 2016, http://archives.nyphil.org/index.php/artifact/c282ba0b-aafa-4fbb-985e-8bb4f3a2a014/fullview#page/2/mode/2up.

sensing stimulated musical sounds.[9] Only eight years later the ondes Martenot—used famously by Olivier Messaien in his *Turangalila* Symphony—was invented by Maurice Martenot.

The Second World War proved a catalyst for many technological advances. Computer technology sprouted from electro-mechanical (half electronic, half mechanical) Torpedo Data Computers—devices just small enough to fit into a submarine, capable of handling complicated calculations for the trajectories of torpedoes.[10] No tuneful nightingales here.

The musical adoption of magnetic tape revolved, as is so often the case, around an enterprising individual—in this instance John Mullin, an electrical engineer and lieutenant in the United States Army. While stationed in England in 1943 he found himself listening to round-the-clock broadcasts of classical music from Germany. At that time, radio broadcasts consisted either of high-quality live broadcasts or lower-quality, prerecorded broadcasts of what were called transcription disc recordings. Mullin noted that the German radio was devoid of the hiss and scratches so common to these recordings. It appeared that either Hitler had the Berlin Philharmonic performing live broadcasts twenty-four hours a day, or the Germans, unbeknownst to the Allies, had invented a new recording device capable of delivering high-fidelity sound.

After Germany's defeat in June of 1945, Mullin had the opportunity to investigate and inspect electronic equipment captured from German soldiers in France, including some lower-quality portable tape recorders. But it was while traveling through Paris that he was offered a demonstration of Germany's highest achievement in the new technology: the Magnetophon K1, developed by *Allgemeine Elektricitäts-Gesellschaft* (*General Electricity Company*), or AEG. This device was the first fully functional, high-fidelity magnetic tape recorder which had actually

[9] Joseph A. Paradiso and Neil Gershenfeld, "Musical Applications of Electric Field Sensing," *Computer Music Journal* 21, no. 2 (1997): 70.

[10] Terry D. Lindell, "Restoration of Pampanito's Rare Torpedo Data Computer," *Lexikon's History of Computing*, accessed June 24, 2016, http://www.computermuseum.li/Testpage/AnalogComputers.htm#Restoration.

been in use on German radio since 1941. Mullin promptly commandeered two of these machines to take back to the United States. With some reverse engineering at the Ampex Corporation, Mullin and his colleague William A. Palmer developed the Ampex Model 200 which, in 1947, became the first commercial audiotape recorder.[11]

Fig. 1-2: Magnetophon K1

Even though this breakthrough device became commercially available in 1947, it was scarcely intended for home music listening—vinyl records already dominated the market. Instead, it was serious musicians and composers who acquired these newfangled machines. They began experimenting with them almost immediately. Before we turn to their achievements, however, we should acknowledge that the first experiments manipulating recorded sound actually took place in an unlikely spot: Cairo, Egypt. In 1944, the Egyptian composer Halim El-Dabh wrote *The Expression of Zaar* by capturing the sounds of a *zaar* ceremony (a Middle-Eastern exorcism ritual) on a magnetic wire recorder—a device that directly preceded magnetic tape—which he then subjected to various reverb effects to create his work.[12]

Magnetic tape, however, quickly took center stage. High fidelity (a combination of wide frequency response and high frequency-to-noise ratio) coupled with the malleability of magnetic tape fueled the electronic music explosion of the 1950s. Magnetic tape could be slowed down, sped up, or played backwards. It could be spliced, layered, and looped. This afforded such a

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[11] The information regarding John Mullin is taken from the following newspaper articles:
Myrna Oliver, "John Mullin; U.S. Pioneer in Tape-Recording Technology," *Los Angeles Times*, July 1, 1999.
Nick Ravo, "John Mullin, 85, Whose Magnetic Tape Freed Radio Broadcasters," *The New York Times*, July 3, 1999.

[12] Thom Holmes, *Electronic and Experimental Music: Technology, Music, and Culture* (United Kingdom: Taylor & Francis: 2008), 156.

colossal range of new sounds that in the span of just a few years, electronic music sprang up with near simultaneity in multiple countries around the world.

Pierre Schaeffer is rightly credited with taking the next step in the development of electronic music—*musique concrète*. Driven initially by curiosity, he amassed a great deal of equipment on his own that enabled him around 1948 to enter into a new phase of exploration. His manipulation of recordings (often through experimentation with the physical medium) drew from a world of sounds that included everything from electric motors to traffic jams, trains to pots and pans, wind to crashing waves, recorded performances on traditional acoustic instruments to open-ended improvisations.[13] Schaeffer described his project this way: "Instead of notating musical ideas on paper with the symbols of solfège and entrusting their realization to well-known instruments, the question was to collect concrete sounds, wherever they came from, and to abstract the musical values that they were potentially containing."[14]

In contrast to the French school of *musique concrète*, the German school of *elektronische Musik* that began in 1949 focused on electronically-derived sounds (sine waves, gates, filters, etc.), though they later worked with recorded sounds as well.[15] Yet the French and the Germans did not toil in complete isolation. In 1952 Karlheinz Stockhausen worked directly with Schaeffer. At the *Studio für elektronische Musik des Westdeutschen Rundfunks* in Cologne, Stockhausen began experimenting in the mid-1950s with altering the attack, sustain, decay, direction (i.e., subjecting to retrograde), and other aspects of recorded sounds on tape. He then

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[13] Max Peter Baumann, "Listening to Nature, Noise, and Music," *The World of Music* 41, no. 1 (1999): 104.

[14] Jean de Reydellet, "Pierre Schaeffer, 1910-1995: The Founder of "*Musique Concrète*," *Computer Music Journal* 20, no. 2 (1996): 10.

[15] Lowell Cross, "Electronic Music, 1948-1953," *Perspectives of New Music 7*, no. 1 (1968): 33.

began applying more "traditional" compositional techniques, including serialism, to his tape-modifying techniques.

Stockhausen's first major achievement—a milestone in Western music—was *Gesang der Jünglinge* (translation: *Song of the Youth*, 1956), whose thirteen minutes were said to have contained thousands of splices. The sole (though pivotal for the work) application of *musique concrète* was Stockhausen's source recording of a single boy soprano singing the medieval canticle of King David and a burning fiery furnace (doubtless a nod to the Holocaust, the truth about which had now become common knowledge). With just this single voice and his modest arsenal of new electronic sounds, Stockhausen used multiple speakers surrounding the audience to create a new, nearly indescribable soundscape.[16]

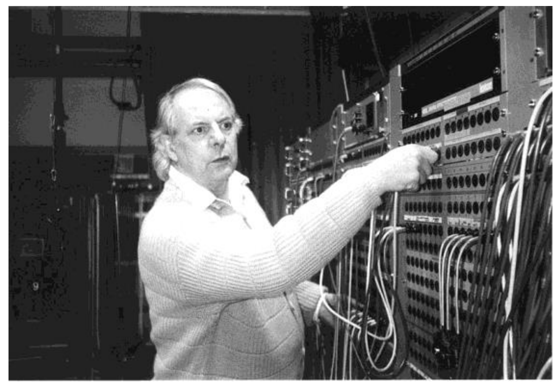

Fig. 1-3: Stockhausen at the *Studio für elektronische Musik des Westdeutschen Rundfunks* in Cologne

Independently and apparently unbeknownst to European musicians, concurrent experiments in sound were being conducted in the United States. Whereas publicly-subsidized radio networks provided the facilities for electronic music experimentation in Europe, in the United States these experiments took place in educational institutions—most notably, at Columbia University in New York City. In 1951 the University purchased a professional Ampex tape recorder in order to record university concerts. Faculty member and composer Vladamir Ussachevsky was put in charge of this precious piece of equipment. While they carried out the designated function, Ussachevsky and fellow professor Otto Luening could not resist also co-opting the machine to experiment with their own sounds.

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[16] Pascal Decroupet and Elena Ungeheuer, "Through the Sensory Looking-Glass: The Aesthetic and Serial Foundations of *Gesang der Jünglinge*," trans. Jerome Kohl, *Perspectives of New Music* 36, no. 1 (Winter, 1998): 97-104.

In 1958 Roger Sessions and Milton Babbitt joined in the formation of the new Columbia-Princeton Electronic Music Center.[17] Simultaneously, the Music for Magnetic Tape Project, formed by John Cage, Earle Brown, Christian Wolff, David Tudor, and Morton Feldman (all members of the informal group of artists known as the "New York School") experimented independently between 1951 and 1954. Having explored electroacoustic composition in his *Imaginary Landscape* series (1939-1952), John Cage completed the entirely electronic piece *Williams Mix* in 1953 while working with the New York School.[18]

Thus far we have described the early origins of purely electronic music, which was subsequently combined with acoustic instruments and ensembles. The developments that followed correspond directly to the advances in technology. The group *Gentle Fire*, organized between 1968 and 1975 by Hugh Davies (who had worked directly with Stockhausen), certainly deserves recognition as pioneers. Something of an electrified Harry Partch ensemble, *Gentle Fire* was a seven-member group that employed piano, percussion, violin, cello, clarinet, recorder, trumpet, invented instruments, voice, and live electronics in sounds that danced cheerfully on the border between art and popular music.[19]

A Brief History of Non-Human Music Making

To place electroacoustic music in its full context, we had best take several steps back in time and examine the longstanding human desire for creating music not directly generated by a human. For centuries predating computers, humankind had shown an active interest in artificial

[17] Vladimir Ussachevsky, "Columbia-Princeton Electronic Music Center," *Revue belge de Musicologie / Belgisch Tijdschrift voor Muziekwetenschap* 13 no. ¼ (1959): 129-130.

[18] Steven Johnson, *The New York Schools of Music and Visual Arts: John Cage, Morton Feldman* (New York: Routledge, 2002), 2-20.

[19] Hugh Davies, "Gentle Fire: An Early Approach to Live Electronic Music," *Leonardo Music Journal* 11 (2001): 53-58.

life and automata (mechanical devices with many moving parts). Similar to how the invention of the microprocessor led to an explosion of electronic technology, Peter Henlein invented spring-driven clockwork around 1500, paving the road for mechanical technology with a compact footprint.

The French inventor Jacques de Vaucanson (1709-1782) appropriated Henlein's technology and pursued groundbreaking work with automata. Music boxes, popular from the late 1700s on, deployed a cylinder covered in a series of pins that, when turned, plucked a set of tuned, metal teeth. This technology was expanded on by Vaucanson in his mechanical masterpiece, *The Flute Player*—a full-sized automaton created in the guise of a shepherd, with a repertoire of between twelve and twenty songs replicated on simulated tabor and pipe.[20]

Dietrich Nikolaus Winkel (1777-1826) and Johann Nepomuk Maelzel (1772-1838) both made important contributions in the field of automata mechanics, though in contentious fashion. Maelzel, a known charlatan and swindler, attempted to take credit for Winkel's invention of the metronome. Maelzel was ultimately exposed in a formal trial—though only after he had already made a good deal of money selling a device he claimed to have invented. The familiar tapered case with the sliding weight and spring mechanism remained virtually unchanged for almost two hundred years. It is easy to overlook the musical debates that this device unleashed about the nature of performance—which continue even to this day.

Maelzel, of course, was also fascinated with automata. In 1805 he developed a large, mechanical orchestral organ that he named the Panharmonicon. It was capable of performing music from a cylinder or music roll that imitated various orchestral instruments (including percussion). Beethoven, who was greatly taken with the possibilities of Maelzel's metronome,

[20] Ian Willcock, "Composing Without Composers? Creation, Control, and Individuality in Computer-Based Algorithmic Composition," in *Electronics in New Music*, ed. Claus-Steffen Mahnkopf, Frank Cox, and Wolfram Schurig (Self-published: 2006), 221.

composed his orchestral piece *Wellington's Victory* for the Panharmonicon. Ironically, in 1821 Winkel developed an instrument similar to Maelzel's Panharmonicon, only more sophisticated; it could "compose" music itself. Dubbed the Componium, this mechanical organ had two music rolls; using mechanical randomization, the machine plugged in various generic segments to create a coherent musical tune and variations in patterns that almost never repeated.[21]

Music-reproducing inventions begun in the nineteenth-century culminated in two final competing acoustic mediums: Player/reproducing pianos and the phonograph/gramophone. The player piano germinated in the middle of the eighteenth century, borrowing heavily from the spring-driven technology of music boxes and barrel organs before it. Similar to the Panharmonicon and the Componium, player pianos reproduced their musical sounds through mechanical means on an acoustic instrument. However, unlike bulky mechanical organs, these instruments were intended for mass production and marketed to domestic consumers for amateur music enjoyment.

Like the music boxes that preceded them, player pianos were generally restricted to performing music punched by teams of technicians onto mathematically laid-out grids known as piano rolls. In this sense they were the distant ancestors of modern-day drum machines. The most advanced and expensive of these instruments, however, included operator controls that could regulate both tempo and dynamics. The purpose of these was to give an operator who had no formal musical training some sense of being part of the performance. In execution these purely mechanical devices were ungainly and adjustments were coarse rather than nuanced. Understandably, the repertoire favored Tin Pan Alley standards such as "Oh You Beautiful Doll" over Chopin nocturnes.

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[21] Willcock, *op. cit.*, p. 225.

Around the turn of the century the German firm Welte introduced a very different instrument that became known as the reproducing piano. Rather than playing back pre-punched versions of popular songs, this new device was designed to capture all the nuances of the greatest classical pianists. Welte dubbed their invention the "*Welte Mignon*," or "Small Welte." "Small," however, was only in relation to the gargantuan player devices (on the scale of Maelzel's Panharmonicon) that the firm mostly manufactured.

The bulky upright recording mechanism was attached to the piano by means of eighty-eight lengthy pneumatic lines activated by small tubes of mercury attached to each key. Such a high-end and costly device would easily dominate the most spacious European living or music room. Welte invited a string of famous pianists from Vladimir Pachmann to Percy Grainger to try out their invention, always insuring that a photographer was nearby. The reproducing results were remarkably good when the entire system was in perfect working order—though this required an inordinate amount of maintenance. While the Welte-Mignon never became a huge consumer product, it showed just how far purely mechanical mechanisms could be developed.[22]

All of the machines described thus far were, effectively, mechanical *musical instruments*, in execution as well as in the sounds that they emulated or produced. In 1877 Thomas Edison changed all that with the phonograph. With his remarkably simple device, sound vibrations were captured onto a tin foil (later, hard wax) cylinder by a stylus activated purely by sound that could "record" for two to three minutes. Edison initially thought the device suitable mostly for spoken dictation from executives that would then be transcribed by secretaries. It would be left to others, such as the legendary Fred Gaisberg (of RCA), to discover the commercial potential of recorded music. Yet because he was now dealing with sound waves, Edison's phonograph marked a fundamental departure from the mechanical world of automata.

[22] Sydney Grew, "The Player-Piano," *Music and Letters* 6, no. 3 (1925): 236-242.

For several decades the phonograph/gramophone competed with the player piano for market share, although the ultimate triumph of the phonograph was a foregone conclusion. The phonograph/gramophone had a smaller footprint, lower cost, and the ability to recreate a wider variety of sounds that more than offset the modest controls users enjoyed on player pianos. What finally sealed the fate of the player piano was the electronic amplification first utilized by Respighi.

Except for simple music boxes and a handful of unique mechanical devices, to count as a musical presentation prior to the twentieth century it was necessary for a group of performers and an audience to assemble in the same place and at the same time. The advent of recorded sounds (and the subsequent broadcasts of these sounds) changed that centuries-old alignment. It allowed performers to reach audiences who were displaced in both location and time. Moreover, users could experience a performance as many times as desired. For successful performers a new bright-line distinction arose between recording sessions and live performances. For most performers this required a major shift in focus from the audience to a horn or microphone. In theory one can imagine the presence of an audience when making a live studio recording—an audience that will exist and be listening once the recording is finished—but the impact of spontaneous audience reaction cannot be discounted. Live performance is inevitably more immediate.

Live broadcasts of ballroom jazz orchestras in New York, Chicago, and other urban centers in the 1920s led to a nationwide explosion in the popularity of jazz. Similarly, the live broadcast of rock ‘n’ roll concerts benefitting the victims of famine and other natural disasters during the 1980s exposed hundreds of millions of people to simultaneous performances across the world.[23]

Replacing Performers with Sounds

One of the most concise philosophical perspectives on electronic music is found in a book titled *An Introduction to the Creation of Electroacoustic Music* by Samuel Pellman (1994). Pellman points out that Karlheinz Stockhausen, Milton Babbit, Edgard Varèse, and most other early electroacoustic composers were raised and educated in the practices, institutions, and traditions of European art music. This music was (and still is) performed in a very ritualized, formal setting. Concert etiquette includes when to sit, when to talk, and when to applaud. Within this framework, concerts are both a social gathering and an artistic event; many middle- or upper-class concertgoers attend concerts in an effort to be certified as "cultured."

Audience expectations are very specific. Audiences expect a division between the seated audience and the typical raised proscenium stage. They expect their seats to face the performance space. There is an expectation that there will be an indication of when the performance will take place: the lighting changes, a curtain may rise, and the performers enter the performance space. The audience expects that something deserving of the attention of both their eyes and ears will occur during the performance. The composer supplies a series of musical instructions for the performers to execute, the details of which are typically defined in the program notes read (ideally) before the event. The performers, now claiming a portion of audience members' time, exercise control through a series of musical events that inevitably reach a conclusion. Many audience members will have had some musical training or experience as performers themselves,

[23] Samuel Pellman, *An Introduction to the Creation of Electroacoustic Music* (Belmont, California: Wadsworth, Inc., 1994), 359.

and are familiar with the musical styles and structures to which they are listening. After the performance, the audience members applaud, exit the hall, and converse with their fellow spectators about what they witnessed: did it meet, exceed, or fail to meet their expectations?[24]

Hence there is ritualized spectacle behind live performances. In the words of Pellman:

> "Much of the excitement of attending a concert derived from the fact of being present as such 'great works of art,' the creations of 'awesomely gifted intellects,' were brought to life. Unlike a painting or a piece of sculpture, which can be touched and possessed, such a piece of music consisted only of the intangibles of tone and time. When the final reverberations subsided, it was gone once again. Therefore, it was important to the listener to be able to confirm the experience by observing clearly the gestures that gave rise to the sound. The ability to associate sight with sound was a vital part of the experience."[25]

Early electronic composers, by and large, still bought into this framework. Therein lies one of the biggest paradoxes in the live presentation of 1950s electronic works; they were completely devoid of actual performers. Stockhausen experienced these challenges with the performance of *Gesang der Jünglinge* in 1956. Limited techniques available to make electronic music, combined with the large, cumbersome equipment used to produce these new sounds, created a situation in which composers were unable to reproduce their music with the equipment onstage. The composition of these works became the performance itself, which occurred at a time well before the presentation, and the product of this process was typically a tape that was played back to an audience through loudspeakers.[26]

Despite the disadvantages described by Pellman, the new genre afforded certain advantages. In theory, electronic music is performed with complete accuracy: the exact intentions of the composer are cemented in the product. The process *is* the performance. Yet this

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[24] These perspectives are borrowed from Pellman, *op. cit.*, pp. 359-360.

[25] Pellman, *op. cit.*, p. 360.

[26] Pellman, *op. cit.*, p. 361.

is an illusion since the particular setup and sound will still vary—often considerably—from hall to hall. That said, the notational system on which the West relied for a thousand years did not even attempt to specify many aspects of performance; there is no proof that nineteenth-century composers, for example, either expected or even wanted this.

Even if only in a limited sense, recorded electronic music can permanently secure and protect the exact sounds the composer specifies, circumventing any limitations of time and space. It removes any fundamental marring of the work by human error, technical hurdles, or misinterpretation. It allows the composer to develop specific new sounds and sound combinations that were previously only in the composer's imagination. Electronic music and recording technology eliminates the variables that may occur between the conception of a work and its performance, leaving the composer in complete control. No longer does a composer have to worry about the performer as a middleman. At the same time, electronic music has contributed to the undue emphasis on perfection; audiences accustomed to it are shocked to hear missed notes or poor intonation.[27]

Milton Babbit welcomed these advantages of electronic music. RCA invited Babbit to both consult on and compose for their new Mark II RCA Synthesizer in the mid-1950s. Babbit's new compositional tool had more flexibility, and most importantly, more precision than the live performers for which he had written in the past. He was actually more interested in the aspects of control this synthesizer offered him, rather than the degree of new sounds and timbres it was

[27] Frank Cox, "Aura and Electronic Music," in *Electronics in New Music*, ed. Claus-Steffen Mahnkopf, Frank Cox, and Wolfram Schurig (Self-published: 2006), 54-55.

capable of producing. Babbit realized his first work for the device in his piece titled *Composition for Synthesizer* in 1961.[28]

There is a disadvantage to the performance of completely electronic works: the presentation is simply a reproduction of previous executions by the composer. Every performance is exactly the same. The audience is no longer offered the opportunity to see firsthand the live realization of an artwork. There is no risk of error, and therefore, no virtuosic performer with which the audience can identify as an individual who has put all of his/her time and effort in preparation for one single chance at an inspired performance.

A second major disadvantage is that although these works were presented in traditional concert halls with the audience facing the performance space, there was no visual dimension to the performance at all. Muses Pellman:

> "There was no opportunity for the listener to associate the sounds being heard with gestures that might have produced them. Few listeners were familiar with the techniques of tape music, so that few could even imagine the gestures that might have been responsible for the sounds. Thus, there was a distinct absence of visual cues that might otherwise confirm that the event was special... This estrangement of sight from sound meant that even ordinary cues for silence and applause were absent, leaving the members of the audience feeling somewhat self-conscious and often perplexed."[29]

Mindful of these disadvantages, in the 1950s composers already sought to develop new ways to create and execute electronic works that resulted in more meaningful (and visual) performances. One of the methods aimed at overcoming this obstacle was to present the electronic work in conjunction with visual media, as Edgard Varèse did in his 1958 *Poème électronique*. Although routinely played without the visual component today, the original piece was integrated with a

[28] Elaine Barkin and Martin Brody, "Babbit, Milton (Byron)," *Grove Music Online. Oxford Music Online* (Oxford University Press), accessed July 7, 2016.

[29] Pellman, *op. cit.*, p. 361.

film consisting of a series of black-and-white photographs chosen by Le Corbusier—the commissioner of the work—and was displayed many times a day inside the Philips Pavilion at the 1958 Brussels World's Fair. Nonetheless, the method that seemed to ultimately prevail in the art music world, at least in terms of live concert performance, was the addition in electronic works of one or more live performers—the birth of electroacoustic music.

Electroacoustic Music – A Symbiotic Relationship

The broadest definition of electroacoustic music is a work that combines one or more live performers with any type of electronically amplified sound. This definition encompasses a broad range of works. One of the goals of this dissertation is to contribute to a proper taxonomy of the different types of electroacoustic works for performers. Early electronic endeavors in music—so-called *musique concrète* and *elektronische Musik*—lack the element of live performance that is the key feature of electroacoustic works.

In 1939 John Cage had composed his *Imaginary Landscape No. 1*—scored for two turntable operators, gong, and prepared piano—predating by more than a decade the documented European experiments with electroacoustic music. It did not take European composers long to realize the disadvantages of solely electronic music, and they quickly developed alternatives themselves. In 1954 Edgard Varèse composed *Déserts* for live ensemble with electronic sounds (to be discussed further in Chapter Two). Introducing a live performer (or ensemble) on the stage supplied many elements that were previously lacking: the ability to associate audible sounds with visual gestures, the excitement provided by the action of live performance, and the slightly morbid possibility of human error.

An interesting dimension of this genre is its unique admixture of past and present. More so than in a traditional composition for acoustic instruments, the audience hears the product of a composer who in “a past” has labored over the electronic portion, while the performers executing the live music operate in “a present.” Unlike the unwavering, unchanging electronic part, the performer injects the music with human flexibility, even unpredictability.

When a live performer joins with electronic music, we as listeners can interpret the changing relationships between the two elements. Electroacoustic music can in some ways be compared to a concerto, in which one or more live performers join together with another contrasting musical element. The soloist(s) can be accompanied by the other(s). They can take a background role and accompany the other. They can battle amongst themselves. They can work together.[30] One major development growing out of the possibilities of these relationships was that of interactive computer music, or music that responds in real-time to the performer. This can be done through a microphone or through gestural interfaces.[31]

A rich example, to be discussed later in more detail, is Kaija Saariaho’s *Six Japanese Gardens* (1994). The electronics in the first and fourth movements play a more ambient, background role to the percussionist. The percussionist simply starts the electronic track and plays the movement independently. The second and third movements feature a more involved electronic track that is triggered at successive points by the performer; the electronics are basically co-equal with the performer. Finally, the last movement injects a competitive mix—the percussionist repeatedly crescendos to a climax, which is then interrupted by triggered

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[30] The perspectives regarding the combining of live and electronic music in this and the previous paragraph are borrowed from Pellman, *op. cit.*, p. 362.

[31] Guy E. Garnett, “The Aesthetics of Interactive Computer Music,” *Computer Music Journal* 25 no. 1 (2001): 21-25.

exclamations from the electronics. In the next chapter we define more concretely the growing varieties of electroacoustic music.

Chapter Two:

A Taxonomy of Electroacoustic Works

The four categories spelled out in this chapter are all interrelated to one degree or another. But to musicians searching for new repertoire these distinctions are important. For listeners, the greater their degree of understanding of the various interactions, the more satisfying their listening experience. Adding live acoustic instrument performers to previously produced electronic recordings marked a huge advancement for composers who were experimenting with new electronic sounds. It provided a much more familiar outlet for audiences who were conditioned to performances with a distinct visual dimension.

The Purely Electronic Backdrop

When Karlheinz Stockhausen premiered *Gesang der Jünglinge* in the auditorium of the Studio for Electronic Music at the WDR (*Westdeutscher Rundfunk*, translation: *West German Radio*) in Cologne, he positioned five high-wattage loudspeakers around the large space.[32] The newly-conceived sounds, combined with a special five-track spatial playback system, doubtless provided considerable stimuli for an audience in 1956. An important part of the experience was the group dynamic, or the shared experience.

But many questions remain unanswered: Who attended? Were there program notes? Did Stockhausen speak beforehand? Or after? What kind of lighting was used? What else was on the program? Was any of the reproducing equipment visible? What did audience members talk about

[32] Why Stockhausen chose to create a work with five (or, in some accounts, six or four) tracks was never fully explained by the composer. When flagship label Deutsche Grammophon decided to publish the work as a stereo LP (several years earlier a much poorer quality monophonic version had been released), the multiple tracks had to be mixed (presumably by Stockhausen) down to two stereo tracks. This is the version known by all but a very few who were present at the work's premiere.

after the performance? One comprehensive article examines the sketches for *Gesang* published by The Paul Sacher *Stiftung* (*Foundation*) in 1983.[33] In another account we have a direct quote from Stockhausen himself acknowledging that he wished to set all eight canticles, but because of deadlines he had to create an ending after having only composed thirteen minutes.[34] A 1963 review examines closely the stereo version released by Deutsche Grammophon.[35] Yet the actual circumstances of the premiere itself seem to have attracted little scholarly attention. To some extent this resulted from the extraordinarily complex preparation that the composition entailed. Yet it also attests to the lack of interest on the part of composers such as Stockhausen in the circumstances of traditional music consumption.

As noted in Chapter One, other purely electronic compositions—such as the Varèse *Poème électronique* at the 1958 Brussels World's Fair—were conceived to be played in conjunction with visual elements. Yet in most respects these works (and their American counterparts) were isolated experiments. Far more people experience *Gesang der Jünglinge* via the Deutsche Grammophon recording than in a concert hall. The setup for the eight minutes of Varèse's three-monaural tracks at the Brussels World's Fair (which was preceded by a work by Iannis Xenakis [1922-2001]), with its hundreds of speakers and *avant-garde* architecture, was impossible to replicate. The concept of "music videos" was still decades away; the only vaguely comparable art form of the time were film soundtracks. Varèse's work was eventually consigned

[33] Pascal Decroupet and Elena Ungeheuer, "Through the Sensory Looking-Glass: The Aesthetic and Serial Foundations of *Gesang der Jünglinge*," trans. Jerome Kohl, *Perspectives of New Music* 36, no. 1 (Winter, 1998): 97-142.

[34] Günter Peters and Mark Schreiber, "'...How Creation Is Composed': Spirituality in the Music of Karlheinz Stockhausen," *Perspectives of New Music* 37, no. 1 (Winter, 1999): 100-101.

[35] Kurt Stone, "Karlheinz Stockhausen: *Gesang der Jünglinge* (1955/56)," *The Musical Quarterly* 49, no. 4 (1963): 551-554.

to a two-channel LP, which could only offer a glimpse of what must have been a mind-altering experience.

Instrumentalist(s) with Recorded Electronics

Composers' desire to combine electronics with live performers percolated—first slowly, and then more vigorously. We begin with the most basic (and perhaps obvious) category of electroacoustic music, a category that is still widely popular today. We can call this *instrumentalist(s) with recorded electronics*. This track has several representative phases across half a century—enough to record the upswing in interest on the part of both composers and instrumentalists.

Déserts by Edgard Varèse is an early example of electroacoustic music involving live performers and recorded electronic sounds. Completed in 1954, it calls for a modified orchestra without strings: fourteen woodwind and brass players, five percussionists (playing almost every percussion instrument imaginable), and one pianist. It requires a conductor and typically a separate audio engineer in charge of the recorded electronic portion. The electronics were originally played live on two monophonic tape players transmitted via two loudspeakers, producing stereophonic audio. Coordinating the musicians and the tape presented several new performance challenges.

Instead of playing along with the electronic portions, the live musicians alternate live playing with three interpolations of the electronic stretches. The score contains three moments where the conductor cues the audio engineer to play the independent electronic segments. When the electronic segment has completed, the audio engineer cues the conductor to begin the next instrumental section. Since the two groups do not play simultaneously, synchronization between the orchestra and the electronics is not an issue.[36]

Fig. 2-1: *Déserts*, mm. 80-84. "OS" designates a pause in the ensemble, and the start (and end) of the electronic segment

While *Déserts* deserves recognition as a significant early electroacoustic piece, it barely capitalizes on the infinite possibilities of electroacoustic music. Instead of augmenting the sound produced by the acoustic instruments, the electronic portions are juxtaposed. Additionally, the electronic segments consist primarily of manipulated recordings of live instruments that are also present in the instrumental ensemble. When listening to a recording of the piece (as opposed to seeing a live performance) the two elements are not particularly distinct.

There are nonetheless performance choices to consider in *Déserts*. The score notes that the entire work can be performed without any of the electronic interpolations, which account for nearly half of the twenty-four minute piece. This would make *Déserts* a lot simpler to execute, especially if a group did not have the appropriate tape players available; however, removing half

[36] Adam Tindale, "Advancing the Art of Electronic Percussion" (PhD diss., University of Victoria, 2009), 15.

of the piece significantly compromises its essence. There is the option of using a separate audio engineer or, with modern digital playback systems, the conductor could easily operate a playback system from the podium, affording more control of the performance to himself/herself.

Varèse's work was premiered in Paris on December 2nd, 1954 for a conservative and wholly unprepared audience between works by Mozart and Tchaikovsky. The premiere was recorded, and now when listening to this first performance one can hear shouts, jeers, and laughter from the unappreciative Parisian audience, who probably reacted to both the live and electronic parts of the music as nonsensical noise. They exhibited neither an understanding nor a tolerance for these new sounds.

The next step in electroacoustic music was to combine electronic and acoustic instruments simultaneously. In 1956 the American experimentalist John Cage wrote *27'10.554" for a Percussionist*. However, like many of Cage's experimental works, this one eludes classification. It assumes a place of importance because it is arguably the first piece written for *solo* percussionist and electronics. Yet the graphic notation of the four instrumental groups is purposely imprecise: metal (M), wood (W), skin (S), and the final group (marked as "A") as described by Cage in the score: "all others, e.g. electronic devices, mechanical arrangements, radios, whistles, etc." Each page denotes a duration of a minute, and the number above each "cell" denotes the passage of a second of time.

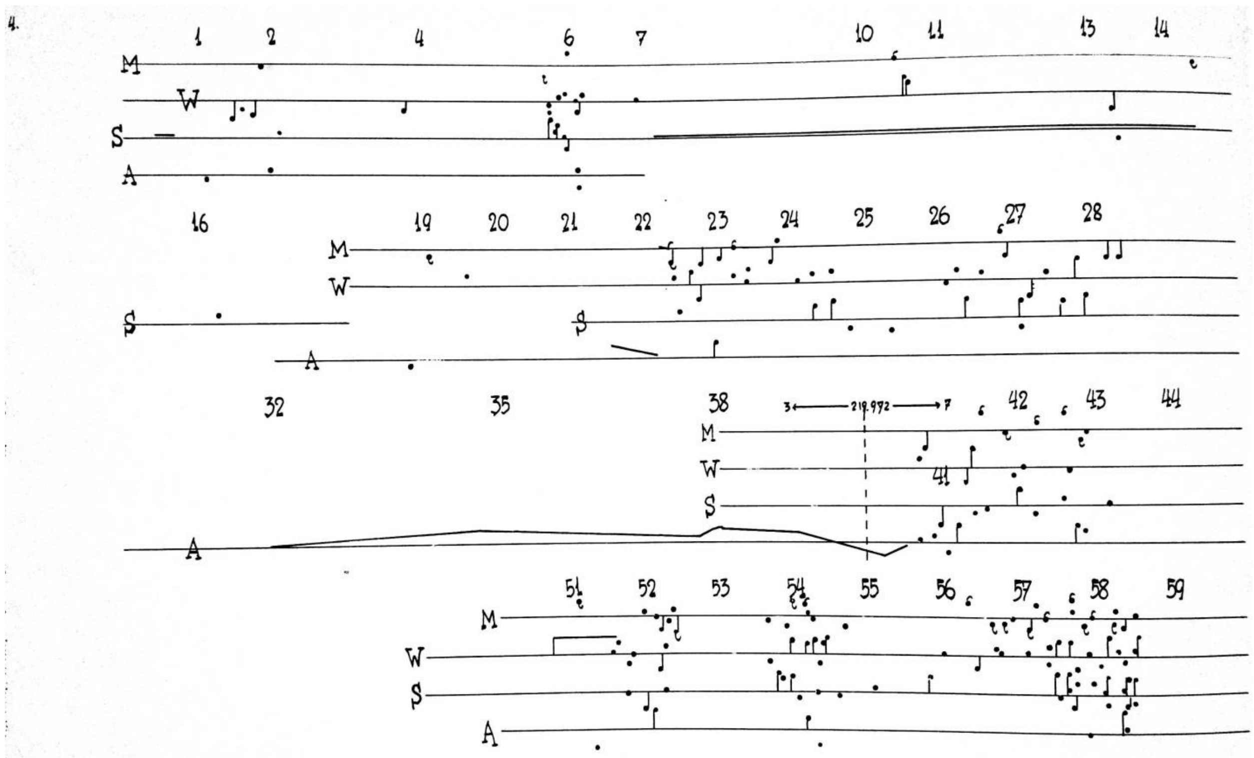

Fig. 2-2: ***27' 10.554" For a Percussionist,*** **p. 4 (minute four)**

27'10.554" for a Percussionist defies convention not only in its graphic notation; Cage does not provide the recorded accompaniment. In the score he explains, "This piece may be performed as a recording or with the aid of a recording." Hence the recorded portion with which the percussionist plays is entirely dependent on the individual percussionist. Furthermore, the coordination between the two parts is entirely unspecified. One could employ recorded acoustic instruments (electronically altered or not), electronically synthesized sounds, or omit the recorded portion altogether. Obviously Varèse and Cage were powerfully intrigued by the possibilities of electronics in the early 1950s, yet it would be another fifteen years before the electronic part formed an indissoluble part of an electroacoustic composition.

Karlheinz Stockhausen's *Kontakte*, composed between 1958 and 1960, takes a step forward in specificity. According to Stockhausen, the piece can be performed in two ways. The work can be performed with only the electronic portion present, much like Stockhausen's *Gesang der Jünglinge*. Or it can be performed with the addition of the piano and percussion parts.

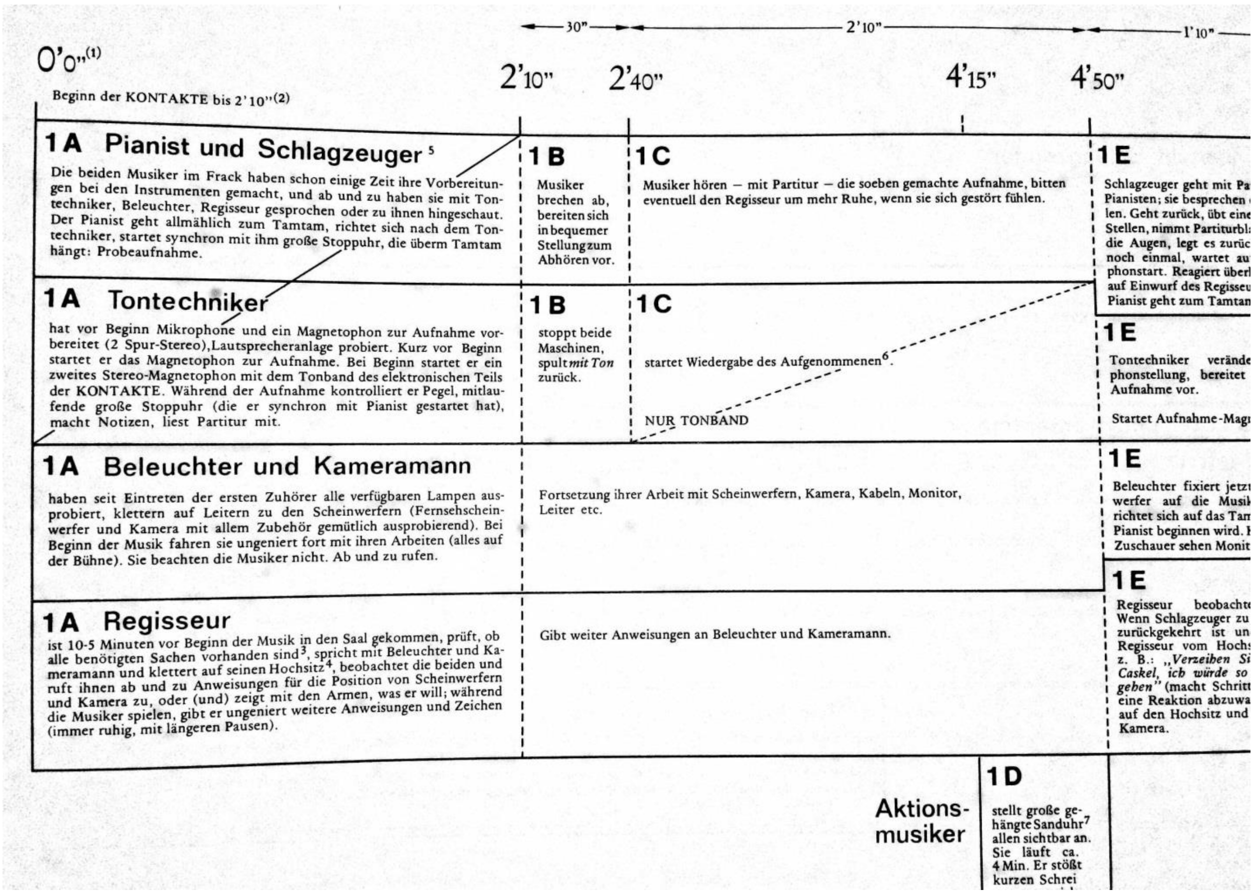

Fig. 2-3: *Kontakte*, p. 1

Indeterminacy and aleatoricism are perhaps two aesthetic considerations that lay behind the high level of discretion left to performers of these early electroacoustic works. An additional factor was probably pragmatic: a desire on the part of composers *not* to rule out performances by ensembles that did not have access to what was still rare and expensive equipment. For this reason composers refrained from offering any strong preferences—including permitting the electronic parts to be omitted. Today, of course, electronics of all types (including 15 ips [inch per second] tape decks) are readily available and there are rarely reasons for omitting the electronics. Moreover, audiences today accustomed to *Werktreue* expect the full acoustical experience.

Between 1963 and 2006, the Argentinian-American composer Mario Davidovsky composed twelve electroacoustic works in a series entitled *Synchronisms*. The fifth of the series, *Synchronisms No. 5*, composed in 1969, is scored for percussion quartet with electronics. Davidovsky states: "One of the central ideas of these pieces is the search to find ways of embedding both the acoustic and the electronic into a single, coherent musical and aesthetic space."[37] This was a bolder step than Davidovsky himself may have realized.

This is a very challenging work to perform because the conductor must keep track of, and conduct alongside, a completely unwavering and rhythmically precise electro-acoustic track, represented both graphically and rhythmically in the score:

[37] Chris Woodstra, Gerald Brennan, and Allen Schrott, ed., *All Music Guide to Classical Music: The Definitive Guide to Classical Music* (San Francisco: Backbeat Books, 2005), 341.

Fig. 2-4: ***Synchronisms No. 5*****, mm. 96-98. Note the tape part at the top of the score**

Furthermore, the conductor or a separate technician must begin the tape part exactly at a specific point in the score:

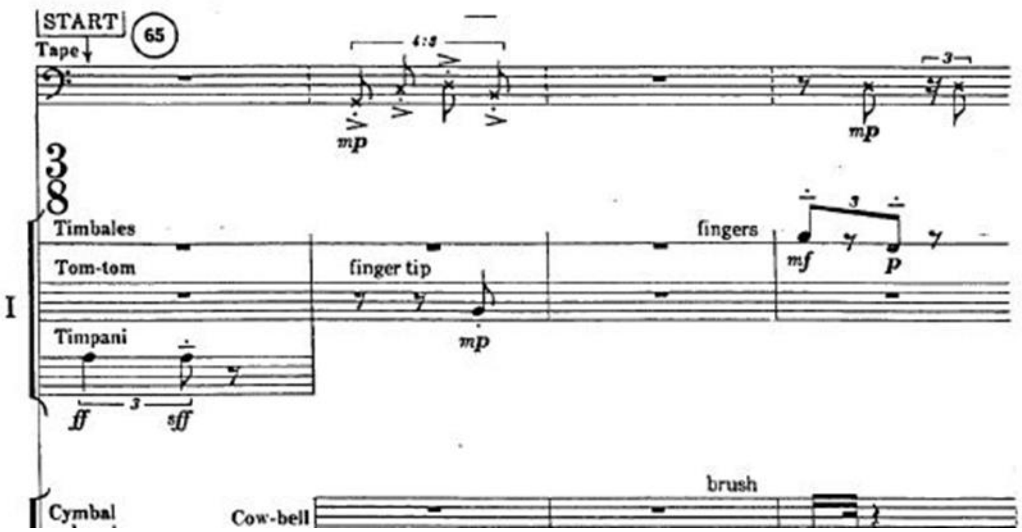

Fig. 2-5: *Synchronisms No. 5*, mm. 65-68. Start of tape part

Because of the way the piece unfolds, the starting of the track at a certain point in the middle of the piece is compositionally pivotal. *Synchronisms No. 5* opens with many overlapping percussive, noise-like sounds; it eventually becomes evident that the acoustic percussion sounds mimic the electronic noises that slowly creep into the texture, which ever more present. This blurring effect remains dependent on starting the track in the middle of the piece—it is essential to the overall aesthetic of the work.

In 1984 Mexican composer Javier Alvarez composed *Temazcal* for solo maraca player and electronics. Similar to Davidovsky's *Synchronisms No. 5*, the performer must rely on a notated representation of the electro-acoustic part (albeit this example has more detailed graphic notation):

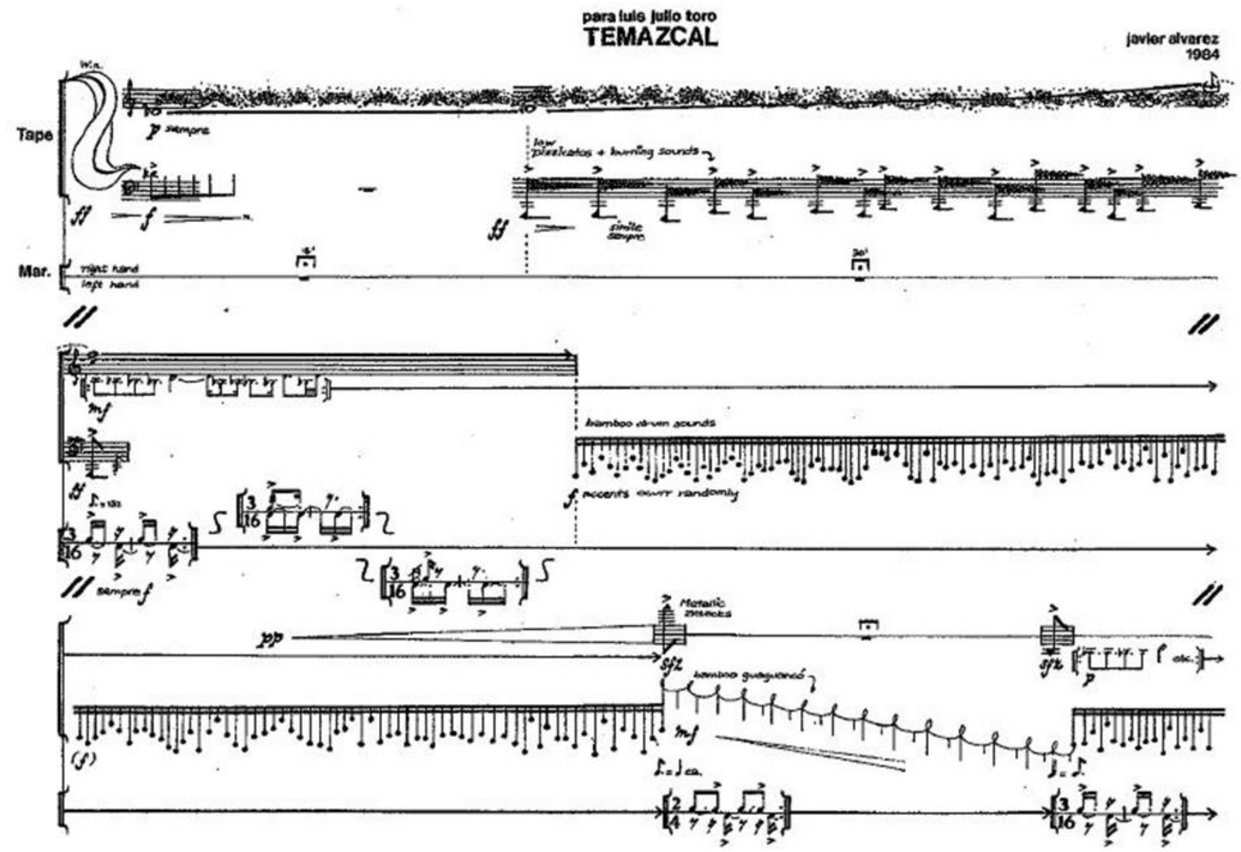

Fig. 2-6: *Temazcal*, beginning

Near the end of the piece, a recorded harp song emerges from the electro-acoustic sounds, and the performer is offered a regularly-notated part alongside the maracas part. The challenge here is that the performer must know the harp part in order to follow along. It would be prudent for the performer to first rehearse the music on a marimba or piano to become accustomed to the part. This is in rather dramatic contrast to the majority of electro-acoustic parts, which only feature graphic or simple rhythmic notation:

Fig. 2-7: *Temazcal*, ending

Bruce Hamilton’s *Portals* (2004) follows clearly in the longstanding tradition of *instrumentalist with recorded electronics*. This piece is for solo multi-percussionist and electronics that consist of both electronically-synthesized sounds and electronically-manipulated recorded sounds. Availing himself of Schaeffer’s *musique concrète*, Hamilton uses several real-world sounds such as doors opening, keys jingling, and Ping-Pong balls bouncing. The percussionist’s score includes a graphically and rhythmically notated electronic part designed to help synchronize the two parts through successive cues, similar to *Temazcal* two decades earlier.

Fig. 2-8: *Portals*, mm. 142-149

An interesting element of *Portals* is the inclusion of electronic music from the popular music realm known as *EDC*, or Electronic Dance Music, at the climax of the piece. The percussionist performs over a pre-recorded electronics part that has been infused with heavy dubstep music and driving drum-and-bass beats, certainly blurring the lines between popular and art music (this piece is discussed further in Chapter Three).

Instrumentalist(s) with Live-Triggered Electronic Events

The divide between this and our first category may be seen as one of degree rather than kind. The former category, *instrumentalist(s) with recorded electronics*, consists primarily of unchanging, pre-recorded electronic parts that usually commence at the beginning of the piece and typically rely on cues or other previously-mentioned methods of synchronization between the performer and the electronics. This new category, *instrumentalist(s) with live-triggered electronic events*, applies to pieces in which shorter audio events occur within the piece, triggered manually by the performer.

This usually involves a more complicated audio setup, because instead of simply being able to start and stop the track in the middle of the piece, the performer will be too preoccupied with his/her instrument to do so. Instead, he/she must rely on footswitch pedals or trigger pads (usually MIDI-controlled) to trigger audio events. This is the primary distinction between a piece such as *Déserts*, where the audio track is started and ended by a technician, and a piece such as *Six Japanese Gardens*, where short audio events are triggered by the performer via a footswitch pedal while simultaneously performing on all the acoustic instruments.

Whereas *Six Japanese Gardens* is a perfect example of an electroacoustic work under the category of *instrumentalist(s) with live-triggered audio events*, the six movements of this work actually encompass all three of the categories mentioned in this chapter. These distinctions will be explored further in subsequent chapters.

Instrumentalist(s) with Electronically-Manipulated Amplification

Shortly after adding electronic/prerecorded sounds to acoustic works, composers sought ways of electronically manipulating the sounds of live instruments in real time. One of the very first examples was Stockhausen's *Mikrophonie I* (1964). This piece utilizes a large tam-tam with six players. Two players use implements on the instrument, two players operate microphones, and two others control electronic filters for the microphones. Chapter Five presents a much more detailed discussion of the piece.

Digital delay is an effect with deep roots in popular music. Beginning with the "slap-back echo" used by producer Sam Phillips at Sun Records in the mid-1950s (and eventually finding its way onto effects racks), digital delay began to interest rock guitarists—most notably Dave Evans (better known as *The Edge)* of the Irish rock band *U2*. The effect of delay (measured in milliseconds) is essentially an echo; the technical way this effect is achieved is by recording the instrument and then playing it back live at a specific, very short time interval (a "delayed" playback of the amplified instrument, emulating natural echo). The delay can be controlled to the specificity of a thousandth of a second, it can be synchronized to a "tap" from the player, and it can be layered multiple times.

Not surprisingly, delay had roots in other settings as well. In emblematic works such as *In C* (1964) and the 1969 experimental album *A Rainbow in Curved Air*, Terry Riley invented the idea of rhythmically controlled delay effects as counterpoint. Reich ran with both his own and Riley's ideas, and turned what was dubbed "minimalism" into arguably the most influential style of the late twentieth century. It made inroads into virtually every musical genre. In 1987, Nigel Westlake composed his marimba solo *Fabian Theory*. For percussionists, this was a revolutionary work that utilizes both digital delay and looping effects. According to the composer's performance notes in the score:

> "An electronic delay system is employed throughout the piece... thereby building a multi-marimba illusion and creating rhythmic counterpoint against a live performance. The player is requested to play in tight synchronization with the delayed signal and by moving through a number of tempo changes, different rhythmic effects are achieved."

The influence of Riley and Reich is obvious, as is (perhaps even more so) that of Robert Fripp and Brian Eno, whose "frippertronics" utilized live improvisation and digital delays. Fripp's band *King Crimson* was working with similar effects in the 1980s, parallel to Westlake's *Fabian Theory*.

The technical details afforded by the composer come in the form of a simple set of instructions at the top of the score:

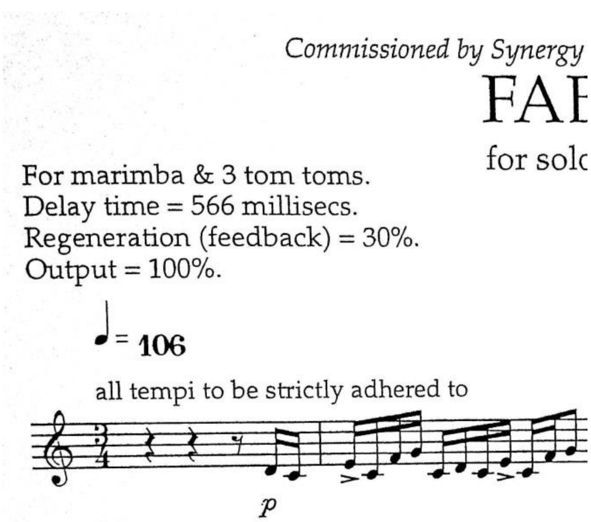

Fig. 2-9: *Fabian Theory*, instructions at beginning of piece

These are the extent of the performance directions, so it is incumbent on the performer to acquire the necessary equipment and learn how to use it properly. At 106 beats per minute, the required delay time of 566 milliseconds would produce essentially a "quarter note delay"—that is, the playback of the amplified marimba will occur exactly one quarter note after the live marimba is played. In addition to delay effects, there is a looping effect midway through the piece:

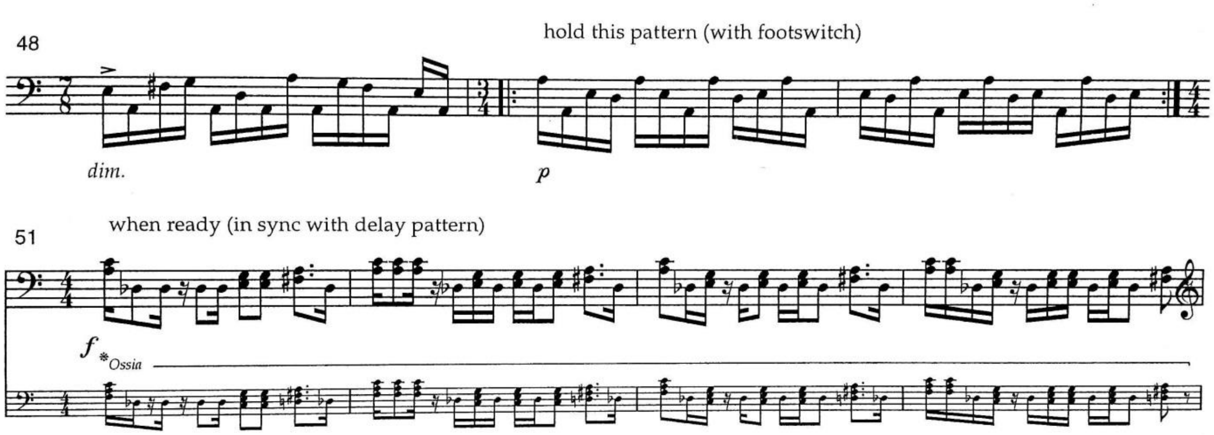

Fig. 2-10: *Fabian Theory*, mm. 48-54: looping effect. Note the *ossia* part allowing for the extended technique of three mallets in the right hand

In this section the performer plays a two-measure phrase that is recorded through the digital delay system and then looped; he/she then plays other material over it. To execute this loop the performer must operate a footswitch, prompting the two-measure phrase to be repeated indefinitely while synchronizing his/her playing to the loop for the following section. Unlike, say, virtuoso compositions for piano, performances of these works are not designed to look as hard as they are to execute. Whereas Liszt wrote many passages to sound more difficult than they actually were, this genre of percussion music adopts an understated aesthetic more in tune with postmodernism.

Finally, the remarkably versatile French composer and visual artist Jean-Baptiste Barrière composed the electroacoustic work *Time Dusts* in 2001, revising it in 2014. Barrière spent a long period as a researcher at IRCAM (1981-1998), but has been doing independent compositions and productions for more than two decades. In the first section of this piece the performer plays an amplified tam-tam, which is then processed through the computer program Max (first developed by Miller Puckette in the mid-1980s) that responds to and augments the sounds being produced. Barrière chooses not to use graphic notation at all for this section; he leaves all of the musical interpretation to the performer:

Time Dusts 1a

Introduction (duration: 2'30)
Largest possible Tam-tam (excited with a triangle mallet)
Scrape Tam-tam with a triangle mallet, in progressive circles from center to periphery, producing a large crescendo.
At the end, during the resonance, move to position for Part I.

Fig. 2-11: *Time Dusts*, beginning

The only parameters Barrière specifies are which implement to use (triangle beater), the duration of time (two minutes and thirty seconds), the size of the tam-tam (large), and a general description of the performance. Interesting comparisons between *Mikrophonie I* and the first section of *Time Dusts* suggest themselves. The obvious similarity is that both are composed for a single tam-tam with electronically-manipulated amplified sound. It is interesting to note that the two composers use the same curious wording to describe the playing of the tam-tam; that is, "exciting" the tam-tam, which is a term adopted from the sciences. These are the only two pieces I have discovered that use this exact term, and it suggests the influence of Stockhausen on Barrière.

Electronic Instruments

As we have already mentioned, inventors began to develop electronic instruments beginning with the Theremin (1920) and the ondes Martenot (1928). These new sounds leaked into the public ear on a much grander scale when they were both used in Bernard Herrmann's score for the film *The Day the Earth Stood Still* (1951).

Synthesizers grew out of the late 1950s and early 1960s. As previously discussed, Milton Babbit used the RCA Mark II Synthesizer in his 1961 *Composition for Synthesizer*. Robert Moog released the Mini-Moog synthesizer to the public in 1970, where its portability and affordability lent itself to its use in popular music, such as rock ‘n’ roll. While these early examples in the history of electronic instruments merit mention here, this topic is not only vast, but it ranges far beyond the scope of this dissertation. We look next at the range of performance challenges facing percussionists drawn to electroacoustic music.

Chapter Three:

Choices and Challenges

Synchronization

Synchronizing acoustic instruments and electronics usually proves to be the first and biggest hurdle when tackling electroacoustic music. Live performers rely on a wealth of intuitive coordination techniques when making music together, including (but by no means limited to) watching each other, breathing and cueing together, being flexible with tempo, and audibly adjusting to one another. However, except at the frontiers of computer music, recorded electronic parts are not human—they do not allow for such flexibility. Besides rhythmic cues in the score, live performers cannot "watch" the tape part for cues as one does with another player; rather, one can only rely on knowing the electronic part by working vigilantly with it in order to become accustomed to it.

Some pieces call for the starting and stopping of an electronic part, which affords the perfect opportunity to remedy any desynchronization that may have occurred during the performance. However, if the electronic part is continuous, one error can doom an entire performance.[38] The inflexibility of tempo can lead to technical issues; to maintain pace with the track the performer is sometimes forced to play faster than is musically sensible, or the performer may feel the section needs more time to breathe.[39] At such times the performer must decide if it is musically appropriate to deviate from the track. It is of course easier to perform pieces whose electronic parts are "atmospheric" and unsynchronized; in these instances the only coordination required is that of dynamic balance between the two elements.

[38] Pellman, *op. cit.*, p. 363.

[39] Mari Kimura, "Performance Practice in Computer Music," Computer Music Journal 19, no. 1 (1995): 69.

For example, *Fear Cage* by Kirk J. Gay (2009) is a duet for two timpanists surrounded by a circle, or "cage," of timpani. An atmospheric track is included with the score and consists of various nature sounds like wind, rain, and light thunder. This adds a very effective, ethereal layer to the sound while posing no additional performance challenges.

Despite their inflexibility, working with electronic parts can offer some advantages. A recording neither rushes nor drags. Playback is maximally consistent. Even with gaps of silence in the electronic part, a live performer with a good sense of rhythm and timing can learn to anticipate these rests accurately from memory, as when a musician practices complex orchestral excerpts or free-form jazz solos with the same recording over and over. After spending a significant amount of time with an electronic counterpart, a musician can start to feel as if the recorded sounds are part of her/his music-making; both elements fuse, and the performer assumes responsibility for the production of all the sound elements in the piece.

Another possible solution to the challenges of synchronization is a "click track." The performer can add an audio track of metronomic clicks alongside an electronic part to solidify the synchronization. The logistical execution of a click track can, however, be tricky. A few options are available. Some compositions include a separate, "practice" audio track with clicks added to the electronic part. If the click track is present in both the left and right channels, it is impossible to split; therefore, it becomes unusable for the performance because not only will the performer hear the clicks in his headphones, but the audience will as well.

On the other hand, if the practice track offers a stereo version with clicks on one channel and the electronic audio part on the other channel, one can easily split the channels so that the click track is sent only to the performer's headphones and the audio track is sent only to the speakers. One disadvantage remains—if the primary electronic part intended for coordination with audio cues happens to be a stereo track with stereo effects, these will be lost.

Portals (2004) includes multiple performance and practice tracks with its score and offers a perfect example of a piece with these issues. A "practice" track is offered with clicks, and a stereo-enhanced "performance" track without clicks—once the percussionist becomes intimately familiar with the practice track—is provided for the actual performance. However, without clicks, it is very challenging to stay synchronized with the electronics, as the electronic part in *Portals* is, at times, very spatial.

A tech-savvy performer/engineer can solve this dilemma. Conceptually analogous to the "cueing" function in turntable DJing, an audio interface or mixer featuring stereo output with a separate headphone output can accurately produce the original, stereo electronic track through the left and right outputs while simultaneously producing a specific click track to the headphone output only. With this solution, the performer hears the track with the clicks through the headphones, and the audience hears the antiphonal stereo track through the speaker system.

Audio Output: Speakers and Balance

Another issue that arises in electroacoustic works is a musical one: the balance between live instruments and the recorded electronic part. The proper balance differs from piece to piece, and one must evaluate the role of each element in the work. Some composers offer suggestions. *Six Japanese Gardens* (1994), for example, is described this way on the composer's website:

> "The amount of amplification required naturally depends on the performance space, but it should never cover the acoustic sound of the instruments. The ideal sound is a clear and rich 'close' sound. The microphone(s) should be placed as close to the instruments as possible. The general level should be rather loud, but not painfully so."

If the score does not specify balances and dynamic ranges, then the performer must regulate the levels. If the electronic part primarily accompanies the performer, then typically the volume of the electronic part should be less than the acoustic instruments. This situation prevails in *Fear Cage* (2009), with its atmospheric, recorded accompaniment. If the roles are reversed, perhaps the electronic part should be louder than the live performer—but this proves to be a much rarer situation.

At the end of *Temazcal* (1984), it would make musical sense to have the harp solo in the electronic part at a higher volume than the acoustic maracas, which seem to accompany the melodic part. If their musical value is equal, neither should overpower the other. The final movement of *Six Japanese Gardens* (1994) stages something of a duel between the performer and the electronics, and the levels of both should match. It is not feasible to accurately assess the levels from where the performer is located. It is essential to have a second set of ears in the audience to monitor the balance beforehand. Acoustic instruments will almost always sound louder from the performer's location.

Additionally, attention must be given to the quality of the sound reproduction system itself. This includes the types, quality, and locations of the speakers within the performance space. In some venues the speaker system is simply a public address (PA) system; in these situations performers must decide whether to bring in their own audio equipment—if the setup is a rental, then it is often beyond the financial reach of many performers.

Certain halls have very advanced systems that can be tuned and adjusted to very specific needs, and electroacoustic music affords fresh opportunities to take advantage of these tunable concert venues—whether the 2,000-seat Segerstrom Concert Hall in Costa Mesa, California; 1,200-seat Ozawa Hall in Tanglewood, Massachusetts, summer home of the Boston Symphony;

or the more intimate 500-seat Harris Hall in Aspen, Colorado. This flexibility is not restricted to elite venues: The 300-seat Concert Hall at Washington & Lee University in Lexington, Virginia features heavy velour “banners” with four velour “sails” between the catwalks that can be adjusted by motors, creating a finely tunable space. The 1,000-seat Concert Hall at Community College in Cedar Rapids, Iowa can be tuned not just for reverberance, but in expert hands and the right instruments, tuned for frequency band reinforcement or diminution. Electronic scores often show the relative strengths of frequency bands, and with enough time a tunable concert hall can be optimized—in essence, applying equalization to the hall before performing in it.

Whether the sound system is rented or hard-wired, the performer needs to be intimately familiar with the dynamic and frequency range of the electronic material. If the track consists primarily of mids and highs, then small monitor speakers without a separate subwoofer may prove sufficient. For example, in Andy Akiho’s electroacoustic snare drum solo *Stop Speaking* (2011), the electronic part consists entirely of spoken words from a digital voice synthesizer. Small speakers work perfectly well in this piece.

If the track incorporates significant sub-bass content, it may be necessary to add a separate subwoofer to the audio system. *Portals* (2004) includes extremely bass-heavy dubstep with significant frequency information below 100 Hz, and thus sounds inadequate without a powerful subwoofer. Regardless of the piece, it is imperative that the audio system be powerful enough to produce the desired dynamic levels without any distortion. This always necessitates a separate sound check, best carried out in the hall with a separate pair of well-trusted ears.

As with the pioneering works discussed above by Varèse and Stockhausen, speaker placement is another important consideration—just as important as Mozart’s stage placement of the *fortepiano* in his piano concerti. If the performance depends upon audio cues, then the main speakers could be placed behind the performer. However, this will move the soloist's sound, much as in a solo concerto, to the forefront. The performer will be acoustically more present simply by virtue of being in front of the orchestra. If this effect is undesirable, the speakers can be placed alongside or in front of the performer, who must then utilize either a separate monitor speaker or a pair of headphones to hear the audio track more easily.

Placing speakers alongside the instruments is the ideal solution for Nigel Westlake's *Fabian Theory* (1987). The speaker placement should allow the live marimba part to blend smoothly with the delayed amplification to produce the "multi-marimba illusion" requested by the composer. In such cases, using headphones to monitor the electronic part can make synchronization more readily achievable.

Some electroacoustic scores call for more elaborate spatial setups, including placing speakers within the ambit of the audience. Saariaho's *Six Japanese Gardens* (1994) utilizes "quadrophonic" sound (4-channel audio) and hence requires an audio mixer with four outputs connected to at least four speakers, two of which are to be placed behind the audience. However, since even the most contemporary composers usually hope to encourage multiple performances, this piece (and most others) also offers a more modest stereo-only version of the electronic sounds.

Manipulating the Electronic Part

What happens when a performer is working with an audio track and is dissatisfied with its dynamics, tempo, or timbre? Does it undercut the composer-performer relationship if the performer uses audio software or live dynamic adjustments to "edit" the audio track? As a point of comparison, the conductor and performer of a concerto have the joint right to request that, within limits, the orchestra play sections at faster or slower tempi to accommodate their interpretation and the technical abilities of the soloist. The conductor feels free (again, within agreed limits) to adjust the balance of the orchestra so that the performer can best be heard.

Therefore, should the performers of electroacoustic works be allowed to modify the electronic part to suit their interpretive needs? Can the same amount of liberty be offered to the performer? My position, based on accumulated experience, is that the performer should have this liberty—indeed, it is the performer's obligation. If a section of the music is simply too fast to be musically appropriate or effective, modern audio software can slow down a track with virtually no audible distortion. If the balance is wrong, one can raise or lower the levels of the audio track where needed. If the audio track lacks a certain timbre, one can adjust the equalization. However, the contrary opinion has substantial merit as well. Most modern composers desire more control over their works, and may not appreciate any modifications to their precomposed electronic parts.

What if an audio track was produced in an era where older technologies limited the sounds available to the composer? Consider again the dubstep section in Bruce Hamilton's *Portals*. In 2004 the electronic music genre of dubstep was just emerging. This technology-driven music genre has evolved just as quickly as the software used to produce it. In the eleven years between its composition and my performance of the piece, Hamilton's electronic track became dated in comparison to the crisper, more dimensional sounds available in modern dubstep music (however subjective this evaluation may be).

I made a leap of faith and elected to hire an electronic music producer to augment the audio track. He added various bass tones and enhanced percussion sounds. Did I overstep my boundaries as a performer and engage in an unwarranted recomposition of the work? Compared to the manner in which eighteenth-century Italian opera—to be sure, a very different time—was freely cut, or augmented with the addition of substitute arias, definitely not. Even though applying eighteenth-century performing aesthetics to a twenty-first century piece is a far cry from normalcy, I decided to apply it in performance.

Yet in today's litigious environment, was I within legal boundaries? Since such customization was not specifically proscribed in the score, I took the position that as a musician I had an obligation to do what was musically necessary in order to realize the full potential of the piece. I not only admitted my manipulation of the track in the performance notes, I gave credit to the audio producer with whom I collaborated.

The Issue of "Period Equipment"

The previous century witnessed the birth of historical performance practices, which included the use of period instruments and techniques to achieve what was touted (often quite ostentatiously) as an "authentic" sound. The implication was that we would hear the music as its creators intended. This glibly overlooks the fact that we no longer hear, for example, with eighteenth-century ears.[40] Nonetheless—although to my knowledge no one has ever looked exhaustively into this issue—given that the genre of electronic music is now over sixty years old, might performers consider applying the same principles to this music? This has the advantage over typical questions of authentic sound in that the changes have occurred within much more recent memory—sometimes within a single performer's lifetime.

Consider Ottorino Respighi's *The Pines of Rome*. In the first performance of this work (December 14, 1924), a gramophone consisting of recorded birdsong was played during the final moments of the third movement ("Pines of the Janiculum"). In contemporary performances, a

[40] See Richard Taruskin, "The Spin Doctors of Early Music," *New York Times*, July 29, 1990.

digital recording of birdsong is played from large speaker systems available in modern concert halls. If the more “authentic” sound of the original performance is actually desired, a music director would commence a search for the original, lower-fidelity gramophone recording and equipment—specifically, the Brunswick Panatrope record player used at the premiere (as discussed in Chapter One). This would presumably produce the most “authentic” experience of the original piece.

Locating a fully functional Brunswick Panotrope player would be something of a fool’s errand. Although they still exist, the few that come on the market are exorbitantly expensive, and one would be buying an instrument that is limited to a single work. One option in terms of seeking the “original” sound would be to use sound manipulation software. While the major emphasis of such software has been to remove surface noise from recordings, there are now several plug-ins that reverse the process, adding hiss and a modicum of surface noise. One could limit the sound source to a single monaural speaker embedded near the orchestra. If Respighi could be brought briefly back to life, would he appreciate efforts to approximate the original sound? Or would he prefer all the amenities of a modern sound system? We can never know for sure, yet the issue should at least be in considered.

The Respighi example is but one of numerous such instances, but it is nonetheless instructive with regard to percussion and electronics. On the surface it would seem that older equipment would simply produce a much lower quality of sound than that to which audiences are accustomed. Yet consider the recent rise in popularity of vinyl record collecting (with all its connections to the world of sampling). Vinyl record connoisseurs argue that despite the noise, hiss, and pops of old records, they invest the old technology for a certain warmth and character that the cooler digital realm cannot match. Furthermore, musicians in both hi-fi and pop music worlds obsess over the sound of 1950s and 1960s tube amplification.

Indeed, for a large portion of its history, electroacoustic music was called “tape music,” and the primary means of sound production was from large, reel-to-reel tape players. Although the subjective values of each remains debatable, there is undoubtedly a difference in sound quality between music played via tape and digitally-reproduced music. In instances where a) the nature of the original equipment is known, and b) it is still possible to get one’s hands on such equipment, should performers invest the time and resources just as period orchestras have with gut strings and pre-Tourte or transition bows?

To be sure, the use of reel-to-reel tape is today almost unheard of and would be considered archaic by most modern percussionists. Nonetheless, if historical performance practices have some worthwhile application to earlier repertory, then what is the argument, except for expediency, against refurbishing old equipment? Anyone who has searched eBay knows that it is ultimately possible to lay one’s hands on, for example, high-quality reel-to-reel machines of the general type used, for example, by Karlheinz Stockhausen when he created *Gesang der Jünglinge* (1954). Refurbishing older equipment and bringing it back into original tolerances and specifications presents more of a challenge. Even this problem is not insurmountable, especially since pop musicians are striving to do the same, thereby making resources available for all.

In just the same way that most major symphony orchestras today own the two enormous C and G bells (oftentimes requiring heavy machinery to be brought onto and off the stage) called for by Hector Berlioz in the finale of his *Symphonie fantastique* (1830), it is probably at least worthwhile for a serious electroacoustic percussionist to acquire, whenever possible, older equipment that at least offers a point of comparison to the modern sound. In just the same way that modern software synthesis offers, for example, sound patches emulating the legendary Yamaha DX7 manufactured from 1983 to 1989, it may be that the most practical solution is digital emulation. Although well beyond the scope of this dissertation, it remains an area with all kinds of intriguing possibilities.

The Performer as Engineer

The performer of an electroacoustic work has to decide whether or not to work with a dedicated audio engineer. Unless the performer has a great deal of previous knowledge and experience with electronic audio equipment, a "do-it-yourself" approach may mean a substantial investment of time and money. Time that would have been spent practicing the music will need to be devoted to making the electronics cooperate. Simple setups, such as a play-along electronic track, will be easier to operate, as they only require an audio player. However, when more complicated technology (such as MIDI or delay processors) is involved, a performer will either need to seek outside help or devote enough time towards educating himself/herself on the operation of the equipment.

Percussionists are naturally inclined toward self-sufficiency. Complicated setups and the engineering required to build and transport them call generally for self-reliance. Consequently, percussionists frequently assume responsibility for all technological aspects of an electroacoustic performance.

If no audio engineer is available, one must do it oneself. There are advantages to taking on the extra responsibility. First, the performer can present the work at any venue. The percussionist will become familiar with the electroacoustic part sooner, and integrate the electronics into the process of learning the piece. The more one learns about electronic setups, the easier it will be to work on future electroacoustic works. Finally, when one is responsible for the entirety of the music, including the electronics, the electronic part becomes integral to the performer’s work, promoting a greater sense of unity between the two parts. Just as a driver feels more in tune with the automobile when are responsible for all of its maintenance, performers feel more in tune with the electronics when they are responsible for the entire setup.

With all the added challenges, why would a percussionist choose to perform one of these electro-acoustic works? Instead of investing in and learning how to work with the equipment, why not spend the time saved learning more works in the acoustic repertoire? As popular musicians have known for almost a century, technology can make a solo performer or a small group a much larger presence than they could be on their own. By working with, learning, and tweaking the equipment, one forges a unity with the electro-acoustic part—a different experience than, say, performing in a duet with a human partner. Even though the performer does not physically produce all of the sounds, the sensation is much the same. In electroacoustic music, performers are able to expand the horizons of their sound world beyond anything they could do in the purely acoustic world.

Finally, with electroacoustic music, one is dealing with sounds of our own time. Those who rail, for example, against the music of Boulez or Stockhausen ought to ask themselves what kind of music two men who grew up during the carnage of World War II should have written. The most gifted composers of electroacoustic music tap into sounds that can feel both more immediate and more real than the musical material of previous centuries. This is not music that occupies some esoteric corner of the modern repertory. It is music that engages naturally with the soundworld of modernity in a way that much contemporary art music does not.

Chapter Four:
A Guide to the Execution of *Six Japanese Gardens*

MIDI

The "Musical Instrument Digital Interface" (MIDI) does not represent actual analog recordings of, for example, the acoustical instruments it lists as numbers 0-100. MIDI is instead a communication protocol with a time clock for synchronization—it simply transmits the data about key presses and patch numbers. The patches mimic the sounds of largely familiar instruments. An analogy might be to compare an audio recording of a piano performance to a piano roll of that same piece of music. MIDI stores the on/off of circuitry data much like a piano roll mechanically tells a player piano when to strike each key. Drum machines, used in pop and jazz contexts, comprised most of MIDI's initial usage in the early 1980s; however, for art composers MIDI offered a low bandwidth means for orchestrating compositions that came reasonably close to the real thing.

Yet MIDI's singular advantage took longer for both manufacturers and users to discover and exploit: MIDI offers a universal language between all electronic equipment that uses the MIDI standard, and since it has a *clock*, MIDI can be used to synchronize rhythmically any electronic devices that implement the standard. Companies like Yamaha and Korg that normally compete fiercely with one another recognized that a common communication language would benefit everyone in the industry. By now, this interoperability is not limited just to musical applications. MIDI can be used to control almost any aspects of a performance, including lighting, video playback systems, and pyrotechnic displays. Their combined potential, in other words, is digitally Wagnerian, especially in the sense of being specified and controlled by a single person.

MIDI systems are connected via ports and special cables (different from audio cables). Most devices have a *MIDI In* and a *MIDI Out* port. The MIDI In port receives MIDI signals, while the MIDI Out port sends the signal a different device. Some MIDI devices have a third port called *MIDI Thru*. It essentially acts like a Y-connector for the MIDI In port. Unlike the MIDI Out port, it allows for the signal from the MIDI In port to be passed along to another device unaltered. MIDI cables have 5-pin male connectors at both ends, and signals are transmitted best when shorter cables are used (i.e. longer cables risk some signal loss). Unlike an audio cable that transmits constantly varying voltages of sound, MIDI cables transmit binary data in the form of 1s and 0s.

MIDI devices transfer data in the form of MIDI messages, and each message represents the triggering of a particular event, such as the beginning or ending of a note, or a change in the timbre of an instrument. Devices that generate MIDI messages are called *MIDI controllers*, and devices that store MIDI data are called *MIDI sequencers*. One disadvantage of MIDI is that the messages can only be transmitted one at a time, hence many simultaneous messages may result in what is known as *MIDI clog*. Furthermore, the possibility of *lag*, or a delay in the signal transmission, can pose significant problems for a musician using a pedal to trigger sounds that are meant to be precisely timed. These limitations are analogous to those in the mp3 and mp4 standards; these were also, in retrospect, not ideal. Just as better sound and video compression protocols (AAC, FLAC, etc.) have emerged since, simultaneous message processing could have been built in to MIDI with a little more foresight on the part of the teams that created the standard. Part of the challenge of working with MIDI controllers is maneuvering around their limitations.

Max software

Max-creator Miller Puckette obtained his undergraduate degree from MIT in 1980 and his Ph.D. in Mathematics from Harvard in 1986. Beginning in 1985 he worked at IRCAM, where he wrote software programs for music composers experimenting with real-time, interactive music processing on computers. From his work at IRCAM he developed a software programming environment called Max, which was first released by Opticode Systems in 1990, then re-released by the software company Cycling '74 in 1999.[41]

The cumulative effect of Max on electronic and other complex music creation and reproducing systems over the last fifteen years can hardly be exaggerated. Puckette's contributions deserve to be listed with those of major composers and performers of contemporary music. For anyone attempting to coordinate events across a spectrum of performance parameters, Puckette's solutions are analogous to Gutenberg's invention of movable type in the mid-fifteenth century.

Max uses a Graphical User Interface (known as a GUI). The GUI for Western music until very recently was the printed score, whose modern roots date back to the seventeenth century. Individual Max programs, which, recalling the quarter-inch audio "patch" cables that once connected the earliest analog synthesizer modules, are called *patches*. They are created on a visual representation of the programming environment called a *patcher*. On this canvas one can arrange various building blocks called *objects*, through which messages are passed and manipulated. It is important to understand that the Max patch for *Six Japanese Gardens* is integral to the composition itself: it is responsible for all of the sounds triggered and the data that determines their amplified reverberation (see Fig. 4-5: the *Six Japanese Gardens* patch). Jean-

[41] Kurt Stallmann, "A Conversation with Miller Puckette: 2008 SEAMUS Award Recipient," *Society for Electro-Acoustic Music in the United States Newsletter* 2 (2008): 6.

Baptiste Barrière assisted in the composition of the electronic part of *Six Japanese Gardens* using Max as his notation system. While still the exception rather than the rule, one can imagine Max competing on an even playing field as a composing tool with software notation programs such as *Finale* and *Sibelius*.

Equipment Setup for *Six Japanese Gardens*

Before performing *Six Japanese Gardens* or any other MIDI-triggered electroacoustic work, performers must understand the *signal chain* that will be used to produce the work's sounds. Specific hardware and software are needed to trigger the audio events and reverberated amplification.

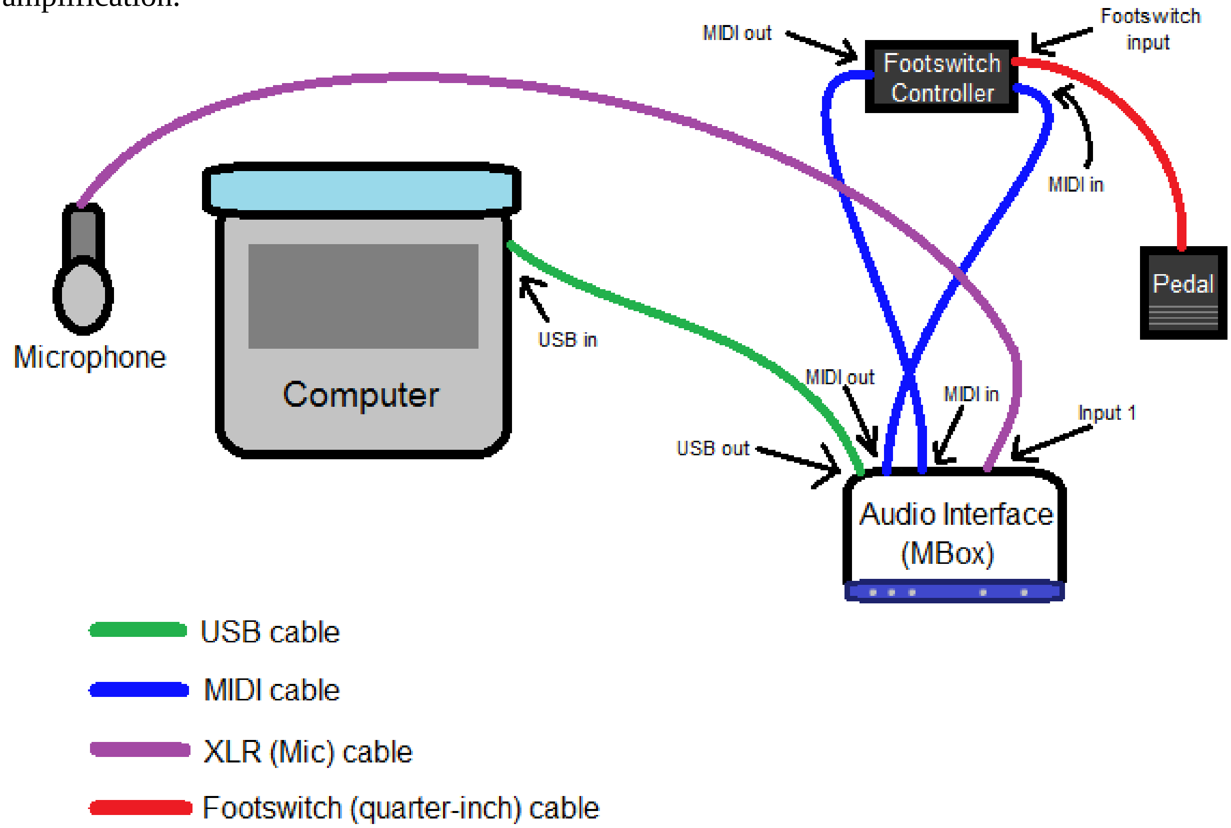

Fig. 4-1: Signal chain for *Six Japanese Gardens* audio setup used by the author (see Fig. 4-2 for a photo of the equipment in this graphic diagram)

The first piece of equipment needed is a computer to run the Max software. The original version of this program was only available on Macintosh systems, but Max has been made available for the Windows operating system as well. The computer itself need not be particularly powerful since the data traffic it will be coordinating occupies a narrow bandwidth. The software is available as a standalone program (the patch), downloadable at no cost from composer Saariaho's website. This software is (for now) maintained and updated by Jean-Baptiste Barrière, the electronic engineer/assistant composer of the work.

Unlike non-electronic written works, this piece requires a person responsible for continually maintaining and making available the software portions of the piece. Jean-Baptiste Barrière has acted as both co-creator and steward of this work, and this position will have to be passed on generationally or organizationally in order for the piece to survive within a sea of constantly changing hardware and software.

Several other hardware components are required in addition to the computer and software (see diagram in Figure 4-2). First is an audio interface. This device serves two functions: first, it receives MIDI signals (from the foot pedal described below) and sends them to the Max patch running on the computer via an interface cable (such as USB or Firewire), allowing the software to respond to input from the pedal to trigger audio events. Second, the audio interface receives analog input from microphones and converts it to a digital signal that is then also processed by the Max patch. This arrangement is crucial for the fifth movement, in which the instruments are miked and amplified using an effect known as *infinite reverb*. This effect adds more reverb to quieter sounds and less reverb to louder sounds, creating a sustained layer of mysterious reverberation within the movement. For the other five movements, a lighter layer of basic reverb is used. Two microphones with stands are added to the equipment list for this movement (though one microphone may suffice).

The next components required are an analog footswitch and a voltage-to-MIDI converting device. The footswitch typically used is a simple electronic keyboard sustain pedal with a quarter-inch output. This quarter-inch output needs to be converted to MIDI data, which can be accomplished by either running the pedal through an electronic keyboard with a MIDI Out port, or by using a smaller voltage-to-MIDI converting device. The device recommended to me by Jean-Baptiste Barrière is the Footswitch Controller by MIDI Solutions, a small box with a quarter-inch input as well as MIDI input/output. Two MIDI cables are necessary to complete this setup—one cable runs from the audio interface to the Footswitch Controller to power the device, and a second one runs from its output back to the audio interface to transmit the foot pedal signals.

I knew very little about MIDI and Max software when I first began to learn *Six Japanese Gardens*. I performed this piece two times—once with Jean-Baptiste Barrière and his crew, and then later by myself for my final doctoral recital. I first collaborated with Barrière to perform the piece as part of a concert showcasing Kaija Saariaho's works along with live visual effects (also created by Barrière). Barrière, acting as my audio engineer, kindly provided and operated all of the equipment: the audio interface, pedal, microphones, software, speaker system, video cameras, projection, and lighting.

The performance even utilized a live video camera operator as part of the visual effects. I had the opportunity to speak at length with the camera operator (the daughter of Saariaho and Barrière), and from her I learned that Barrière and his crew have presented this piece on tour many times, collaborating with a variety of performers, including legendary percussionist Steven Schick, who performed the entire piece from memory.

I knew little about the setup for this first performance, and I did not need to. I had a separate engineer handling all of those concerns. This allowed me to focus my attention on the percussion parts. However, for my second performance I also assumed the position of the engineer. I bought all the necessary equipment but was initially bewildered by how to set it up and make it work properly. Luckily, thanks to an extremely helpful series of emails between the generously accessible Barrière and myself (see Appendix A for a full transcription), I was able to put together a very serviceable setup.

Barrière initially explained the setup like this (I have preserved his distinctive way with the English language):

> "To run the electronics of this piece, you basically need a computer, a sound interface, and a pedal to trigger cues; and of course a sound system (a mixer and speakers; without forgetting a few microphones, mostly for the crotales in part 5).
>
> "See here for more details and proposition about equipment: http://www.petals.org/Saariaho/SixJapaneseGardens-electronics.html
>
> "The sound interface is a device that allows to get: first a better sound quality than the computer embedded sound, second the possibility to have multiple outputs (usually 8), useful in this piece to have quadraphonic [sound] (while most computers have only stereo), that is the possibility to make the sound spatialized around the audience.
>
> "There are many models out there, more or less powerful and expensive. It is hard to recommend a particular model, it depends on your means, and what you may do with it beyond this project. Note however that some interfaces are built with some useful software, allowing editing and mixing for instance (e.g. ProTools). Also, some interfaces have a pedal input (e.g. some MOTUs), which simplifies the set up, but that may not be the best criteria."[42]

[42] Jean-Baptiste Barrière, e-mail message, April 7, 2016.

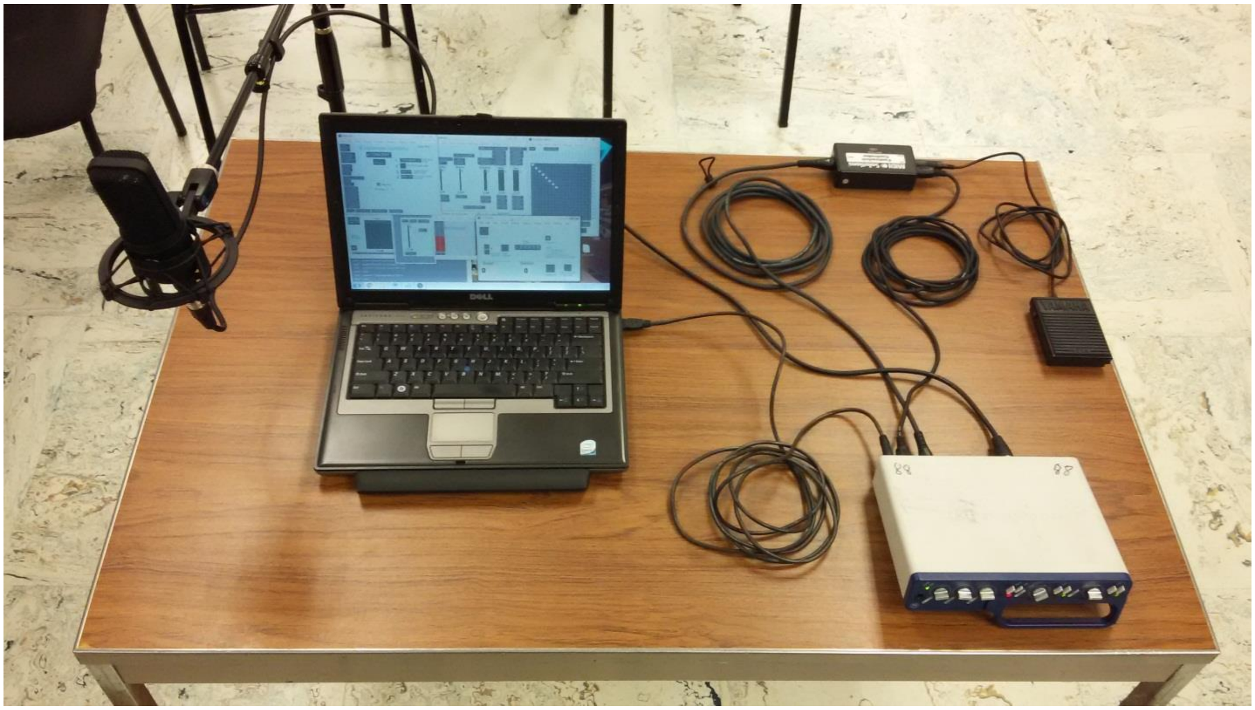

Fig. 4-2: Equipment setup for *Six Japanese Gardens*, front (see Fig. 4-1 for a graphic diagram of the equipment in this photo)

Fig. 4-3: Equipment setup for *Six Japanese Gardens*, back

Barrière recommended some useful equipment to buy for *Six Japanese Gardens*, which I did. I used an MBox 2 from Digidesign as my audio interface, and a Yamaha FC5 sustain pedal, which I ran through a footswitch controller manufactured by MIDI Solutions. I initially tried simply plugging them all together, hoping they would work, but to no avail. First, the standalone patch did not function properly on my computer. Barrière suggested I download the full Max program software, and generously sent me the original, fully-editable *Six Japanese Gardens* file, which worked well on my computer. However, the footswitch still did not register properly.

This first issue was easily resolved. The footswitch controller by MIDI Solutions arrived without instructions, but Barrière explained to me that I needed to run the second MIDI cable from the audio interface to the input of the footswitch controller in order to power this device. Once I followed these instructions, a red "MIDI" light on the box lit up, indicating that the device now had sufficient power.

Now that my hardware was fully functional, only a few obstacles stood in my way. While the footswitch registered, it was not calibrated to the proper value. Barrière explained:

> "...it must probably be that the MIDI Solutions needs initial programming.
> In that case, it is a little bit tedious: you need to download their program here:
> http://www.midisolutions.com/progtool.htm
> then open it, and go to 'Settings' in their menu, and select 'generate control change' which will show a window in which you should set the parameters to be:"[43]

[43] Jean-Baptiste Barrière, e-mail message, May 29, 2016.

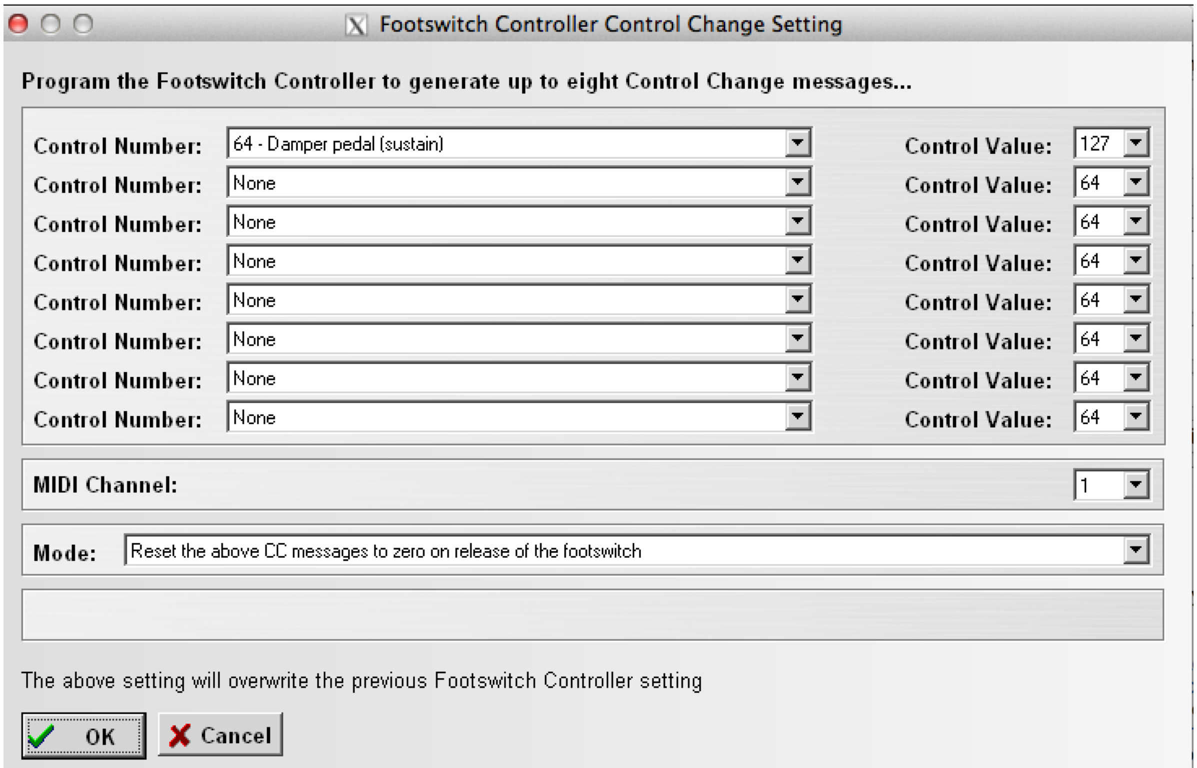

Fig. 4-4: Programming the MidiSolutions' Footswitch Controller

After doing this one must click on the "Program" menu and click "Program the Footswitch Controller...," choose the appropriate audio interface, and click the button that says "Transmit Settings." The readout should display "F0 00 00 50 04 02 40 7F 00 F7," and only then will the footswitch transmit the proper values within the Max patch. Here is how the Max patch should look at this point:

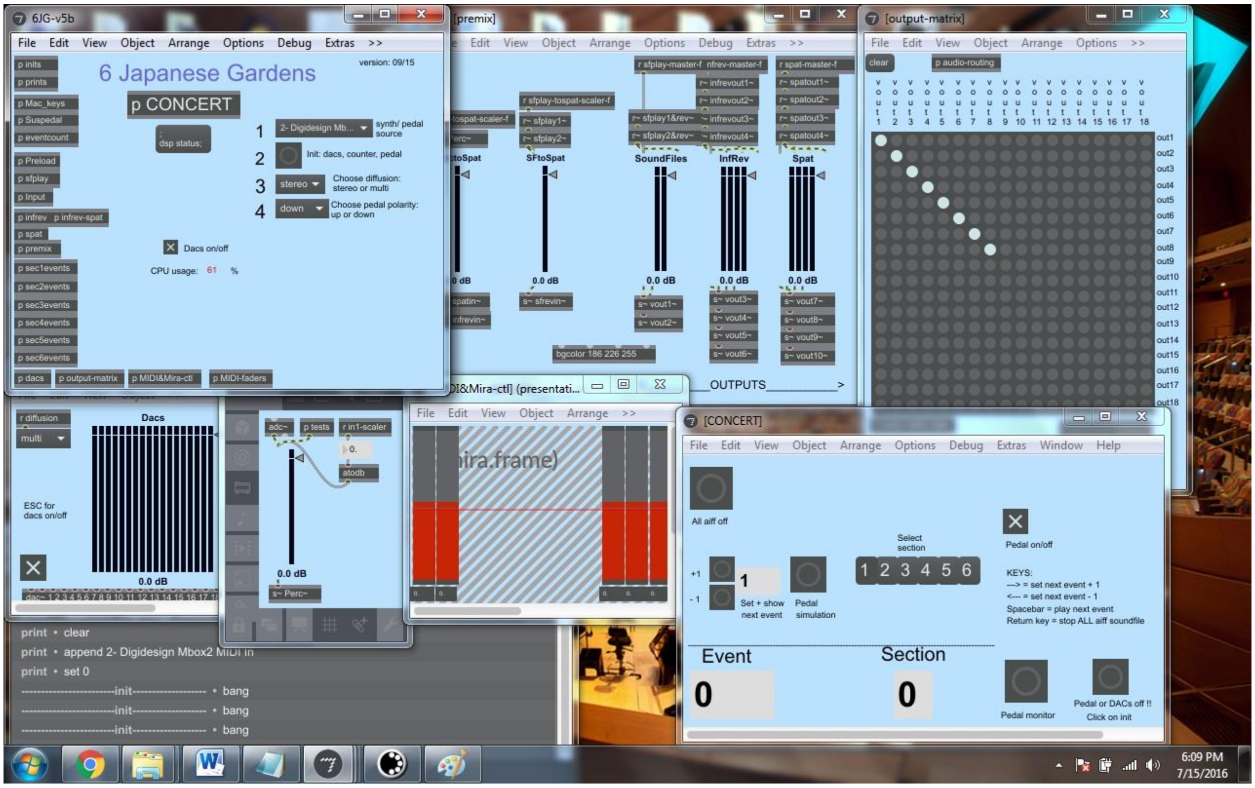

Fig. 4-5: The *Six Japanese Gardens* patch

The first thing to know is that despite the numerous windows opened with Max, the only windows with which the performer needs to concern himself/herself are the ones labeled “6JG-v5b” and “[CONCERT].” The “6JG” window has four numbered steps for initial setup. You first choose your audio interface. If it is not displayed, click the “Options” menu and then click “Audio Status...,” which opens a menu to setup your audio interface.

After setting up your audio interface, click the button next to “2” to initialize several things, including the pedal. Next, choose the output type—Multi (quadrophonic), Stereo (most common), or Off. If the wrong output type is selected, the audio may not play. Finally, under number “4,” you can choose to make the pedal trigger on depress or release (I recommend depress, or “down.”).

Once everything is set up, the performer works within the “[CONCERT]” window. One can choose movements one through six in the “Select section” area, and while practicing the piece one can choose each audio event (trigger) by its number. This is useful if you wish to practice a multi-trigger movement starting from a particular middle point, and not the beginning.

If a performer wishes to try and perform the piece with the electronics but with no added equipment, you can navigate all the functions of this "[CONCERT]" window with the keyboard and mouse. Since the spacebar is programmed to trigger the next audio event, a wireless keyboard can be used as a makeshift foot pedal. One could actually perform the work without any equipment except for a portable computer plugged into a speaker system. Yet in practice, the spacebar is quite unreliable (not to mention visually unprofessional) as a foot pedal in any real performance situation.

I am well aware that a typical percussionist might become discouraged by this complex setup of hardware and software. If a single component does not work smoothly, the entire signal chain will not function. The important thing is not to be overwhelmed by the totality but rather to solve each problem in the chain one at a time. Most universities and performing arts centers have staff members who are familiar with these new kinds of technologies, and in the coming years, working with them will become more and more common. Eventually, the initial learning curve for the electroacoustically-curious percussionist will be less daunting.

I encountered a handful of minor issues in the performance of *Six Japanese Gardens*. I would recommend that the performer move the location of the footswitch pedal for each movement. Rather than reaching awkwardly at a distance, the pedal should always be situated closest to the instruments used. Since any accidental triggering can ruin a performance, I found that I could attain much more accuracy standing with both feet firmly on the ground. I then lifted one foot and depressed the pedal firmly for each trigger. It is important that the pedal be placed exactly in the spot you are accustomed to depressing so that you avoid the embarrassment of missing the pedal altogether.

I also experienced some issues with feedback while working on this piece. I was using one wedge (speaker) monitor, and a non-directional microphone (the opposite type of microphone recommended for this setup). This, unfortunately, provided the ideal condition to generate loud feedback. I found that I could eliminate it by doing the following: I manually bypassed the microphone input for every movement but the fifth by pressing the "DI," or direct input button, on Input 1 of the MBox. This disabled the microphone, and thus the reverb, on every movement but the fifth. In the fifth movement I still experienced feedback, so I simply disabled the monitor during the fifth movement. This allowed the audience to still hear the infinite reverb, but it did not send it through my monitor, and therefore the microphone did not pick up unintended sounds. Had I used the proper type of microphone (as Barrière had used when he assisted me during my first performance of the piece), feedback may have been a non-issue altogether; however, I was able to devise a working solution with the equipment I was using.

To summarize the essential information in this chapter, the performer needs the following: one audio interface, one voltage-to-MIDI converting device, one footswitch pedal, two microphones with stands, a microphone (or two), MIDI cables, a computer, and—if not already provided in the hall/performance space—a sound system and mixer.

Prices for the equipment vary widely. The interface, MIDI converting device, and pedal should be obtainable starting around $500. Two high-quality microphones would effectively double (or triple) the cost of the setup (though I only used one microphone). Without including the price of the computer or audio system, a performer would need to invest around a thousand dollars in equipment in order to be able to perform this piece (not to mention many hours of time in research and self-education). Despite these substantial costs and additional efforts, I can say unequivocally that the artistic rewards for a successful performance of this work far outweighs the burdens of preparation.

Chapter Five:

***Mikrophonie I* and *Six Japanese Gardens*: A Comparative Examination**

Because it is such a seminal work, *Mikrophonie I* serves as an ideal benchmark for *Six Japanese Gardens*. *Mikrophonie I* is responsible for so many "firsts" in the electroacoustic genre that it would be difficult to conceive of the creation of *Six Japanese Gardens* without it.

Karlheinz Stockhausen: *Mikrophonie I* (1964)

Mikrophonie I (1964)—the first in a triptych of live electronic works—was, even for Stockhausen, a radical experiment. Using electronically-manipulated and amplified instruments, it pushed the boundaries of sound production. Stockhausen had spent the previous decade creating new sonorities by electronically manipulating sounds recorded on electronic tape. Although *Gesang der Jünglinge* was a breakthrough, the live presentation via loudspeakers lacked both a visual element and an immediate, live performance dimension, like those found in *Gruppen* and *Zeitmasse*. *Mikrophonie I* can be seen as Stockhausen's attempt to interject visual, live performance aspects into an electronic work, while simultaneously giving self-conscious birth to new sounds.

Fig. 5-1: Stockhausen's tam-tam

In this work two percussionists employ a number of implements to manipulate one large tam-tam. Two other performers deploy directional microphones at the tam-tam, and two more operate electronic equipment—an electrical filter and a potentiometer—to modify the

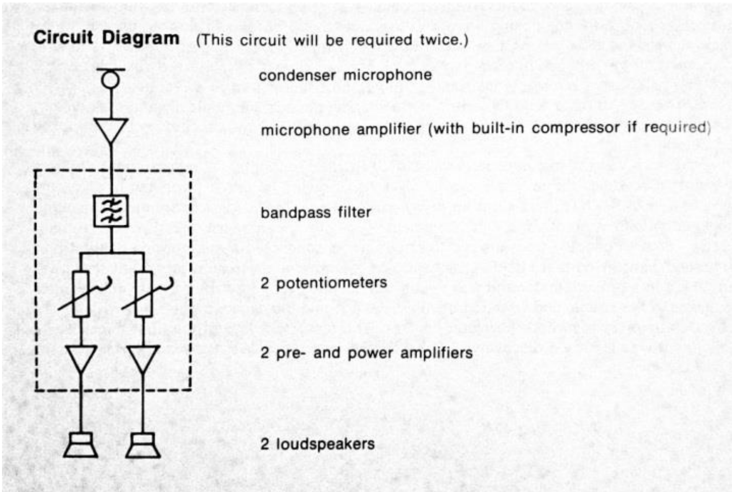

Fig. 5-2: Circuit diagram for electronics provided in score

frequency band and volume of the amplified sound.

Stockhausen conceived *Mikrophonie I* (a word play on "microscopy") as a deliberate experiment that would bring to life sounds "usually beneath our notice."[44] He had obtained a large tam-tam for an earlier composition, *Momente*, so he decided to experiment on this instrument with various implements found around the house—glass, cardboard, metal, wood, rubber, and plastic. He hit and scraped the tam-tam with one hand while holding a directional microphone in the other, at various distances and angles in relation to the contact point of the tam-tam; at times, he would even touch the microphone on the surface of the instrument.

In the introduction to the score Stockhausen—who may have been ignorant of practices in popular music—commented that:

> "The microphone has, up to now, been treated as a lifeless, passive recording instrument for the purpose of obtaining a sound playback that is as faithful as possible: now it also had to become a musical instrument, and to be used in turn to affect *every* aspect of sound."[45]

His collaborator, Jaap Spek, contributed to the experiment by simultaneously operating two filters. One was an electric filter that determined which bands of frequencies were passed to the amplification system, essentially altering the timbre and pitch of the sound. The second filter,

[44] Tim Souster, "His Eggs," *London Review of Books* 14, no. 6 (1992): 9.

[45] Similar experiments with microphone use had been occurring simultaneously in the popular and recorded music realms, predating *Mikrophonie I*. It is quite unlikely that Stockhausen was attempting to take false credit for inventing these techniques, however—Stockhausen was probably unaware of these concurrent discoveries.

a potentiometer, altered the dynamic level, or volume, of the sound. The two collaborators spent time improvising with these devices, creating as many new sounds as they could. Their experiments yielded many sounds that in nature did not seem acoustic at all; rather, the sounds were ironically suggestive of those produced synthetically by electronic means.

In addition to new sounds, Stockhausen saw in this work an opportunity for injecting a powerful performance dimension that was extremely visual. Although it would not have been directly necessary, he decided to employ two opposed groups of players on each side of a single tam-tam, positioned perpendicularly to the audience. Each group includes a percussionist hitting and scraping the instrument, a microphone recordist shadowing the player, and a filter operator, positioned in the middle of the hall, controlling the output of the microphonist (at this vantage point, the filter operator can hear the sounds and watch the player and microphonist). This kind of setup allowed for both seriousness and whimsy—both essential parts of Stockhausen's 1960s aesthetic.

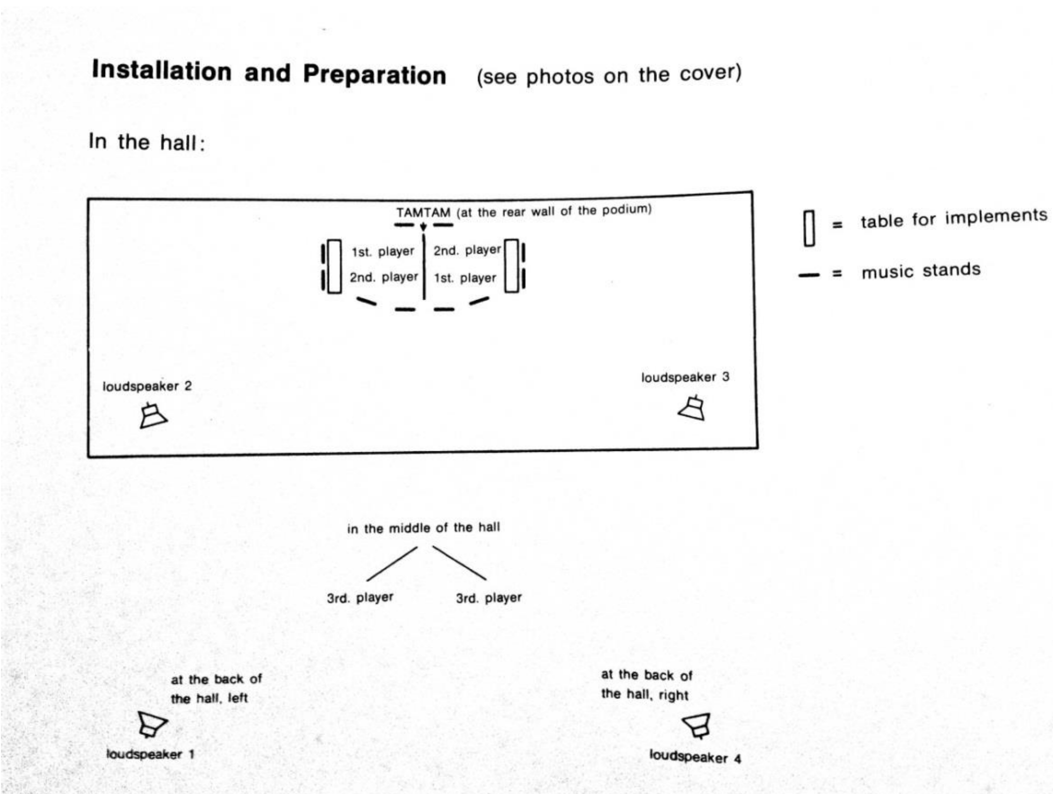

Fig. 5-3: Performance diagram provided in score

Stockhausen acted as one of the electronic filter operators in the early performances of this work. The filter operators are charged with two tasks: within the score Stockhausen delineates the frequencies to be projected and the volume of the loudspeakers. However, the spatial variable is left to the performer—the filter operator has two potentiometers, one for the front speaker and one for the rear (see diagram to right). The sound can be moved from the front to the back of the hall, and when this force is multiplied by the two performers (right and left), a quadrophonic "surround" sound experience results.

With modern computer technology Stockhausen might well have been able to automate the filter operators. However, since one of the primary aims of this work was to reintroduce the human performance element into electronic music, he would probably have decided against automation even if it had proved possible.

One truly remarkable element of Stockhausen's work within *Mikrophonie I* is the way he is able to control all aspects of this live, electronic performance through extremely precise notation. In the introduction to the score Stockhausen comments on how he came to this strategy by comparing his compositional experience to that of *Kontakte* (1960):

> "In *KONTAKTE* for electronic sounds, piano, and percussion, which I composed in 1959/60, a 4-track tape of electronic music is played back over loudspeakers while two instrumentalists are performing. The tape runs continuously through the work, from start to finish; the musicians read the score—in which the electronic music can be followed exactly—and play the instrumental parts, which are also notated down to the smallest detail. My original plan was to let the musicians react to the electronic music in a way that would vary from one performance to the next, and also to make the playback of the electronic music dependent on the course of the performance followed by the instrumentalists, by stopping and starting the tape recorder, by varying the dynamics, and by closing and opening individual channels. After several attempts in rehearsals during preparations for the performance this had to be abandoned. I was not content with the results, and decided on a score in which all the details were unambiguously determined by me. Subsequently, however, I did not abandon the idea of uniting electronic

> and instrumental music in a still closer manner, perhaps even of finding a solution in which an indissoluble fusion and feedback would take place between these two areas."

It was perhaps the realization that the available technology was unable to perform with the precision that, for example, MIDI triggering offers today, which caused Stockhausen to undertake a different approach directly on the heels of *Kontakte*. How, then, was he able to compose a controlled work for these six performers on one tam-tam? Using graphic notation, Stockhausen presents every aspect of the performance in vivid, Germanic detail:

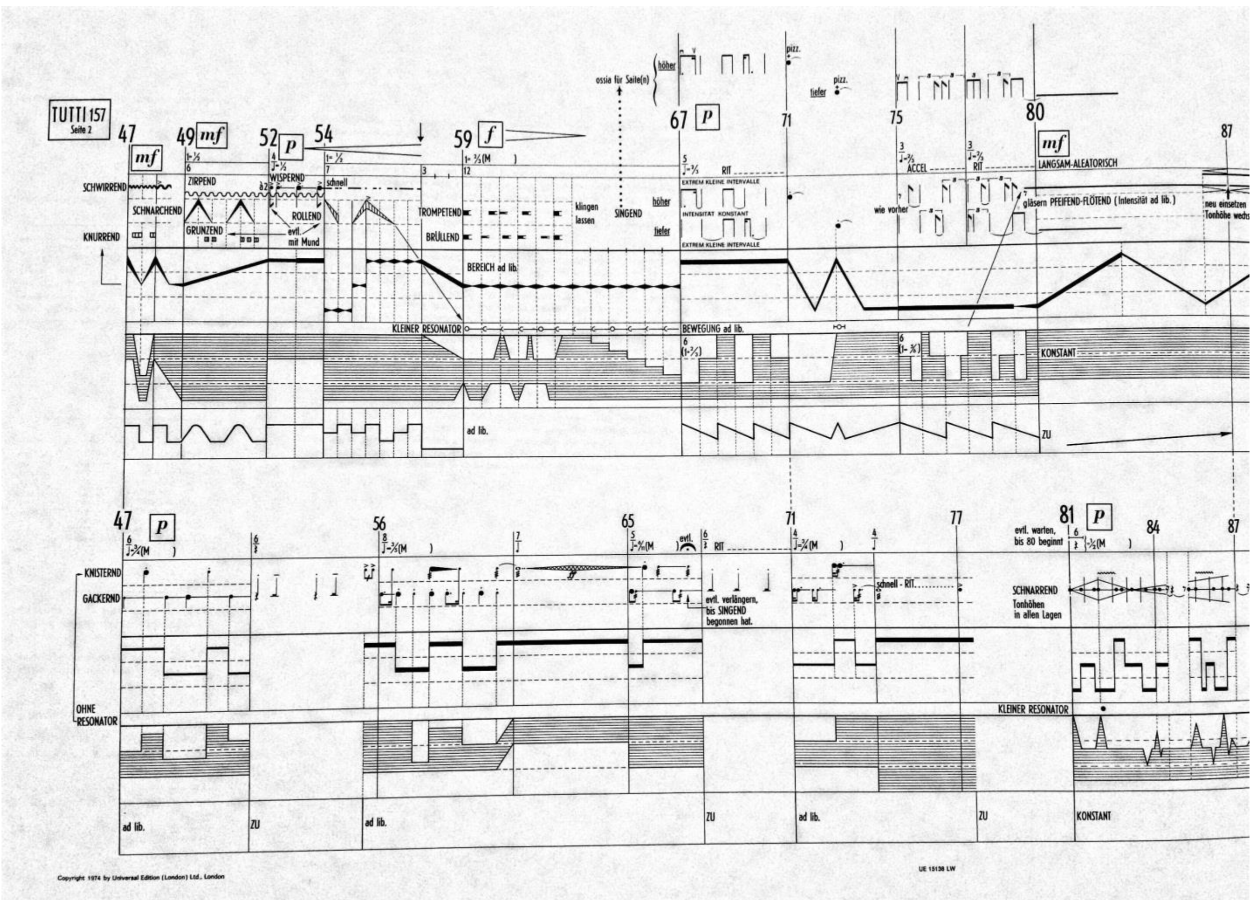

Fig. 5-4: Page of *Mikrophonie I* score

In the score, the six performers are split into the two groups of three—both groups consisting of a percussionist on the tam-tam, a microphone recordist, and a filter operator. Stockhausen provides each part with detailed instructions, and the events have to be co-ordinated amongst all six performers. The percussionists are told in what register to play, what articulations to use, the durations, and the volume. The microphonists are told how close to hold the microphone to the tam-tam, how close to the point of excitation on the tam-tam, and when to use different size resonating containers in coordination with the microphone. The filter operators are instructed as to what sound frequency filter bands to use, and the dynamic level of the sound (altered via the potentiometer).

Besides the challenge of translating the original German score notation, there are many decisions to be made by the performers of *Mikrophonie I*. The order of the thirty-three movements is predetermined by the performers in a very detailed scheme, arranged through connection relationships between each of the sections:

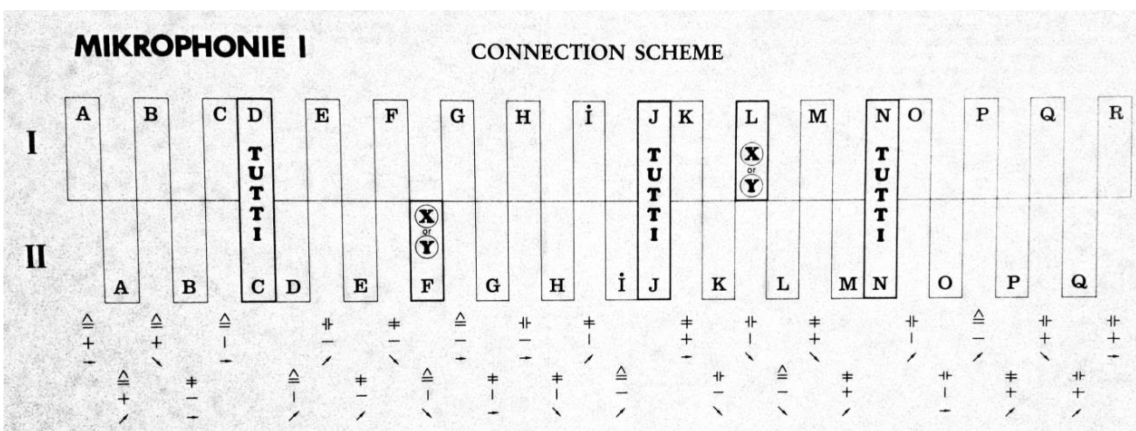

Fig. 5-5: Movement connection scheme in *Mikrophonie I*

The typical issues of texture, balance, and expressivity are very tightly controlled in the score, so there is not a lot of decision-making left to the performers. However, execution is another matter. The divided ensemble itself presents a major challenge: without a conductor (which Stockhausen seems to have ruled out), how does the coordination between the two teams of three players occur? Since the various difficulties of performance have limited the number of extant live performances, we do not have a very sizeable performance tradition from which to draw.

Another fundamental issue facing a performer today is that, since the piece was composed more than half a century ago, some of the equipment originally used is over a half-century old and may seem outdated. Whereas obtaining or building the required filters would not prove too challenging, a more convenient solution today would be to use modern equipment, such as digital computer filters and/or control panels; however, does this newer technology alter the sound, and therefore the piece, in any significant way?

If one considers the difference in sound quality and experience between listening to a vinyl recording on old two-way speakers, and listening to a high-definition, lossless, digital music file on modern three-way speakers, we might well expect the same kinds of differences in a digital performance of *Mikrophonie I*. The issues of historical performance practice presented by this work are fundamentally no different from those which violin players face when deciding what kind of instrument to use for a piece of Baroque music.

Hence *Mikrophonie I* remains even today a work with daunting performance challenges. Unlike the situation with other works of great difficulty, the passage of time has not made its performance any easier. In certain key aspects it has made it even more difficult. The logic with which its thirty-three sections can be connected and reordered is intentionally open-ended, encompassing opposites such as similarity and difference. Hence attached to this work is a kind of "permanent *avant garde*" status. Ironically, the same will not be true of Saariaho's *Six Japanese Garden*, composed thirty years later (1994) and on the surface looking just as, or even more, complex.

Kaija Saariaho: *Six Japanese Gardens* (1994)

Kaija Saariaho—a leader in a generation of celebrated Finnish composers that includes Magnus Lindberg and Esa-Pekka Salonen—has always seen herself as negotiating the boundary between music and noise. While some might argue that this is exactly the region explored more than a generation earlier by John Cage, Saariajo's journey has taken her on a markedly different path. While Cage was always uncomfortable with anything approaching the traditional Western orchestra, Saariaho embraced and augmented that ensemble. Her "noise" is not the sounds of everyday concert life explored by Cage, but a world of sonic sensuality.

This is due in part to her roots in the 1970s "spectralism" of Tristan Murail and Gérard Grisey. By deconstructing the elements of tones according to the most basic building blocks of human perception and the harmonic series, the groundwork was laid for a shifting kaleidoscope of sounds far removed from both the extreme serialism of Boulez and the utilitarian sounds of Cage. Saariaho's music often conveys moments of intensity that in the course of a work find resolution in a form that hints at minimalism. This stylistic and emotional range is certainly why her music has grabbed the attention of many listeners prepared to dislike contemporary music.

Throughout *Six Japanese Gardens* Saariaho utilizes electronics to augment and intensify the acoustic landscape of the work in several ways: static audio accompaniment tracks, triggered audio events, and manipulated amplification are three specific electroacoustic formats found throughout the piece. In the first movement, entitled *Tenju-an Garden of Nanzen-ji Temple*, the percussionist plays a minimalist part—the rhythm of every note in this movement is a quarter note, played at fifty-four beats per minute.

The rhythm remains constant, yet the instrumentation shifts slowly. Two musical lines overlap, each fading in and out from a *pianissimo* dynamic, but without any rests. The movement requires only a single trigger (notated by a large “V” in the electronic line of the score) from the percussionist at the very beginning. The electronic track is a sustained layer of filtered voice and crickets (reminiscent of Respighi’s nightingales in *Pines of Rome*), which provides a continuous wash to the music.

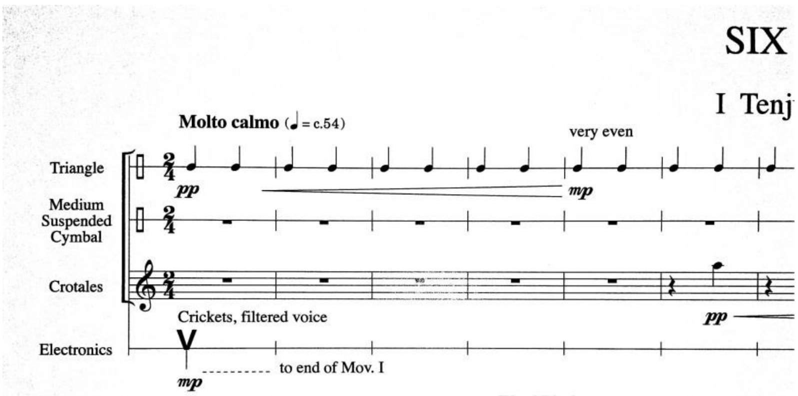

Fig. 5-6: ***Six Japanese Gardens*, beginning of first movement**

The percussive sounds do not provide much sustain, so the electronic part fills in the spaces between each quarter note. Each of the two elements—the minimalist percussion part and the electronic part—would not by themselves provide sufficient musical interest; however, when combined, the two layers together form a cohesive and hypnotic stretch of music. This soundscape resembles something of an ancient ritual taking place in the *Nanzen-ji Temple*. With the static chanting and slowly-shifting instrumentation one can imagine a vast, cloudy mountain range on which this temple sits. In this sense Saariaho’s aesthetic is openly programmatic, especially when compared to Stockhausen’s focus on the instrument—making people crouch around the tam-tam, almost worshipping it—rather than its voice.

The second movement, *Many Pleasures (Garden of the Kinkaku-ji)*, contrasts sharply with the first. Both the percussion part and the electronics play a much more rhythmically active role, and they both feature the sounds of many finger cymbals. The finger cymbals mixed with rhythmic chanting in the electronics and the persistent clanking of a metal plate in the percussion part evoke a jubilant yet magical scene of the kind familiar from Japanese folk tales. In this movement the percussionist has six trigger points that must be activated at precise moments in the score via the trigger pedal. The electronics include wooden and metallic percussive sounds that are combined with vocal chant samples.

Fig. 5-7: *Six Japanese Gardens*, second movement, mm. 29-32

The principal performance challenge in *Many Pleasures (Garden of the Kinkaku-ji)* is that the performer must work together with the electronics whilst coordinating the trigger points accurately. Saariaho gives the performer a rhythmically notated musical line under the percussion part that provides just enough information to keep the two parts aligned. The electronic part consists of sixteenth-note rhythms, dotted quarter notes, eighth-note quintuplets, and sustained sounds, which must align with all of the rhythms the percussionist plays. This is achieved by ear alone. Performing this movement is akin to playing a duet with another performer—which in this instance happens to be electronic. Triggering electronic events with a foot pedal feels much like cueing a second player with a nod. The electronics are no longer an accompanying track; they function on equal terms with the live performer.

Saariaho labels the highly contrasting third movement *Dry Mountain Stream*. The perpetual motion of this movement is akin to that of the perpetual motion of a stream. Sections of constant sixteenth notes are juxtaposed by more turbulent moments of polyrhythm, and these moments feel much like traversing along the bumpy bottom of a dry stream. Functionally this movement operates similarly to the previous movement. There are fourteen trigger points for the electronic part. Some audio events are as short as one measure long, while some stretch out to thirty measures.

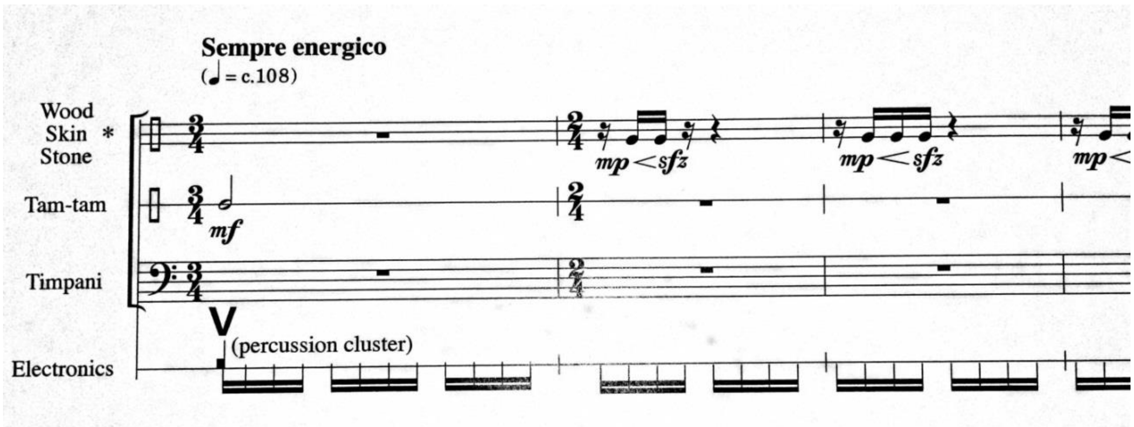

Fig. 5-8: ***Six Japanese Gardens*, third movement, beginning**

Fig. 5-9: ***Six Japanese Gardens*, third movement, mm. 38-42**

However, the electronic element in this movement functions more as rhythmic accompaniment than it does in the previous movement. The audio triggers consist of either short, filtered percussion events or longer, constant sixteenth-note percussion rhythms with which the percussionist must align her/his part. The fourteen events are triggered in order with each subsequent pedal trigger; hence one of the dangers in a movement like this is either missing a trigger or accidentally activating a trigger in advance. There is no way of correcting such a mistake during a performance, so the percussionist must pay extreme attention to when each trigger point occurs, and the hardware must be reliable enough to execute a single audio event (only) when the pedal is depressed. This significantly increases the difficulty of what is already a very challenging movement. As previously mentioned, this technique is executed more easily when the performer maintains both feet on the ground, lifting and stomping on the pedal for each individual trigger.

The fourth movement is titled *Rock Garden of Ryoan-ji*.[46] Like the first movement, there is only one audio trigger for the entire movement. It consists of filtered singing and various abstract, electronic sounds – it is triggered at the beginning of the movement and lasts for the entire duration.

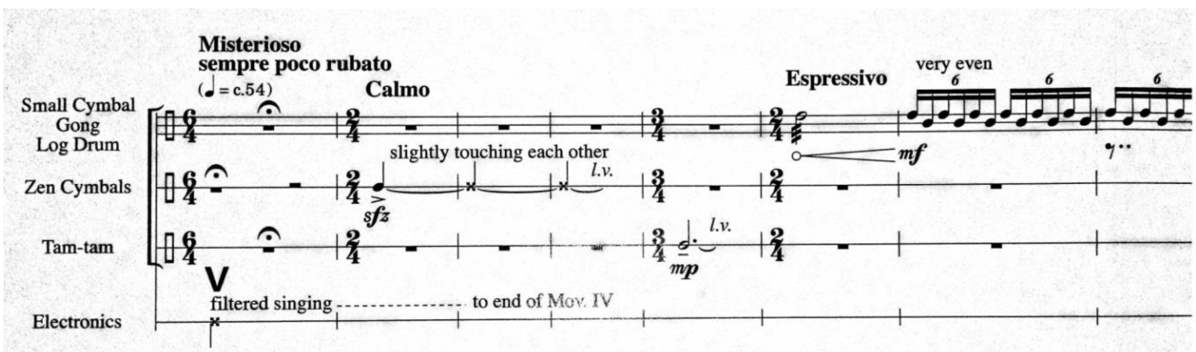

Fig. 5-10: *Six Japanese Gardens*, fourth movement, beginning

There are two key differences between this movement and the first, however. The percussion part is not minimalist; there are several sections calling for fast, complex percussion events that are interrupted by three longer, sustained moments in which two zen cymbals are struck together and allowed to touch each other slightly, creating a sizzle effect reminiscent of the sound production in *Mikrophonie I*.

The second key difference is in the electronic part—there is one layer of sustained throat singing throughout, but there are four instances where an additional, sustained cymbal-like sound

[46] Inspired by the same gardens, John Cage composed a piece called *Ryoanji* in 1983.

occurs: at 0:21 a lower-pitched occurrence, and at 0:45 a much brighter occurrence. At 2:03 the lower-pitched sound returns, then at 2:27 the brighter sound takes over again.

These sounds are not subtle in character, yet there is no mention of them in the score, or any specific direction as to whether the performer should coordinate these events or not. While working on this movement with the electronic track I found that these cymbal sounds generally occur at roughly the same time that the striking and subsequent sizzling of the zen cymbals happens.

For my initial performance of this piece I was fortunate enough to be working directly with Jean-Baptiste Barrière, husband of the composer, electronic engineer of the piece, and a composer himself. From this experience I learned that Barrière and Saariaho work extremely collaboratively on this music, so I felt comfortable asking Barrière for his advice on the performance questions from the fourth movement. He advised me that the electronic part is meant to float as an uncoordinated, sustained layer, much like the first movement, and that there is no need to try and coordinate the parts.

However, as a performer I felt that the electronic cymbal sounds blended so well with the sizzling of the zen cymbals that I decided to coordinate the cymbal events. This provided a nice layer of sound during these open moments of rest, and between the alternatively rigorous percussive events. The performer simply needs to play the rhythmic, percussive moments at the speed necessary to align the zen cymbal events with the sustained cymbal events in the electronic part to achieve this effect. In performance it is very convincing. If I were given full control of the electronic portion, I believe it would be more effective to have the electronic cymbal sounds triggered on their own layer via the foot pedal, but since the piece was not composed in this manner, I had to time the playing of my part as best as I could to allow this effect to take place.

The affect of this movement proves elusive. A rock garden is a static, calm, relaxing place, yet *Rock Garden of Ryoan-ji* radiates tension and intensity. It is tempting to hear the static electronic part as representing the fixed garden and the active percussion parts as evoking the raking of rocks in the garden, yet Saariaho rarely works in such simple reductions. In the end the garden proves elusive and mysterious—both ideas central to its allure.

Moss Garden of the Saiho-ji, the fifth movement of the piece, is scored for crotales and five percussion instruments: triangle, tambourine, and a set of wood, metal, and stone instruments chosen by the performer. The delicate crystalline soundscape of this movement evokes the ethereal nature of a verdant Japanese moss garden.

Fig. 5-11: *Six Japanese Gardens*, fifth movement, beginning

Unlike the previous four movements, the fifth does not feature the playback of previously-recorded audio tracks. Instead, this setup is miked and the live playback is manipulated through a computer. The effect used is called "infinite reverb:" it adds more reverb to quieter sounds, and less reverb to louder sounds, essentially adding a continuous wash of sound to the music.

Like the first movement, *Moss Garden of the Saiho-ji* exhibits minimalist characteristics. Each hand plays a rather repetitive pattern that is subjugated to rhythmic manipulation and the addition of notes. The right hand plays quintuplets on crotales, a mounted tambourine, and a mounted triangle. The left hand plays on the wood, metal, and stone instruments, in notes of increasing diminution; first, eighth notes are played against the right hand quintuplets, then triplets, quadruplets, then broken sextuplets. Slow eighth notes are played between only two instruments near the end of the piece, which creates a moment of open space, contrasting with what was previously a climatic, rhythmically complex arrangement of five notes against six. The electronic reverb aids in the sustain of sound during this quiet period of around ten seconds of simple eighth notes.

Beautiful stone bridges are abundant features of Japanese gardens. Saariaho chose the name *Stone Bridges* for the final movement of this work, and it is the loudest and most rhythmically active of all. This movement reverts back to the use of triggered, pre-recorded audio events. The first event begins the piece, and the performer crescendos from nothing in the midst of all the electronics. The electronics fade out as the performer takes over with an explosion of fast, *fortissimo* timpani and percussion notes.

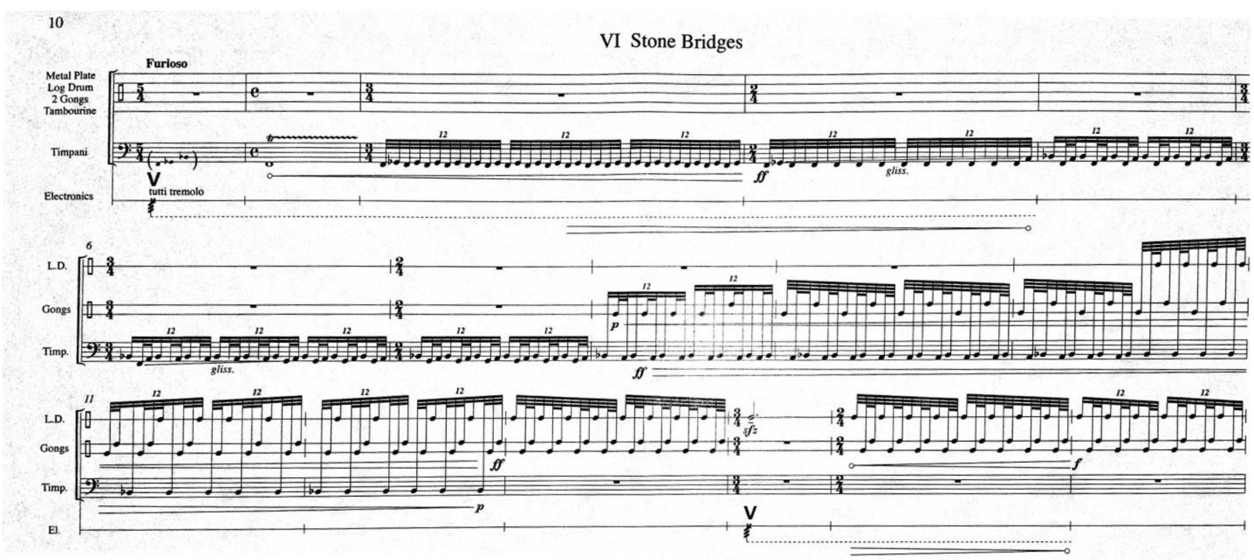

Fig. 5-12: *Six Japanese Gardens*, sixth movement, beginning

These energetic bursts of percussion are juxtaposed with single measures of triggered electronic sounds. The relationship between the performer and the audio in this movement sounds much more like a duel than a duet; however, the shots fired by the opponent are triggered by the performer herself/himself. The final audio event is like that at the opening, and frames the entire movement: a long, sustained sound characterized by the sound of wind that fades away just as the live performer also fades out.

Fig. 5-13: *Six Japanese Gardens*, sixth movement, part of last page. Note the open measures of electronics contrasted against the rapid measures of percussion

The challenge faced in this final movement is similar to the second and third movements. If the performer accidentally triggers two events instead of one, he/she will be ahead by one audio event in the piece. The only way to overcome this error in performance would be to recognize the double-triggering and skip the next trigger. That would, however, create a large moment of awkward silence within the piece. Yet the alternative would be to run out of audio events and to play the conclusion of the piece with no accompanying sound. This illustrates the added difficulty of performing a piece with electronic audio triggers—there is no good way to fix an error once it occurs.

Comparisons

While *Mikrophonie I* and *Six Japanese Gardens* are both electroacoustic works, they differ fundamentally in both their creation and their aesthetic goals. As mentioned previously, the origins of *Mikrophonie I* lie in experiments with the combined sound potentials of a tam-tam, a microphone, and an audio filter. We think conventionally of new instruments as being invented by instrument makers who then place them at the disposal of composers. Although the historical relationship is more complicated, before Stockhausen there are no examples of a composer physically fusing, for example, a flute and a violin together to create a single hybrid "flutolin". Electronic devices, whatever their original intended use, lend themselves much more to a hybridization that can lead to a new sub-genre of musical composition.[47]

Stockhausen pioneered the use of a microphone as a dynamic musical instrument in the European art music world (in spite of appearing on the cover of *Sgt. Pepper's Lonely Hearts Club Band* and rumors of a personal relationship with John Lennon and Paul McCartney, he was apparently ignorant of parallel developments in popular music). Holding and aiming a microphone was scarcely a common technique in electroacoustic music at the time. In fact, this technique was so revolutionary that it has generally not been replicated by other composers; the technique of manipulating the amplification of acoustic instruments, however, has been imitated many times over.

Stockhausen had spent the previous decade manipulating electronic tape to produce new sounds that were unlike any acoustic instruments heard before. Since the new work was premiered in the same manner that acoustic music had been presented for the past several centuries, it can be argued that he was offering electronic sounds as a replacement for acoustic

[47] Aurelio de la Vega, "Regarding Electronic Music," *Tempo* 75 (1965): 4.

instruments. However, in *Mikrophonie I,* Stockhausen employs an acoustic instrument—a tam-tam—to produce sounds that feel almost completely electronic in nature.

When one sees a tam-tam sitting on a stage, the sounds of Debussy's *La Mer* or Stravinsky's *The Rite of Spring* may come to mind; however, Stockhausen prized greatly the power to change a listener's very perception, and new kinds of compositions were the avenue to that consciousness-altering goal.[48] With two microphones, audio filters, and a myriad of physical implements, Stockhausen was able to transform the acoustic tam-tam into an entirely different realm of sounds. The musical function of the electronics in *Mikrophonie I* is arguably not an expressive one—it is more akin to a scientific experiment in sound production in an effort to discover entirely new, unheard-of sounds. This may suggest a false dichotomy of compositional goals, but it is what many believed during this time period. Clearly the composer was thinking way ahead of his time. In that sense *Mikrophonie I* is much like a "founding father" of the electroacoustic genre, although its unique characteristics still to this day defy categorization.

Six Japanese Gardens uses electronics in a completely different way to a less experimental and more expressive end. The electronic sounds are a pre-composed and pre-recorded element, functioning as counterpoint to the live, acoustic parts. The composer, not the performer, is the primary creator of the electronic sounds. Saariaho draws upon the old-fashioned tradition of *musique concrète* by utilizing real-world, recorded sounds, such as crickets chirping in the background of the first movement. In the first and fourth movements, the electronic sounds provide a supportive, extramusical layer to the acoustic part. They create an atmosphere underneath which the performer can make music.

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[48] Alcedo Coenen, "Stockhausen's Paradigm: A Survey of his Theories," *Perspectives of New Music* 32, no. 2 (1994): 207.

The electronics act as a musical counterpart in the second, third, and fifth movements. There are several times when the electronic part maintains a constant rhythm (usually the smallest unit pulse—the sixteenth note), above which the performer must keep strict time in executing the written-out portions. At other times, the electronic tracks function as a contrasting outburst of sound. In the second and third movements, these musical outbursts are presented in conjunction with the live performer; in the final movement the outbursts function as a contrasting juxtaposition against the onslaught of acoustic percussion sounds.

The closest relationship between *Mikrophonie I* and *Six Japanese Gardens* occurs in the fifth movement of Saariaho's work, where an entourage of percussion instruments is provided augmented resonance through the use of microphones and reverberation filters. Unlike *Mikrophonie I*, the location of the microphones and the filter levels are static. However, they are used in a similar fashion to change the sound of the acoustic instruments to produce a more otherworldly, ethereal effect.

While *Mikrophonie I* and *Six Japanese Gardens* both belong to the constantly broadening electroacoustic genre—the through-line of this dissertation—they each illustrate just how musically diverse a category it has become. *Mikrophonie I* was a radical sound experiment in 1964, and more than half a century later many listeners will still hear about it as a radical sound experiment. Not just rhythmically but overall musically it remains very challenging to grasp. To be sure, there is ultimately musical form and structure, but to an uninitiated listener it easily suggests a cacophony of randomly assembled sounds. It was, and is, a work without many traditional frames of reference.

Composed some thirty years after the "experiment" of *Mikrophonie I*, *Six Japanese Gardens* was no longer in the position of having to launch a new style. From a cultural standpoint, the radical sound experiments from the middle of the twentieth-century—akin perhaps to the early string quartets of Joseph Haydn in the 1770s—had already concluded. The sound choices available to Saariaho were now almost without limit. She made an independent choice to use electronic sounds to augment a multi-percussion work. Just as the visual experiments of impressionist and expressionist painters paved the way for further abstraction in the visual arts, the sound experiments of Stockhausen created the acoustic and technological basis for the next generation of electroacoustic composers—composers like Saariaho, who have made imaginative use of electroacoustic technologies to augment the soundscape of their imaginations.

The unique and richly productive collaboration between Kaija Saariajo and Jean-Baptiste Barrière may suggest a comparison between Stockhausen and Jaap Spek in *Mikrophonie I*. However, the unique degree of interconnectedness, indeed fusion, that Saariaho and Barrière have now achieved over a period of decades remains unique within the world of not only electroacoustic music but of Western music altogether. In its own eclectic way, *Six Japanese Gardens* is also a work that remains largely *sui generis*, and in this fashion these two landmarks of electroacoustic music find their closest kinship.

I am aware that, thanks to the privilege I enjoyed of working closely together with both Saariaho and Barrière, I am now part of the slowly growing performance tradition attached to *Six Japanese Gardens*. In this sense I feel a certain responsibility to pass on the lessons I have learned to others who may wish to study and perform this extraordinary work. This dissertation fulfills part of that mission, but I look forward equally to working with performers in a live setting where this special work comes mysteriously to life.

Appendix A

Full Transcript of Emails Between Nikolaus Keelaghan and Jean-Baptiste Barrière

Nikolaus Keelaghan, Apr. 6th, 2016

Hello Jean-Baptiste!

I am preparing for my final DMA recital while working on my dissertation, which primarily focuses on the performance of percussion-with-electronics medium. I am trying to educate myself on MIDI technology so that I can use it for my performance and discuss it in my dissertation.

Could you please let me know what hardware/software is required to execute the foot-pedal triggering of the audio events in Six Japanese Gardens? I now have the time and resources to obtain the equipment and learn how to use it myself, but I need some help in figuring out what exactly I need. I am quickly finding out that MIDI and MAX are extremely complicated subjects that would require years to master, but I need to learn at least as much as I need to know as a performer to execute Six Japanese Gardens.

Thank you very much for your help,
Nikolaus Keelaghan

Jean-Baptiste Barrière, Apr. 7th, 2016

Dear Nikolaus,

to run the electronics of this piece, you basically need a computer, a sound interface, and a pedal to trigger cues; and of course a sound system (a mixer and speakers; without forgetting a few microphones, mostly for the crotales in part 5).

See here for more details and proposition about equipment :
http://www.petals.org/Saariaho/SixJapaneseGardens-electronics.html

The Max patch, can actually be running on Macintoshs and PCs. I remember you have a PC, so I can prepare you a version for PC. I will send it to you through WeTransfer (it is too big to go through email).

The sound interface is a device that allows to get: first a better sound quality that the computer embedded sound, second the possibility to have multiple outputs (usually 8), useful in this piece to have quadra (while most computers have only stereo), that is the possibility to make the sound spatialized around the audience.
The are many models out there, more or less powerful and expensive. It is hard to recommend a particular model, it depends about your means, and what you may do with it beyond this project.

Note however that some interfaces are build with some useful software, allowing editing and mixing for instance (e.g. ProTools).
Also, some interface have a pedal input (e.g. some MOTUs), which simplifies the set up, but that may not be the best criteria.

Let me know the questions you have.

If you want, we can also Skype so that you can ask me directly questions. My Skype name is jbbarriere.

I will pass briefly by L.A. at the beginning of June, on my way to Ojai, but that may be not be the best moment to meet.

Best wishes,
jbb

Nikolaus Keelaghan, Apr. 8^{h}, 2016

Hello Jean-Baptiste,

Thank you so much for your quick and detailed response. I think I am developing an understanding of the equipment and process, but as a newcomer I still have a few questions.

If I am understanding correctly, the audio interface is used both for the output of sound from the Max patch, but also for the input of sound from the microphones for the 5th movement, and it is connected via USB to the computer. I guess the most important question to ask is what kind of requirements does an audio interface need for this piece? I have been looking around and I have seen everything from large mixers to small boxes, but I am rather unsure of what I need and/or what might be useful to me besides what I need for Six Japanese Gardens. There are so many different interfaces and I am so new to this that maybe I just need some suggestions on which ones to consider buying.
Here are some that I have run across:

http://www.amazon.com/Behringer-Q1202USB-12-Channel-Mixer/dp/B00CTKI45M/ref=sr_1_21?s=musical-instruments&ie=UTF8&qid=1460161345&sr=1-21&keywords=audio+interface+usb

http://www.amazon.com/Digidesign-MBox-Audio-Tools-Interface/dp/B000BGIUKA/ref=sr_1_1?s=musical-instruments&ie=UTF8&qid=1460162629&sr=1-1&keywords=m-box

The M-Box has two inputs, two outputs (stereo only?), and two MIDI inputs. Would this eliminate the need for a MIDI interface?

If not, then is it correct that I need a USB MIDI interface to connect the pedal to the computer, like this one:

http://www.amazon.com/MOTU-Fast-Lane-USB-Interface/dp/B0002D0F78

or

http://www.amazon.com/midiplus-Tbox2X2-USB-MIDI-Interfaces/dp/B00WU6F4M6/ref=sr_1_15?s=musical-instruments&ie=UTF8&qid=1460161345&sr=1-15&keywords=audio+interface+usb

Then - all the "sustain" pedals I have seen so far have only a 1/4 inch plug. Do I also need a MIDI Data Pedal Controller to connect from the pedal to the MIDI interface? Effectively converting the simple pedal into a MIDI controller? Such as:

http://www.amazon.com/MIDI-Solutions-Continuous-Pedal-Controller/dp/B0002GH9BK/ref=sr_1_26?s=musical-instruments&ie=UTF8&qid=1460161760&sr=1-26&keywords=MIDI+pedal

Finally, the last step would be the standalone Max Patch software, that would work with the audio interface (both in the input and output of sound) and the MIDI interface (for the input of the triggering of the audio events).

Thank you for all the help. I must confess that this is actually rather daunting for an inexperienced person like myself. My goal is to obtain a decent-quality setup that I can understand how to use by myself and explain in my dissertation, without making an enormous investment (and also having something I can use for recording or other projects).

Sincerely,
Nik

Jean-Baptiste Barrière, Apr. 10th, 2016

Le 9 avr. 2016 à 02:55, Nik Keelaghan <nkeelaghan@ucla.edu> a écrit :

> *Hello Jean-Baptiste,*
>
> *Thank you so much for your quick and detailed response. I think I am developing an understanding of the equipment and process, but as a newcomer I still have a few questions.*

If I am understanding correctly, the audio interface is used both for the output of sound from the Max patch, but also for the input of sound from the microphones for the 5th movement, and it is connected via USB to the computer.

Actually there are different types of interfaces: some connected via USB, and others connected through Firewire.
The input is used also, beyond Part 5, to reverberate and spatialized the all percussion set.

I guess the most important question to ask is what kind of requirements does an audio interface need for this piece? I have been looking around and I have seen everything from large mixers to small boxes, but I am rather unsure of what I need and/or what might be useful to me besides what I need for Six Japanese Gardens. There are so many different interfaces and I am so new to this that maybe I just need some suggestions on which ones to consider buying.
Here are some that I have run across:

http://www.amazon.com/Behringer-Q1202USB-12-Channel-Mixer/dp/B00CTKI45M/ref=sr_1_21?s=musical-instruments&ie=UTF8&qid=1460161345&sr=1-21&keywords=audio+interface+usb

http://www.amazon.com/Digidesign-MBox-Audio-Tools-Interface/dp/B000BGIUKA/ref=sr_1_1?s=musical-instruments&ie=UTF8&qid=1460162629&sr=1-1&keywords=m-box

Both have actually only stereo outputs. So you cannot do quadra with them. However, this may be sufficient in many cases (that is for many pieces).

The M-Box has two inputs, two outputs (stereo only?),

Yes.

and two MIDI inputs. Would this eliminate the need for a MIDI interface?

Yes. But all such interfaces are actually including MIDI.

If not, then is it correct that I need a USB MIDI interface to connect the pedal to the computer, like this one:

http://www.amazon.com/MOTU-Fast-Lane-USB-Interface/dp/B0002D0F78

or

http://www.amazon.com/midiplus-Tbox2X2-USB-MIDI-Interfaces/dp/B00WU6F4M6/ref=sr_1_15?s=musical-instruments&ie=UTF8&qid=1460161345&sr=1-15&keywords=audio+interface+usb

No, you do not need an extra MIDI interface, As said upper, most if not all sound interfaces are actually including MIDI.
But you need something to convert the pedal into MIDI (e.g. MIDI Solutions' Footswitch controller, see www.midisolutions.com)
…if there is not a pedal input on the sound interface, like on this one:
http://www.amazon.com/MOTU-828mk3-Hybrid-Firewire-Interface/dp/B0014BOXZC/ref=sr_1_2?s=musical-instruments&ie=UTF8&qid=1460239172&sr=1-2&keywords=motu+828
or this one (used, so more affordable):
http://www.amazon.com/MOTU-828-MKII-Motu-MK2/dp/B015WT3QGI/ref=sr_1_3?s=musical-instruments&ie=UTF8&qid=1460239172&sr=1-3&keywords=motu+828

> *Then - all the "sustain" pedals I have seen so far have only a 1/4 inch plug. Do I also need a MIDI Data Pedal Controller to connect from the pedal to the MIDI interface? Effectively converting the simple pedal into a MIDI controller? Such as:*
>
> *http://www.amazon.com/MIDI-Solutions-Continuous-Pedal-Controller/dp/B0002GH9BK/ref=sr_1_26?s=musical-instruments&ie=UTF8&qid=1460161760&sr=1-26&keywords=MIDI+pedal*

Not this one, but this one:
http://www.amazon.com/MIDI-Solutions-20-1104-Footswitch-Controller/dp/B0002GH8IE/ref=sr_1_1?s=musical-instruments&ie=UTF8&qid=1460239379&sr=1-1&keywords=MIDI+Solutions'+Footswitch+controller%2C

But only if your sound interface of choice does not include a pedal input like the MOTU.

You should know that any MIDI synthesizer/keyboard can also be used to the conversion from voltage (the pedal) to MIDI. It tell you that in case you have one at home.

> *Finally, the last step would be the standalone Max Patch software, that would work with the audio interface (both in the input and output of sound) and the MIDI interface (for the input of the triggering of the audio events).*

Yes. Max can handle both audio and MIDI (and actually video as well).

> *Thank you for all the help. I must confess that this is actually rather daunting for an inexperienced person like myself. My goal is to obtain a decent-quality setup that I can understand how to use by myself and explain in my dissertation, without making an enormous investment (and also having something I can use for recording or other projects).*

This is very courageous. Does not hesitate to ask any question you may have.

Sincerely,
Nik

Best wishes,
jbb

Nikolaus Keelaghan, Apr 13th, 2016

Hello Jean-Baptiste,
Thank you so much for taking the time to explain. I think I have decided on what I am going to purchase.

For the audio interface, I am going to go with the MBox 2. It is portable, USB (I don't have firewire on my laptop), and it comes with ProTools, which I had been looking into getting anyway for recording purposes. I am okay with not having quadraphonic audio for this project - stereo will suffice.

Then, I will get a keyboard sustain pedal and the Midi Solutions Footswitch Controller to allow the pedal to plug in via MIDI to the MBox.

So, a total of three hardware items, totaling under $500. It should be sufficient to perform Six Japanese Gardens. If you could confirm that this setup will work, I will put the order in as soon as I hear back from you.

Thanks,
Nik

Jean-Baptiste Barrière, Apr. 13th, 2016

Dear Nikolaus,

this is a wise selection, which should be useful to play live, as well as record and edit, many pieces much beyond 6JG.

Good work!

Best wishes,
jbb

Nikolaus Keelaghan, May 11th, 2016

Hi Jean-Baptiste,
I've got all of my hardware - The MBox2, the MIDI Solutions Footswitch Controller, the pedal, and the cables. Now all I need is the software - the standalone MAX patch, PC version (I think the 6JG website only has the Mac version). Could you please send me the software?
Thanks,
Nik

Jean-Baptiste Barrière, May 11th, 2016

Dear Nik,

Le 12 mai 2016 à 04:14, Nik Keelaghan <nkeelaghan@ucla.edu> a écrit :

> *Hi Jean-Baptiste,*
> *I've got all of my hardware - The MBox2, the MIDI Solutions Footswitch Controller, the pedal, and the cables.*

Wonderful!

> *Now all I need is the software - the standalone MAX patch, PC version (I think the 6JG website only has the Mac version). Could you please send me the software?*

I did actually send it to you through WeTransfer on April 7:

> *Envoyé par email à 1 destinataire*
> *nkeelaghan@ucla.edu (pas encore téléchargé)*
> *1 fichier, 220 Mo au total*
> *6JG-v5.zip*
> *Message*
> *This is a PC version. You do not have to install Max: it should work with these files only (you may have to copy the sound files in the same folder than the application).*
> *Télécharger le lien*
> *https://we.tl/GoSLuh9R64*

You just need to go to this link.

> *Thanks,*
> *Nik*

Let me know how it goes.

Best wishes,

jbb

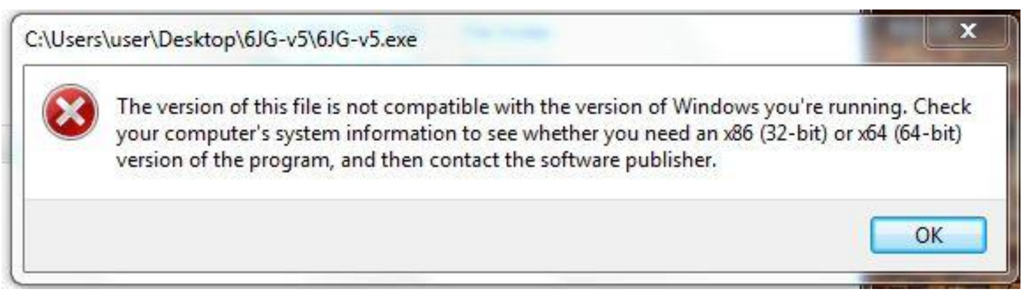
Nikolaus Keelaghan, May 13th, 2016

Hi Jean-Baptiste,

Sorry, it had been so long that I forgot you had already sent me the link.

I downloaded the windows program but unfortunately I am getting an error upon opening the .exe file - I am running a 32-bit version of Windows on this laptop, but it seems that this application is only able to run on newer, 64-bit systems. (My home desktop PC is my new, more powerful machine but I only use this old laptop at school for more basic things...). I don't even know if I could install a 64-bit operating system on this machine... Do you have an older PC version of the 6JG program for 32-bit operating systems? I'll attach a screenshot of the error message I am getting when trying to open the file...

Thanks,
Nik
[Attached image:]



Jean-Baptiste Barrière, May 14th, 2016

Dear Nik,

I am under Windows 10 (64 bits), so this is a bit tricky.

I just sent you a 32 bit version through WeTransfer so you should get the notification soon.

I hope your machine is powerful enough…It will be very hard for me to help you if there are problems, but normally it should work fine.

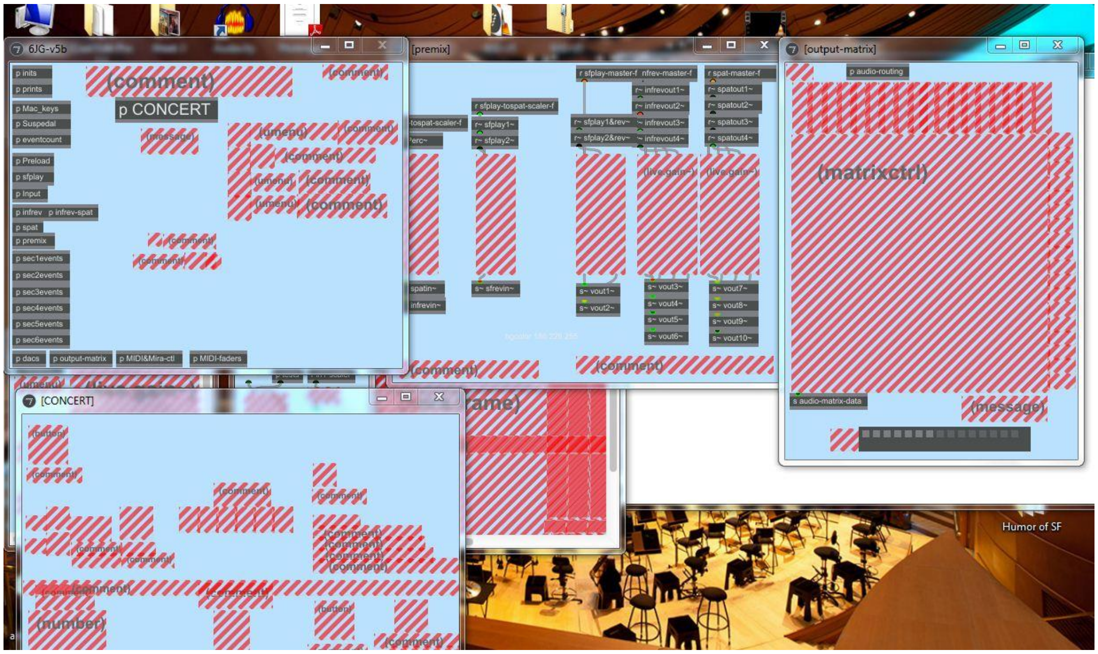
Let me know how it goes.

Best wishes,
jbb

Nikolaus Keelaghan, May 19th, 2016

Hi Jean-Baptiste,
I have got the program working now, but I'm just unsure of how to use it. I took a screenshot of what comes up when I get the program running. Is this correct? I have all my hardware plugged in and I've tried the pedal, but nothing happens so far.
Thanks,
Nik

[Attached image:]



Jean-Baptiste Barrière, May 19th, 2016

Dear Nik,

this is not correct at all. Basically, what it shows is that, when opening the patch, it does not see the related files…Which file did you try to open exactly? You need to double-click on the Application file, not the 'collective' file. Check this first.

Remotely, this is going to be difficult to debug. I tested on a PC under Windows 10 and it worked perfectly…I cannot guarantee anything for older versions of Windows; besides, it may even be that your machine is too old to be able to run the patch...

I can only propose that you download Max (www.cycling74.com) for Windows 32 bit, and that I send you this time, not a standalone application, but the files to run the editable version of the patch. Normally, the other way - with the standalone application - should be easier, but if you cannot make it to work, we may have to go the ‘normal' way, which at least allows trying things step by step to see what the problem may be.

We could even do that while talking through Skype in ’sharing screen’ mode, which would allow me to see what is exactly happening on your machine.

First tell me which file you are using.

Best,
jbb

Nikolaus Keelaghan, May 20th, 2016

Hi Jean-Baptiste,

Basically I was getting an error when trying to open the application file - saying that it could not open because a "maxAPI.DLL" file is missing on my computer. Some sort of registry error? I googled the error but couldn't find an easy solution. I tried right-clicking and clicking on "troubleshoot compatibility," which eventually allowed the application to open, but in the manner that I showed you. It doesn't seem to be operating correctly.

I was able to install Max for Windows, so I think the final thing we could try is what you suggested - the "normal" way, using the files to run the editable version of the patch through the actual Max program, which seems to be working.

If this continues not to work on this old laptop, I'll simply try to borrow a newer laptop from somebody for my performance. I have a friend with a macbook who might be willing to swap machines with me for a couple of weeks if need be. My performance is coming up, and it is actually going to be on the evening of June 5th - otherwise, I would come up to Ojai to seek out some help from you personally. I apologize that I keep running into issues on this old machine and I appreciate your constant help in trying to run the program.

Thanks again,
Nik

Jean-Baptiste Barrière, May 21th, 2016

Dear Nik,

I am right now sending you the full editable version through WeTransfer.

Once received, just click on the patch and it should load everything correctly.

Remember you must have selected your interface in the menu Options/Audio Status (or click on the box ‘DSP status’ in the patch.

Keep me informed about how it goes.

Best wishes,
jbb

Jean-Baptiste Barrière, May 25th, 2016

Dear Nik,

here is a version reduced to the strict minimum.

Let me know how it works.

Best,
jbb

[Attached: 6JG-v5b-redux.maxpat]

Jean-Baptiste Barrière, May 25th, 2016

Dear Nik,

I just found a potential bug in one file:

Please do replace the old one by this one.

All the best,
jbb

[Attached: between.maxpat]

Nikolaus Keelaghan, May 25th, 2016

Hi Jean-Baptiste,

Thank you for the fixed file.

So far I've had some good luck and some bad luck.

Currently I can get the MAX patch working fine - the software works. There are some issues with communication between the audio interface and the computer.

The first issue is when I play the audio through the MBox, the sound is choppy, as if it cuts out for a millisecond every few seconds. The second issue is that I can't get the MIDI signal though to the computer. I have the pedal connected to the MIDI Solutions footswitch controller, which is connected to the MIDI in on the MBox.

Under "audio status," the MBox driver is selected. Under "MIDI Setup," the MBox MIDI In is selected. However, when pressing the pedal, nothing happens. Luis Henao, the tech person at our school, tried helping me - we tried the "MIDI test" option under "Extras," but there was still no response from the pedal. We tried different pedals and still no luck.

I have no idea how to troubleshoot this problem without testing my setup against other hardware (which I don't have). It could be a faulty footswitch controller, a faulty MIDI input on my MBox, a faulty MIDI cable, or a software issue. Also, I don't know why the audio is sounding choppy through the MBox. It was a secondhand MBox I borrowed from a friend - it's the only hardware I'm using that isn't brand-new.

In case I just can't get my setup to work, I am currently planning on using a "Plan B:" just using the onboard audio on my laptop, and using the spacebar on a wireless keyboard as a footpedal. That will, at the least, trigger the audio events. Though it will be a little disappointing to have invested so much time and money to not get this to work...

I sincerely appreciate all of your help so far.
Thanks,
Nik

Jean-Baptiste Barrière, May 25th, 2016

Dear Nik,

Le 26 mai 2016 à 00:36, Nik Keelaghan <nkeelaghan@ucla.edu> a écrit :

> *Hi Jean-Baptiste,*

Thank you for the fixed file.

So far I've had some good luck and some bad luck.

Currently I can get the MAX patch working fine - the software works. There are some issues with communication between the audio interface and the computer.

The first issue is when I play the audio through the MBox, the sound is choppy, as if it cuts out for a millisecond every few seconds.

One possible reason may be that the computer has not enough CPU (memory) or is too slow…Could you check and tell the type of processor and the amount of memory you have? There are ways we can still try to tune up some parameters to reduce the load on the computer. Click on 'dap status' and change the values for I/O vector size and Signal vector size. Does it make a difference?
What is saying the 'CPU usage' in the main window? Is it lower or higher?
Also, you can try to check Scheduler on overdrive.
Again, does it make a difference?

The second issue is that I can't get the MIDI signal though to the computer. I have the pedal connected to the MIDI Solutions footswitch controller, which is connected to the MIDI in on the MBox.

The MIDI solutions need to be connected in and out to be powered (by MIDI). Is this the case? There is a red light which should be visible on the box when it is powered correctly. Can you see it?

Under "audio status," the MBox driver is selected. Under "MIDI Setup," the MBox MIDI In is selected. However, when pressing the pedal, nothing happens. Luis Henao, the tech person at our school, tried helping me - we tried the "MIDI test" option under "Extras," but there was still no response from the pedal. We tried different pedals and still no luck.

I have no idea how to troubleshoot this problem without testing my setup against other hardware (which I don't have). It could be a faulty footswitch controller, a faulty MIDI input on my MBox, a faulty MIDI cable,

You need 2 MIDI cables connected. Is this the case?

or a software issue. Also, I don't know why the audio is sounding choppy through the MBox. It was a secondhand MBox I borrowed from a friend - it's the only hardware I'm using that isn't brand-new.

Probably more the question of a too old computer…

In case I just can't get my setup to work, I am currently planning on using a "Plan B:" just using the onboard audio on my laptop, and using the spacebar on a wireless *keyboard as a footpedal. That will, at the least, trigger the audio events. Though it will be a little disappointing to have invested so much time and money to not get this to work…*

Do not give up: we will find a way to make your set up working. At least if the computer is fast enough.
Do you have Skype installed on it? If so, we could make an appointment and test it together.

I sincerely appreciate all of your help so far.
Thanks,
Nik

Please answer to the questions upper and do the tests. I can still try to simplify the patch as much as possible. I will do that tomorrow after your answers.

Best wishes,
jbb

Nikolaus Keelaghan, May 29th, 2016

Hi Jean-Baptiste,

I am making some headway. First off, with the choppy audio:

One possible reason may be that the computer has not enough CPU (memory) or is too slow…Could you check and tell the type of processor and the amount of memory you have?
There are ways we can still try to tune up some parameters to reduce the load on the computer.
Click on 'dap status' and change the values for I/O vector size and Signal vector size. Does it make a difference?
What is saying the 'CPU usage' in the main window? Is it lower or higher?
Also, you can try to check Scheduler on overdrive.
Again, does it make a difference?

The processor is a 1.8ghz dual-core Intel. It has 1.5 mb of ram.

However, for some reason, as I am working with the machine now, the choppiness of sound seems to have resolved. It seems to be a problem that happens some of the time but not all. Maybe a simple restart helped. I tried the redux version and had similar results. I tried the other solutions you suggested but the CPU usage seems constant - around 30%. If I keep getting choppy audio, it seems to run fine when the audio output goes through the computer, so I could use the headphone port of the computer if I need to.

The second issue is that I can't get the MIDI signal though to the computer. I have the pedal connected to the MIDI Solutions footswitch controller, which is connected to the MIDI in on the MBox.
The MIDI solutions need to be connected in and out to be powered (by MIDI). Is this the case? There is a red light which should be visible on the box when it is powered correctly. Can you see it? You need 2 MIDI cables connected. Is this the case?

Until you suggested it, I had no idea that the footswitch controller needed a MIDI in plugged in for power. I didn't even know there was a light on the box! I just bought another cable, and now it's lit up. I have one cable from the MIDI out on the Mbox going into the MIDI in on the footswitch controller, and the MIDI Out from the footswitch controller is going into the MIDI in on the MBox.

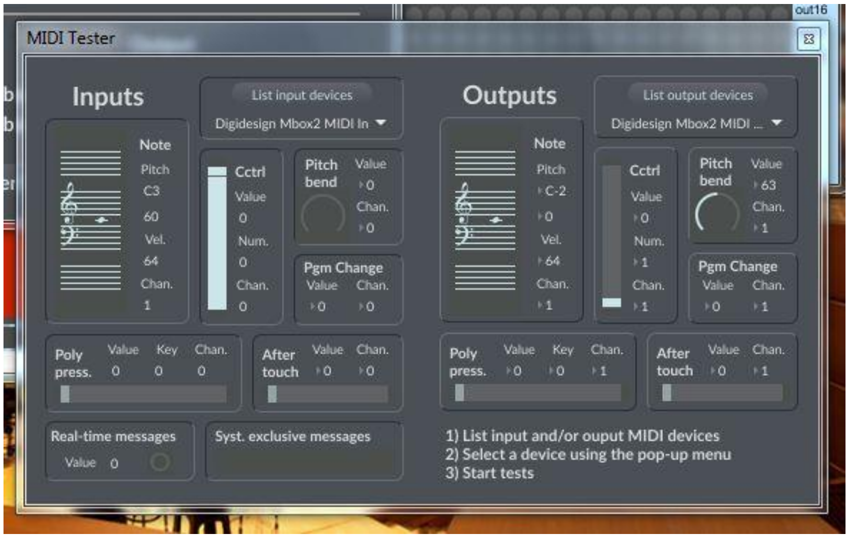
It seems that now the computer is seeing the MIDI signals. When I ran the "MIDI Tester" in MAX, it is picking up when I depress the signal (The value of "Velocity" changes from 0 to 64 when I press the pedal). However, the 6JG patch doesn't seem to recognize the pedal... Under the 6JG main windown in MAX, I have the MBox MIDI in selected as the synth/pedal source and I've clicked the dacs/counter/pedal initializer, so I don't know why it's not recognizing the pedal when it seems to be working now. This is the last step in trying to get this to work... any suggestions?

Thanks,
Nik

Nikolaus Keelaghan, May 29th, 2016

Here is a snapshot of the pedal in action in the MIDItester:

[Attached image:]



Jean-Baptiste Barrière, May 29th, 2016

Dear Nik,

Le 29 mai 2016 à 19:22, Nik Keelaghan <nkeelaghan@ucla.edu> a écrit :

> *Hi Jean-Baptiste,*
>
> *I am making some headway. First off, with the choppy audio:*
>
>> One possible reason may be that the computer has not enough CPU (memory) or is too slow…Could you check and tell the type of processor and the amount of memory you have?
>> There are ways we can still try to tune up some parameters to reduce the load on the computer.
>> Click on 'dap status' and change the values for I/O vector size and Signal vector size. Does it make a difference?
>> What is saying the 'CPU usage' in the main window? Is it lower or higher?
>> Also, you can try to check Scheduler on overdrive.
>> Again, does it make a difference?
>
> *The processor is a 1.8ghz dual-core Intel. It has 1.5 mb of ram.*

This is actually a very old processor and very little memory by today's standards (common size is 8MB). But this should in fact not be a problem to run this patch, which was done way before such standards.

> *However, for some reason, as I am working with the machine now, the choppiness of sound seems to have resolved. It seems to be a problem that happens some of the time but not all. Maybe a simple restart helped.*

Yes, this makes sense. It could be that the system does not 'free' the memory, so that restarting should force it.

> *I tried the redux version and had similar results. I tried the other solutions you suggested but the CPU usage seems constant - around 30%.*

This is actually quite good, more than enough to run the patch. So the problem is not there.

> *If I keep getting choppy audio, it seems to run fine when the audio output goes through the computer, so I could use the headphone port of the computer if I need to.*

Well, that seems to show that the problem is with the driver of the M-Audio…May be you should check that you have the proper driver for your version of Windows; it could be that this ia a newer version which is demanding to much to the system...

The second issue is that I can't get the MIDI signal though to the computer. I have the pedal connected to the MIDI Solutions footswitch controller, which is connected to the MIDI in on the MBox.

> The MIDI solutions need to be connected in and out to be powered (by MIDI). Is this the case? There is a red light which should be visible on the box when it is powered correctly. Can you see it? You need 2 MIDI cables connected. Is this the case?

Until you suggested it, I had no idea that the footswitch controller needed a MIDI in plugged in for power. I didn't even know there was a light on the box! I just bought another cable, and now it's lit up.

May you should have read the manuals...

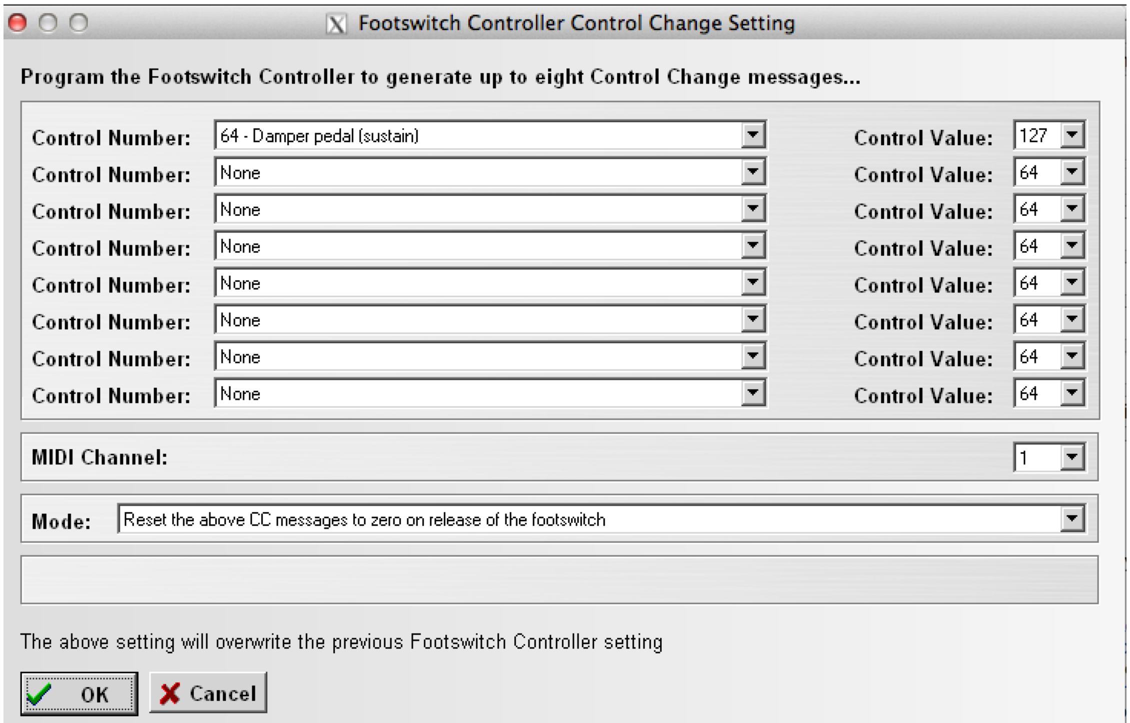
I have one cable from the MIDI out on the Mbox going into the MIDI in on the footswitch controller, and the MIDI Out from the footswitch controller is going into the MIDI in on the MBox.

It seems that now the computer is seeing the MIDI signals. When I ran the "MIDI Tester" in MAX, it is picking up when I depress the signal (The value of "Velocity" changes from 0 to 64 when I press the pedal).

Are you sure? Normally it should go without transition from 0 to 127. 64 is rather the number of the controller. Please check very precisely what happens.

However, the 6JG patch doesn't seem to recognize the pedal... Under the 6JG main windown in MAX, I have the MBox MIDI in selected as the synth/pedal source and I've clicked the dacs/counter/pedal initializer, so I don't know why it's not recognizing the pedal when it seems to be working now. This is the last step in trying to get this to work... any suggestions?

Besides what is mentioned upper, and which could explain things, it mus probably be that the MIDISolutions needs initial programming.
In that case, it is a little bit tedious: you need to download their program here:
http://www.midisolutions.com/progtool.htm
then open it, and go to' Settings' in their menu, and select 'generate control change' which will show a window in which you should set the parameters to be:



It should then show:
F0 00 00 50 04 02 40 7F 00 F7
{ Program the Footswitch Controller to generate CC#64 of value 127 on MIDI Channel 1 when the footswitch is depressed, and send a value of zero when it is released (control-click to edit) }

If there is no mistake, this should solve it.

Try it and let me know how it goes.

Thanks,
Nik

Best wishes,
jbb

Nikolaus Keelaghan, June 1st, 2016

Hi Jean-Baptiste,
Great news! It works!
I apologize for my ignorance with the MIDI Solutions controller - the device came in a box with no manual or instructions.
The programming tool fixed the problem - now the pedal works with the MAX Patch.

I am very happy we finally got this system to work! A million thank-yous for helping me so diligently through the process. I am looking forward to performing the piece this Sunday.
Thank you very much,
Nik

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