

Performer and Electronic-Activated Acoustics:
Three New Works for Solo Percussion and Live Electronics

by

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ABSTRACT

Technological advancements in computers and audio software and hardware devices in the twenty-first century have led to the expansion of possibilities for music composition, including works for acoustic instruments and live electronics.

Electroacoustic composition is rapidly and continually evolving, and much that has been written about compositional techniques for percussion and live electronics is becoming outdated. Live electronics include performer-triggered events, audio processing, electronic responses to various inputs, and electronic decision-making during live performances. These techniques can be employed in a variety of ways. This project sheds light on how modern composers of different musical and cultural backgrounds reimagine the use of percussion through the lens of new technologies.

Through the commission, examination, and recording of three new works for solo percussion and live electronics, the author seeks to further explore and highlight electroacoustic compositional techniques for solo percussion. A specific compositional element to be included in these commissioned works is the activation or manipulation of the acoustic properties of percussion instruments by electronic components. The three artists who contributed works are percussionist-composer Jeremy Muller, composer and multimedia artist Jordan Munson, and composer, sound artist, and performer Garth Paine. The creativity demonstrated in their previous works made them desirable candidates for this project. Each of them approached their composition in different ways. In *Hysteresis*, Muller utilizes a loudspeaker underneath a vibraphone to expand the sound palette of the instrument with microtonal electronic sounds that match the instrument's timbre. In *Where Light Escapes You*, Jordan Munson layers various electronic sounds with the

vibraphone to create a slowly evolving texture that also incorporates a bass drum and the buzzing of snare drums. In *Resonant Textures*, Paine spatializes vibraphone, cymbal, and electronic sounds to create a meditative and immersive listening experience. Ultimately, each of the three composers implemented distinctive compositional and performance tools to create new works that provide a glimpse into the future of percussion music.

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CHAPTER 1

INTRODUCTION

The Beginnings of Electronics, Noise, and Percussion in Music

In the early twentieth century, the development of new electronic technology and its use in music was closely linked with the increased musical exploration of noise through percussion instruments and mechanical devices. The introduction of electricity in music came as early as the mid-eighteenth century with two keyboard instruments: the Denis D'or, created by Prokop Diviš in what is now the Czech Republic,¹ and the Clavecin électrique, created in France by Jean-Baptiste de la Borde.² Historical accounts are unclear about whether electricity aided in the sound of the Denis D'or by electrically charging the strings, or if the electricity was used merely as a practical joke to electrocute the performer. The Clavecin électrique sent a stored electric charge when a note on the keyboard was depressed that triggered a clapper to tremolo between two bells. Later, in the second half of the nineteenth century, various forms of electronic and mechanical player pianos were developed before Thaddeus Cahill invented the Telharmonium, or "Dynamophone," in 1897.³ A massive and expensive electronic keyboard device, the Telharmonium was first showcased in 1906 but never became commercially viable due to

¹ Hugh Davies, "Denis d'or," *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed September 24, 2015, <http://www.oxfordmusiconline.com/subscriber/article/grove/music/47638>.

² "Clavecin électrique," *Grove Music Online. Oxford Music Online*, Oxford University Press, accessed September 24, 2015, <http://www.oxfordmusiconline.com/subscriber/article/grove/music/53319>.

³ Peter Manning, *Electronic and Computer Music* (New York: University of Oxford Press, 2004), 3.

its interference with telephone signals and its excessive expense at the onset of the First World War. The machine did make news around the world, however, and inspired artists of the Italian Futurist movement and other composers like Ferruccio Busoni, who included praise for the varied sonic possibilities of the Telharmonium in his essay “Sketch of a New Esthetic of Music” in 1907.⁴

The Italian Futurists played an important role in the expansion of musical aesthetics in the early twentieth century. They were interested in incorporating all types of sounds in music, especially noises from industrialized society. Futurist artists like Balilla Pratella and Luigi Russolo penned publications advocating the rejection of traditional musical traditions and the acceptance of sounds found in everyday life.

Russolo’s manifesto, written in 1913 and titled *The Art of Noise*, stated:

Everyone will acknowledge that all musical sound carries with it a development of sensations that are already familiar and exhausted, and which predispose the listener to boredom in spite of the efforts of all the innovatory musicians. We Futurists have deeply loved and enjoyed the harmonies of the great masters ... Now we are satiated and we find far more enjoyment in the combination of the noises of trams, backfiring motors, carriages and bawling crowds than in rehearsing, for example, the ‘Eroica’ or the ‘Pastoral.’⁵

Russolo also built his own instruments, called *intonarumori*, which each made unique noises that would be free of historical musical connotations and could help expand the sonic palette of musical timbres.

In the decades that followed, many composers experimented with the inclusion of noise in music by writing for percussion and mechanical devices. George Antheil

⁴ Ibid., 4.

⁵ Luigi Russolo, *The Art of Noises*, trans. Barclay Brown (New York: Pendragon Press, 1986), 25.

included sirens, electric bells, and airplane propellers along with xylophones and player pianos in his 1926 work, *Ballet Mécanique*. Arthur Honegger's *Pacific 231* in 1923 was inspired by the sound of a steam locomotive while Dmitri Shostakovich and Amadeo Roldan included movements in their pieces (*The Nose* and *Ritmicas 5* and *6*, respectively) that used only percussion instruments. There were also several new electronic instruments invented in the 1920s, including the Theremin, Ondes Martenot, Trautonium, Dynaphone, and Sphärophon. These instruments inspired continued research and development of new electronic sound sources, but at the time they did little to create new musical styles because they were mostly used as novelty devices performing more traditional music styles.⁶ In the 1930s and 40s, the continued development of electronic devices would join the growing use of percussion and machines in music to expand the possibilities of music expression. In this way, the use of electronics and percussion has been closely linked for nearly a century because of their similar role and increased usage in contemporary music.

Edgard Varèse was an influential composer at the forefront of these musical developments that were beginning in the second decade of the twentieth century. The Futurists inspired Varèse to seek a broadening of the musical language. Subsequently, he worked towards a new approach to composition that utilized “organized sound,” which involved new processes focused on “sound masses of varying quality, density, and volume.”⁷ His methods for composing for acoustic instruments were very progressive, as he sought new techniques and new instruments that would create unique and varied

⁶ Manning, 4–5.

⁷ *Ibid.*, 8.

sound masses. An example of his progressive compositional methods is *Ionisation*, a piece finished in 1931 that is widely regarded as the first standalone work written for Western percussion ensemble. His artistic and structured approach to organizing the variety of traditional percussion instruments and sound-effect objects like sirens into sound masses made a significant impact on composers who were trying to make musical sense of noise. Varèse also continually sought the development of new electronic devices that would enable him to create new sounds and methods for composition, but struggled to find the right opportunities and funding that could satisfy his creative goals until much later in his life. It was not until the 1950s, after the development of magnetic tape, that Varèse was able to complete two innovative works involving electronics (*Déserts* and *Poème électronique*) that partially realized his artistic goals.

John Cage was one of the many composers influenced by Varèse who propelled the noise-centric, tradition-free, music movement further. Beginning in the 1930s, Cage contributed greatly to the percussion ensemble repertoire by writing influential works for the medium, amassing a large instrument collection of world and “found” instruments for which he and other composers could write, and organizing and performing in his own percussion ensemble that premiered and commissioned many new works. Like the Futurists and Varèse before him, Cage was also active as a writer throughout his career. His writings detail very influential and significant artistic perspectives that would not only inspire countless artists in their respective work, but also explain the method and meaning behind many of his and his contemporaries’ music. First delivered as a lecture in

1940, “The Future of Music: Credo” is one of Cage’s earliest and most famous writings.⁸ In it, Cage professed that “percussion music is a contemporary transition from keyboard-influenced music to the all-sound music of the future” and that he believes “the use of noise to make music will continue and increase until we reach a music produced through the aid of electrical instruments, which will make available for musical purposes any and all sounds that can be heard.”⁹ *Imaginary Landscape no. 1*, written in 1939, was his first piece that involved electronics, and it was also one of the first examples of a composition that involved live electronic sounds with acoustic instruments. The piece was written for a quartet that included muted piano, cymbal, and two variable-speed turntables playing fixed and variable frequency recordings. The next three pieces that followed in that series (*Imaginary Landscapes no. 2, 3, and 4*) also made use of live electronics, including: an amplified coil of wire attached to a phonographic tone arm, audio frequency oscillators, variable-speed turntables, an electric buzzer, a marimbula with a contact microphone attached to it, and radios.

The Early Use of Recording Technologies in Music Composition

A number of artists experimented with the manipulation and live playback of early recording technologies in the 1920s and 30s. In two separate writings in 1922 and 1923, László Moholy-Nagy advocated for a shift from using the phonograph as an

⁸ Leta Miller, “Henry Cowell and John Cage: Intersections and Influences, 1933–1941,” *Journal of the American Musicological Society* 59, no. 1 (2006): 92.

⁹ John Cage, “The Future of Music: Credo,” in *Audio Culture: Readings in Modern Music*, ed. Christoph Cox and Daniel Warner (New York: The Continuum International Publishing Group Ltd., 2005), 26–27.

instrument of reproduction to one of production.¹⁰ He continued: “this will cause the sound phenomenon itself to be created on the record, which carried no prior acoustic message.”¹¹ Moholy-Nagy, Darius Milhaud, Paul Hindemith, Varèse, and Ernst Toch each experimented with different ways of manipulating the playback of phonographs, including changing the speed and direction of the record and cutting grooves into it. Ottorino Respighi scored for a phonograph recording of a nightingale bird song to be played during his *Pines of Rome* in 1924 and John Cage used live manipulation of record playback in his *Imaginary Landscape no. 1* as was previously discussed. The increased advocacy and usage of electronic recording devices as original sound sources continued into the 1940s, when it exploded in popularity and possibilities with the development of the magnetic tape and computer systems.

Rapid technological advancements and growing interest in new sound techniques during and following World War II created an environment in which electronic music would begin to flourish.¹² Two broadcast networks in Paris and Cologne developed studios in the late 1940s and early 1950s where many composers and sound artists began to experiment. The Radiodiffusion Télévision Française (RTF) network in Paris allowed Pierre Schaeffer to open a lab for research and experiments in musical acoustics, which

¹⁰ László Moholy-Nagy, “Production-Reproduction: Potentialities of the Phonograph,” in *Audio Culture: Readings in Modern Music*, ed. Christoph Cox and Daniel Warner (New York: The Continuum International Publishing Group Ltd., 2005), 332.

¹¹ Ibid.

¹² Manning, 19.

was known for a while as Club d'Essai.¹³ The music created by Schaeffer and other members of his studio, such as Pierre Henry, became known as *musique concrète*, which refers to the exclusive use of recorded sound materials, with no electronically synthesized sound. Schaeffer's early work analyzing sound recordings and composing test pieces, including the influential *Etude aux chemins de fer* in 1948, was done on phonograph records. It was in the early 1950s that magnetic tape recorders became more commercially available and RTF gave Schaeffer and his staff a new studio with several advanced tape recorder devices.¹⁴ The subsequent work completed in the studio, as well as Schaeffer's published 1952 treatise on *musique concrète* titled *Esquisse d'un solfège concret*, attracted many composers to experiment with the new technology and electronic possibilities for composition. Some of the more prominent composers who visited and composed works included: Pierre Boulez, Olivier Messiaen, Darius Milhaud, Iannis Xenakis, and Karlheinz Stockhausen.

Around the same time, the Nordwestdeutscher Rundfunk (later renamed to Westdeutscher Rundfunk) network in Cologne approved the establishment of an electronic music studio in 1951, which became fully operational in 1953. The formation of the studio in Cologne was the result of a group effort by Werner Meyer-Eppler, Robert Beyer, Herbert Eimert, and Fritz Enkel. Stockhausen also joined the studio soon after its completion, and the music created by these artists was referred to as *elektronische*

¹³ Ibid., 20.

¹⁴ Ibid., 25.

Musik.¹⁵ *Elektronische Musik* was centered on the meticulous control over electronic synthesis of sounds by various tone and white-noise generators, which were then altered by various forms of tape manipulation. The compositions and writings that came from the artists at the studios in Paris and Cologne, along with the facilities themselves, were immensely influential in the formation of additional electronic music studios around the world and the rapid and diverse development of electronic music that has continued to the present day.

Other electronic studios in the 1950s included a studio in Milan at the Radio Audizioni Italiane network, co-founded by Luciano Berio and Bruno Maderna, and a studio in New York known as the Columbia-Princeton Electronic Music Center, led by Otto Luening, Vladimir Ussachevsky, and Milton Babbitt. In Milan, Berio, Maderna, and other artists who frequented the studio took elements of both *musique concrète* and *elektronische Musik* and included more expressive musical elements focused on texture and sonority.¹⁶ At Columbia University, Luening and Ussachevsky began an electronic studio and were later joined by Babbitt in collaboration with Princeton University, funded through the Rockefeller Foundation. The Columbia-Princeton Electronic Music Center would be used by several important electronic music composers in addition to Luening, Ussachevsky, and Babbitt, including: Varèse, Halim El-Dabh, and Mario Davidovsky. The center proved influential with the works written by these composers that were featured on its self-titled album released in 1961.

¹⁵ Ibid., 41.

¹⁶ Ibid., 69.

Outside of the radio studios there were also different groups working on the newest forms of electronic music, such as a composer collective founded in New York called the Music for Magnetic Tape Project. This endeavor was started by Cage to bring together engineers Louis and Bebe Barron and his close group of composer friends, often labeled as the New York School, which included Morton Feldman, Earle Brown, David Tudor, and Christian Wolff. This collective explored the possibilities of tape manipulation and assisted each other, in the absence of a real electronic studio, with the laborious process of splicing and piecing together tape. In the end, the group only created three complete pieces in their few years working together: Cage's *Imaginary Landscape no. 5* and *Williams Mix*, along with Wolff's *For Magnetic Tape*.¹⁷ The Music for Magnetic Tape Project, in addition to the Milan and New York electronic studios, are great examples of the further exploration of new technological and compositional possibilities separate from the Paris and Cologne models.

The Development of Synthesizer and Computer Music

The Columbia-Princeton Electronic Music Center's acquisition of an RCA Mark II Synthesizer in the late 1950s helped to speed up certain elements of electronic music composition. Although the synthesizer was still an analog device, using a punched card control system, the process took a fraction of the time that the Cologne studio required with many control knobs and considerable splicing of tape.¹⁸ The invention of the transistor opened the door for voltage-controlled and self-contained systems that could

¹⁷ Ibid., 75.

¹⁸ Ibid., 96.

synthesize sound through oscillators and amplifiers. Robert Moog was one of the first to develop such a module, and by 1966 the Moog Synthesizer was commercially available. Other commercial options became available and drove competition in the marketplace, ultimately raising the level of accessibility for composers and artists around the world to begin creating electronic works.

A digital computer version of the synthesizer came in 1960 with the MUSIC III program created by Max Matthews and his colleagues at Bell Laboratories in New Jersey. Before this, there were limited experiments on computer sound production done in the early 1950s, and Matthews began his work developing programs for digital sound synthesis at Bell Laboratories in 1957.¹⁹ Even with the creation of MUSIC III, sound synthesis could not be done in real time. This meant that computers could create sounds only after being given time to process the program, leading to them being used as an easier way to create tape pieces. Creating and manipulating sounds on a computer would quickly replace the laborious process of editing and splicing tape. Computer technology and new versions of the MUSIC program slowly advanced in the 1960s. It was not until microprocessors were developed in the mid-1970s and digital synthesizers became more widespread in the late 70s that composers could include live electronic sounds in their works. Digital audio recorders also appeared in the 1970s and further expanded the possibilities for sound manipulation and music composition.

The Institut de Recherche et Coordination Acoustique/Musique (IRCAM) was founded in 1970 by Pierre Boulez, and with significant financial backing it became the

¹⁹ Douglas Keislar, "A Historical View of Computer Music Technology," in *The Oxford Handbook of Computer Music*, ed. Roger Dean (New York: Oxford University Press, 2009), 19.

force in new music research and production that it is still today. John Chowning did some of his earliest work with his algorithm for FM synthesis while working at IRCAM before he started the Center for Computer Research in Music and Acoustics (CCRMA) at Stanford University with Leland Smith in 1975. One of the most significant contributions to electronic music created at IRCAM was Miller Puckette's development of Max in 1988. Max is a visual, object-based music programming software that allows composers to digitally construct unique "patches" to create, manipulate, and organize sound in a variety of ways. The Max program was named after Max Matthews, and it was expanded in 1997 with a digital processing element named Max Signal Processing, or MSP (which are also Miller S. Puckette's initials), leading to the modern program's title: Max/MSP.²⁰ Puckette was also the leader in creating Pure Data, free and open source software that, for many purposes, is very similar to Max/MSP. These two programs, especially Max/MSP, have become standard platforms for composing and performing in the twenty-first century. They present essentially all the possibilities of music technology that slowly developed over a century, such as a multitude of sound synthesis methods, recording processes, expressive and spatial shaping capabilities, and computer interactions, into a single, immediate, and expansive platform that continues to develop and create new possibilities for the future.

²⁰ Von Hansen, "An Introduction to Interactive Music for Percussion and Computers" (D.M.A. diss., University of Kansas, 2014).

Music for Percussion and Electronics

Some of the earliest and most significant pieces for acoustic instruments and pre-recorded tape were written for ensembles that included percussion. Maderna's *Musica sur due Dimensioni* for flute, cymbal, and tape was written in 1952 and Varèse's *Déserts* for winds, five percussionists, and two tape recorders was premiered in 1954. Stockhausen completed *Kontakte* in the late 1950s, which included a version for a quadrophonic tape part with piano and percussion. William Cahn's *Etude for Taperecorder and Percussion* in 1969 and Hans Werner Henze's *Prison Song* in 1971 were two of the first pieces written for solo percussion and pre-recorded tape. Several other solo percussion works with fixed tape parts were written in the following decades, including pieces by Martin Wesley-Smith, Javier Alvarez, Bruce Hamilton, and John Luther Adams.

As with pre-recorded electronics, the first compositions utilizing live electronic sounds also included percussion in an ensemble setting. Cage's first three *Imaginary Landscapes* as well as his work *Credo in US*, call for various forms of live electronic sound production with predominately percussion instruments. As with many of Cage's works, these pieces were years ahead of their time, written between 1939–1942. Other composers began writing for live electronics in the 1950s, including Mauricio Kagel's *Transición II* for piano, percussion, and two tape recorders that are used to record and play back part of the performance later in the piece. Stockhausen wrote two pieces in the mid-1960s that used live electronic elements and could be performed on a single percussion instrument, but involved between four and six people to actually perform the works. *Mikrophonie*, composed in 1964, was written for a single tam-tam played by two performers, and live electronic elements that are controlled and executed by four

assistants. Alvin Lucier has written a large number of pieces for live electronics and acoustic instruments, with many including percussion. One of his best-known works, *Music for Solo Performer*, was provocative in that it uses the amplified brain waves of the performer, via electrodes attached to their head, to produce electronic sounds that resonate in percussion instruments that are distributed around the performance space. While the use of amplified brain waves was certainly unique and made the most news, the scoring for sympathetic resonance in percussion instruments was also unique and would be a technique used in many more of Lucier's pieces over the decades that followed. Several of his works, including *Music for Piano with One or More Snare Drums*, make use of percussion solely as a resonating vessel. Many more of his pieces include the electronic activation of the resonant properties of acoustic instruments. This technique has rarely been utilized outside of Lucier's work, which is one of the reasons for its inclusion in this project.

Live electronic compositions started to become more commonplace as technology advanced and with the emergence of Max/MSP and Pure Data in the 1990s. The earliest significant work written for solo percussion with live electronics in Max/MSP was Kaija Saariaho's *Six Japanese Gardens* in 1993. In *Six Japanese Gardens*, the performer triggers electronic components at certain points in the piece with the use of a foot pedal. The electronic components include pre-recorded sounds as well as live audio processing of the percussion instruments. The live audio processing includes reverberation and spatialization and requires microphones to be set up around the instruments. In the two decades since Saariaho's groundbreaking work, there has been an exponential growth in the amount of compositions for solo percussion and live electronics. One such work is

Ben Hackbarth's *Open End*, written in 2007. In *Open End*, Hackbarth wrote for solo vibraphone with an accompanying Pure Data patch that runs fixed-media audio samples through three speakers, one of which is underneath the vibraphone. Like *Six Japanese Gardens*, the performer triggers sound events through the speakers at specific moments in the piece with the use of a foot pedal. Some of these sound events include an individual channel for the speaker underneath the vibraphone, which plays sounds into the resonators of the instrument where the tones are able to resonate along with the playing of the performer. This technique is similar to that used by Lucier; the electronics activate and make use of the resonant properties of acoustic instruments.

Definition of Terms

Along with the variety of steadily evolving electronic technologies being incorporated into music composition over the past century, there have been numerous terms created to describe the resulting electronic music styles and techniques. Many of these terms have either become outdated as the technology has progressed or have been used contradictorily, leading to much ambiguity. To that point, some published writings have even acknowledged such ambiguity and then continued to use the unclear verbiage. In an attempt to increase the level of clarity and discourse on this topic, even if only for the sake of precision in this paper, I would like to offer specific terminology and definitions to be used when discussing electroacoustic music. If electroacoustic music broadly refers to the combination of electronic and acoustic sounds, other terms, such as “live,” “fixed-media,” and “interactive,” should provide more precise descriptions and understanding of specific techniques used in electroacoustic music.

First, *live electronics* refers to any form of electronic audio processing and any form of communication between performer and electronics during a performance. Such communication can include a performer triggering a message to an electronic device, electronics responding to various forms of input, or electronics making decisions. The main stipulation for live electronics is that they must take place during a performance. Therefore, the electronic aspect of any piece for an instrument and recording (or “tape”) that involves only the pressing of play before the piece begins, is not considered “live” because there are no real-time electronic aspects involved in the performance. *Live audio processing* is a type of live electronics that includes electronic manipulation of sound during a performance. For many works, that means microphones are used to pick up sounds of acoustic instruments, and a computer or electronic device alters that audio before it is played back through loudspeakers. A much less common type of live audio processing is the manipulation of fixed-media components during a piece.

Fixed-media refers to any media created before the piece begins that remains the same from performance to performance, often referring to pre-recorded samples. For pieces written for an instrument and recording, the recording is an unchanging fixed-media component that starts at the beginning and plays simultaneously with the performer. That does not mean, however, that fixed-media components cannot be involved in live electronic works. Fixed-media selections can be triggered during a performance by various devices, such as a foot pedal or a computer “tracking” the performance and responding to certain input signals. Real-time triggering is variable and dependent on the individual performance and performer, making this use of fixed-media a live form of electronics. Triggering by means of a foot pedal or a tracking computer can

also be used for electronic components that are not pre-recorded and may include multiple possible outcomes. Computers can be programmed to respond or make decisions in a variety of ways. Two of these ways include randomizing algorithms and programmed reactions to specific input signals. These processes initiate an electronic response or decision that is based on a programmed set of rules or circumstances and therefore should not be considered interactive. For pieces utilizing these types of electronic techniques, I am recommending the increased use of the simple term *non-interactive*, because all too often the term *interactive* is used in reference to any live electronic technique.

With the advancement of computer technology and the ability for systems to have intelligible and legitimately interactive relationships with human performers, care must be given not to use *live electronics* and *interactive electronics* as interchangeable terms. As an authority in the field of interactive music systems and artworks, Garth Paine has sought for years to redefine the term *interactive* as it relates to music. After discussing the dictionary definition of “interactive” in the context of musical practices in his article “Interactivity, Where To From Here?” Paine uses the metaphor of a human conversation to demonstrate a true interactive relationship. The path of conversations are not known in advance and the

process of interaction is extremely dynamic, with each of the parties constantly monitoring the responses of the other and using their interpretation of the other parties input to make alterations to their own response strategy, picking up points of personal interest, expanding points of common interest, and negating points of contention.²¹

He goes on to say that in order for a musical system to be interactive, “it must be capable

²¹ Garth Paine, “Interactivity, Where To From Here?” *Organised Sound* 7, no. 3 (2002): 297.

of changing and evolving. The process of evolution must promise continually new outcomes that are based upon the nature of a response-response relationship where the responses alter in a manner that reflects the cumulative experience of inter-relationship.”²² His works involving the tracking of sounds and visual movements in order to develop a system of interaction between a computer system and performers, (or audience members in an installation exhibit), are very influential in demonstrating his assertion of what a truly interactive music system should be.

Of course, many of these terms related to electroacoustic music are not mutually exclusive and can be used in conjunction with one another. For example, a work with live electronics can include live audio processing while also being interactive; however, it is important to remember that just because a composition includes live audio processing and is therefore considered to make use of live electronics, does not mean that it is also interactive. Due to years of ambiguous and incorrect use of the term *interactive*, it would best to err on the side of clarity and use the term *non-interactive* if there is any uncertainty. Using these terms correctly can go a long way towards clarifying the specific components of electroacoustic works, which will aid in the growth of the repertoire by allowing for creative advancements in specific techniques to be recognized and appreciated.

Purpose of Project

Technological advancements in computers and audio software and hardware devices in the past three decades have led to the expansion of possibilities for music

²² Ibid., 298.

composition, including works for acoustic instruments and live electronics. While there have been great strides made in the exploration these new possibilities, there have also been several techniques that have become commonplace. As technology continues to advance and open new doors, the purpose of this project is to further explore electroacoustic compositional techniques through the commission, examination, and recording of three new works for solo percussion and live electronics. In addition to these works using new techniques, a goal for this project is to inspire further dissemination of electroacoustic compositional techniques and the continued growth of the body of repertoire for solo percussion and live electronics. A specific compositional element to be included in these commissioned works is the activation or manipulation of the acoustic properties of percussion instruments by electronic components, similar to elements in the works of Lucier and in Hackbarth's *Open End*. This concept could be executed in a number of ways, and with a variety of percussion instruments, leading to many new possibilities in the field of electroacoustic composition. The creativity demonstrated by the participating composers in their previous works was a highly sought-after quality when considering possible project contributors.

Jeremy Muller is a percussionist whose performance experience and interest in various sound sources and technological tools have led him to composing. Active as a performer and educator, Muller has also written several works for percussion and electronics. His exploration of sound sources in the acoustic realm, as seen in his pieces for the Brazilian berimbau, as well as his experience with the program Pure Data, have produced several noteworthy compositions. His creativity also shows in his various forms of graphic notation and his adaptation of science-inspired ideas. Jordan Munson is a

multi-media artist whose compositions blend acoustic and electronic sounds in colorful sonic textures. With a Masters in Music Technology, Munson uses electronics to synthesize, record, and manipulate sounds that can be layered over time to produce beautiful and unique effects. He has also produced visual works of art and installations that have been exhibited in museums, and many of his music compositions include video components. Munson is a multi-instrumentalist and programmer who regularly performs and produces shows with his electroacoustic ensemble Big Robot. Garth Paine is an internationally acclaimed composer and sound artist from Australia with several decades of creative experience in performance, composition, and interdisciplinary media arts. His works blend acoustic and electronic sounds in imaginative and often interactive ways. His expertise in working with sound as material and his thorough knowledge of a wide variety of technology are demonstrated in his unique programming approaches, sophisticated compositional concepts, sonic imagination, and the compelling aesthetic quality of each individual work. He is also a highly respected scholar and writer in the areas of interactivity, digital culture, and acoustic ecology.

Instrumentation

The instrumentation requested for the commissions was simply anything in the percussion family that could be played by a single performer, and the specifics were left up to the composer. Each of the three works were written almost entirely for solo vibraphone. The only exceptions are the electronic activation of snare drums and inclusion of bass drum in the last few minutes of Munson's *Where Light Escapes You* and the electronic activation of cymbals in Paine's *Resonant Textures*.

The Leedy Drum Company and J. C. Deagan, Inc. made advancements in the development of the vibraphone in first few decades of the twentieth century. Each company was developing their own versions of steel and aluminum barred instruments; Deagan developed a version for use in pipe organs and Leedy built steel marimbas and non-chromatic aluminum vibraphones. Leedy was the first to add a pulsating vibrato effect by a mechanism that raised and lowered the resonators in 1916, followed by the modern revolving fan blades in 1921. Deagan finally came out with an aluminum barred chromatic instrument that had both resonators and a dampening pedal in 1927 that was named “vibra-harp.” When Leedy followed suit with the same features in 1929, the Leedy “vibraphone” name stuck with the original Deagan design. Jazz musicians began using the vibraphone right away in the 1930s, and its first use in the orchestra was in Alban Berg’s unfinished opera *Lulu* (1935). The timbre and sustain of the vibraphone made it a popular instrument in the development of contemporary music in the later twentieth and early twenty-first centuries, especially in works with electronics. Its mellow metallic sound, use of extended techniques like the bow or motor, and precise control of sustain and dampening with the pedal make it well-suited as a versatile sound source in the exploration of new sounds and styles. In this project, each of the three commissioned composers found the vibraphone to be well suited for their compositional concepts and goals.

CHAPTER 2

JEREMY MULLER – BIOGRAPHICAL AND MUSICAL CONTEXTS

Hysteresis, the first commission to be examined, was written by American percussionist and composer Jeremy Muller. Born in 1982, Muller's creative activities are devoted to the integration of technology, science, and music performance. Muller utilizes each of these topics in *Hysteresis*, composed and premiered in 2015. The piece includes a Pure Data patch, scientific and mathematical themes, and technically demanding parts for the performer.

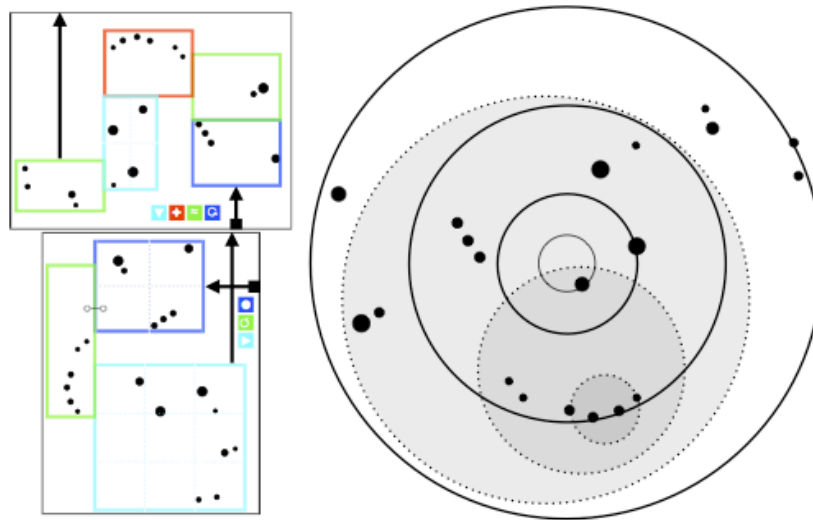
Before delving into *Hysteresis*, a brief introduction of Muller's career and style is in order. As a percussionist, Muller has premiered the works of several notable modern composers and performed with ensembles such as Percussion Group Cincinnati, Crossing 32nd Street, and New Paradigm Percussion Quartet. He has also performed at the International Computer Music Conference, Percussive Arts Society International Convention, International Symposium on Latin American Music, and the Banff Centre for the Arts. As a composer, Muller has written engaging and varied works that utilize technological elements and unique notational systems. Artists such as Simone Mancuso, the Arizona Contemporary Music Ensemble, and the Northern Illinois University "Bau House" Ensemble have premiered his pieces and several of them are published by Bachovich Music Publications, Engine Room Publishing, and Marimba Productions.

Muller has been the recipient of several grants and awards, including the JumpStart Research Grant at Arizona State University and the first prize at the Classical Revolution Phoenix Second Bi-Annual Composition Competition. Holding a Doctor of Musical Arts degree from Arizona State University and a Master of Music degree from

the Cincinnati College-Conservatory of Music, he is currently on the faculty of Scottsdale Community College in Scottsdale, Arizona where he teaches percussion, composition, and electronic music courses.

Compositional Style and Selected Works

Muller's varied creative interests, including computer programming, mathematics, and astronomy, inspire him to explore many conceptual approaches and techniques in his compositions. His compositional style is best considered through these different approaches and techniques rather than looking for a consistent sonic aesthetic. Many of his works include percussion, and since 2012, many have incorporated electronic elements. His music sometimes features themes that help determine certain elements of the piece, such as instrumentation, structure, notation, electronic sounds, and pitched and rhythmic material. Muller has also developed new forms of graphic notation for several of his works. Written in 2014, *Agóna* is an example of a theme-inspired composition with unique graphic notation. *Agóna* is scored for four melodic instruments with timbre control and the notational system is based on star maps of constellations, shown in Figure 1. While other composers have incorporated star maps in their pieces and notation before, such as John Cage's *Atlas Eclipticalis*, Muller utilized the constellations in his own graphic notation system. The performers are assigned specific symbols and color blocks to help them each interpret the notes in the constellations. The structure of the piece is also determined in real-time during the performance by the random ordering of the different constellations on cards, which are laid out on a table in front of the performers.



© Jeremy Muller, 2014

Figure 1. Jeremy Muller: *Agóna*, score excerpt

Premiered in 2014, *Auricle* is distinguished by its novel graphic notation and indeterminate structure. The piece is for the microtonal Brazilian berimbau and includes live electronics with its use of live audio processing. The live electronic elements are run by a Pure Data patch, which also displays the notation and generates the indeterminate game-like structure of the piece. The performer is faced with navigating a maze, and each of the different areas in the maze manipulate the acoustic sound of the berimbau in different ways. The piece is a journey through that maze, ending when the performer reaches the center. As the performer makes decisions, different musical material is chosen by the computer to be displayed on the screen in graphic segments. In this way, the structure of the piece is indeterminate and can vary from performance to performance.

CHAPTER 3

AN EXAMINATION OF JEREMY MULLER'S "HYSTERESIS"

Hysteresis is a ten-minute work for solo vibraphone and live electronics. The electronic components required for a performance are: a computer, foot pedal, audio interface with at least two output channels, loudspeaker, and headphones. The loudspeaker is to be placed underneath, and facing up into, the vibraphone, and the headphones allow the performer to hear the click track that is utilized in small segments at various points in the piece. *Hysteresis* utilizes standard staff notation and includes the electronic part written out for the performer to reference in relation to vibraphone part.

Influenced by Ben Hackbarth's *Open End*, Muller's *Hysteresis* integrates the use of a loudspeaker underneath the vibraphone as a main compositional element. Just as in *Open End*, the goal of the electronic part played through the loudspeaker in *Hysteresis* is the indiscernible extension of the vibraphone's sound palette; however, the utilization of the part is different in Muller's work. The electronic part played from the loudspeaker underneath the vibraphone in *Hysteresis* is much more active than the electronic part in *Open End*. The loudspeaker is also the only electronic sound source in the piece, compared to the additional stereo pair of loudspeakers employed in *Open End*, making it a much more central component of the work.

Hysteresis consists of a single instrumental voice: the vibraphone. While the performer plays on the vibraphone, the electronics are designed to blend into the sound of the instrument; however, the active microtonal electronic part certainly expands the timbre and sonic capabilities beyond what is typical of a vibraphone solo. The title *Hysteresis* refers to varying points of perception among audience members relating to the

interplay between the acoustic and electronic sounds. Muller was interested in a phenomenon known as the Van Noorden Ambiguity in which the listener perceives the blending and separating of two pitches differently in accelerating and decelerating trills. Physicist and musicologist Leon van Noorden tested at what speeds and frequencies the listener would perceive two trilled pitches as a single sound or as two separate notes. There was a disparity in his results that was dependent on whether the trill was accelerating or decelerating, which is an example of hysteresis.²³ “Hysteresis” is a term used in many academic fields, but in this context Muller is referring to a response that is dependent on context or provided instructions, such as whether the trill is accelerating or decelerating or whether the listener is instructed to listen in a specific way. Muller’s desire for *Hysteresis*, with his use of electronic and acoustic sounds as both blended and individual entities, is for the audience to sense a similar effect of ambiguity when perceiving what sounds are acoustic, electronic, or a mixture of each. The piece does not have a clear pulse or rhythmic sense but instead is largely comprised of figures that unfold at various rates and with various activity levels depending on the section. *Hysteresis* begins with a sparse texture and subtle electronic effects and slowly builds to a much more active and robust texture with exaggerated electronic sounds. Near the end, it returns to a sparse texture that is similar to the beginning.

Structure

The structure of *Hysteresis* was determined by several related concepts. First, the piece is divided into four sections whose lengths are derived from the Fibonacci

²³ Andy Farnell, *Designing Sound* (Cambridge, Massachusetts: MIT Press, 2010), 92.

sequence. The Fibonacci sequence is a numerical pattern beginning with 0 and 1 in which the next number is determined by adding the previous two numbers (i.e. 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, etc). The series has been discovered in works by Bartók and used by such other composers as Iannis Xenakis and William Duckworth. The four sections of *Hysteresis* are 13, 21, 34, and 55 measures in length, representing the eighth through eleventh integers in the Fibonacci sequence as outlined above. The structure within each of these sections is then split into two subsections that are the length of the previous two integers in the Fibonacci sequence. For example, in the first section that is thirteen measures long, it is divided in to five and eight measure subsections to match the preceding two integers in the sequence. Muller accentuates these two subsections with a “golden ratio moment” at their transition point.²⁴ The golden ratio is an irrational number sometimes labeled by the Greek letter phi with the value 1.618... Many artists have used this number when determining a pleasing ratio for shapes, where, for example, the longest side of a well-balanced rectangle divided by the shorter side equals approximately 1.618.²⁵ The Fibonacci sequence follows very closely to the golden ratio as well. When a number in the sequence is divided by the preceding number, the result approaches 1.618... The larger the numbers in the Fibonacci sequence used in this calculation, the closer to phi the ratio is. Each of the four sections in *Hysteresis* includes a “golden ratio moment,” where the pinnacle of the section occurs at the point the two subsections meet.

²⁴ Jeremy Muller, Unpublished Program Notes, September 10, 2015.

²⁵ Eric W. Weisstein, “Golden Ratio,” from *MathWorld*—A Wolfram Web Resource, access October 4, 2015, <http://mathworld.wolfram.com/GoldenRatio.html>.

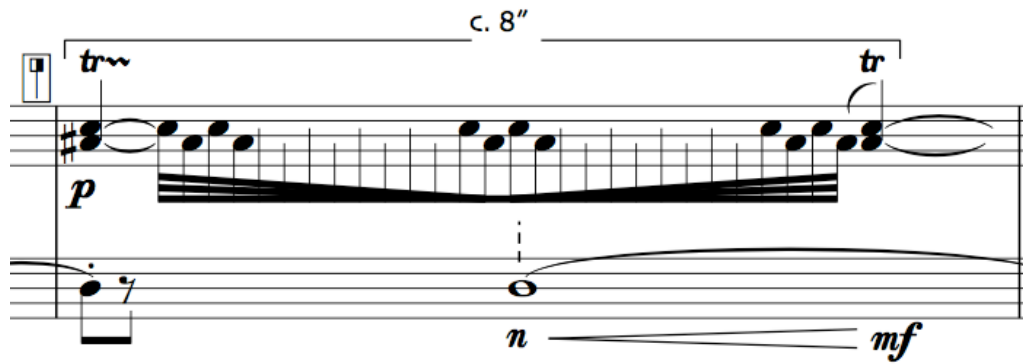


Figure 2. Jeremy Muller: *Hysteresis*, mm. 5

Vibraphone Part

The vibraphone part requires the use of four-mallet technique, both for utilizing four mallets at once and for playing with two mallets in one hand and a bow in the other. The use of medium-soft mallets, medium-hard mallets, soft mallets, and a bow (traditionally used for string instruments) are clearly indicated in the score with small symbols. As shown in Figure 2, the vibraphone part is notated on two treble clef staves. Initially, the mallet part, to be played with the right hand, is written on the top staff while the bowed notes, played with the left, are on the lower staff. Beginning in measure 30, however, the bottom staff includes mallet passages as well. There are numerous tremolo figures throughout *Hysteresis*, many of which need to be executed with a one-handed roll technique. Many of these one-handed figures are notated to speed up or slow down the rate of the strokes, shown in Figure 2. Figure 2 is also an example of how the left hand must bow notes while the right hand plays a tremolo figure, which is marked with a specific duration in seconds. Specific time markings for tremolos are common in *Hysteresis*, adding length to figures outside of the indicated tempo. At times, the

performer must bow multiple notes and use the mallets to quickly strike various accented notes while playing a tremolo, shown in Figure 3.

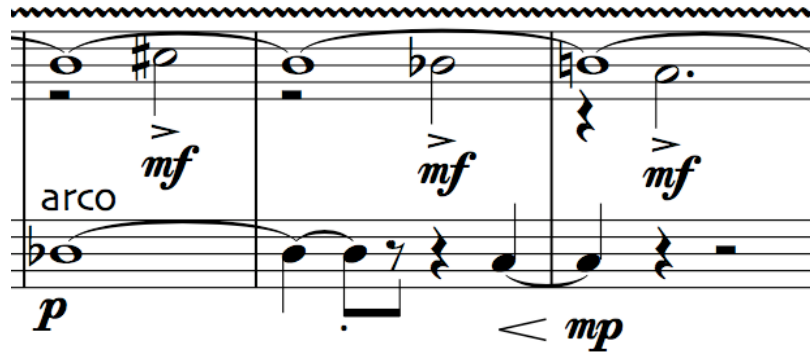


Figure 3. Jeremy Muller: *Hysteresis*, mm. 22–24

The use of the vibraphone pedal is notated throughout. In some sections where the pedal is to be held down, there are notes with staccato articulations. For these passages, the performer will have to use a muted “dead” stroke so that the mallet heads stay on the bars to dampen their vibrations, shortening their ring. In measure 45, a five-second figure begins with staccato articulations and Muller instructs to gradually lessen the amount of mallet dampening over the length of the figure to transition from shorter notes to more ringing ones.

Electronic Part

A Pure Data patch, shown in Figure 4, controls the electronic components of *Hysteresis*, which consist of fixed-media sounds triggered by the performer with a pedal, making it a non-interactive live electronic piece. These triggered sounds are played through the loudspeaker underneath the vibraphone. Several of the cues that the

performer triggers also include short click track segments, which are controlled in the Pure Data patch and played through a different channel that goes to the performer’s headphones. The goal of the electronic sounds is to expand the sound of the vibraphone by playing “de-tuned” and microtonal pitches in a timbre that matches the vibraphone. In this way, the vibraphone suddenly can achieve a much wider range of pitches and effects, perhaps even confusing audience members who do not notice the speaker. The electronic sounds are altered only in pitch, and do not include any other forms of electronic effects or manipulation. The positioning of the loudspeaker also allows the electronic sounds to resonate in the resonators of the vibraphone along with the acoustic sound of the bars being played by the performer, melding the acoustic and electronic sounds even more into a cohesive timbre.

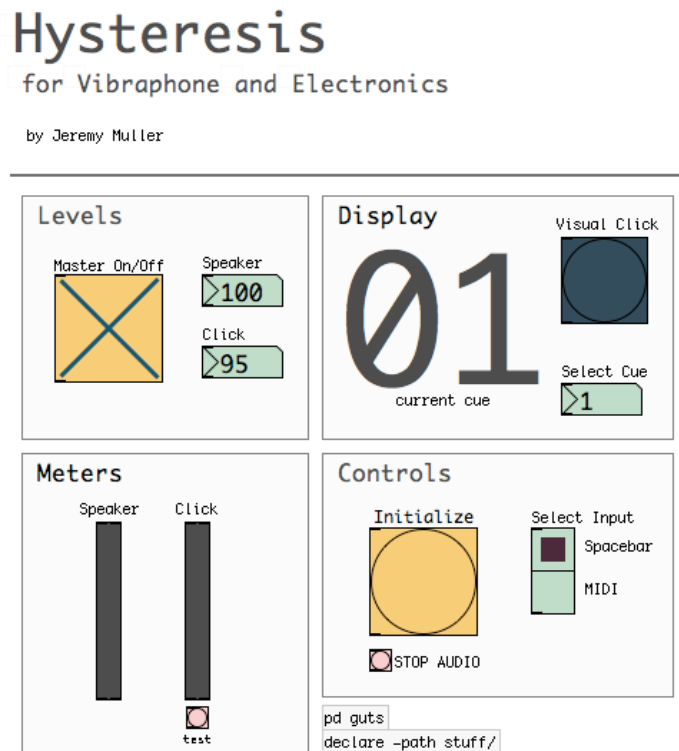


Figure 4. Jeremy Muller: *Hysteresis* Pure Data patch

Tonality and Rhythm

The range of pitches used in *Hysteresis* increases symmetrically and dramatically from the beginning to the end. The piece starts with a B natural on the vibraphone, which is the exact center of a standard three-octave vibraphone range, and the range starts to expand slowly and evenly in each direction when it incorporates Bb and C in measure 5. It is not until measure 12 that A and C# are added to the texture, and Ab and D are not utilized until measure 27. While this limited range may normally seem uninteresting, the microtonal pitch changes and glissando figures in the electronic part add many intriguing sounds to the initially limited vibraphone range. The two pitch sets used by Muller to create most of the pitched material (B, C, D, E, F#, G#, A# and B, C, Db, E, F#, A, Bb) are also symmetrical when moving out from the B in each direction. The methodical and symmetric expansion in the range of pitches utilized, along with the moving microtonal electronic sounds, creates an engaging effect of uniform growth from the beginning to the end.

Similar to how the tonality of *Hysteresis* is determined by a pattern, Muller also uses the Fibonacci sequence to dictate the rhythmic material in the work. The rhythms in the piece predominately consist of eighth notes, triplets, quintuplets, and thirty-second notes, which mirror four of the numbers found in the sequence (2, 3, 5, and 8). Along with this thematic rhythmic material, there are several sections in which the rhythm is created by “de-tuned” and sustaining electronic sounds. Rather than playing a rhythm acoustically with mallets or electronically through speakers, a rhythm is created by an effect known as “beating.” The pitches in the electronic part are carefully “de-tuned” to create this “beating” effect when they are played along with the acoustic pitch. Beating is

an acoustic phenomenon that occurs when two tones that are slightly out of tune with each other are played simultaneously. The effect sounds like pulsing, with a quick and continuous alternation in volume. The speed at which the pulsing occurs is dependent on how far apart the two frequencies are, usually measured in hertz. The written rhythms in the vibraphone part are sometimes a dialogue between the vibraphone and the beating effect. For example, in measure 30 (shown in Figure 5), the vibraphone part's final note is an F#, which is to be played at the same time as the electronic part playing an F# that has been lowered, or flattened, by five hertz. Muller carefully evaluated the speed of the beating between the in-tune vibraphone F# and the de-tuned electronic F# and determined that it was the speed of a quintuplet in the tempo of the piece, 60 beats per minute. He then wrote for the vibraphone to play a quintuplet that ends on the de-tuned, simultaneous F# so that the beating effect would continue the rhythm during the next beat. This technique of passing off rhythmic material between the vibraphone and the beating effect created by the electronics and acoustic sound is a unique compositional effect and important rhythmic component of *Hysteresis*.

The image shows a musical score for measures 29 and 30 of Jeremy Muller's *Hysteresis*. It consists of three staves: Vibraphone (Vib.), Speaker (Spkr.), and a lower staff. Measure 29 features a vibraphone part with a tremolo effect, indicated by a bracket labeled 'c. 3"'. The speaker part has a dynamic marking of 'sim.' (sustained) and a '(pedal)' instruction. Measure 30 begins with a circled '7' above the vibraphone staff, followed by a dynamic marking of 'mp'. The vibraphone part concludes with a quintuplet of notes, with the final note being an F#. The speaker part also features a quintuplet of notes, with the final note being an F# that is '5 Hz flat' relative to the vibraphone's final note. A dynamic marking of 'f' (forte) is present above the vibraphone's final note, and another '5' is written below the speaker's final note.

Figure 5. Jeremy Muller: *Hysteresis*, mm. 29–30

Potential Performance Issues and Suggestions

The precise tunings of the pre-recorded electronic sounds and their relationship to the precise acoustic pitches could present a problem if a vibraphone is not tuned correctly. *Hysteresis* and its accompanying Pure Data patch were created for a vibraphone tuned to A=442. This is a common tuning standard for percussion keyboard instruments, and the goal was for the piece to work correctly on as many instruments as possible. There is potential for Muller to create another version of the patch for A=440 instruments in the future, but there is currently no timetable for such a project. In addition to the exact tuning frequency used for the instrument, the instrument has to be in tune with itself. If any of the individual bars have become out of tune with the rest of the instrument, it could dramatically alter the effect of the piece. A performer must ensure that their instrument is accurately and completely tuned to A=442 to give the most effective performance of *Hysteresis*.

There are several challenging technical moments in *Hysteresis*, many of which arise from using the one-handed roll technique for the written tremolos. The performer must frequently bow with the left hand while doing a one-handed tremolo in the right hand. With varying challenges related to that technique alone, the performer must diligently practice: a long, smooth bow stroke while playing a tremolo (measures 16 through 18), changing the speed of the tremolo while bowing (measures 5 and 12, shown in Figure 2), and bowing multiple pitches during one tremolo figure (measures 22 through 24, shown in Figure 3). Along with that last technique in measures 22 through 24, the performer must also strike three notes with mallets while playing the tremolo. For this figure, the author recommends momentarily stopping the one-handed roll motion

with the right hand to quickly strike the pitches with the outside mallet, usually referred to as mallet four. A quick and sharp movement will help to produce the accent on the struck notes while minimizing the time away from the tremolo.

The one-handed tremolos also present challenges with their intervals and the resulting arm angles. In measure 5, the simultaneous bowing of a B while playing a tremolo on Bb and C necessitates a sharp right arm angle while also rotating the body to the right. The author recommends to play the Bb with the right outside mallet (mallet four) and the C with the inside right mallet (mallet three). The performer must lean to the right and open the body up to the left, in addition to sticking out their right elbow, to create the necessary angle for the mallets. Also, while there is no bowed note in measure 9, it is still recommended to use the same sticking for the sake of consistency. A similar technique is needed for the one-handed tremolos on a single pitch, but with a less severe arm angle than the Bb and C. To roll on one note, the elbow still needs to be pivoted out so that the mallet shafts are perpendicular to the length of the bar. One mallet head should be in the center, while the other should be on one of the edges of the bar.

An additional challenge when playing a one-handed figure is encountered in measure 29 (see Figure 5). Between the bowed note on the downbeat of measure 29 and the rhythm notated on count two of measure 30, the performer must lay down the bow and pick up medium-hard mallets. The author recommends having a suspended cymbal stand set up next to the end board on the low end of the vibraphone that is the same height as the instrument and has the top screw pointing towards the performer. The performer will be able to quickly and easily slide the bow opening by the frog onto the screw, hanging it on the stand. In the same motion, the performer can then grab a pair of

medium-hard mallets from a music stand next to the cymbal stand, all in measure 29 while the right hand is playing the three-second figure. Then, in the counts of rest at the end of measure 29 and beginning of measure 30, the performer can place the medium-soft mallets from the right hand onto a stand located on the right side of the vibraphone and grab one of the medium-hard mallets from the left hand. To pick up the bow again, the author recommends that the performer move the left hand mallet back into the right hand on count three of measure 33 and pick up the bow on count four. This requires the performer to play the quintuplet figure on count one of measure 34 with one hand in order to quickly play the bowed note on the second eighth note of count two.

The location and usage of the electronic trigger pedal presents a challenge when coupled with the use of the vibraphone pedal. The author recommends operating the vibraphone pedal with the non-dominant foot and placing the trigger pedal to the side of the vibraphone pedal where it can be operated with the dominant foot. While the dominant foot traditionally operates the vibraphone pedal, the non-dominant foot can handle the infrequent pedaling included in this piece and that allows the dominant foot to operate the much more active electronic pedal. Careful practice of balancing and shifting weight between the two feet is necessary for sections that include active pedaling with both the vibraphone and electronic pedals. Coordinating foot movements and remaining balanced are added difficulties beyond the demands of the mallet and bow techniques on the vibraphone. The challenges are well worth the effort, however, as the interplay between the electronics and vibraphone creates effects that are engaging and distinctive throughout *Hysteresis*.

CHAPTER 4

JORDAN MUNSON – BIOGRAPHICAL AND MUSICAL CONTEXTS

The next piece to be examined, *Where Light Escapes You*, was composed by Jordan Munson (b. 1983) and premiered in 2015. Munson is a multi-media artist “whose work explores memory, ephemera, and our relationship to technology.”²⁶ Like Muller, Munson is from the United States and studied as a percussionist. Munson, however, received formal training in music technology, earning a Master of Science in Music Technology degree from Indiana University-Purdue University Indianapolis (IUPUI).

Munson blends sound and visual art in his music compositions for traditional performance spaces, as well as creating interactive sound and visual art installations. His compositions have been premiered by some of the top university percussion ensembles and contemporary music programs in the United States, while his video art has been exhibited around the world at such places as the Musicacoustica Festival in Beijing, the New World Center, and The Phillips Collection. Munson also performs regularly as a multi-instrumentalist, having collaborated with such artists as Matmos, Bora Yoon, Nico Muhly, and R. Luke DuBois, along with Scott Deal and Michael Drews in their electroacoustic ensemble Big Robot. He has performed and presented at numerous conferences and universities, including the Percussive Arts Society International Convention (PASIC), International Association for the Study of Popular Music-Canada International Conference, Musicacoustica Festival, University of Illinois at Urbana-

²⁶ Jordan Munson, “Full Bio,” <http://www.jordanmunson.com/full-bio> (accessed September 30, 2015).

Champaign, University of Louisville, Bowling Green State University, Oklahoma State University, and University of Kentucky.

Munson has been a Lecturer in the Department of Arts and Music Technology at IUPUI since 2008. At IUPUI, Munson is involved in research and development at the Donald Tavel Arts and Technology Center and earned the Innovative Technology Recognition Award in 2008. As a member of the Percussive Arts Society Technology Committee, Munson chaired the committee that created proposals and coordinated logistics for electroacoustic concerts at multiple PASIC conventions.

Compositional Style and Selected Works

Many of Munson's musical works make use of found media, experimental instruments, and visual art. They also unfold slowly as gradually shifting sonic landscapes, which are crafted through the layering of textures. Munson did not receive formal compositional training, but has been composing ever since he was in high school with an intuitive and organic process for creating the flow and textures of his works and using his technical training to digitally construct them. All of his compositions include electronics and many of them are also written for percussion, ranging from solo to small chamber ensembles. *Circle of Wills* is a percussion quintet with live electronics and accompanying video that makes use of unusual percussion instruments, such as a motorized hotel bell, aluphone, and rare tuned sleigh bells made by J. C. Deagan, Inc. that are housed at the University of Kentucky. Premiered in 2014, *Until My Last* is another example of his scoring for experimental instruments with the use of a music box

and a homemade “Little Bits” synthesizer along with piano, live electronics, and responsive lights and video.

Munson’s compositions often include programmatic themes, leading to titles and accompanying visual art that are thought provoking additions to the music. *How Long Is The Coast of France?* was premiered in 2008 and is an example of a composition created based on extra-musical concepts. Munson was inspired by natural and man-made architecture, specifically about a juxtaposition he perceived in nature between the geometric shapes of fractals and the varied components in non-hierarchical structures. His interest in this juxtaposition motivated him to write parts that develop and function independently of each other, but that are still seemingly related in a larger system. The piece is scored for electronics and a trio of percussionists each playing a set of three pitched metal instruments (crotales, almglocken, and “pitched cymbal bells” or temple bowls). As each of the pitches in the three groups of instruments become louder and more active, the overtones from the different instrument timbres and pitches start to connect together in a singular sonic landscape. The accompanying video follows a similar process by distorting and blending images so that they are almost unrecognizable and then overlapping and pulsing them in homogenous color schemes so that the brain can vaguely make connections between them.²⁷

²⁷ Jordan Munson, “How Long Is The Coast of France?” <http://www.jordanmunson.com> (accessed September 30, 2015).

CHAPTER 5

AN EXAMINATION OF JORDAN MUNSON'S "WHERE LIGHT ESCAPES YOU"

Where Light Escapes You is written for live electronics and a solo percussionist playing both a vibraphone and a bass drum with a foot pedal. A performance of *Where Light Escapes You* is approximately eight minutes and forty-five seconds long and requires the use of a computer, contact microphone, electronic foot pedal, audio interface with at least four output channels and two input channels, four loudspeakers, and two snare drums that are to be mounted above two of the loudspeakers so that they vibrate sympathetically. The notation is distinctive in that it combines traditional staff notation, graphic notation, and time markings to indicate pitches, dynamics, rhythmic activity, and pacing (see Figure 6).

The figure displays a musical score on a grid background. At the top, time markers are placed at 0'00", 0'15", and 0'30". The score is divided into two main sections: the upper section for the Bowed Vibraphone (Right Hand) and the lower section for the Two-Mallet Vibraphone (Left Hand). The Bowed Vibraphone part begins with a treble clef and a note marked '8va----|'. Below the staff, the instruction 'BREATHY, WITH SHORT BOWS' is written. The dynamics for this section are indicated by 'fff' and 'ppp' with vertical lines. The Two-Mallet Vibraphone part also uses a treble clef and features several notes with stems and dots, some of which are marked with '(0'10")'. Below this staff, the instruction 'PEDAL SUSTAIN, AD INFINITUM -----' is written. The dynamics for this section are also indicated by 'fff' and 'ppp' with vertical lines.

Figure 6. Jordan Munson: *Where Light Escapes You*, beginning to 0'30"

In the score of *Where Light Escapes You*, Munson says the piece is “influenced by those remote places where true darkness and silence exist. All at once tranquil and urgent, these environments offer up a deep knowledge of the space around us, hidden within the absences.”²⁸ This contributed to his desire for the elements of the piece to flow together so that there would be no clear delineation of sections.²⁹ He was able to accomplish this effect through his choice of instruments and the subtly shifting layers that slowly alter the texture as the piece progresses. Before he began composing, Munson had certain types of sounds in mind that he wanted to incorporate into the piece, specifically the sounds of the vibraphone and different varieties of bell sounds with low bass tones. He began his process of composing by recording and creating sounds to use for the electronic part. In addition to the bell-like sounds throughout the piece and the bass tones that enter in the second half, Munson also recorded pitches played on the melodica, a keyboard wind instrument. He was interested in the dichotomy presented with the instrument because it has a meditative drone-like quality when playing single notes, while the layering of its pitches provides a sense of tension.³⁰ All of these sonic elements gradually shift in volume and density, along with being slowly folded in and out of the texture, creating a cohesive sonic landscape throughout the duration of the work. Within this landscape, several of the acoustic and electronic components add layers of elusive melodies, providing *Where Light Escapes You* with a vaguely melodic quality.

²⁸ Jordan Munson, “Where Light Escapes You” (unpublished score, October 25, 2015), PDF file.

²⁹ Jordan Munson, Unpublished Program Notes, October 2, 2015.

³⁰ Ibid.

Vibraphone and Bass Drum Part

Like *Hysteresis*, the vibraphone part for *Where Light Escapes You* requires the performer to play with two mallets in one hand and a bow in the other for the majority of the piece, while also requiring the performer to play with four mallets at once. As shown in Figure 6, the score specifically indicates the use of mallets in the left hand and the bow in the right hand by notating them on separate lines. At the beginning of the piece, there is an instruction for the pedal to be held down for the entire duration of the work. Munson then notates muted staccato, or “dead,” strokes with filled-in note heads and regularly struck notes that will ring with empty note heads. At times, the part requires the left hand to play one-handed rolls with the mallets in both the muted and ringing styles. The vibraphone part shifts between the keys of D major and B minor and therefore, with the absence of a key signature, there are frequent sharp symbols for the pitches C# and F#. The sharp designations stay true for all repeated C#s and F#s in which the sharp is only present on the first pitch. The vibraphone part also occasionally employs larger note heads, in order to depict which notes should be emphasized. The bass drum part is notated on its own line and includes a steady sequence of single notes at triple forte, which trigger electronic bass pitches that form something of a bass line.

One distinctive technique that Munson used when composing the vibraphone part of *Where Light Escapes You* was allowing the computer to essentially “compose” a portion of it. He set up a computer with a microphone that would track and log what he improvised on a vibraphone in MIDI messages. The “composing” was done as the computer had to make decisions about what exactly it heard. With a sustaining metal instrument like a vibraphone, there are substantial overtones and frequencies present in

addition to the fundamental pitch. The MIDI transcript of what Munson played on the vibraphone included some of that higher harmonic content in addition to the fundamental pitches, which made the transcript denser than what he actually played. Munson used some of the material from the computer's "composition," but had to sort through and edit it to make sure that it would be playable by a single person and that it would fit in the range of the instrument.

Electronic Part

The electronic component of *Where Light Escapes You* is generated from a Max/MSP patch. The patch plays fixed-media sounds that are triggered at the beginning of the piece, by the performer with a foot pedal, and by the bass drum notes. The input from the contact microphone attached to the bass drum triggers the patch to play computer-synthesized bass figures and to add reverberation and amplification to the sound of the bass drum. The electronics are considered live and non-interactive because they consist of elements triggered by the performer and the live audio processing of the bass drum. The electronic components are also carefully crafted and arranged so that they activate the acoustic sound of two snare drums placed on each side of the vibraphone. The sympathetic resonance in the snares can be heard subtly in the first half of the piece and more presently when the louder electronic bass pitches come in after being triggered by the bass drum. With a dedicated channel and loudspeaker situated under each snare drum, the electronics are also able to create a panning effect from drum to drum on the different sides of the stage. This component of *Where Light Escapes You* demonstrates a unique chain effect of acoustic and electronic triggering as the acoustic sound of the bass

drum triggers the electronic bass tones, which lead directly to the activation of the snare drums.

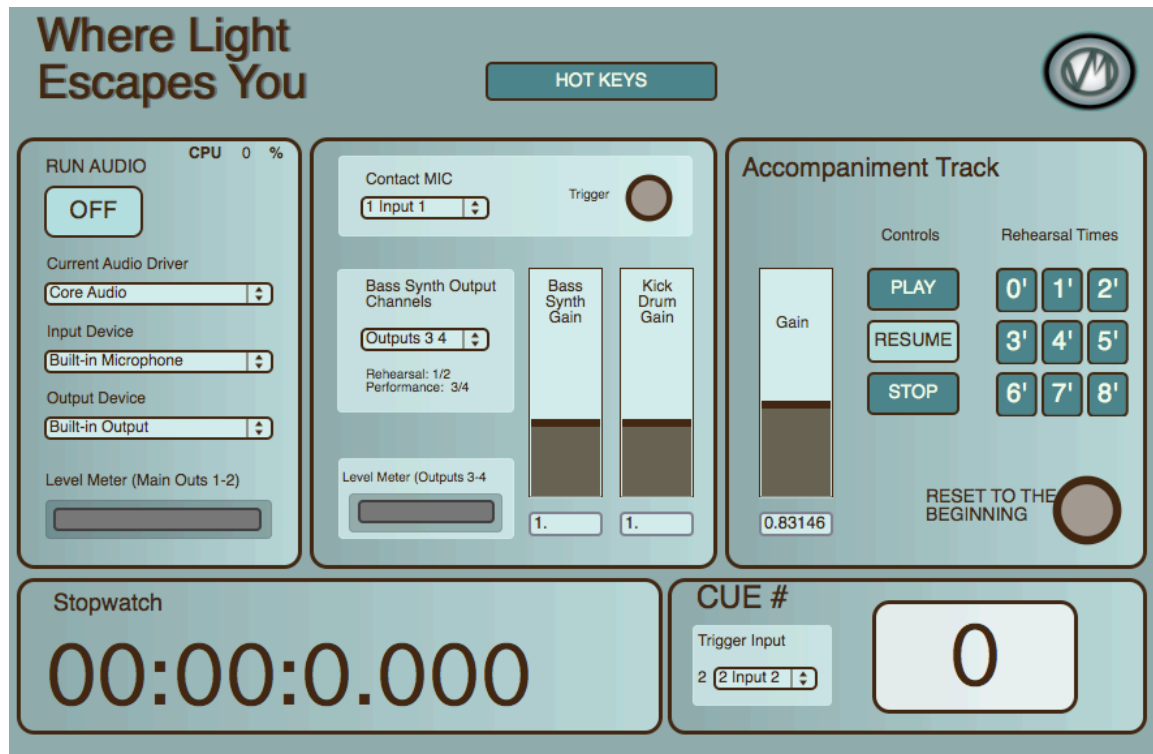


Figure 7. Jordan Munson: *Where Light Escapes You* Max/MSP patch

Shown in Figure 7, the accompanying Max/MSP patch for *Where Light Escapes You* is very easy to use, with several features available via pull-down menus. With just a few clicks of the mouse on the main screen, the performer can choose their input device and channels, output device and channels, turn audio on or off, and adjust the volume for the bass drum and bass notes. Munson previously composed exclusively in Max/MSP but has started to incorporate Ableton Live when working on his most recent projects. In the past few years, the two programs have become more integrated, as seen in the new component of Ableton called “Max for Live.” In Max/MSP, a composer can use its vast

tools to construct the framework and technical aspects of a piece. In Ableton, recording, looping and manipulating sound is intuitive and more flexible than in Max/MSP. Munson recorded a majority of the sounds heard in the electronic part and the original sound sources include: melodica, vibraphone, music box, and various types of bells. Munson then carefully manipulated these sounds and layered them with additional synthesized electronic sounds to construct a framework of the piece. By utilizing Ableton in addition Max/MSP, Munson is able to expand his compositional process by using the newest technological advancements to create innovative sounds and compositional structures.

As a visual artist as well as a composer, Munson routinely includes various forms of video in his compositions and he created a video that is to be played during a live performance of *Where Light Escapes You*. The video is generated through Max/MSP along with the audio, which allows for the video to progress along with the musical elements. The components of the video are similar in style and theme as some of his other works in that they are mostly abstract with slowly changing frames that give the viewer a sense of vague recognition. The screen is often predominately a single shade of color that serves as a sort of colored filter to any objects or movements taking place. The color shading also slowly changes throughout the piece along with the developing sonic texture.

Potential Performance Issues and Suggestions

There are several components in the set up for *Where Light Escapes You* that could present challenges to the performer. First, there are two recommended ways that will help the performer avoid the need to manually depress the vibraphone pedal for the

entirety of the performance. One possibility is to place a heavy object on the pedal so that it stays depressed, and another is to place an object in the space between the dampener pad and a mechanism at the top of the vertical rod that connects the pedal to the dampener pad. This second technique can only be done on certain vibraphones where the depression of the pedal moves a piece away from the bottom side of the dampener pad, allowing for the placement of an object in that space to keep the pedal down. If possible, the author believes the second option to be preferable because it leaves more open space on the floor by the performer's feet, which is especially helpful in *Where Light Escapes You* due to the presence of an electronic foot pedal and a bass drum pedal.

There are a few options for the positioning of the bass drum around the vibraphone. It is possible for it to be played while at the high end of the vibraphone, with the pedal coming out from the drum perpendicular to the vibraphone bars. This positioning may require careful balancing as the right leg reaches for the pedal, but because the bass drum part consists of only single notes and not active rhythms, the foot can move over for a single "kick" motion and return to a standing position. Two other options include placing the bass drum directly behind the performer so that they can step straight back and play with the heel of their foot and using a double-bass pedal. While positioning the bass drum behind the performer leads to less reaching and therefore allows for easier balance, it could create further challenges. With the bass drum behind the performer, they must locate the pedal with the foot while it is completely out of view, and they must play a loud, full stroke with essentially a "backward" foot technique of the heel moving downward to the pedal. The third option, the use of a double-bass pedal, presents probably the most streamlined possibility for the performer in that a pedal can be

placed right underneath the vibraphone with the extension run out to the side of the instrument where the bass drum is positioned. The only downside for using double-bass pedals is the fact that there are more moving intermediary parts between the pedal and the actual striking of the drum, leaving possibilities (depending on the quality of the equipment) for mechanical issues or a delay in the sound. For *Where Light Escapes You*, however, a delayed response is not an issue as the bass drum notes are not synchronized with other rhythmic events. The bass drum notes initiate the electronic bass pitches and add single, low frequency impact notes to the texture.

The author recommends the use of hard vibraphone mallets for the first six minutes of the work and medium-soft mallets when the performer picks up four mallets for the final section. This choice of mallets helps the vibraphone to fulfill Munson's intentions in different sections of the piece. At times, the vibraphone should match the texture of the electronic part, and at other times the vibraphone should contrast with it. Hard mallets provide single struck notes with an articulate, bell-like quality, which helps the notes to be heard across the wide dynamic range of triple piano to triple forte. The sound produced by the hard mallets combined with the longer bowed notes in the first six minutes of the piece blend in with the electronic texture that consists of varied rhythmic and sustaining sounds. The use of medium-soft mallets, which have more cord or yarn on the mallet head that softens the attack of the mallet core, in the final chorale section allows the rolls to sound smooth. The smooth and sustained sound of the rolls serves as a contrast to the electronic part that has grown to a very dense and active texture.

Notated in the mallet part are one-handed rolls with both solid and empty note heads. The solid note head rolls designate a muted "dead" stroke technique, which call

for a quick burst of non-ringing strokes. These solid-note head rolls are mostly written on one note, and to execute them the performer must pivot the elbow out so that the mallet shafts are perpendicular to the length of the bar, as discussed with *Hysteresis*. The performer could also choose to play a majority of these rolls with the mandolin roll technique, in which the mallets play both above and below the bar on the edge closest to the performer. With the mandolin roll technique, however, the performer would not be able to play the rolls on C#s and F#s. The rolls written with empty note heads can be played with a more traditional rebounding technique that produces a sustained ringing sound without hearing the individual strokes of each mallet. A few of these empty note head rolls are notated on one pitch, and the performer will have to rotate the elbow as described above; however, most of them are written for two different pitches and therefore the arm angle will be subject to the varying intervals between the two mallets, discussed below.

The most demanding elements of performing *Where Light Escapes You* come from the challenges faced while having to simultaneously bow and play with mallets. First is the simple hurdle of becoming comfortable with the coordination for the right hand moving vertically for bowing and the left hand playing on a horizontal plane with several types of mallet techniques, such as a rebounding stroke, “dead” stroke, and one-handed roll. Secondly, the opening minute and fifteen seconds require a very active and somewhat improvised bowing on one note while the left hand is playing very quietly and sparsely. In this section, the contrasting playing motions and styles required of the two hands prove challenging to execute simultaneously. The author recommends practicing just the bow part alone to get a sense of the graphic notation and the technique of playing

active bow strokes in the requested “breathy” fashion. Munson explained that the “breathy” effect should mostly include the sound of the bow hair on the bar with only the occasional sound of the bar ringing and any inadvertent squeaks from the rosin. Munson also suggested that the increased density and size of the graphic notation of the bowed part should serve both as an indication of more stroke activity and increased bow pressure.³¹ For the more active and dense figures in this section, the author recommends staying within several inches of the frog-side of the bow for maximum control while achieving an agitated quality. For periods of less activity, using slower and longer strokes with more of the bow length helps to provide a calmer sound that effectively contrasts to the more agitated figures. After practicing the opening bow part alone to master control over these intricacies, the performer can then try to slowly add in the mallet part in small increments to work towards creating a cohesive texture.

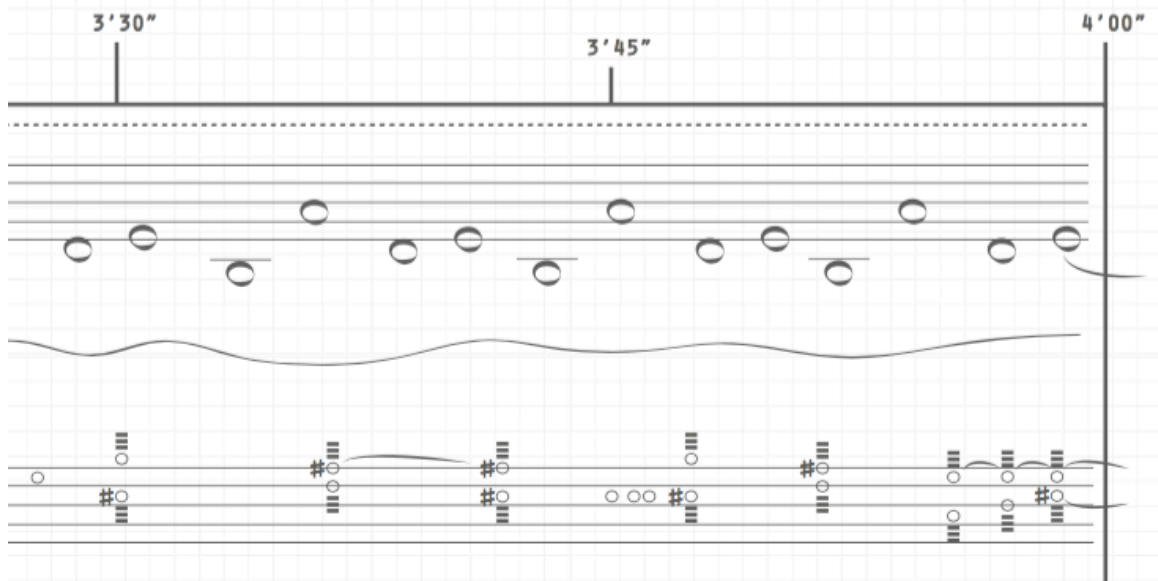


Figure 8. Jordan Munson: *Where Light Escapes You*, 3'30"–4'00"

³¹ Ibid.

Following the opening section, the bow part begins to include different pitches that are bowed in a more traditional, ringing fashion. It is not necessary to bow each note until the next one is notated; instead, the performer should bow each note until it speaks at the appropriate dynamic level and then let it ring. Another playing challenge arises after the opening section when the texture starts to increase in density around the 2'45" marking. The coordination of the bow and mallet parts becomes more difficult as the parts become increasingly active due to difficult arm angles created by the mallet and bow parts crossing over each other and challenging intervals written in the left hand rolls. Up until the 2'45" mark the right hand bowed notes are higher pitches than the mallet notes. Then, the bowed part gradually descends while the mallet part ascends, leading to mallet pitches that are higher than the bowed notes (see Figure 8). Two different approaches are recommended while playing these crossover sections. First, the performer can lean to the left while facing right and reaching up the instrument with the left hand. A second approach would be to cross the right hand over the top of the left arm. In most cases where there are mallet pitches higher than bowed notes, the part can be executed by the first approach, leaning to the left so that the left side of the body is next to the instrument and opening up to the right. This allows for the right hand to bow across the front of the body while the left hand reaches upwards along the instrument to play higher notes at an angle that is almost perpendicular to the "normal" approach when squarely facing the instrument. When the left hand climbs in to the highest octave after the fourth minute, the second approach must be used with the right hand reaching over the top of the left arm in order to bow several notes. This technique provides much less desirable angles for both the mallet rolls and bowed notes and therefore is not recommended unless

completely necessary. The two moments where the author deems it necessary are both shown in Figure 9, specifically: the bowed A and D during a rolled G and C# at 4'20", and the bowed B, A, D, and E from 4'35" to 4'42".

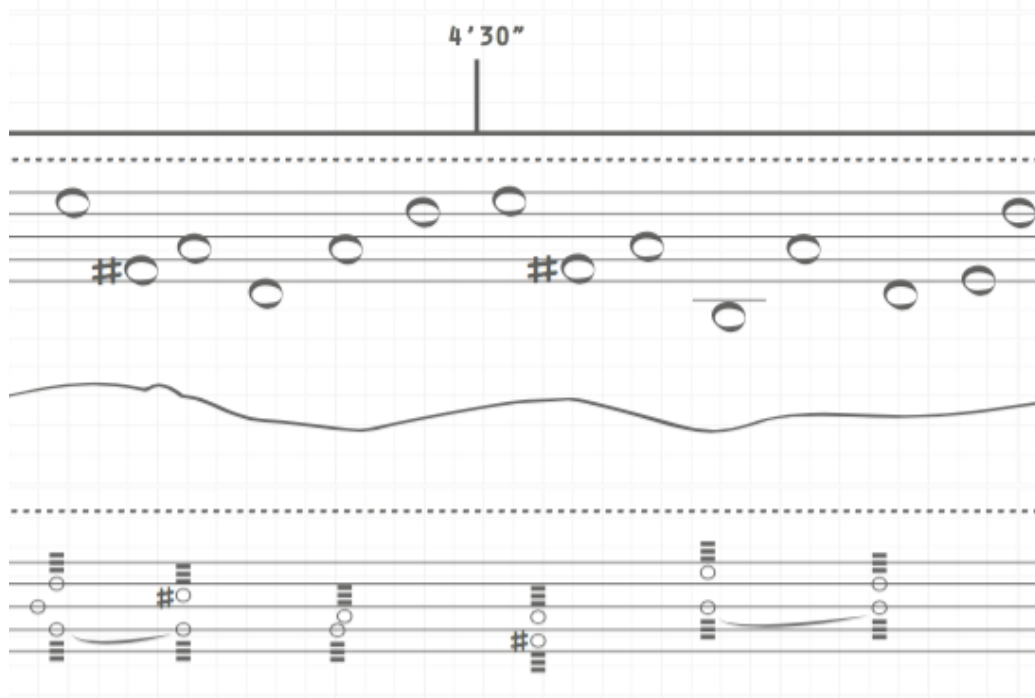


Figure 9. Jordan Munson: *Where Light Escapes You*, 4'20"–4'40"

With rotating the body to the left as the general approach for playing left handed notes that are higher than bowed notes, the performer will sometimes need to quickly swing their body over to the right because of leaps to the high range in the bow part and challenging intervals in the left hand. As the right hand bow part becomes increasingly active, there are multiple octave leaps that require the performer to shift their weight to reach up to the higher note in time. There are also three one-handed rolls that require the left outside mallet to play on the lower manual while the inside mallet is on the upper manual. One occurs around 3'10" on an A and F#, another at 4'20" with a G and C#

(shown in Figure 9), and the final occurrence is around 5'50" with a B and C#. For these rolls, the performer's body will have to lean heavily to the right and open up to the left while bringing in the left elbow to achieve the correct arm angle. It is worth noting that the G and C# roll at 4'20" is also one of the spots where the right hand needs to cross over the top of the left. There are also two rolls on D and F# between 3'35" and 3'50", shown in Figure 8, for which the author recommends to play the F# with the left outside mallet and the D with the inside mallet using the extreme arm angle with the elbow out and the body leaning to the left. This technique is recommended to avoid swinging the position of the body all the way around from the left to the right, which would create further challenges with the bowed notes that follow. By kicking out the left elbow, the body can remain relatively in the same position and allow for the right hand to continue bowing seamlessly.

From 4'55" to 6'00", there are bowed notes written with solid note heads and the instruction for "short swells." For these bowed notes, the performer should crescendo the note quickly and then stop the bow stroke with the hair of the bow still on the bar to prevent any ringing. This technique will create short bowed notes that compliment the muted rolls of the left hand, creating an articulate, non-ringing texture that contrasts with many of the other sections in the piece. Following this non-ringing segment is the final chorale section of the piece in which the bass drum and electronic bass notes enter. In this section, the striking of the bass drum triggers each electronic bass pitch, which is comprised of an approximately six second rhythmic pulsing figure followed by the sustained electronic pitch. The timing of the mallet chords and the bass drum notes directly relates to the length of the rhythmic aspect of the electronic bass pitches. The

next electronic pitch should not be triggered until the rhythmic figure of the previous pitch is complete and therefore, at minimum, the bass drum notes should be approximately six seconds apart. By equating the shortest length between bass drum notes to this six-second duration, the performer can then determine the relative durations between other more widely spaced bass drum notes. From carefully noting the spacing between notes throughout this final section, the author applies the minimum duration to each of the notes that are six to seven grid lines apart.

The elements of graphic notation in *Where Light Escapes You* provide performers with opportunities for artistic interpretation. From the sound of the bow at the beginning of the piece, to the pacing of the bass drum and rolled chords at the end, performers are able to bring their own sound and approach to the piece. This freedom of interpretation and pacing creates a naturally evolving character in *Where Light Escapes You* and allows for varied performances between different artists.

CHAPTER 6

GARTH PAINE – BIOGRAPHICAL AND MUSICAL CONTEXTS

Garth Paine, a prolific and internationally recognized artist, takes yet another approach to live-electronic composition in the project's final commissioned piece, *Resonant Textures*. Paine's artistic training and cultural background differ from those of Muller and Munson and he has gained a wide variety of experiences as an artist over the course of more than three decades. Born in 1962 in Sydney, Paine spent much of his career in Australia and Great Britain before moving to Arizona in 2012. He was trained in flute performance, composition, and software engineering at the University of Tasmania, the Swinburne University of Technology, and at the Royal Melbourne Institute of Technology where he earned a PhD in Interactive Media. He is active as a composer, performer, writer, and educator.

Many of Paine's compositions explore new interface possibilities for electronic music performance and interactivity and have been performed around the globe in North America, Europe, Asia, and Australia. Some of his live-electronic works involve his participation as a performer on flute and other acoustic or electronic instruments. He has also created interactive works to be exhibited as installations, along with pieces for dance, in which physical presence, gesture, and behavior generate the elements of the music through real-time video tracking and bio-sensing. Furthermore he has designed and implemented interactive museum exhibitions at the Melbourne Museum, the Jewish Museum of Australia, and the Eureka Stockade Centre. Another area of research and compositional inspiration for Paine is the field of Acoustic Ecology. He has long used

field recordings in his pieces and used sound as a platform for engaging in environmental work.

Paine is currently an Associate Professor of Digital Sound and Interactive Media and of Composition at Arizona State University, holding a joint appointment in the School of Arts, Media, and Engineering, the School of Music and the Global Institute of Sustainability. He also directs the Acoustic Ecology Lab at ASU. From 2012–2014, he was Interim and Associate Director of ASU's School of Arts, Media, and Engineering. Prior to his appointments at ASU Paine was Associate Professor of Digital Music and Director of the Virtual, Interactive, Performance Research environment lab (VIPRe) at the University of Western Sydney.

Paine has also received recognition as a scholar and is regarded as a leader in research on interactivity in music and media arts. He has contributed important writings on this and other subjects, presented at conferences such as New Interfaces for Musical Expression (NIME), and helped lead research projects such as the Taxonomy of Interfaces/Instruments for Electronic Music performance. His most recent research centers on Acoustic Ecology. In 2013 he initiated the Listenⁿ Project, in which artist-created and crowd-sourced field recordings using ambisonics technology gathered in deserts in the American Southwest serve as basis for scientific study and creative works, and foster community engagement and environmental stewardship. Paine co-organized the Listenⁿ Symposium in 2014 and co-chaired the Balance-Unbalance International conference in 2015, both events that explore intersections between the arts, sciences, technology, and environmental studies. In 2015, he co-founded the Acoustic Ecology Lab at ASU.

As a performer, Paine has presented his works at the International Symposium of Electric Art, Ear to the Earth Festival, John Cage Centennial Festival, SiteWorks, Agora/Résonances Festival, New York Electronic Arts Festival, Liquid Architecture, Aurora Festival, The Australian New Music Network concert series, and SXSW Eco 2015.

Paine has been the recipient of numerous honors, including First Prize as the Most Creative project at the 2014 SouthWest Maker Festival, the New Media Arts Fellow at the Australia Council for the Arts, and Composer in Residence at the Staatliches Institut für Musikforschung in Berlin. Paine has also received several grants for his projects and research from institutions such as the Australian Research Council, the Australia Council for the Arts, the ASU Herberger Institute for Design and the Arts, the ASU Institute for Humanities Research, and the University of Western Sydney.

Compositional Style and Selected Works

Paine's research and creative activities are intertwined and so diverse that is difficult to describe or label his artistic output in a concise way. In general, many of his compositions seek to combine acoustic sounds with various forms of electronic processing. By utilizing different types of instruments and acoustic sounds, Paine explores various ways to manipulate complex live sound with the goal of creating a broad array of timbres. Paine's vast technical skills allow him to investigate cutting edge technologies to broaden the structural possibilities in composition and expand the sonic palette.

Paine has collaborated with several notable percussionists, including Michael Atherton and Simone Mancuso, and created several intriguing works for percussion instruments and electronic works using percussion sounds, including *Bowl Chant*, *Glitch*, *33 Degrees 50 Minutes South*, *Drum Machine Piece*, *Oscillations*, *Sonic Residues*, and *Glistening Edge*. His piece *Sonic Residues*, premiered in 2015, is for percussion and electronics. It is a duet written for one percussionist playing waterphone and another performer using a Karlax, a wireless MIDI controller that translates the performer's spatial gestures into control data which is used to drive the synthesis algorithms. In *Sonic Residues*, the waterphone is played in a variety of ways, using fingers, mallets, and a bow, for instance, to produce a myriad of sounds that are recorded by a microphone and then manipulated by Paine gesturing with the Karlax. The Karlax controls the re-synthesis software he developed in a software framework called Kyma running on a computer. The rich overtones and sound effects of the waterphone are fully explored and then expounded upon with the application of unique electronic hardware and software technologies to create an engaging sonic landscape.

His interest in sound as an “exhibitible object” has led to numerous interactive installations and dance works that involve various forms of movement tracking to generate a sonic landscape.³² One such interactive installation was *Gestation*, shown at the 10th New York Digital Salon in April and May of 2003, DesignX: Critical Reflections, and at NIME02. The work included two galleries. In the first gallery, a camera tracked the amount of movement generated by exhibit guests. The analyzed

³² Garth Paine, “Bio,” <http://www.garthpaine.com/About/bio.html> (accessed September 30, 2015).

behavior patterns were used to drive generative sound algorithms in a surround sound configuration in that gallery. There were no pre-recorded sound sources used, and the aesthetic was meant to be one of intimacy and fluidity to match a large projected image in the second gallery. The imagery consisted of an array of life forming cells in which fetuses would develop and grow according to the activity and movements sensed in the first gallery. Some of the source material for the visual component came from real ultrasound images and the position and growth of the fetuses was controlled by data communication from the sound and video sensing computer in the first gallery. This complex project is another example of Paine's many multi-faceted projects.

CHAPTER 7

AN EXAMINATION OF GARTH PAINE'S "RESONANT TEXTURES"

Paine's *Resonant Textures* is a composition for solo vibraphone, four mounted cymbals, and live electronics. A performance of this work is intended for a non-traditional performance venue, where the cymbals are placed in the cardinal corners of the space and the performer is positioned in the middle. During the performance the audience can freely choose where to sit, immersing themselves in an enveloping sonic environment with the sounds coming from the vibraphone, cymbals, and loudspeakers.

Resonant Textures is an organically evolving sound field in which different acoustic and electronic sound sources contribute harmonic material through gradual layering to create a continuously changing resonating space. The spatial setup enhances the work's meditative qualities. The piece has a fixed structure, but its length and pace is indeterminate. The performer's progression through the piece should be in response to the development of the sound field and the unique sonic properties of the performance venue.

The pieces of electronic equipment needed to perform *Resonant Textures* are a computer, an audio interface with at least four output channels and two input channels, an electronic pedal, an amplifier for four channels, two microphones, two loudspeakers, and four "sound exciter" speakers that attach to the cymbals.

Paine's process for creating the various components of *Resonant Textures* started with a discussion with the author of various performance and sonic capabilities of the vibraphone and his close examination of the sounds of the cymbals and vibraphone. After meeting with the author, Paine had determined most of the aspects of the vibraphone part,

including the specifications for the use of mallets, bows, and motor. Through his careful studying and charting of vibraphone and cymbal sounds, he gained an understanding of how specific harmonics and frequencies of each cymbal and the vibraphone related to one another and could be used together. The specific resonating frequencies for each cymbal were also meticulously discovered and documented. With this knowledge of the frequencies and harmonics of each instrument, Paine then programmed the electronic components for the live audio processing that would manipulate the sound of the vibraphone and contribute more harmonic material to the piece's texture. He also used his meticulous study of each cymbal's resonating frequencies to program electronic elements that activate the cymbals around the space through sympathetic resonance. Paine then worked toward realizing the spatial setup by considering how the components would work together in an open and reflective space.

Vibraphone Part

The vibraphone part requires two mallets, two bows, and access to power for the vibraphone motor to function. The motor should be set so that the speed of the pulses created by the spinning of the fan blades equals the rate of sixteenth notes at the tempo of 130 beats per minute, which is near the top of the speed range for most vibraphone motors.

The score is notated on a traditional staff and is divided into two large sections that consist of segments based on different semitone pitch sets. The first section of the piece has seven pitch set segments, which are labeled A through G (see Figure 10). The order and amount of times they are each played are left up to the performer with the

following stipulation: the segments can either repeat or move forward or backward from one segment to the next without skipping. For example, from A, the performer can repeat A or go to B. When playing B, the performer could repeat B, move back to A, or forward to C, but cannot skip to any of the other segments. These seven segments in the first section are notated as thirty-second notes that crescendo and decrescendo, but the desired effect is essentially a roll at a continuously fast mallet speed. Even though these swells are all written as the same duration in a common time measure, the performer can alter their length for more variety. The performer should make sure to pause at the end of each segment before moving to a different segment to allow for the electronics to finish processing that pitch set.

The second section of *Resonant Textures* includes four segments that use the same pitch sets as the first four segments in the first section, only an octave higher (see Figure 10). These segments are to be played with two bows and can be played in any order and as many times as the performer wishes. In this section, Paine instructs to bow the notes as long as possible, to wait for the electronics to process after each bowing, and to not “over crowd the sound space.”³³

³³ Garth Paine, “Resonant Textures” (unpublished score, October 21, 2015), PDF file.

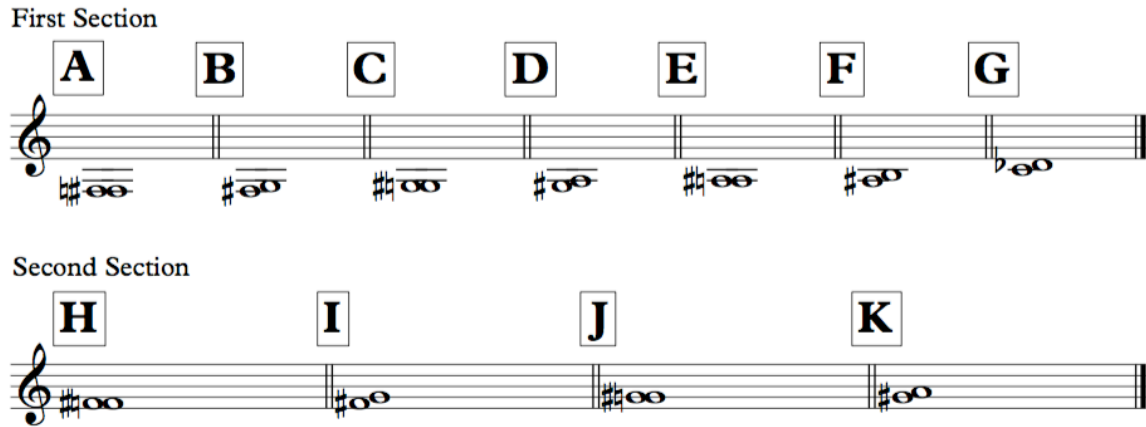


Figure 10. Garth Paine: *Resonant Textures*, segment pitch sets

Paine wanted the vibraphone to be perceived as a resonant surface that produced tones rather than as a percussion instrument that played rhythmic events. This would allow the instrument, along with the cymbals and electronics, to build a homogenous sound field that is a continuous resonating space not constructed from specific sound sources.³⁴ Paine specifically requests the use of very soft marimba mallets so that the individual attacks are deemphasized and the continuous ringing of the bars is the most audible sound. The fast speed of the motor and the use of semitone pitch sets create a similar beating effect as in Muller's *Hysteresis*. The resulting complex and pulsing tone of the vibraphone, however, has a unique color that allows the audience to perceive the instrument less as a percussive instrument, and more as a resonant surface. For the full effect of the fast motor speed and sustaining semitone pitch sets, the pedal must be held down for the entire piece. The two methods for keeping the pedal depressed during an entire performance that were suggested for *Where Light Escapes You* can also be utilized

³⁴ Garth Paine, Unpublished Program Notes, October 15, 2015.

in *Resonant Textures*. These suggestions included placing a heavy object on the pedal and placing an object in a mechanism underneath the dampener pad that would force the pedal to stay down.

Electronic Part

Like in *Where Light Escapes You*, a user-friendly Max/MSP patch drives the live, non-interactive electronic components of *Resonant Textures*. Paine's patch, however, is programmed to do entirely different things. Shown in Figure 11, the *Resonant Textures* patch implements a different form of live audio processing than Munson's piece. The patch continuously records portions of the vibraphone performance through two microphones and manipulates the sound as it plays back through the loudspeakers on a loop. The recording and playback of the vibraphone is variable from performance to performance with a randomizing process controlling when the patch starts to record, how long it records for, and what portions of the recordings it loops.

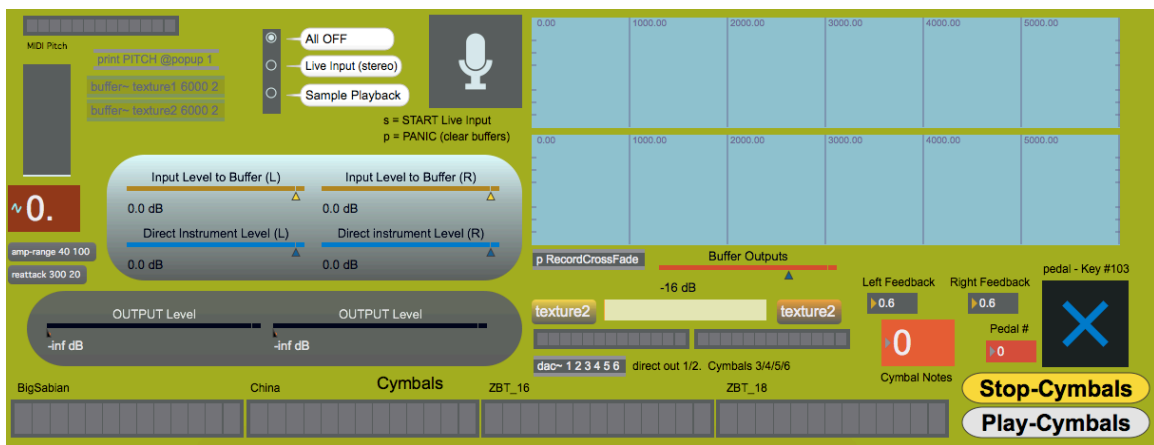


Figure 11. Garth Paine: *Resonant Textures* Max/MSP patch

The patch also randomizes and synthesizes specific frequencies that are sent out through four different channels and played into the cymbals to make them vibrate sympathetically. The cymbal frequencies are sent from the Max/MSP patch on the computer to the audio interface, where the four signals are then sent into the amplifier and ran to the four individual cymbals around the performance space. Attached to the cymbals by small adhesive pads are Dayton Audio DAEX25 Sound Exciters, which are small speakers that are designed to play sound while facing down into reflective surfaces. The small adhesive pads are able to keep the speakers attached to the cymbals while not affecting the cymbals' vibrations. The frequencies played into the cymbals by Max/MSP are the specific resonating frequencies of the four cymbals that the author provided Paine. It is necessary to program into the patch the specific resonating frequencies of the cymbals that will be used in performance since no two cymbals are alike. Thus, the piece is currently tailored to the author and the author's instruments. The author's four cymbals are the only cymbals that can currently be used for a performance of *Resonant Textures* until Paine works specifically with another artist and that artist's set of cymbals to alter the patch.

The playing of the cymbals' resonant frequencies actually involves frequency ranges down to specific hertz, in which the computer slides from one exact frequency to another over the course of several seconds. This range of frequencies, along with varied amplitudes, activates the sound and overtones of the cymbals in a complex and robust way, creating what Paine calls a "controlled resonance."³⁵ The patch is programmed with nine groups of frequencies for each cymbal. Within each group, there are between one

³⁵ Ibid.

and four ranges of resonant frequencies. The timing of activation of each cymbal during performance is pre-determined, but the patch randomizes the specific frequencies played by each cymbal. The pre-determined sequence for activating each cymbal includes a signal for one of the nine frequency groups. The computer then randomly selects a frequency range from that pre-determined group. This allows not only for different results when the same group plays consecutively, but also for each performance of *Resonant Textures* to be unique. It is also worth noting that the sound of the resonating frequencies played by the speakers is somewhat audible, but typically blends in with the sound of the cymbal so that it is almost indiscernible. The entrance of the cymbals into the texture is left open to the performer, who initiates the cymbals' playing sequence with an electronic foot pedal.

Potential Performance Issues and Suggestions

In *Resonant Textures*, each sonic element contributes an individual voice while also combining with the other elements to create a homogenous sound environment. In performance, the vibraphone part presents limited technical demands. The most challenging aspects of *Resonant Textures* concern the creation of the right texture and effects and the correct function of the electronics. While the part may look simple on paper in regards to technique, the performer should spend time carefully exploring the acoustics of the venue and practicing the musical elements of the rolls and bowed notes to achieve the right touch and colors that will contribute to the overall sonic environment. The author recommends the use of Mallettech "Leigh Howard Stevens" LS1 mallets

because their light weight and loose yarn wrap activate the bar with very little attack, allowing for the rolls to be as smooth as possible across the wide dynamic range.

The choice of performance venue is also an important consideration for *Resonant Textures*. A resonant room is the most desired option, with some combination of open space and reflective surfaces, which can often be found in art galleries. The structure and size of the venue will have a significant impact on the overall sound of the piece. The spacing of the cymbals around various venues creates unique interactions between the cymbals and between the cymbals and vibraphone. If the instructions provided by Paine are carefully followed, with sensitivity toward the sound produced by the vibraphone and overall texture being created in a proper performance space, the performance should be effective. *Resonant Textures* allows the performer to respond to the sound environment and specific venue to create a meditative and immersive work for the audience.

CHAPTER 8

CONCLUSION

The exploration of new technologies in music composition, specifically seeking new possibilities for combining electronic and acoustic sound, was the central aim of this project. The three resulting pieces are unique and indicative of the varied possibilities that exist for electroacoustic composition. Jeremy Muller's *Hysteresis* includes electronic sounds that are triggered live by the performer with the use of a foot pedal. The placement of the speaker underneath the vibraphone allows the electronics to ring in the resonators of the instrument, blending with the acoustic sound of the vibrating bars. Muller's prominent inclusion of the beating effect is also a manipulation of the acoustic sound by the playing of de-tuned electronic pitches. His creative use of these electronic techniques effectively expands the sound palette of the vibraphone. With the use of only a vibraphone and the electronic sounds blending into the sound of the vibraphone, *Hysteresis* consists of a single instrumental voice, which contrasts greatly to the active and layered textures of Jordan Munson's *Where Light Escapes You* and Garth Paine's *Resonant Textures*. Working with a single instrumental voice, Muller writes for mallets and bow to be used simultaneously to employ their varied timbres. The resulting technically demanding nature of the vibraphone part reflects Muller's background and performance experience as a percussionist.

Munson's *Where Light Escapes You* also features a challenging vibraphone part that makes use of mallets and a bow simultaneously. Some of the electronic components of the piece are triggered with a foot pedal as well. *Where Light Escapes You*, however, incorporates additional instruments along with the vibraphone. In the final minutes of the

piece, the performer plays a bass drum with a foot pedal. The sound of the bass drum directly triggers electronic bass notes and is processed live by the computer. These electronic bass notes are played through loudspeakers that are positioned underneath snare drums, which vibrate and buzz sympathetically with the bass sounds. In this way, there is a unique chain effect of acoustic and electronic responses with the acoustic bass drum triggering electronic bass notes, which then initiate the acoustic sound of the snare drums. Paine utilizes sympathetic resonance and live audio processing as well, though his instrumentation differs, and his live audio processing is more complex and acts more as a central component of his piece, *Resonant Textures*.

Resonant Textures is written for a spatial setup, where sounds come from different areas of the space, and the audience is free to move around to experience the work from different perspectives. This spatial set up is unique among the three commissioned works, yet it is still possible for a single performer because the cymbals that are mounted around the edges of the space are activated by electronics. The cymbals ring sympathetically from small “sound exciter” speakers that play the specific resonating frequencies directly into each of the cymbals. The performer plays a vibraphone in the center of the space while the sound of the vibraphone is randomly recorded, manipulated, and played back in loops. While the technical demands of the vibraphone part in *Resonant Textures* are not as challenging as *Hysteresis* or *Where Light Escapes You*, the variable nature of both the acoustic and electronic components provides musical challenges for the performer in terms of listening and responding to the texture as it is created in the particular performance space.

It is the author's hope that, through these three compositions, this project has not only demonstrated new innovative possibilities for composing electroacoustic percussion works, but has also inspired composers and artists to explore further. With the rapid and continual development of technology in the twenty-first century, electroacoustic music of this period will be defined not by a homogenous aesthetic, but by the varied utilization of new techniques and electronic capabilities.

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APPENDIX A

RECORDINGS OF JEREMY MULLER'S "HYSTERESIS," JORDAN MUNSON'S
"WHERE LIGHT ESCAPES YOU," AND GARTH PAINE'S "RESONANT
TEXTURES"

[Consult Attached Files]

The attached audio files are in .mp3 format and can be played with an MP3 player on Macintosh and Windows computers. The recordings were completed on separate days and in different locations. *Where Light Escapes You* was recorded in Indianapolis, Indiana on the 25th of October. *Resonant Textures* was recorded in Tempe, Arizona on November 9th and *Hysteresis* was recorded on November 10th, also in Tempe.

APPENDIX B
LETTERS OF PERMISSION

November 6, 2015

Dear Dr. Jeremy Muller,

I am completing a doctoral research paper at Arizona State University entitled "Performer and Electronic-Activated Acoustics: Three New Works for Solo Percussion and Live Electronics." I am seeking your permission to reprint excerpts from your pieces "Agóna" and "Hysteresis" in my research paper. Score excerpts from the pieces are to be reproduced as examples in chapters 2 and 3.

The requested permission extends to any future revisions and editions of my research paper, including non-exclusive world rights in all languages, and to the prospective publication of my research paper by UMI. These rights will in no way restrict republication of the material in any other form by you or by others authorized by you. Your signing of this letter will also confirm that you own the copyright to the material for which permission is being sought.

If these arrangements meet with your approval, please sign this letter where indicated below. Thank you very much.

Sincerely,



Alex Wier

PERMISSION GRANTED FOR THE USE REQUESTED ABOVE:



Jeremy Muller

Date: 11/9/15

October 28, 2015


Dear Jordan Munson,

I am completing a doctoral research paper at Arizona State University entitled "Performer and Electronic-Activated Acoustics: Three New Works for Solo Percussion and Live Electronics." I am seeking your permission to reprint excerpts from your piece "Where Light Escapes You" in my research paper. An image of the piece's accompanying computer application and score excerpts from the piece are to be reproduced as examples in chapter 5.


The requested permission extends to any future revisions and editions of my research paper, including non-exclusive world rights in all languages, and to the prospective publication of my research paper by UMI. These rights will in no way restrict republication of the material in any other form by you or by others authorized by you. Your signing of this letter will also confirm that you own the copyright to the material for which permission is being sought.

If these arrangements meet with your approval, please sign this letter where indicated below. Thank you very much.

Sincerely,


Alex Wier

PERMISSION GRANTED FOR THE USE REQUESTED ABOVE:



Jordan Munson

Date: 10/28/15

November 6, 2015

Dear Dr. Garth Paine,

I am completing a doctoral research paper at Arizona State University entitled "Performer and Electronic-Activated Acoustics: Three New Works for Solo Percussion and Live Electronics." I am seeking your permission to reprint excerpts from your piece "Resonant Textures" in my research paper. An image of the piece's accompanying computer application and score excerpts from the piece are to be reproduced as examples in chapter 7.

The requested permission extends to any future revisions and editions of my research paper, including non-exclusive world rights in all languages, and to the prospective publication of my research paper by UMI. These rights will in no way restrict republication of the material in any other form by you or by others authorized by you. Your signing of this letter will also confirm that you own the copyright to the material for which permission is being sought.

If these arrangements meet with your approval, please sign this letter where indicated below. Thank you very much.

Sincerely,



Alex Wier

PERMISSION GRANTED FOR THE USE REQUESTED ABOVE:



Garth Paine

Date: 11/5/2015