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FINDING THE "TECH" IN TECHNIQUE: A PEDAGOGICAL APPROACH TO ELECTROACOUSTIC CONCERT PERCUSSION PERFORMANCE PRACTICE

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A DOCTOR OF MUSICAL ARTS PROJECT

A project submitted in partial fulfillment of the
requirements for the degree of
Doctor of Musical Arts in the
College of Fine Arts
at the University of Kentucky

By
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2019

ABSTRACT OF PROJECT

FINDING THE "TECH" IN TECHNIQUE: A PEDAGOGICAL APPROACH TO ELECTROACOUSTIC CONCERT PERCUSSION PERFORMANCE PRACTICE

Premise and Objectives

In our increasingly technology driven society, the impact of technology touches nearly every aspect of our lives in some form or another. This has been acutely felt within the world of percussion, with electroacoustic works representing perhaps the most rapidly expanding area of concert percussion over the last twenty years. Electroacoustic music couples electronic technology with traditional acoustic instruments and/or performance practices.

Broadly, this paper outlines a systematic approach to teaching electroacoustic performance practice, based on elements found in a cross-section of percussion literature. In using such an approach, not only does each student become more capable of dealing with this growing body of literature, but also the process of educating these students becomes more efficient for the teacher. As a result, delivery becomes more effectively standardized, and resources can be shared more efficiently among multiple students who may be studying different types of electroacoustic repertoire.

Method

To organize this exploration, three main genres of electroacoustic repertoire for percussion are compared: prerecorded soundscape, live processing, and electronic pieces. This comparison illuminates the tools and techniques that are relevant to each type of repertoire and reflects not only the narrower focus of electroacoustic percussion, but also the broader goals of applied percussion instruction in the context of a "total" percussion program.

Each classification is explored by addressing its critical elements using prime examples from the relevant standard repertoire. For the first classification of works, tape pieces, the project includes discussion on signal flow, balancing electronic and acoustic sound sources, an introduction to digital audio workstations (DAWs), and monitoring techniques. Two primary examples of the repertoire are used to contribute to this discussion; Javier Alvarez's *Temazcal* for maracas and tape, and Brian Blume's *Strands of Time.*

Live processing works present increased challenges with concepts, including sound reinforcement, recording production, how to edit and creatively manipulate sound both in post-production and live, and detailed concepts of signal flow, often including MIDI protocol. To explore the concepts specifically relevant to live processed works, Nigel Westlake's classic work, *Fabian Theory*, for amplified marimba and three toms, is offered.

Electronic works give students further opportunity to explore MIDI mapping, patch and parameter changes using both hardware and software, and sometimes sound design. In this context, there is a brief exploration of Steve Reich's *Violin Phase*.

Finally, an exploration of Hans Werner Henze's, *Prison Song* demonstrates how all of this technology and technique can come together in combination works. The work requires live sound reinforcement, pre-recorded soundscapes, separate monitoring, live processing, and live MIDI controllers. The paper closes with a brief summary of extra pedagogical considerations, including resource management, pedagogical philosophy, and further implications.

Conclusion

By examining the logical steps of pedagogically developing through the different broad categories of electroacoustic music, with an emphasis on its reflection of broader liberal values and critical applied analysis, it is believed that this research could yield a model for a more thoughtful approach for applied percussion teachers.

KEYWORDS: Percussion, Electroacoustic, Electronic Music, Performance, Ableton Live

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4-02-2019

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DEDICATION

For my "real" C/V, Ceci and Victor, who serve as my unending source of fuel.

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I owe an enormous debt of gratitude to a number of different people that have been integral throughout this whole process.

My Project Chair, mentor, colleague, and friend, Jim Campbell, is a true professional in every sense of the word. Besides being an exemplary performer and composer, he is a teacher's teacher of the highest order, who teaches a lot more than the notes. He has the gift of being able to teach humanity. I have been lucky to learn beside him throughout our time together, and almost feel guilty for having such a great model.

I am also grateful for the generous input of my committee members, Ben Arnold, Skip Gray, and Albert Hardin, and outside reader Alan Desantis. Their thoughtful input has challenged me intellectually and helped to create a better finished product.

Without the unending support of my parents, I don't know if I would ever even have dreamed of this as a potential accomplishment. My mother, Marie Stokes Hill, my stepfather, James F. Hill, who has always been a father to me, and my late father, William Brady Harrison, are all integral parts of who I am. I don't have words for the love and support that you have shown throughout the years. Even without a hood, I am shrouded in your love and support.

Also, to my extended family, including my three sisters, and my in-laws who have been monumentally supportive throughout this process, I owe a tremendous thank you. Special thanks to Judy Verbeck, who has gone an extra mile in helping to pick up the pieces with the kids, as well as to my taskmaster sister, Michelle Harrison, without whose love, time, help, and attention I probably would have fully fallen apart a time or two (rather than just a bit).

The love that I have for my children, Victor James Harrison and Cecilia Brady Harrison, is the primary reason I began this process. Without them in the world, I'm sure that I wouldn't have had the courage to make such a monumental leap of faith. They keep me entertained, exhausted, and fueled, all at the same time.

Undertaking this task has been challenging while also managing my other professional responsibilities and simultaneously raising a young family with two kids. However, it would have been simply impossible without my hardworking partner, superstar co-parent, wife, and head proofreader, Heather Verbeck Harrison. I dearly cherish your perspective. The journey that we started a decade ago is somehow still going strong, and regularly continues to unfold something new.

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CHAPTER ONE

BACKGROUND AND INTRODUCTION

Performance Technology in Contemporary Percussion Repertoire

As in most applied areas of music, technology and electronics has an increasing presence in the concert repertory. Where it was once remarkable to hear a "classical" performance that involved electronics or a performance with a prerecorded soundscape, it is now fairly commonplace. While this might be true of many instrumental areas, perhaps nowhere is this more relevant than in the continuously exploratory and diverse world of concert percussion, which has widely embraced electronics decades before most other instrumental areas. Percussion literature is often viewed as having its modern origins in the work of such electronics pioneers as Edgar Varese, John Cage, Karlheinz Stockhausen, and Steve Reich. With a constantly developing repertory that includes thousands of works involving electronics, and multiple yearly professional conferences and symposiums such as the Percussive Arts Society's International Conference (PASIC), SEAMUS (Society for Electroacoustic Music in the United States), Electronic Music Midwest (EMM), and IRCAM (Institut de Recherche et Coordination Acoustique/Musique- Institute for music/acoustic research and coordination), there is demonstrable need for deeper consideration into developing a logical and pedagogical approach to electroacoustic music for serious concert percussionists.

Even with the employment of electronic technologies seeming hand in hand with traditional percussion literature, it is still important to examine its relationship

to the evolution of percussion. In so doing, we might ask existential questions such as why electronics are relevant to concert percussion, and more specifically why is it important to develop a systematic approach to this arm of the percussion literature?

Electronics are simply a form of technology. **Technology** comes from the Greek word "techne," meaning "art, skill."[1] A definition of technology is "1. a. The application of science, especially to industrial or commercial objectives. b. The entire body of methods and materials used to achieve such objectives."[2] The word **technique** can be defined as "1. The systematic procedure by which a complex or scientific task is accomplished. 2. The degree of skill or command of fundamentals exhibited in any performance."[3] Stated plainly, technology is the tool that we use, and technique is the way that we use it. It need not be argued for most classical musicians that technique is a part of everything that we do as musicians and certainly something that merits serious study and refinement.

To that end, technology is no different, even at its most basic level. Consider that percussion began thousands of years ago from origins of which we are unsure. Our percussion forebears realized that rocks of various sizes sounded good when struck together. They ordered the pitches of the rocks, adjusted the sizes, and created collections of sounds that could be communally performed upon. They also realized that various pieces of wood sounded good when struck together.

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[1] *Merriam-Webster,* s.v. "technology," accessed December 14, 2015, https://www.merriam-webster.com/dictionary/technology.

[2] *The American Heritage Dictionary of the English Language*, New College ed., s.v. "technology."

[3] *The American Heritage Dictionary of the English Language*, New College ed., s.v. "technique."

Eventually they hollowed out a piece of wood and pulled an animal hide over it and then struck it with another stick of wood to create a drum.

Of course, all of this eventually ends with our present-day state. Now, when percussionists play snare drum, they can carefully choose wooden snare drum sticks that are chosen for a specific musical application. Considerations that go into this choice include: the mass, density, and weight of the wood, length and width of the body, taper of the shank, bead type, etc., as this all affects the performer's facility and ultimately, the sound produced for the audience. However, it is still just a piece of wood. The same is true when you think of the thousands of different types of marimba mallets used on an instrument that was once simply a collection of primitively cut wood slats suspended over gourds whose origins of which were limited to the natural supply of the season's regional production. Both sticks and mallets are simple demonstrations of how gradual technical advancements can profoundly impact the percussive arts, yet have become so mundane to a percussionist's daily routine that they are generally not recognized as technological developments.

Considering the extreme diversity of sounds that percussionists are required to understand and deliver as musicians, it would be pretty odd for us to ask, "why do we need marimba, or why do we need snare drum?" The use of electronics is really no different.

We need electronics for the same reason that we need a snare drum or marimba or vibraphone—to make great music that affects listeners with a deeper understanding of humanity by offering a dynamic process in which they can find

meaning. If any of these tools can assist in the educational exchange of ideas then it is a worthwhile endeavor. The evolution of technology is one of the ways that our art form continues to grow and remain relevant.

In light of the fact that this repertoire has developed into such an integral and significant part of percussion solo literature with hundreds, if not thousands of works to choose from, it is important that a pedagogical method exists to address the repertoire's specific performance practice. In stark contrast to the hundreds of snare drum and mallet texts that exist, I do not know of a single method or etude book devoted specifically to electroacoustic concert percussion works. I believe that an articulated explanation of the relationship between the specificities of electroacoustic works and the foundational concepts of critical listening and sound development that belie a fundamental approach to any musical repertoire benefits students and teachers alike by improving learning outcomes that create more thoughtful, informed, skilled, and flexible musicians. This kind of thoughtful and methodical approach to addressing an enormous diversity of styles, techniques, and instruments is a necessity for university percussion teachers in the twenty-first century.

Goals of a Signature Pedagogy

When tasked with developing a pedagogical method of any type, it seems imperative to first define pedagogy and identify its most valuable goals and attributes relative to the specific topic.

Pedagogy is generally described as "the method and practice of teaching,"

"the science and art of education," and "the profession and science of teaching." Pedagogy is defined by the *Encyclopedia Brittanica* as, "the study of teaching methods, including the aims of education and the ways in which such goals may be achieved. The field relies heavily on educational psychology, or theories about the way in which learning takes place."[4] The word is a derivative of the Greek word *paidagōgia*, from *paidagōgos*, itself a synthesis of *ágō*, "I lead," and *país*, genitive *paidos*, "child": hence, "to lead a child."[5] The earliest known examples of the use of the term pedagogue come from early Greek and Roman civilizations where "The custom, then, of placing one's child[ren] in the care and oversight of a trusted slave was a continuous (and ever widening) practice from the fifth century B.C. until late into imperial times."[6]

It was through this tradition that pedagogy in the classical sense was first tied to not just directly imparting knowledge, but to the general development of moral character, a persistent introspection, and the fundamental goal of the human to benefit the greater good of society. The traditional foundation of a liberal education, established in various forms from the ninth century forward, includes the study of both the humanities' triumvirate of grammar, logic, and rhetoric, as well as the scientific arts' quadrivium of arithmetic, music, geometry, and astronomy.

However, it was the father of modern pedagogical theory, nineteenth-century German philosopher Johann Friedrich Herbart, who attempted to more

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[4] *Encyclopedia Brittanica*, s.v. " pedagogy," accessed October 25, 2017, https://www.britannica.com/science/pedagogy.

[5] *Online Etymology Dictionary,* s.v. "pedagogy," accessed March 16, 2018, https://en.wikipedia.org/wiki/Online_Etymology_Dictionary.

[6] N. H. Young, "Paidagogos: The Social Setting of a Pauline Metaphor," *Novum Testamentum* 29, no.2 (1987): 150.

clearly codify some of the goals of pedagogy within a liberal education in a way that still clearly relates to its classical origins. Herbart writes, "The sole and entire task of education [*Erziehung*] is encompassed by the concept, "morality" [*Moralität*]."[7] Yet Herbart goes on to outline that morality is actually tied into what he calls a "many sidedness," which is another way to say that every mature individual has many different areas of interest that make up the whole person. The pedagogue then, is charged with developing each pupil's unique interests and talents as best they can, with the ultimate goal not merely being to impart knowledge, but to enable a student to lead a virtuous life. In this case, a virtuous life is regarded as an ideal of personal individual freedom based on the skills, critical thinking, and internal discipline necessary for persistent introspection and self-awareness that also brings societal awareness. This ideal is not necessarily attained as much as striven for, and fosters continuous growth and development long past the point of contact with the teacher.[8]

Herbart further elaborates his pedagogical model, which treats each area of interest with cycles of "engrossment" (*Vertiefung*) and "reflection" (*Besinnung*), each with its own progressive and resting phases.[9] This model reflects what we currently refer to as doing (experiential learning) and reflection (reflective learning). Thus a teacher does not simply offer a principle or fact to the student, but has the student experience and process the concept on his or her own, enabling the active learner

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[7]Johann Friedrich Herbart, *Johann Friedrich Herbart's [sic] Sämmtliche Werke*, ed. G. Hartenstein, (Leipzig: Voss, 1906), 259.

[8]Alan Kim, *The Stanford Encyclopedia of Philosophy,* ed. Edward N. Zalta, (Winter 2015 ed.), s.v. "Johann Friedrich Herbart," accessed March 21, 2018, https://plato.stanford.edu/archives/win2015/entries/johann-herbart

[9] Herbart, 38.

through apperception, or the mental process of attaining fuller consciousness by assimilating concepts into the body of ideas one already possesses. This is further clarified in Herbart's work, *Allgemeine Pädagogik* (1806; "Universal Pedagogy") into five different steps of teaching that include preparation, presentation, association, generalization, and application.[10]

Understanding the relationship between music and a liberal arts education, it should now be considered that music performance is often thought to also represent a professional or vocational course of study due to its highly specific skill set that typically enables students to make a living in the profession working as a music performer, educator, or in a related position. Considering this perspective, while not ignoring its extension from the humanities, requires us to think through not only pedagogical issues related to its humanitarian roots, but also the questions relevant to the foundation of a professional/vocational pedagogy. This approach to education usually favors an applied approach to a specific skill set, combined with a limited theoretical knowledge as it directly pertains to the craft. "The purpose of an academic curriculum is to induct students into a field of knowledge while the purpose of a vocational curriculum is to induct students into a field of practice"[11] The blurred lines developing between a humanities-based approach to teaching music at the university level and a more vocational, professional, or career oriented

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[10] *Encyclopedia Brittanica*, s.v. "Johann Friedrich Herbart," accessed October 25,2018, https://www.britannica.com/biography/Johann-Friedrich-Herbart.

[11] Leesa Wheelahan, "Beyond the Contextual: The importance of theoretical knowledge in vocational qualifications and the implications for work" (paper presented at the 4th International Conference, Centre for Research in Lifelong Learning, 'The Times they are a-changin – researching transitions in lifelong learning', University of Stirling, Scotland, June 22-24, 2007), 2, accessed March 21, 2018, http://hdl.handle.net/10072/18718.

pedagogical approach are sometimes viewed as compromising the integrity of the degree. The following text comes from a publication by The National Task Force on Civic Learning and Democratic Engagement and was funded by the U S Department of Education:

> A troubling chorus of public pronouncements from outside higher education has reduced expectations for a college education to job preparation alone. Dominating the policy discussions are demands that college curricula and research cater to "labor market needs" and to "industry availability." Still others call for an increase in "degree outputs"—much as they might ask a factory to produce more cars or coats…The call for educational reform cast only as a matter of workforce preparation mistakenly adopts a nineteenth-century industrial model for complex twenty-first-century needs. Reframing the public purpose of higher education in such instrumental ways will have grave consequences for America's intellectual, social, and economic capital. Such recommendations suggest colleges are no longer expected to educate leaders or citizens, only workers who will not be called to invest in lifelong learning, but only in industry-specific job training.[12]

This summarizes for many, the relationship between a liberal arts education and a primarily professional or vocationally oriented education.

Although they share some similarities, it is probably pertinent to draw a distinction between professional, and vocational or technical education. While vocational and technical training are generally thought to be trade specific studies that lead to jobs in skilled manual labor oriented fields that do not typically require a college degree, professional studies typically do require a college education and generally lead to white collar employment, such as lawyers, nurses, doctors, some

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[12] The National Task Force on Civic Learning and Democratic Engagement, "A Crucible Moment: College Learning and Democracy's Future," Association of American Colleges and Universities (report commissioned by the Department of Education and released at the White House, Washington D.C., January 2012), 9–10, accessed March 21, 2018, https://www.aacu.org/sites/default/files/files/crucible/Crucible_508F.pdf.

religious leaders, etc. There are many different types of professional schools, with differing content, pedagogies, and requirements. Georgetown University has a typical approach to its professional schools in this respect, and makes this distinction on their student resources page:

> The distinction between graduate school and professional school is somewhat like the distinction between basic science and applied science; the differences lie in the focus. In graduate school, students focus primarily on mastering a particular field of study. Graduate degrees do not focus on training a student for a specific career, although the expertise that is gained should ultimately be applicable to a field of work. In professional school, the student focuses more directly on preparing for a specific career. Coursework and training are rooted in traditional disciplines, but emphasize "real world" applications.[13]

It is noteworthy to observe that this distinction being made in the above quote, is one between graduate school and professional school, not undergraduate school and professional school, with the implication being that there is a more broadly based liberal arts emphasis in an undergraduate curriculum that prepares students to extend their education or professional endeavors afterward as they so choose.

But further examination of a professional education can yield some insight into the pedagogy of a task specific field such as music. Known as *signature pedagogies*, these ways of teaching foster "disciplinary ways of thinking or habits of mind"[14] in students, rather than just a skill. As stated in the publication *Pedagogy*

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[13] "Graduate School vs Professional School," Georgetown University Student Resources, http://www.georgetowncollege.edu/bio/student-resources/graduate-school-vs-professional-school/ quoted in Richard Coble, "Pedagogy for Professional Schools and Students," Vanderbilt University Center for Teaching, accessed October 18, 2018, https://cft.vanderbilt.edu/guides-sub-pages/pedagogy-for-professional-schools-and-students/.

[14] Nancy L. Chick, Aeron Haynie, and Regan A. R. Gurung, *Exploring Signature Pedagogies: Approaches to Teaching Disciplinary Habits of Mind,* (Sterling, VA: Stylus Publishing, LLC, 2009), 2.

for Professional Schools and Students by the Center for Advanced Teaching, at Vanderbilt University, "signature pedagogies not only teach the content of a discipline, but also seek to train students to think as professionals or experts of the discipline itself… it becomes clear that *thoughtful professional teaching promotes both professional skills as well as critical thinking*."[15] Lee Schulman goes on to expand the ties between a professional education and a more traditional education. "Professional Education is not education for understanding alone; it is preparation for accomplished and responsible practice in the service of others. It is preparation for 'good work.' Professionals must learn abundant amounts of theory and vast bodies of knowledge. They must come to understand in order to act, and they must act in order to serve"[16] With this understanding, a multifaceted approach to teaching that develops character through theoretical knowledge, critical thinking, skill specific training, and an underlying sense of ethics forms the basis for a pedagogical model for a professional education. Patricia Brenner goes a step further in outlining a developmental progression toward a fully mature professional preparation. This five-stage qualification is based on the interplay between the dynamic aspects of critical thinking and professional practice that are representative of a responsible professional education. Although it was originally designed for application to the field of nursing, it has practical implications for a wide variety of fields, and has been used for such. The five stages include:

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[15] Richard Coble, "Pedagogy for Professional Schools and Students," Vanderbilt University Center for Teaching, accessed March 21, 2018, https://cft.vanderbilt.edu/guides-sub-pages/pedagogy-for-professional-schools-and-students/.

[16] Lee S. Shulman, "Signature pedagogies in the professions," *Daedalus* 134, no. 3 (Summer 2005): 53.

Novice: Novices "have no experience with the situations in which they are expected to perform tasks."

Advanced Beginner: Someone with limited professional training who can note "recurrent meaningful situational components, called aspects," but is unable to make a value-based distinction between them.

Competent: Describes a professional with approximately 2-3 years of experience that can start to thoughtfully process actions in terms of long-range goals, where the "plan dictates which attributes…are to be considered most important."

Proficient: "The proficient performer perceives situations as wholes, rather than in terms of aspects…Experience teaches the proficient nurse what typical events to expect in a given situation and how to modify plans in response to these events."

Expert: "has an intuitive grasp of the situation and zeros in on the accurate region of the problem without wasteful consideration of a large range of unfruitful possible problem situations."[17]

Based on these qualifications, it is clear that a complete professional preparation does not occur without a theoretical study that fosters critical thinking as well as technique to develop a more holistic approach to the subject. Benner goes on to outline a series of pedagogical strategies for each level that develop from a strict application of context free rules toward a primarily intuitive and holistic understand of concrete situations, built on a strong relationship between theory and practice.[18] As Benner states it, "Theory offers what can be made explicit and formalized, but

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[17] Patricia Benner, "From Novice to Expert," *The American Journal of Nursing*, Vol. 82, No. 3 (March 1982): 402-407, accessed March 22, 2018, http://www.jstor.org/stable/pdf/3462928.pdf?refreqid=excelsior%3Aec2f25779712f049e406e2f07555f45e.

[18] Richard Coble, "Pedagogy for Professional Schools and Students," Vanderbilt University Center for Teaching, accessed March 21, 2018, https://cft.vanderbilt.edu/guides-sub-pages/pedagogy-for-professional-schools-and-students/.

clinical practice is always more complex and presents many more realities than can be captured by theory alone. Theory, however, guides clinicians and enables them to ask the right questions" (p. 407). This perspective highlights some strong similarities between a professional pedagogy and liberal arts pedagogy, in valuing the development of critical thought, self-reflection, theoretical knowledge, specific application, and development of a holistic approach to life and work that is concerned with the greater good.

Being that the study of music is rooted in a liberal education but also has elements of it that are largely consumed with task specific skill sets, I believe that it is reasonable to view music education at the undergraduate level as having elements of both a liberal education and a professional education, without being fully consumed by either. Ironically, the ability to think critically and creatively to problem solve is not only one of the cornerstones of a liberal education, but just may be one of the more essential skills for surviving in any workplace that is still evolving, including music or especially technology. "Workers need to be able to transcend specific contexts and use decontextualized theoretical knowledge in different ways and in different contexts as their work grows in complexity and difficulty." [19] The question remains, how does this specifically relate to teaching electroacoustic percussion at the undergraduate level?

The critical elements that shape my own version of a signature pedagogy, as it pertains to electroacoustic percussion, include facets of some of the

[19] Wheelahan, 2.

aforementioned pedagogical models that can be specifically adapted to this field. Some of this includes teaching both experientially and with reflective assimilation, focusing on both theory and practice, or technique, and exploring existential questions regarding the foundations of music making. Other considerations that should specifically go into developing the pedagogy should include issues surrounding the availability of resources, the efficiency of the presentation of material, variability in student development, and how this relates and balances with the other demands that are relevant to comprehensive percussion study in a university undergraduate curriculum, including snare drum, keyboard percussion, timpani, auxiliary instruments, etc. Further, when one examines the symbiotic relationship between music and technique, the theoretical and the practical relationship are yet reflected in a deeper level of consideration that can be explored.

While there are few, if any, true absolutes concerning the best teaching model for this broad of an application, I hope to use these ideals and considerations to generate specific examples of how to integrate these important concepts. In so doing, it is my intention to develop some sense of best practice and demonstrate a thoughtful pedagogic approach to teaching electroacoustic percussion repertoire at the undergraduate level.

Electroacoustic Subgenres

Much of the electroacoustic concert repertoire is derived from primarily three different electronic means of interaction which fall largely within the following classifications:

1) **Soundscape Works**, also known as "Tape" Pieces—works that include an acoustic instrument paired with a pre-recorded soundscape played simultaneously in coordination with one another. These compositions most often use digitally supplied audio files, but the earliest examples of these works used tape (and vinyl records before that) as a medium for the audio track. Because of that, these works are commonly referred to as "tape" pieces regardless of the technology used for the electronic audio.

2) **Live Processing Works**—pieces that involve processing a live audio signal of an acoustic instrument that is played back simultaneously with the acoustic performance in a coordinated way.

3) **Electronic Works**—Pieces that use electronic percussion instruments to actuate electronic sounds in real-time. While these works are not necessarily acoustic by definition and therefore technically outside the world of electroacoustic percussion, a strong argument can be made that these works should be considered electroacoustic from a pedagogical perspective because many of the fundamental performance techniques are based upon standard percussion techniques and methods and, as well, these works reflect the same fundamentals of musicianship required of the standard acoustic repertoire. This body of works also includes Do-It-

Yourself instruments and effects. However, for the scope of this paper, we will address electronic instruments only as they pertain to truly electroacoustic works that involve an element of identifiably acoustic performance.

Each category utilizes slightly different types and aspects of technology, thus requiring a modified skill set. I will explore each classification by addressing their critical elements using prime examples from the relevant standard repertoire: 1) tape works; 2) live processing works; 3) purely electronic works and works that combine elements. In doing so, I hope to illuminate a developmental approach between these categories that progressively builds a foundation of skills related to fundamentals of general musicianship and critical thinking, while remaining efficient from both a pedagogical and resource requirement perspective. It is because a large portion of the electroacoustic repertoire draws on the simultaneous use of a variety of these classifications that I will conclude with an example of how these elements can come together in an advanced concert work.

Equipment Overview

Just as it is imperative for any musician to understand the basic workings of their instrument in order to play their best, it is also imperative to understand the basic devices of electronic music and their functions when studying electroacoustic music. These tools are quite wide ranging and come from an enormous variety of manufacturers and models that are constantly being updated. Although each tool

doesn't necessarily apply to every musical situation, on the whole their diversity presents the opportunity to build on their varying complimentary techniques. The fact that each tool's corresponding technique often applies differently to the various categories of electroacoustic concert repertoire offers the opportunity to develop a broad, strong skill set in a sequential way. Also, while it is necessary to develop a deep and specific command of any piece of equipment that one works with directly, it is also just as important to have a broad theoretical understanding of the components and their functions in order to be able to adapt to the technological developments that affect these tools in the constantly evolving world of electronic music.

Electronic music tools can be categorized in a number of different ways. One broad category of tools that can be used for a wide variety of applications is transducers. In order to preserve a musical perspective, and because of the dizzying array of technical differences between all of the parts in any electroacoustic rig, it might be best to think about the components in relation to how they function musically within a system. A **transducer** is largely viewed as a device that can convert one form of energy to another.[20] However, for the purposes of pedagogical specificity, I use the term to describe specifically those items that convert other forms of energy (primarily sound) into electrical energy, also known as a **sensor**, such as a microphone or a record player's needle. One specific subset of the broad group of transducers that converts electricity into mechanical energy, and

[20] "Transducer/Types of Transducer," *Electrical Engineering and Technology,* accessed March 26, 2018, https://www.electrical4u.com/transducer-types-of-transducer/.

eventually sound energy, is **actuators**, which includes speakers and buzzers. Finally, devices or parts of devices that simply change some aspect of a signal while leaving it in its original type of energy are termed **modulators**. One example of this is a volume dial on a radio. Notice that some tools can serve multiple functions, but this categorization relates each tool's function to its place in the signal path of sound production in a sequential order that generally follows as: transducer, modulator, and finally actuator.

The following list presents a basic description and breakdown of the primary tools and equipment that might be found in the context of an electroacoustic performance. Although the list is certainly not exhaustive, it may still present some tools that fall outside the pedagogical development of an undergraduate student, due to limitations of time and resources when balanced with the remainder of a comprehensive curriculum. It is never-the-less important to understand their function in the scope of the larger body of repertoire to create an awareness of their applications and to offer perspective on the genre as a whole. The scope and depth of this list will be expanded in more detail as each genre of electroacoustic music is presented.

1) **Audio Inputs-** Audio Inputs, commonly categorized as **transducers, or sensors,** convert sound into electrical energy. This can also encompass other forms of energy, including anything that receives vibration, light, motion, or other information, and then outputs an electronic signal that can be electronically amplified, processed, or converted into sound. Audio input

devices convert a wide variety of recording mediums, including other forms of electricity, into a traditional analog electrical signal, including record (physical energy), tape (magnetic tape), CD (digital information), MP3 (digital information), and other digital sound files. These devices include **record players, tape players, CD players**, **phones, other MP3 players**, **or a computer**. Given that the vast majority of electroacoustic works currently being produced use digital technology, most works written today that make use of prerecorded material use some kind of digital sound file.

A **microphone** inputs sound by translating it directly into an electrical signal and is perhaps the most commonly recognized transducer. Since it is used both to make recordings as well as for most pieces that involve any kind of live processing of an acoustic sound, a microphone has a wide variety of applications that are met using many different types of microphones. Some of these include dynamic, condenser, ribbon, and tube microphones. Microphones can be handheld, placed on a stand, or even worn on the head, depending on the application. Many applications are best suited for a wireless microphone, which also requires a **wireless transmitter and receiver** that may be either digital or analog. Most microphones output a weak signal that requires amplification before any modifications can be made to it, and therefore need what is called a **preamplifier,** which can color the sound. Although a preamplifier, commonly referred to as a preamp, is not technically an input transducer because the same type of energy enters and exits the device, it is treated

generally as an input device due to its function as an important link to the input of the signal. It is common for preamplifiers to already be present in mixers or input/output devices. Another important type of transducer includes drum triggers, which convert the acoustic energy directly from the vibration of a drumhead into an electronic interface.

Electronic drums, a **MalletKAT**[21] or other electronic percussion keyboard instrument, or **synthesizers** include a few of the many other possibilities of electronic instruments that largely fall under this category as well. Technically, some of these instruments use "brains" or sound generators that exist as separate modules to make sound. Other electronic **sensors,** or instruments that sense other kinds of energy, such as light, motion, or magnetism, such as a **Theremin**, are also input devices.

2) **Modulation Devices-** Modulation devices, also called **modulators**, include anything that alters an existing signal, such as electricity or digital information, but keeps it in the same medium. A **mixer** is one kind of modulator that blends and adjusts audio signals, often by controlling volume levels or adding effects to the sound. Mixers are not uncommon, but are often replaced functionally for solo repertoire by a **computer**, which can control a seemingly infinite number of variables using a myriad of different

[21] A MalletKAT is an electronic mallet percussion controller that is the tradename for a "powerful MIDI percussion mallet controller using true FSR sensing technology" made by Alternate Mode. Alternatemode.com, accessed November 14, 2017, https://www.alternatemode.com/malletkat/malletkat-grand/.

flexible software options. The **software** that is often used to do most recording, editing, and playback is referred to as a **Digital Audio Workstation (DAW)**. To facilitate the computer's translation from an electrical signal to a digital one (and back again) an audio input device, or input/output box (i/o), also known as an **audio interface**, is usually required.

Outboard audio effects are other modulation devices. These stand-alone units are also called **signal processors** and often offer either a specific audio effect, or an array of different audio effects. A couple of examples of this might be a **digital delay machine, a reverb unit, or a compression device**.

Another familiar modulator is commonly called a **launchpad**. This is a device with electronic pads, pots (dials), and faders (sliders) that may be assigned to many different functions.

Less common modulators could include various **do-it-yourself electronics**, hacked modulators, and custom-built solutions that can include sound modulation based on infrared motion detection.[22] Examples might include repurposing the motion sensors on a **Playstation 2** for use as a modulator, or the use of an accelerometer within a modern **mobile smartphone** to alter a parameter based on its detection of tilt and velocity.

[22] Do It Yourself Electronics include anything that is custom designed and built using available materials that are either repurposed from other electronic devices or are expressly created to build new electronic creations from a modular platform. Some common examples include Arduino chips, Raspberry Pi, and LittleBits.

Light sensitive devices, or even **sound sensitive triggers** can also function to alter a signal path, affecting the sound.

3) **Output Devices-** Devices that output sound, more specifically known as **actuators** (also sometimes referred to as transducers in other contexts)**,** convert electricity into sound by way of physical vibration. **Speakers** are a standout example of actuators, and simply convert electricity into sound via a vibrating body. All electroacoustic works involve some kind of electronic sound (even if just reinforcing the acoustic instrument), thus, every electroacoustic work involves some kind of speaker. While all speakers need an amplified signal to convert to a reasonable volume level, some speakers contain the amplifier (the equipment that strengthens the electrical signal enough to be turned to sound by a speaker) and some do not, requiring the amplifier as an external addition in the signal path. Speakers that contain the amplifier are called **active speakers**, while those that do not are called **passive speakers**. Some speakers are specifically designed to help the performer hear while performing. These are known as live **monitors**, and may be designed to be used on stage or actually placed inside the ear using earbuds, which are otherwise known as in-ear-monitors. It is interesting to note that, although not advisable because its speakers are not typically powerful enough to reasonably function in the context of a live performance, a computer may serve collectively as both an input device, a modulator, and

an output device. However, even though a computer is capable of these different tasks, they are all executed by different parts of the machine.

Buzzers and other mechanical means of producing sound can be used in electroacoustic works, although they tend to be more specialized and for more electronically complex pieces than are served by traditional speakers alone. Examples of these sound production alternatives sometimes include buzzers vibrating on drumheads, or a motor that drives an implement to strike an instrument.

With equipment that is this divergent and not always applicable to every subgenre of electroacoustic repertoire, it is most effective to approach the teaching of these relevant tools in an organized, methodical, and pedagogically minded way. For that reason, I would like to explore their method and sequential introduction based on the fundamental concepts that are relevant to each style of electroacoustic concert repertoire in the order of tape works, live processing pieces, and electronic works. I will use select milestone works representative from each category of electroacoustic repertory to demonstrate the broad concepts related to each subgenre.

CHAPTER TWO

ELECTROACOUSTIC ORIGINS

Early Percussive Beginnings

The origin of what is now commonly referred to as electroacoustic repertoire for percussion is difficult to pinpoint and has a number of strong influences. Some of the earliest pieces for percussion ensemble and fixed electronic media include works by the luminary composer and percussion champion, John Cage. His earliest example, *Imaginary Landscapes No. 1*, from 1939, is scored for percussion and two variable speed turntables with frequency recordings. This was followed by *Credo in US* (1942), *Imaginary Landscapes No. 2* (1942), *No. 3* (1942), *No. 4* (1951), and *No. 5* (1952), all of which use various electronics. Of the *Imaginary Landscapes* series, Cage said, "It's not a physical landscape. It's a term reserved for the new technologies. It's a landscape in the future. It's as though you used technology to take you off the ground and go like Alice through the looking glass."[23]

It is also hardly coincidental that one of the first milestones of percussion ensemble repertoire, *Ionization* (1929-31), was composed by electronic music pioneer, Edgar Varese, who also wrote one of the first mixed ensemble works with electronics and percussion, *Deserts,* in 1954.

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[23] Richard Kostelanetz, "John Cage and Richard Kostelanetz: A Conversation about Radio," *The Musical Quarterly* 72, no. 2 (1986): 218, accessed March 22, 2018, http://www.jstor.org/stable/pdf/948120.pdf?refreqid=excelsior%3Acb9a6fd7ebd1dbffd5377f6f6bfe9013.

From Tape and Beyond

Composer Halim El-Dabh is widely credited for creating the first completely electronic tape composition with his *The Expression of the Zaar* in 1944, using magnetic tape, a new technological German byproduct from the Second World War that was made available to him in Egypt. In the work, he manipulated a raw recording of a zaar street ceremony by using various effects, such as echo chambers, reverb, and voltage controls from the studio at Middle East Radio.[24] But it is Pierre Schaffer who is better known for exploring this medium and more fully establishing what came to be regarded as *musique concrète*, while working out of the Radiodiffusion Francais (French Radio Broadcasting), where he established the Studio d'Essai (Test Studio) in 1942. Schaffer's *Cinq Etudes de Bruits* (Five Studies of Noise), from 1948, is a milestone work that came out of this period. He later founded the *Groupe de Recherche de Musique Concrète* (Group In Search for a Concrete Music) with electronic music pioneer Pierre Henry and relocated his working studio to the French Radio Institution in 1951 where he had the opportunity to work with better tape equipment.[25] It was during this period, in 1952, that he wrote his treatise on electronic music, *À la Recherche d'une Musique Concrète* (*In Search of a Concrete Music*). Varese also made considerable contributions to music concrete, and his *Poem Electronique*, which was premiered in

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[24] Thom Holmes, *Electronic and Experimental Music: Technology, Music, and Culture*, third edition (New York: Routledge, 2008), 153-154, 157.

[25] Carlos Palombini, "Machine Songs V: Pierre Schaeffer: From Research into Noises to Experimental Music," *Computer Music Journal* 17, no. 3 (Autumn 1993): 14–19, accessed March 22, 2018, http://www.jstor.org/stable/3680939?seq=3#page_scan_tab_contents.

1958 at the Brussels World's Fair, is another notable staple of the repertoire. The premiere of the work required elaborate sound spatialization that called for an enormous installation in the performance space that utilized literally hundreds of speakers.

Electronic Nationalism

Simultaneous with the French establishment of *musique concrète*, there was the rapid development of a German style of electronic music simply known as *elektronische musik*, which many considered to be in direct opposition to *musique concrète.* Although they both used various common methods and structures for electronically manipulating source material, musique concrète drew its source material from concrete sounds, which were often mundane prerecorded sounds that existed in the world as concrete artifacts (i.e., the sound of footsteps). Elektronische musik, on the other hand, generally drew its source material from purely electronic material conceived in the studio.[26] Examples of electronically sourced material included such things as sine tones produced by an oscillator, electronically generated pulses, and filtered white noise. Such music created more dissociative listening, and did not offer the same contextual conflict of familiar sounds that could be created with musique concrète. One of the great early masterworks from this school was Karlheinz Stockhausen's 1956 tape work *Gesang der Junglinge* (Song of the Youths), which was premiered at the auditorium of the studio for electronic music at the *Westdeutscher Rundfunk* (West German Radio) in Cologne where

[26] Holmes, 6.

Stockhausen was working at the time. *Westdeutscher Rundfunk* was a well-known center for elektronische musik.[27] This work is notable for a number of reasons, including its multichannel spatialization and its mixing of musique concrète and elektronische musik elements for the first time by integrating source material from a boy soprano seamlessly with otherwise electronically created source material. One thing that both musique concrète and elektronische musik have in common is that they are both conceived for reproduction on speakers alone and are therefore fundamentally acousmatic, which means that the sound is visually divorced from its actuation, so that the listener does not see the originating cause.[28]

Toward More Mature Tape and Live Processing Works

Stockhausen further expanded the boundaries of electronic composition with his 1960 serial masterwork for electronics, piano, and percussion, *Kontakte*. Whereas Varese's earlier mixed ensemble work, *Deserts*, explored alternated sections of electronic material and live acoustic performance, *Kontakte* is one of the earliest pieces to fully integrate the live acoustic and electronic sounds into shared sonic space. Of the title, Stockhausen stated that *Kontakte* (Contact) "refers both to contacts between instrumental and electronic sound groups and to contacts between self-sufficient, strongly characterized moments. In the case of four-channel

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[27] Nikolaus Adrian Keelaghan, "Performing Percussion in an Electronic World: An Exploration of Electroacoustic Music with a Focus on Stockhausen's Mikrophonie I and Saariaho's Six Japanese Gardens" (DMA diss., University of California Los Angeles, 2016), 8–11, accessed March 22, http://escholarship.org/uc/item/9b10838z.

[28] Joseph Sannicandro, review of Sound Unseen: Acousmatic Sound in Theory and Practice by Brian Kane, Oxford, Oxford University Press, 2014, *Journal of Sonic Studies*, accessed March 22, 2018, http://sonicstudies.org/kane2014.

loudspeaker reproduction, it also refers to contacts between various forms of spatial movement."[29]

Stockhausen continued to push formal electronic/acoustic relationships with his 1964 work, *Microphonie I*, for six performers and amplified tamtam. *Microphonie I* was part of a trilogy of similar works that Stockhausen composed for electronic transformations to be executed during the performance, setting a model for what we now refer to as live processing. This was in stark contrast to its electroacoustic predecessors, which were largely based on interactions between live instrumentalists and purely preprocessed and recorded electronic media, such as a record or tape, or what we now call a tape work. Stockhausen observed, "normally inaudible vibrations . . . are made audible by an active process of sound detection (comparable to the auscultation of a body by a physician); the microphone is used actively as a musical instrument, in contrast to its former passive function of reproducing sounds as faithfully as possible."[30] In so doing, he brings the audience a step further away from the acousmatic listening experience of traditional elektronische musik or musique concrete, which had long frustrated traditional expectations of classical concertgoers who were accustomed to attentively watching the sounds originate in front of them during a performance.

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[29] Karlheinz Stockhausen, *Texte* 2: Aufsätze 1952–1962 zur musikalischen Praxis [Texts 2: Essays on 1952-1962 musical practice], ed. Dieter Schnebel (Cologne: Verlag M. DuMont Schauberg, 1964), 105.

[30] Karlheinz Stockhausen, "Mikrophonie I (1965), für Tamtam, 2 Mikrophone, 2 Filter und Regler." in *Texte zur Musik* 3 [Texts about music] (Cologne: Verlag M. DuMont Schauberg, 1971): 57–65, quoted in *Wikipedia,* s.v. "Microphonie (Stockhausen)," accessed March 22, 2018, https://en.wikipedia.org/wiki/Mikrophonie_(Stockhausen)#CITEREFStockhausen1971a.

The Columbia-Princeton Electronic Music Center in New York City also produced a number of notable works since its founding in the 1950s by Milton Babbit, Vladamir Ussachevsky, Otto Luening, and Roger Sessions. While the studio was home to a robust collection of music production tools, the centerpiece was a powerful synthesizer built by RCA to the exacting specifications of Babbit and Ussachevsky, the RCA Mark II Sound Synthesizer. This powerful tool offered a great amount of control over all aspects of sound, and proved instrumental in further advancing the concept of total serialism with the many composers who spent time there, including Babbit, Sessions, Ussachevsky, Luciano Berio, Charles Wuorinen, Varese, El-Dabh, and Mario Davidovsky, to name a few.

Of these composers, it may be Davidovsky who had the greatest influence and contribution toward the genre we now call tape pieces. In 1962, he completed *Synchronisms 1*, the first piece of his series of twelve works for live acoustic instruments (either solo or in ensemble) and electronic soundscape, which were completed over a forty-year span. Although *Synchronisms 1* was written for flute and tape, *Synchronisms 5* (1969), for electronic sounds and five percussionists, is now an established staple of the electroacoustic percussion ensemble repertoire.

27′ 10.554″ for a percussionist (1956), by John Cage, is often credited as being the first specifically solo work written for percussion and electronics. Although the work includes a detailed timeline with clearly presented material, much of the electronic requirement is intentionally vague. In the score, Cage directs the percussionist to play from staves that represent four different percussion sounds, including woods, metals, skins, and "all others, e.g. electronic devices, mechanical

arrangements, radios, whistles, etc." The work is designed to be played either in part or in whole, and given that he also gives the instruction that the work "may be performed as a recording or with the aid of a recording" (which he does not furnish), the level of electronic interaction, if any, is left completely to the performer.[31]

Even with the myriad of influences that eventually establish both tape works and live processed works, it would be years before the young world of electroacoustic music would have a legitimate percussion solo work that would be inextricably coupled with electronics. This is not to say that the mid 20th century history of electronic and electroacoustic music has little bearing on the current state of electroacoustic concert percussion literature—quite to the contrary. In exploring these historical developments, it is possible to recognize several important relationships to current percussion art music that are relevant to university level students.

First, is the understanding of how nationalistic influences and ideals affect an aesthetic outcome. This difference between German, French, and American concepts of electronic music is mirrored in their respective classical traditions, and is thusly observed even in the choices that a percussionist makes with respect to choosing cymbals or playing snare drum, based on the stylistic origin. The idea that this concept is consistent within the broader world of art music, be it acoustic or electronic, further underscores the relevance of a holistic approach toward understanding this aspect of musicianship.

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[31] Keelaghan, 37.

Perhaps more importantly, one can extrapolate a fairly clear developmental process that occurs historically between tape works and purely electronic works, to live processed works, to works of mixed medium. This development is not important only from a historical perspective, but also as a logical pedagogical process that reflects an awareness of influence and methodology mirrored in today's musical landscape.

This general move away from acousmatic works, toward electronic works that incorporate live human performance, either with or without electronic manipulation of the acoustic sounds, further reinforces the establishment of electroacoustic works within the canon of traditional western art music, thus preserving the audience's conventional role as both an observer and listener. Moreover, even though there has been a been a seemingly exponential increase in the number of electroacoustic concert percussion works written over the last decade, it is clear that the world of percussion has a long-standing association with electronic music and its former champions. This history underscores the need to develop a dedicated pedagogy that enables the passage of these techniques and information on to the percussionists of tomorrow. This deep association forms an important part of percussion's complex identity where norms and boundaries are continually developed and pushed.

CHAPTER THREE:

DEVELOPING AN APPROACH TO SOUNDSCAPE/TAPE WORKS

Temazcal, by Javier Alvarez

One of the first truly indisputable, classic, and quintessential examples of electroacoustic solo percussion repertoire is Javier Alvarez's, *Temezcal,* for maracas and tape. Alvarez wrote this work in 1983 and 84 while he was studying composition and electroacoustic production techniques at the Royal College of Music in London. The work is scored for maracas and a prerecorded soundscape, for which he supplies an elaborate graphic score along with very specific performance instructions that govern not only the style of the percussion playing, but also the live audio playback. Of the piece, Alvarez writes,

> Temazcal (Alvarez, 1984) stems from the Nahuatl (ancient Aztec) word literally meaning "water that burns." The maraca material is drawn from traditional rhythmic patterns found in most Latin – American musics, namely those from the Caribbean region, southeastern Mexico, Cuba, Central America and the flatlands of Colombia and Venezuela. In these musics in general, the maracas are used in a purely accompanimental manner as a part of small instrumental ensembles. The only exception is, perhaps, that of the Venezuelan flatlands, where the role of the maracas surpasses that of mere cadence and accent punctuation to become a soloistic instrument in its own right. It was from this instance that I imagined a piece where the player would have to master short patterns and combine them with great virtuosity to construct larger and complex rhythmic structures which could then be juxtaposed, superimposed and set against similar passages on tape, thus creating a dense polyrhythmic web. This would eventually disintegrate clearing the way for a traditional accompanimental style of playing in a sound world reminiscent of the maracas' more usual environment.
>
> The sound sources on tape include harp, a folk guitar and double bass pizzicatti for the tape's attacks, the transformation of bamboo rods being

> struck together for the rhythmic passages and rattling sounds created with the maracas themselves for other gestures.
>
> The piece is dedicated to Luis Julio Toro who first performed it at the East Mountain Artist Series in London in January 1984. [32]

Since receiving an honorable mention at the 1985 Bourges Electro-Acoustic Music Festival, Temazcal has become part of the contemporary percussion repertoire and is regularly performed and broadcast worldwide. Although the original work was first produced using traditional tape techniques at the time, the work has since been transferred to a digital format and both the music and soundscape are sold and distributed today as an online package of electronic files, available through his website, www.temazcal.co.uk.

There are many unique and specific performance challenges to this piece besides managing the electronics. A few challenges include developing the technique and musicality of Venezuelan Joropo style maraca playing, being able to improvise effectively in multiple idioms, and interpreting a graphic score. While it is not necessary for our present purpose to go into great exploration and pedagogical detail on all of these aspects of the work, it is relevant to have a basic grasp of them to better understand how to best control the sound system and what performance factors should influence an informed interpretation.

The score of *Temazcal* represents an outline of the maraca part as well as a graphic depiction of the computer-generated tape that the performer interacts with

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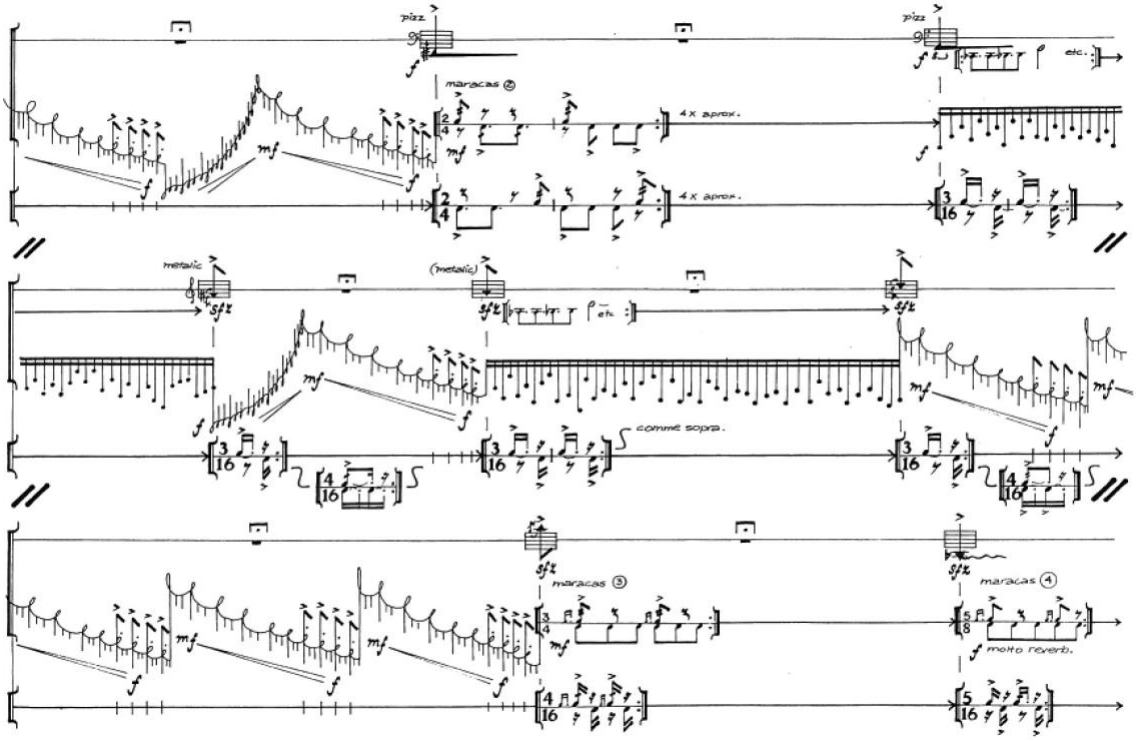
[32]Javier Alvarez, "PASIC Tech Day Performance Notes and Session Abstracts," *The Donald Tavel Arts and Technology Research Center,* accessed March 23, 2018, http://music.iupui.edu/research/uncategorized/pasic-tech-day-abstracts-and-program-notes/.

during the performance. See figure 1. Even a cursory examination of the score reveals how extremely intricate the electronic soundscape is. The performer's job then becomes to perform the maraca part, both preconceived and improvised, in close coordination and reaction to the soundscape, using the Joropo inspired cells that the composer offers as building blocks (see figure 2). Once the prerecorded tape dissolves into Joropo folk music near the end of the work, the listener is transported from an alien sound to a very simple and grounded musical style, with

Figure 1. Javier Alvarez, Temazcal, P. 5.[33]

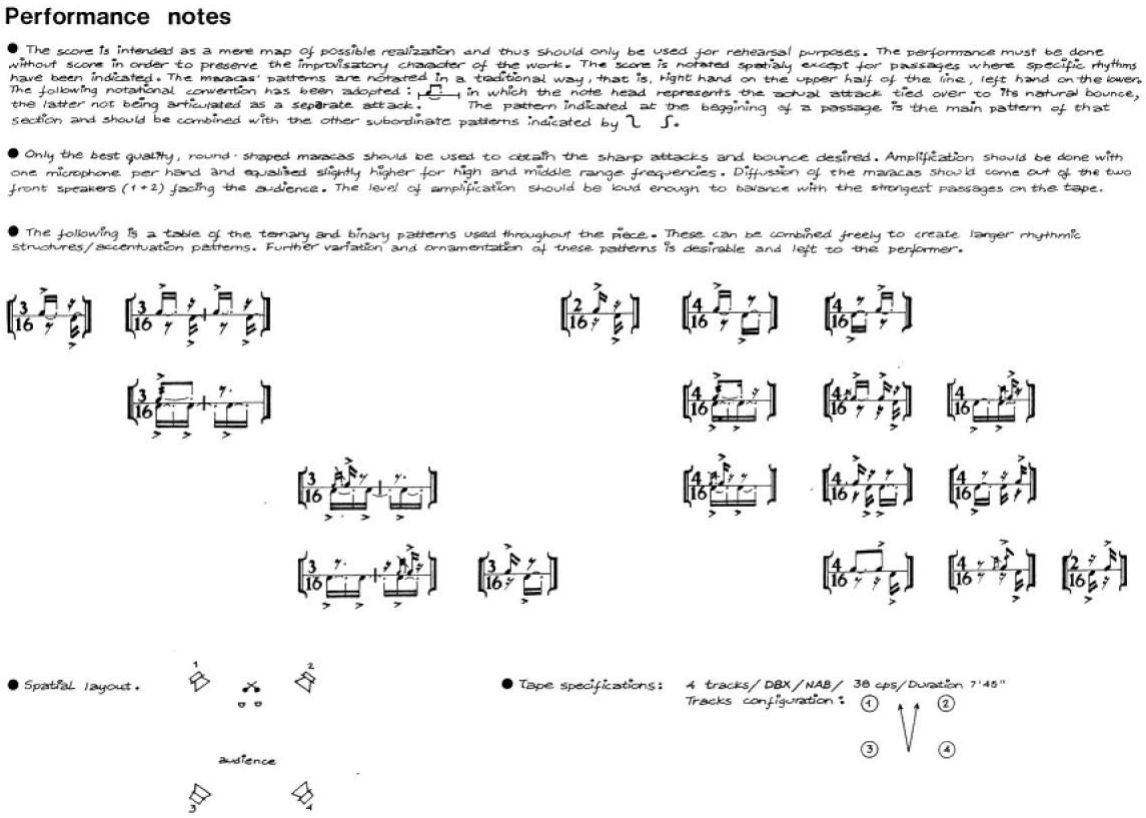


the common thread of the maracas cleverly and unpretentiously bridging the gap between the two. When a performer looks at the relationship between the

[33] Javier Alvarez, *Temazcal* (London: Black Dog Publications, 1984), 5. All Rights Reserved. Used with permission.

electronic recording and the maraca part from a musical perspective, it seems clear that more than being a solo work, the essence of the piece is actually chamber music, and more specifically, a duet.[34]

Figure 2. Javier Alvarez, *Temazcal*, Performance Notes, P. 2.[35]



Technique from a Musical Perspective

When approaching the work as a duet, it becomes incumbent for the performer (and teacher) to identify the essential performance elements of a duet. The dynamic of a duet is one in which each part is reacting to the other to create a

[34] Brady Harrison, "Temazcal" (performance video), posted April 19, 2013, accessed March 23, 2018, https://www.youtube.com/watch?v=GW8vC4NF4oQ.

[35] Javier Alvarez, *Temazcal*, 2. All Rights Reserved. Used with permission.

synergistic outcome. In order for each musician to maintain a continuous real-time reaction, traditionally each musician must be able to see and hear the other. In contrast, sounds or music for which a person cannot see the actuating cause are called acousmatic. Acousmatic accompaniments pose a number of performance challenges when compared to working with other live collaborators. For example, the pre-recorded soundscape does not respond to the live performer, nor can the live performer see the visual cue of the actuation of sounds that are being created by the recording. Therefore, it is imperative that the live performer be able to clearly hear all aspects of the accompanying soundscape in order to perform in precise synchronization with it.

Because of this unique challenge, it often becomes necessary to think of the sound that the audience hears and the sound that the performer hears as two different independently manageable sound sources with differing characteristics based on their intended use. What the live performer hears is called a monitor audio signal, and there are a number of different options as to how that might be produced. For instance, the performer may hear the soundscape through the loudspeakers that the audience also hears (in this case it would be no different than the loudspeaker signal), through a separate set of speakers that are aimed at the performer often called stage monitors, or through a small headset of speakers worn over the ear (headphones) or inserted into the ears with earbuds, also known as in-ear monitors. See figure 3. In-ear monitor systems should always be equipped with sound limiters to mitigate any hearing damage that could result from spikes in the signal chain. The latter two methods of headworn options allow the advantage of

Figure 3. Live Monitor Options.

customizing and isolating the mix that a performer hears separately from what the audience hears, but all three options have different applications. Although these applications are ultimately guided by the desired musical outcome of the work, they are also dependent on the technical requirements of the specific piece and how the monitors are integrated in the signal chain. This is one of the many reasons that it is imperative for every performer to have a comprehensive understanding of one of the first broad competencies that I outline for the study of electroacoustic concert music: basic audio signal path and its relevant parts.

Basic Audio Signal Path

In the same way that a purely acoustic musician's method and facility are informed by an understanding of their instrument, having a comprehensive understanding of signal flow and its various parts is important to efficient and artistic performance of electroacoustic music. Audio signal flow, which is also referred to as signal path, signal structure, and audio signal chain, is the entire path that the audio signal takes from the source to the output.[36] This includes where the signal goes, what kind of energy is conducted at each step, and how each stage affects the sound. A basic signal path can be expressed by creating a simple audio circuit diagram, which is a visual presentation that each student should learn to create when starting to work on any electroacoustic repertoire. Figure 3 provides a launching point for discussion and exploration of best practices by displaying a couple of basic options that exist as one specific part of an audio signal path that might be appropriate for works that use just one prerecorded soundscape or track, similar to *Temazcal.*

Much can be learned by considering the various strengths and weaknesses between some of the possible solutions by examining figure 4. In Option 1, the audio file, which is delivered in the form of a CD track or other digitally downloadable recording, is played through a digital device (e.g., computer, mp3 player, CD player, etc.) and transfers that digital audio into an analog audio signal that goes out of a headphones output jack on the device. A cable then takes the

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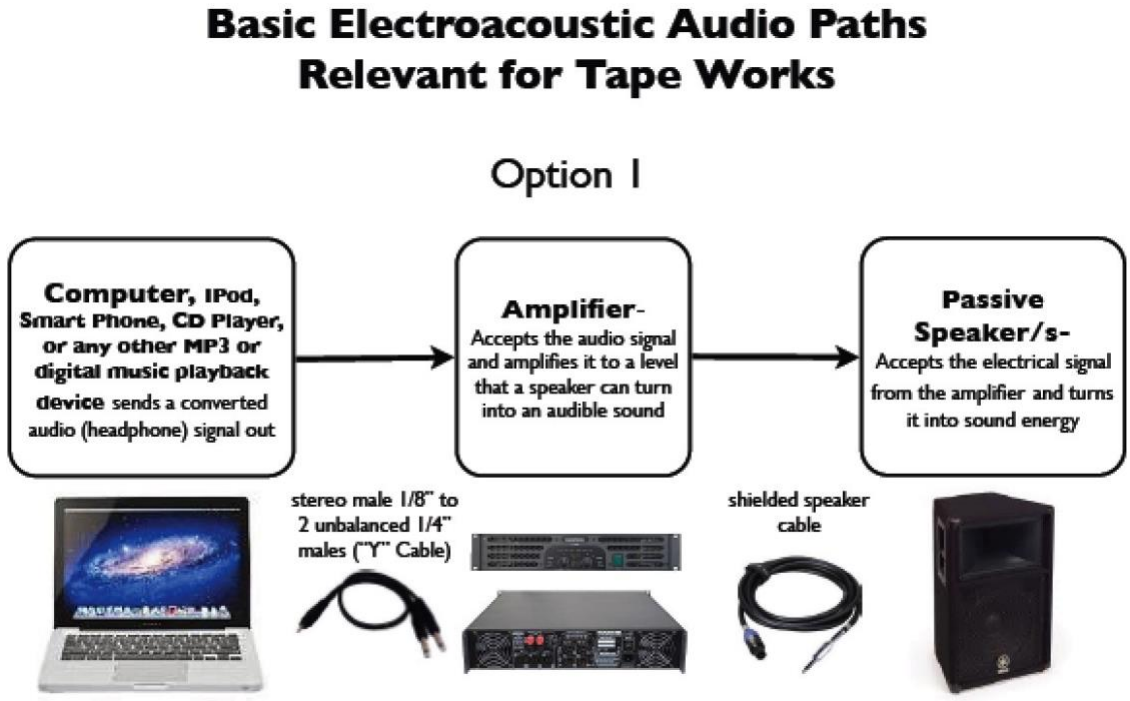
[36] Steven Roback, *Pro Tools 6 for Macintosh and Windows,* 2nd ed. (Berkely, CA: Peachpit Press, 2004), 303.

Figure 4. Basic Electroacoustic Audio Paths Relevant for Tape Works, Option 1.



signal from the digital device and transfers it to an amplifier that amplifies the signal so that it is strong enough to be transferred to audible sound by the next component in the chain, the speakers.

Although such an option is possible, it has a number of inherent musical, technological, and pedagogical weaknesses. To understand its shortcomings requires a slightly deeper understanding of how the parts of the system function. Firstly, from a musical perspective, it is incumbent on the performer to consider the composer's intent when pondering the technical design elements of a work's execution. While most musical performances allow for some element of performance flexibility over direction offered in a score, the composer's wishes still must be considered, and in the genre of composed works involving electronics,

composers often assert their position regarding the electronic aspects of the performance. This is, in part, because many composers seek out the element of electronics as a method of gaining a more complete control over the performance than a purely human musical reproduction can provide. By controlling an increased number of aspects of the performance, composers are better able to consistently replicate the audience's experience between different performers and performances. Considering this, a brief review of the performance notes (figure 2) reveals some essential information about both the musical and technical intentions of Alvarez. Based on these notes that outline a spatial layout of the speakers, we know that Alvarez originally intended that the work be played with four different tracks being routed through four different speakers which surrounded the audience from the four corners of the space. It should be noted however, that these intentions were tied to the original version of the piece, which was created with analog four track tape specifications, and that now when the digital sound file is supplied with the score, it comes as a two channel (typically thought of as left and right) stereo sound file.

A more thoughtful technical approach reveals how one can better execute these musical instructions using this basic audio path option as set forth from figure 4. Most digital devices (computers, smart phones, mp3 players, and often CD players) send a stereo headphone audio signal to their audio output at a level that is primarily intended to feed a pair of headphones. The headphone audio signal that goes out of the digital device is in stereo on one cable, which means that one conductor in the cable will carry the left audio signal, one conductor will carry the

right audio signal, and the remaining conductor provides a ground for the circuit. However, amplifiers are typically setup only to receive one channel of audio information in each audio input, which means that the signal will be reduced to a mono signal at the point of entering the amplifier. In other words, if one were to simply route a cable from the headphone jack into a single input on the amplifier, one half of the signal would be lost. One way to circumvent this would be to split the stereo signal into two separate channels using a special Y cable. In this event, the stereo signal would be split into two separate, unbalanced mono audio signals that could each feed into two separate inputs on the amplifier to regain both channels of audio for the final product. The downside to doing this is that the audio that the Y cable produces is not as clean because the amplifier is being fed with two unbalanced signals.

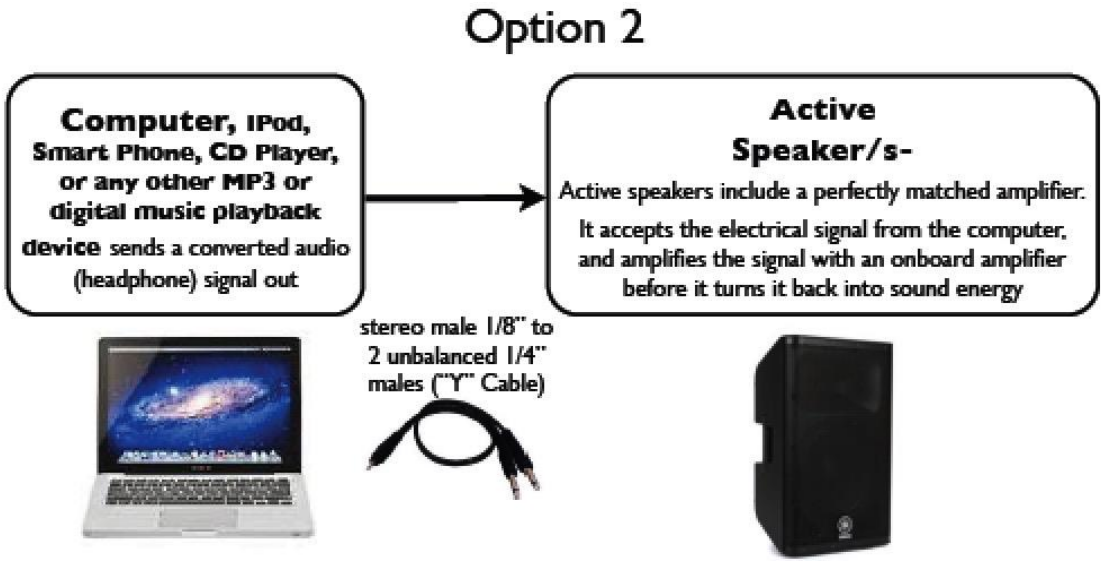
One other consideration for this configuration is the effort involved in the logistics and matching of the amplifier to the speakers. Standalone amplifiers are heavy and must be carefully impedance matched to any speakers that they are paired with. Impedance, which is a measurement of how much resistance is present in a circuit, is measured in Ohms. Generally speaking, speaker level audio signals run at a very low impedance, usually between 4 and 16 Ohms. In order to sound at their best, speakers are designed to be used at the same Ohm rating as the amplifier, which is given at each input and output on both the amplifier and speakers. Furthermore, when running multiple speakers off of a single amplifier, the equation changes in order for the speakers to be optimally matched. This means that not all amplifiers are appropriate to run any particular speaker, and the system designer, in

this case the performer, must be careful to match them appropriately, using an Ohms matching equation. To do otherwise could result in poor sound quality or even damage to the equipment itself. While this example contains what are commonly referred to as passive speakers, speakers that contain the amplifier are known as active speakers, rather than passive speakers. Active speakers eliminate the problem of Ohms matching and bring us to a second option for the signal path.

As an evolutionary development from option 1, option 2 (figure 5) uses a nearly identical signal path as option 1, but with one exception; instead of a separate amplifier and speakers, it uses active speakers, which by definition include the amplifier. This scenario eliminates the need for amplifier/speaker matching because the amplifier that is housed within each speaker is specifically matched to allow the speaker to produce its best sound quality. Although the speakers do require a power connection to operate, this simplifies a step in the signal chain. There remains however a fundamental problem with this setup, which involves the integrity of the signal coming from the computer. In order to better understand it, one must have a full comprehension of the difference between balanced and unbalanced signals.

Most audio cables have an inherent inductance, or magnetic field, that acts as an antenna for unwanted static and other noise interference when a signal is travelling through it. This is why the type of cable and how it interacts with the system is critical to eliminating the noise as the signal is received in the next component. Cables that carry analog audio signals typically fall into two broad

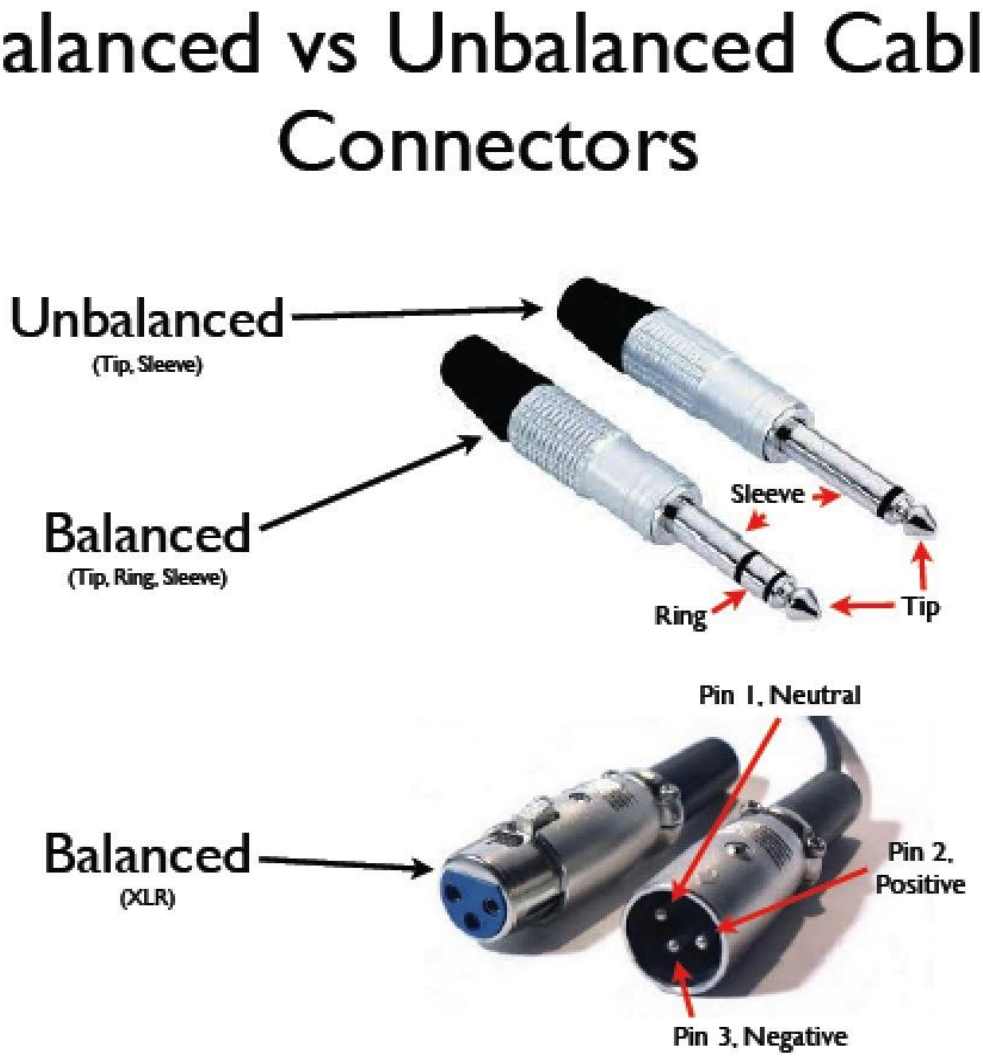
Figure 5. Basic Electroacoustic Audio Paths Relevant for Tape Works- Option 2, Active Speakers.



categories: unbalanced or balanced cables. Although both balanced and unbalanced cables can use a variety of connectors, it is important to recognize the most common connector types and their defining differences. See figure 6. Unbalanced cables have two conductors and typically are used to transmit an audio signal from a guitar, synthesizer, or other electronic instrument. One conductor of the cable carries the audio signal, the other conductor serves as a ground that also functions as a shield. These are often called instrument cables, T/S, or Tip/Sleeve cables, named for the common two-part quarter inch divided connector.

A balanced cable, sometimes also called a stereo cable (even though balanced and stereo *signals* are two different things), typically uses three conductors to deliver audio signals. These signals can include mic level signals coming from microphones as well as line level signals from pro audio mixers, digital interfaces,

Figure 6. Balanced vs. Unbalanced Cable Connectors.



audio processors, etc. Two of these conductors carry the audio signal and one serves as the shielding ground, which serves to help prevent the introduction of noise into the system via the cable itself by absorbing much of the electromagnetic interference.

A balanced signal reduces noise in the system with a very clever process of summing two identical out-of-phase signals in such a way as to eliminate any noise

that has been caught in the signal flow between components. See figure 7. Between devices that are designed to use balanced audio signals, the two audio conductors are carrying the same signal, turned 180 degrees out of phase. This enables the device receiving the balanced signal to sum up the two incoming audio signals in a way that eliminates the introduction of noise and doubles the strength of the original audio signal.[37] Unbalanced signals on the other hand, deliver a single audio signal that easily attracts interference without integrating a method for removing the noise once the signal has reached its destination.

Because equipment that is setup to send or receive a balanced audio signal relies on the cable itself to also be balanced in order for the system to work, it is imperative that the cabling appropriately match the system. While balanced cables are intended to work with systems to remove unwanted noise at the next input point, unbalanced cables are not.

As an example, let us reexamine figure 5 as to what would happen if that first device (i.e. a computer) is simply connected by a stereo cable to a balanced input on the speakers without splitting the signal. Stereo sound gets its depth from the combination of two different audio signals, one left and one right. Together these two different audio signals create what is called a stereo image. Every sound in a stereo recording is panned, which means that it is emphasized in varying degrees toward a particular direction, either left, right, or center. A sound that is panned all the way to the left is only present in the left channel, or audio signal, and not the

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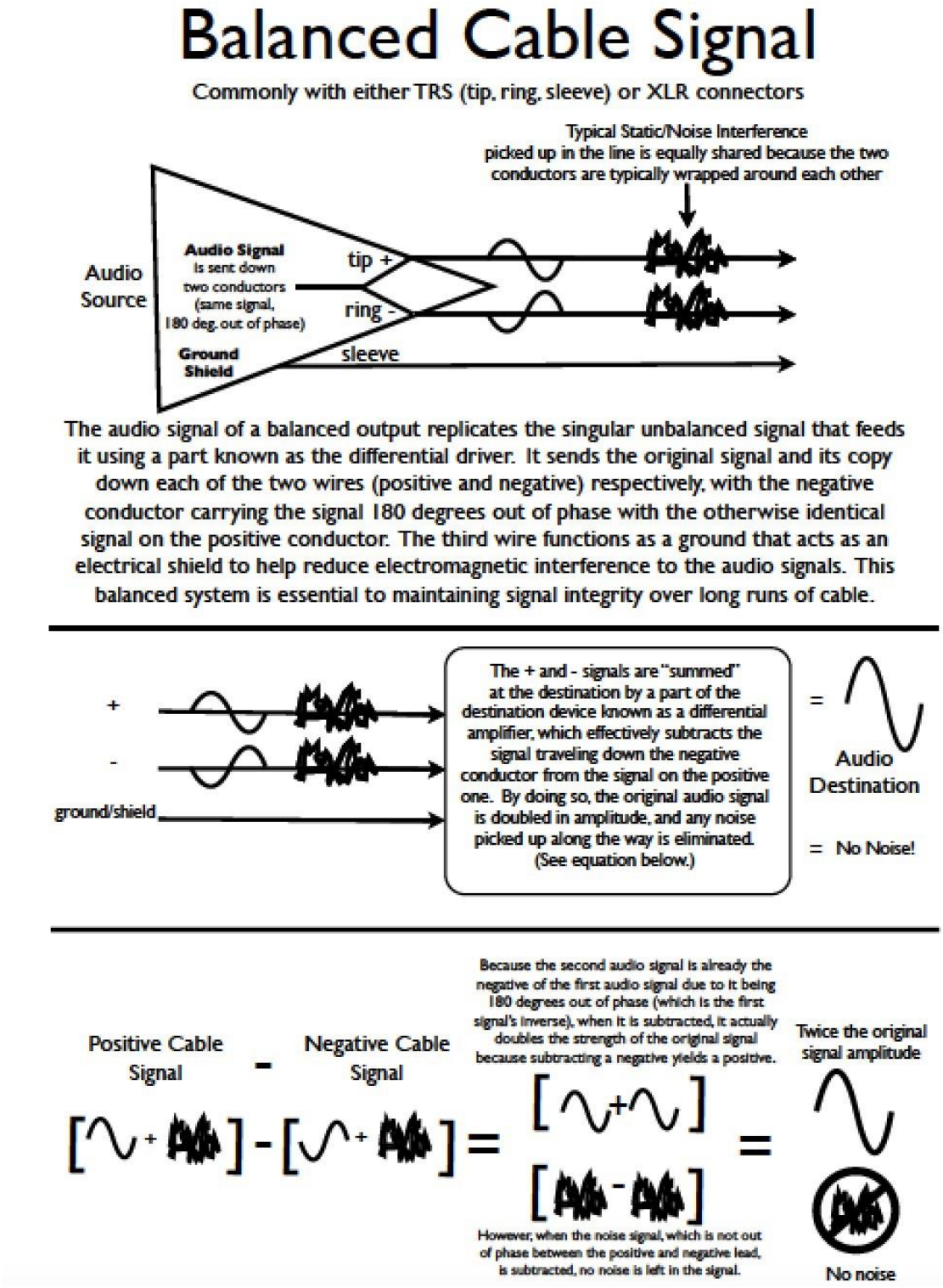
[37] Dave, "What the Heck is an XLR Connector?" *Notes and Volts*, August 23, 2011, accessed March 23, 2018, http://www.notesandvolts.com/2011/08/what-heck-is-xlr-connector.html.

Figure 7. Balanced Cable Signal.



right channel. Hence, the listener hears the sound on the left side and not the right. Sounds that are panned dead center, are simply produced in both channels in equal amounts. Most recordings use a combination of panning both left and right for various sounds, but are panned primarily toward the center as a whole. If the stereo signal is sent down a stereo cable, which is in essence a balanced cable in terms of construction, and fed into a balanced input on the amplifier, then the right channel is subtracted from the left channel at the input, just as balanced signals are typically handled. When this happens, all of the audio that was replicated between the two channels because it was panned toward center would be lost because it would be summed (really subtracted) from itself (see figure 7), erasing it from the stereo image and resulting in extremely compromised sound quality. It is for this reason that the stereo signal coming from the computer should be split into two separate (left and right) signals before it is fed into any amplifier. This splitting that occurs in the use of a Y cable, which can split a stereo signal into two independent mono signals, results in two separate and unbalanced feeds going into the amplifier.

Although the presence of an unbalanced feed is really not ideal in either of the audio paths previously outlined in figures 4 and 5, it presents more potential to cause a problem in the signal path outlined in figure 5, where the amplifier is contained within the speaker cabinet itself. Because the amplifier placement is dictated by the speaker placement, the length of the cable run from the computer or other sound source to the amplifier is likely to be much longer, and therefore more susceptible to electromagnetic radio interference that could easily interfere with an unbalanced signal over a long distance. When a typically weak, unbalanced line

level signal reaches an amplifier, the amplifier amplifies both the intended signal and any noise that has been picked up in the line on the way there, resulting in a less favorable signal to noise ration. It is for this reason that the line level signal running into the amplifier is usually balanced, to help eliminate unwanted noise. In contrast, speaker cables, which run from an amplifier to a speaker and are typically unbalanced, carry a strong, amplified signal that will be minimally degraded by any atmospheric interference. This is because any interference that enters the line from electromagnetic induction at that point in the signal path is only a small percentage of the already strong signal, and therefore is insignificant in comparison to the intended final result. Regardless, these collective observations reveal that both audio path options that we have thus far examined (figures 4 and 5) generally have clear technical weaknesses that will have a less than ideal effect on the integrity of the audio sound quality.

In musical terms, the technical limitations of both opening audio diagram options (figures 4 and 5) that we have thus far explored come down to a common fundamental musical principle, tone quality. Yet there is another shortcoming that has yet to be addressed by either of these possible audio paths: the lack of a separate and customizable monitor system. Returning to the idea that tape works are a form of chamber music, an effective monitor remains crucial to a successful performance of this repertoire. Neither of the two aforementioned signal path options allow for an effective monitor system separate from the common audience speakers. A different signal path might address that problem as well as some of the other issues associated with both options 1 and 2.

Option 3 (see figure 8) addresses monitoring and some of the other issues previously explored regarding options 1 (figure 4) and 2 (figure 5) as well. In this third option, a mixer has been inserted between the computer/audio source and the amplifier. An audio mixer may perform many tasks, but primary among them is "to take signal from multiple sources, combine them, and send the results to one or more destinations."[38] Inserting an audio mixer into the signal path can help to correct many of the shortcomings associated with the previously discussed audio path options. It is easy to add a personalized monitor (wired or wireless), which we have already established as an essential tool, into this set-up. This is because most mixers have a separate live monitor output or headphone output jack, which sends that dedicated signal.

Beyond the utility of an effective monitor solution, most mixers send balanced outputs on to the next component in the system, thereby cleaning up some of the audio quality problems that have shown to be intrinsic to an unbalanced signal. Furthermore, a mixer delivers a *line level* signal instead of a headphone level signal to the amplifier, which addresses a yet-to-be-discussed signal imbalance present in our first two signal path options. Different from a headphone level signal, a line level signal refers to the 0 decibel level signal (which is equivalent to one volt) that amplifiers are designed to be fed.[39] This is designed to typically be the highest level in any signal chain before the sound is amplified. This corrects the issue of

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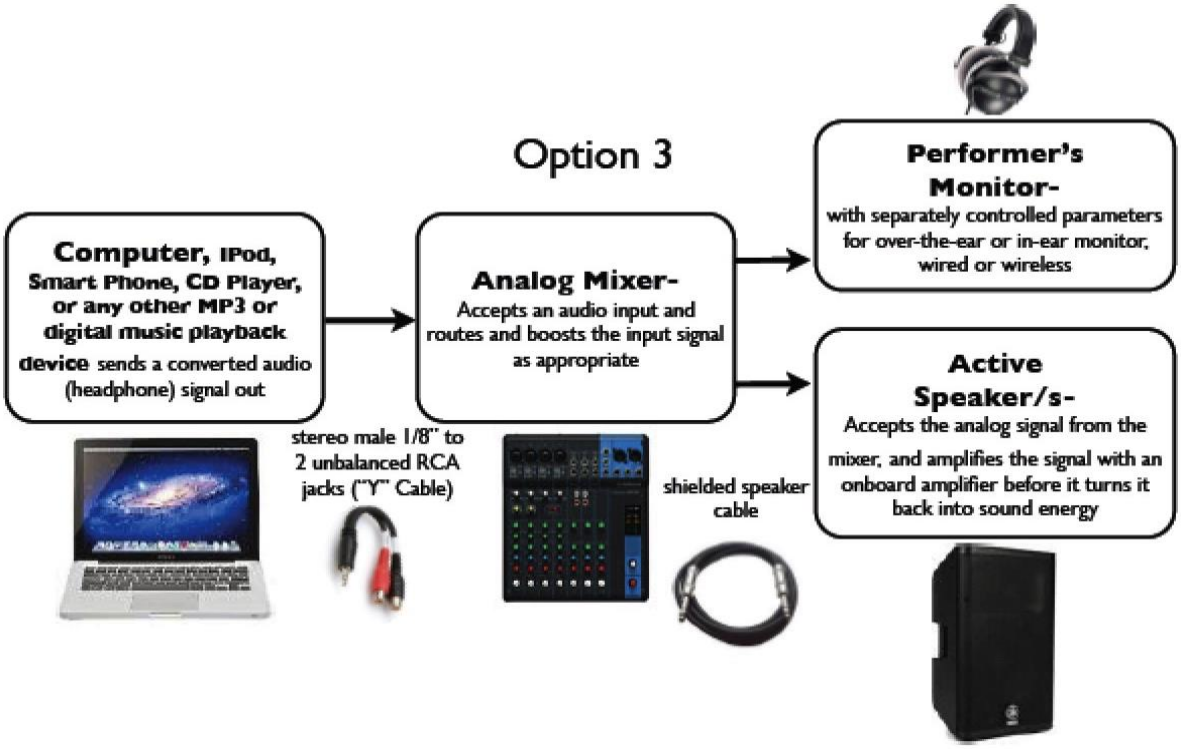
[38] Sweetwater, "Live Sound Mixers: Analog vs. Digital," InSync, March 1, 2016 accessed March 23, 2018, https://www.sweetwater.com/insync/analog-vs-digital-live-sound-mixers/.

[39] "Mic Level and Line Level: What do They Mean?" Shure, August 3, 2016, accessed March 12, 2017, http://shure.custhelp.com/app/answers/detail/a_id/758/~/mic-level-and-line-level----what-do-they-mean%3F.

sending a headphone signal into an amplifier, which is usually a higher output than a line level and consequently can result in distortion.

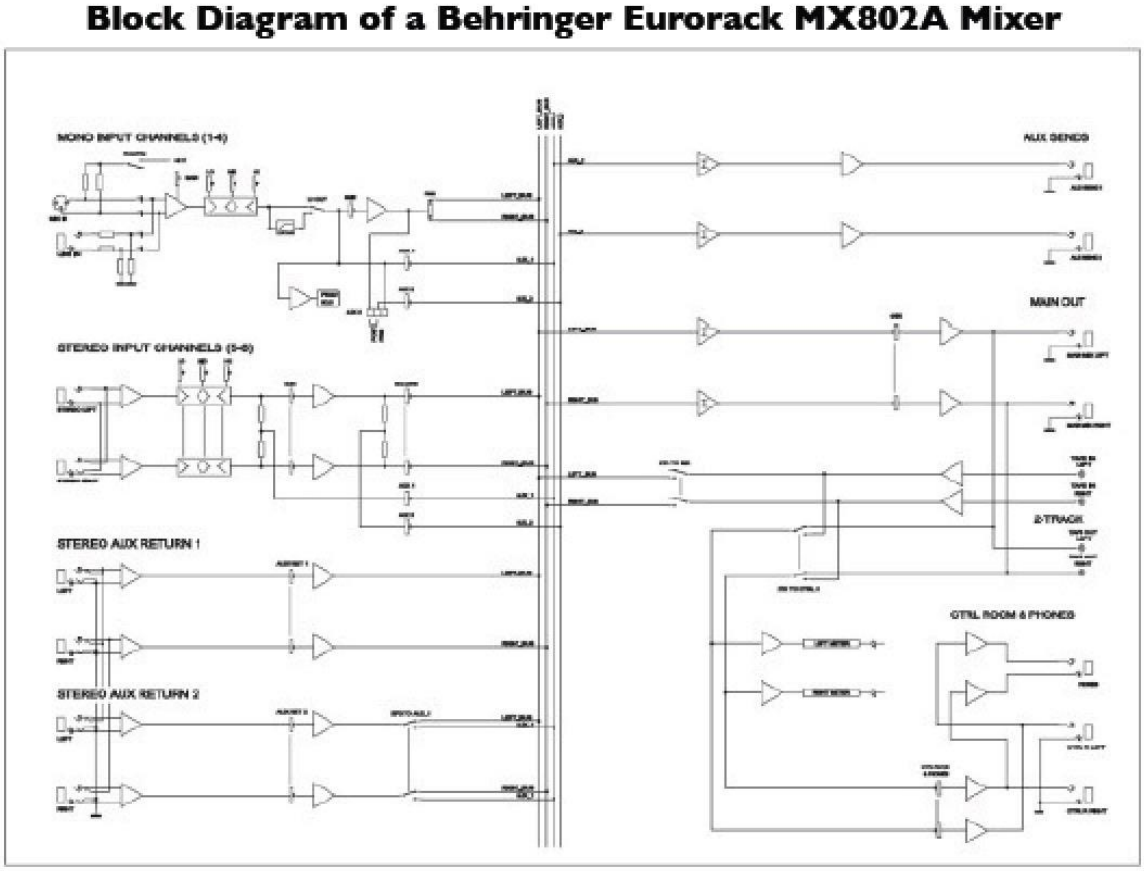
Figure 8. Basic Electroacoustic Audio Paths Relevant for Tape Works-Option 3, Mixing Board with Performer Monitor.



It should be understood that there are major differences among mixers. Mixers offer an enormous variety of routing options, effects, number of channels, and inputs that can support instruments and microphones, etc. For this reason, it is important to study the signal path and understand the signal diagram that comes with a mixer. For a reference example, please see the included block diagram for a Behringer Eurorack MX802A mixer in figure 9. Some of the features of a typical mixer, such as audio channels with preamplifiers, also apply to a number of other

functions that are necessary for electronic and electroacoustic music beyond the category of tape works. Perhaps though, one of the most important differences with relevance to tape works is whether the mixer is a digital or analog model.

Figure 9. Block Diagram of a Behringer Eurorack MX802A Mixer. [40]



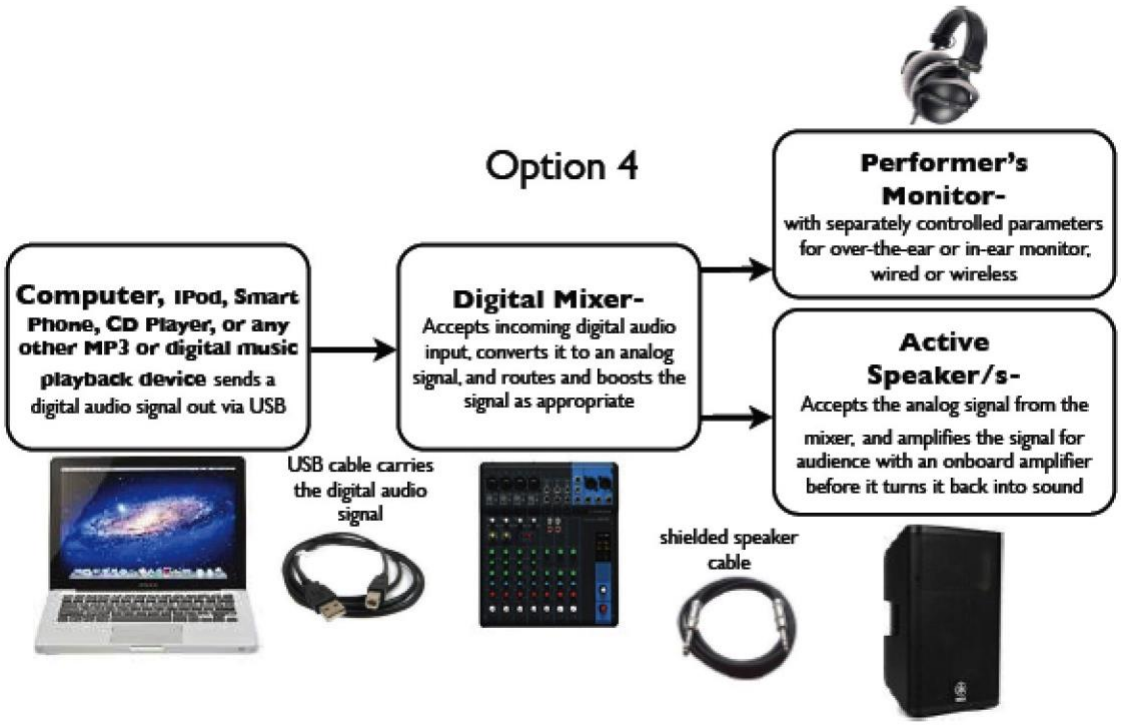
Rather than dealing with digital information, analog mixers take in an analog audio signal, such as a signal coming from the headphone output of a computer, and process the audio as a continuously variable voltage. Most mixers even have a connection specifically intended to accept a headphone-level signal and pass it on to

[40] Michael Drolet, "Behringer MX802," Sound, September 5, 2016, accessed March 23, 2018, http://jac.michaeldrolet.net/behringer/MX802/MX802.htm.

the amplifier as a balanced line-level signal. In this case, the computer is actually doing the work, via its on-board sound card, of converting the original digital audio file into an analog audio signal before sending it on to the headphone jack. The problem with this is that most consumer level computer audio chips are cheap and offer midlevel audio conversion at best.

Digital mixers include an audio conversion processor. These converters, sometimes called analog-digital/digital-analog units (often referred to as AD/DA, or A/D/A), execute the signal transformation between digital and analog audio signals. Depending on the model of the digital mixer, these processors typically provide higher quality audio processing than most computer resident onboard sound converters. This enables the computer to pass on the audio as a clean binary signal via a digital connection such as USB, Firewire, or Thunderbolt. Figure 10 is a graphic depiction of this fourth signal flow option that we consider. Once the binary signal has reached the digital mixer, the mixer then converts the digital signal to an analog signal and passes it forward using whatever routing the user has set up. In doing so, it not only makes higher quality audio conversion rates, but also it likely renders any software-based audio tools that might be on the computer more effective. It does this by allowing the computer and the mixer to exchange a wide variety of performance data, such as routing information. At the heart of most computer audio tools is a type of software known as a digital audio workstation, or DAW, which generally manages communications with any other peripherals. Although software-based digital audio is a topic that will be explored in more detail in later chapters, suffice it to say that the possibilities digital audio tools present

Figure 10. Basic Electroacoustic Audio Paths Relevant for Tape Works-Option 4, Digital Mixing Board with Performer Monitor.



allow for an enormous amount of creativity. Though this option mitigates several of the issues noted with the other possibilities, there is still a weakness in this set-up because it generally allows for transmission of only two channels of audio at a time. We continue an exploration of signal flow by examining how this system might affect a performance of Brian Blume's, *Stands of Time*.

***Strands of Time*, by Brian Blume**

Brian Blume's innovative 2010 work, *Strands of Time*, is written for solo marching snare drum, Remo TSS, and digital soundscape. *Strands of Time* exemplifies the ever expanding and evolving role that technology plays in redefining the western paradigm of classical percussion with the reinvention of one of the most

foundational of percussion instruments, the snare drum. While it may be difficult or surprising to consider a modern marching drum as an instrument suitable to the concert hall rather than a football field, the treatment of the instrument as such truly creates an interesting and unique sonic experience, of which there are few other direct parallels in the concert repertoire. It is probably for this reason that the work has so quickly garnered such a strong reputation as being one of the defining new staples of electroacoustic concert percussion repertoire. This is easily evidenced by a simple Youtube search, which turns up many performances of the piece.[41] Of the work, Brian states:

> I have often felt that there is a lack of contemporary rudimental snare drum solos written for the concert percussionist and the concert hall, and I hope that *Strands of Time* may be a step in compensating for this lack. This work for marching snare drum, TSS (or smaller snare drum), and CD presents musical challenges that other modern solos might not. The title refers to the idea of multiple strands or threads of music (live and electronic) that interweave and integrate to create a unified whole.[42]

Blume specifically lays out a couple of different signal path options to execute his work, but is clear in his argument for the strengths of his stated singular preference. See figure 11. He prefers that the stereo track with its effects be delivered to the audience while the performer hears the separate performer audio track with the embedded click track, which should be separately controlled and isolated from the stereo track that the audience hears.

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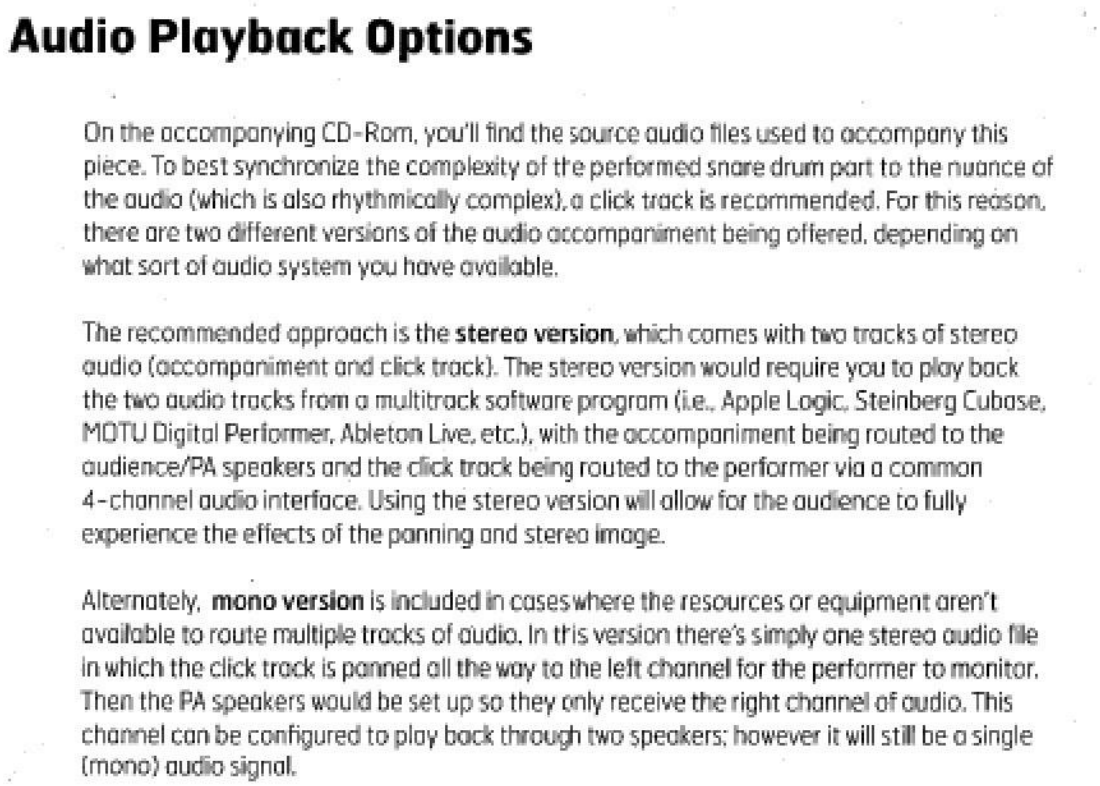
[41]Brady Harrison, "Strands of Time" (performance video), posted July 14, 2013, accessed March 23, 2018, https://www.youtube.com/watch?v=pvmFWnvPpP4.

[42] Brian Blume, *Strands of Time* (Portland, OR: Tapspace Publications, 2010), 2.

Figure 11. Playback Options, Brian Blume, *Strands of Time*, 2010 Tapspace Publications.[43]



Audio Playback Options

On the accompanying CD-Rom, you'll find the source audio files used to accompany this piece. To best synchronize the complexity of the performed snare drum part to the nuance of the audio (which is also rhythmically complex), a click track is recommended. For this reason, there are two different versions of the audio accompaniment being offered, depending on what sort of audio system you have available.

The recommended approach is the **stereo version**, which comes with two tracks of stereo audio (accompaniment and click track). The stereo version would require you to play back the two audio tracks from a multitrack software program (i.e., Apple Logic, Steinberg Cubase, MOTU Digital Performer, Ableton Live, etc.), with the accompaniment being routed to the audience/PA speakers and the click track being routed to the performer via a common 4-channel audio interface. Using the stereo version will allow for the audience to fully experience the effects of the panning and stereo image.

Alternately, **mono version** is included in cases where the resources or equipment aren't available to route multiple tracks of audio. In this version there's simply one stereo audio file in which the click track is panned all the way to the left channel for the performer to monitor. Then the PA speakers would be set up so they only receive the right channel of audio. This channel can be configured to play back through two speakers; however it will still be a single (mono) audio signal.

Again, given the close coordination between the soundscape and the live performance, the presence of a monitor is clearly essential to a successful execution of the work. However, what makes the monitor signal different in the case of *Strands of Time* from *Temazcal*, is that there is a separate monitor track that has been created by the composer that the performer needs to be isolated from the what the audience hears. This performer monitor track contains not only the play along soundscape, but also has a click track embedded in it that allows for an intricate

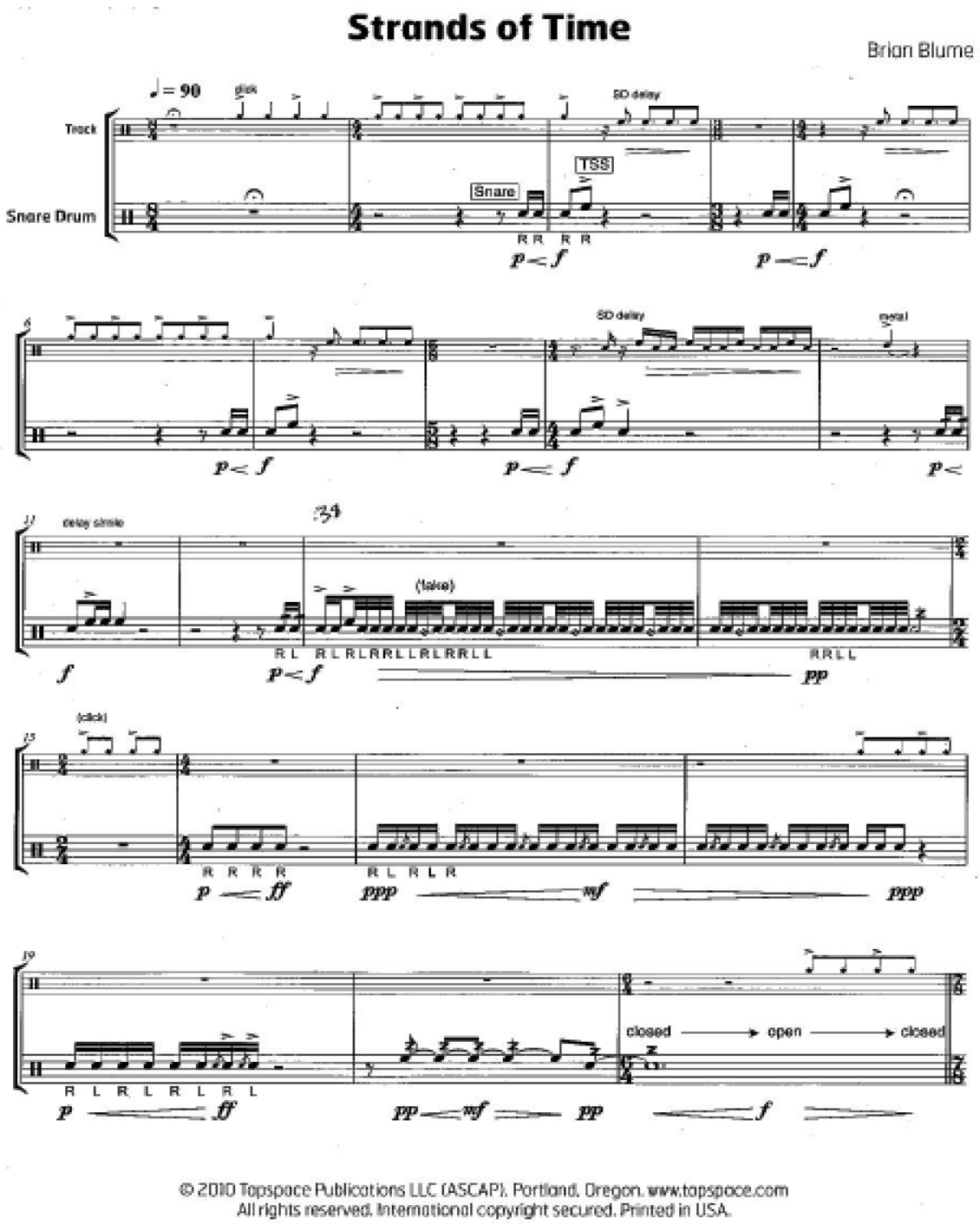
[43] Blume, 3. All Rights Reserved. Used with permission.

synchronization between the prerecorded sounds and the live performance. This click track is visually represented in the score with some of its variances, along with many of the computer-generated sounds. See figure 12, measure 1.

Because there is a separate click track made specifically for the performer in addition to a stereo soundscape that has been created for the audience, the last signal path option that we explored in figure 10, which integrated a mixer for *Temazcal,* is no longer an ideal solution. The deficiency of the scenario outlined in figure 10 lies primarily with the two channel routing limitations that accompany the audio outputs between the computer and mixer, either digital or analog. Blume highlights this fact in the layout of a possible solution that would be mono instead of stereo (see figure 13), which he clearly conveys is not the ideal intentional design of the work, because it leaves out the stereo image that involves panning, thus changing the experience for the audience. Notice the similarity to our signal path option 3, figure 8, in his diagram for a mono signal solution for *Strands of Time*.

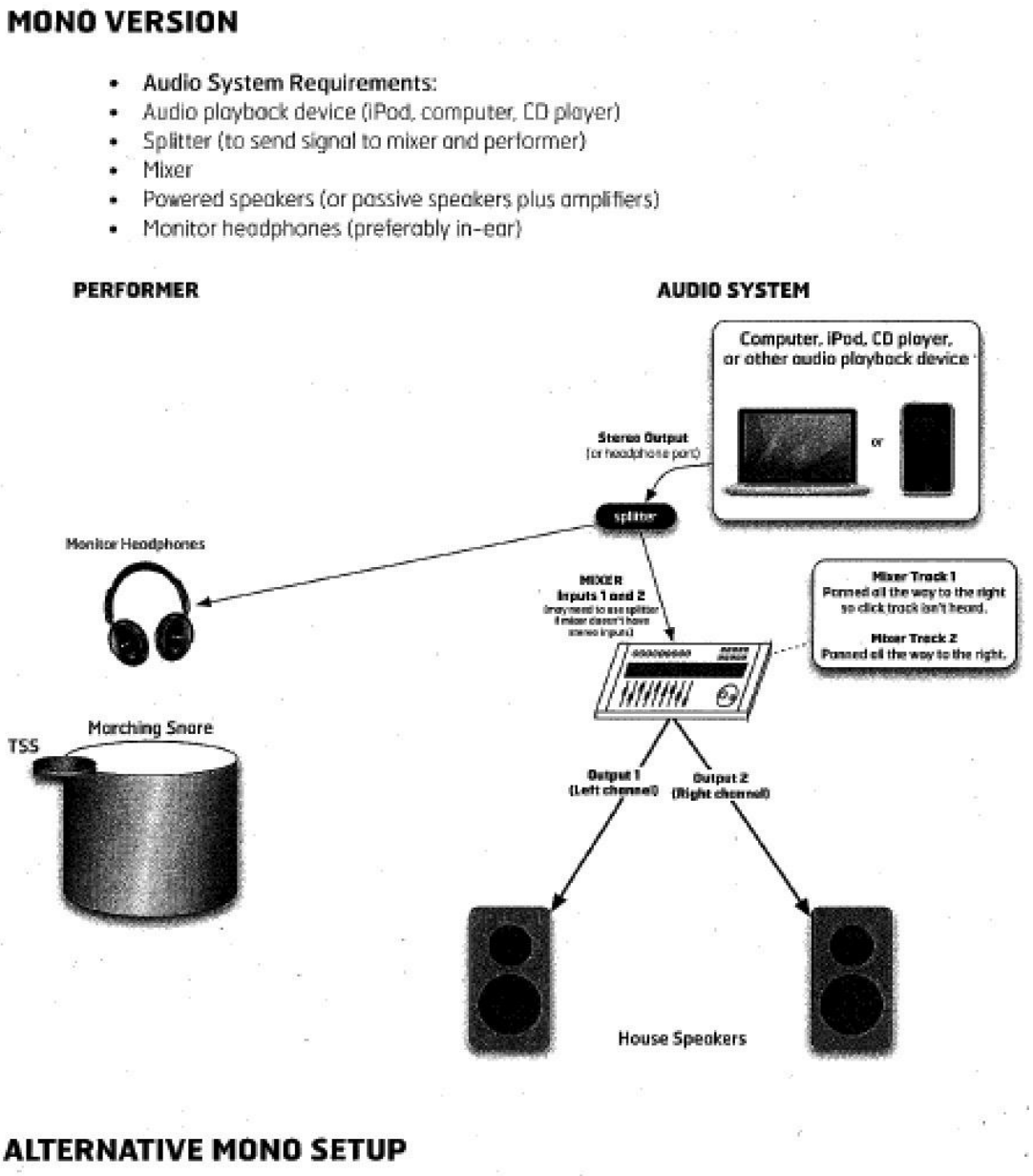
This leads us to a more ideal and definitive solution that allows for greater routing options through the use of an audio interface instead of a mixer. Blume presents this in the first setup he outlines (see figure 14), which facilitates a stereo version of the work. The utility of the interface that makes the stereo version possible is that it allows for more output options (minimally four, in this case) that are all individually assignable using a DAW. This is not where the advantages of a software-based music system end, however.

Figure 12. Brian Blume, *Strands of Time*, mm. 1-21.[44]



[44] Brian Blume, 5. All Rights Reserved. Used with permission.

Figure 13. Performance Notes for Mono Signal Performance, Brian Blume, *Strands of Time*, P.3.[45]



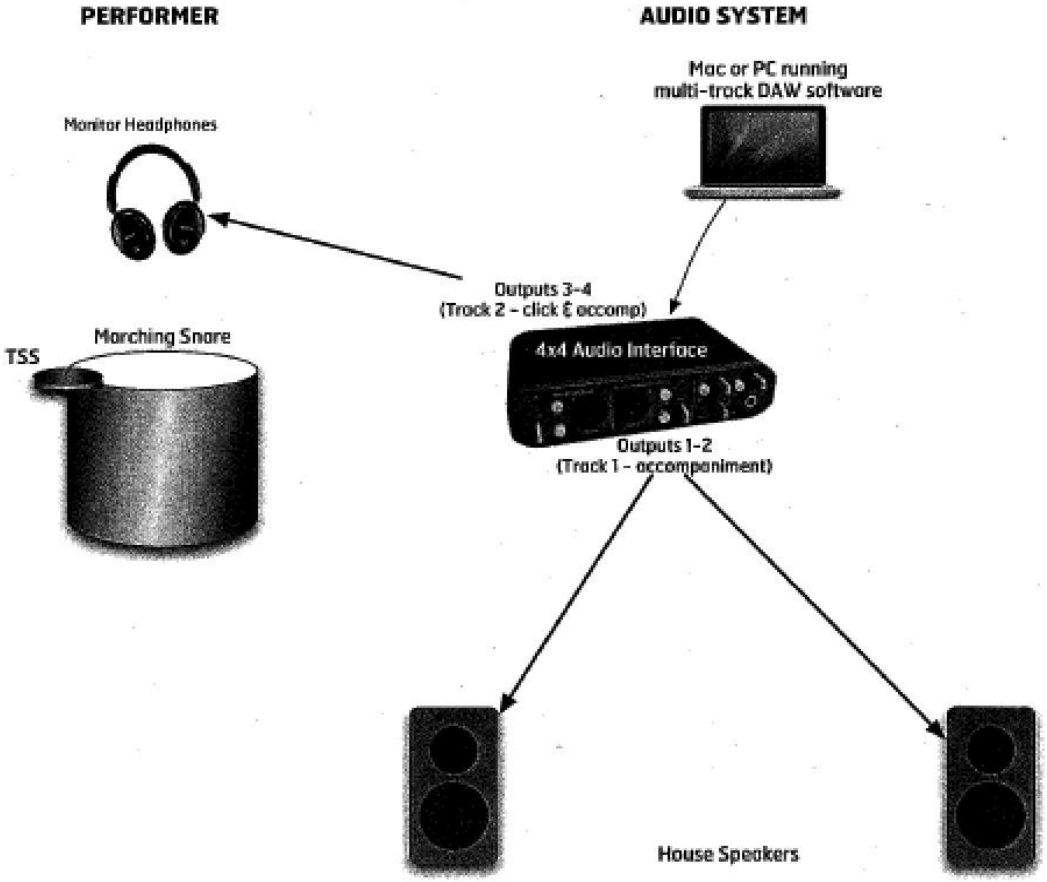
[45] Brian Blume, 3. All Rights Reserved. Used with permission.

Figure 14. Performance Notes for Stereo Signal Performance, Brian Blume, *Strands of Time*, P.4.[46]

Setup Examples

STEREO VERSION (recommended)

- **Audio System Requirements:**
- Mac or PC
- Multitrack DAW software (Logic, Cubase, Live, Digital Performer, etc.)
- Audio interface with at least 4-channel output
- Powered speakers (or passive speakers plus amplifiers)
- Monitor headphones (preferably in-ear)

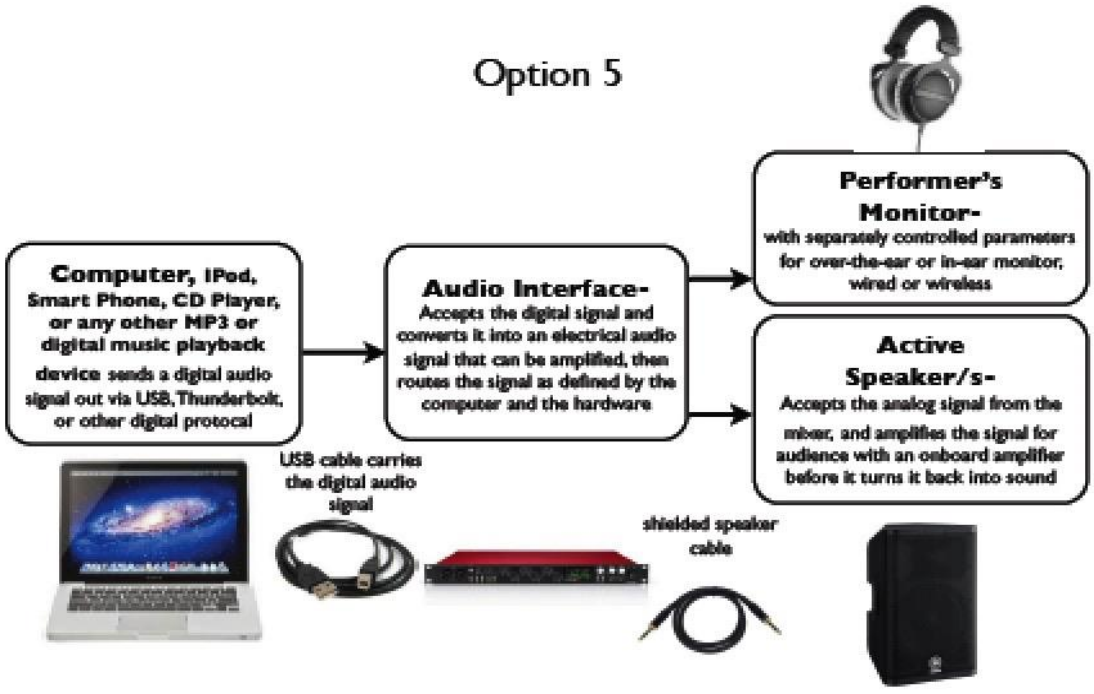


[46] Brian Blume, 4. All Rights Reserved. Used with permission.

The Advantages of an Audio Interface

The integration of an audio interface in lieu of a mixer brings us naturally to what would be our fifth option in terms of the earlier discussion of signal paths (see figure 15). Audio interfaces, also known as digital audio converters (DAC), digital input/output devices, or i/o converters, communicate with the computer via a digital protocol using either a USB, Thunderbolt, Firewire, or similar cable, and serve the primary function of converting signals between digital audio and analog audio as needed.

Figure 15. Basic Electroacoustic Audio Paths Relevant for Tape Works-Option 5, Audio Interface with Performer Monitor.



In its input capacity, an i/o device receives a digital or an analog audio signal that it translates to digital and sends it to the computer for processing and

manipulation. As an output device, the i/o receives digital information from the computer and translates it into an audio signal that it then sends on to the next component/s in the signal chain, as designated by the computer software.

Because the digital conversion process is powered by the specially designed and dedicated hardware processor itself, which allows for a more dedicated, faster, and advanced processor than is typical to stock computer soundcards, the processing power and audio quality of the signal can be very high compared to most computers and mixers.[47] Additionally, audio interfaces usually have other input options, which can accommodate various numbers of microphones and electronic instruments, sometimes including MIDI (musical instrument digital interface) instruments, depending on the model. While the advantages of sound quality and routing capability make an interface a near essential tool for tape pieces, it is the interface's other attributes and expandability that make it make it even more attractive when considering its application to a wider array of electroacoustic repertoire. Perhaps more importantly, it allows the performer to fully use the DAW and other software tools in the computer that rely on an interface to route and be used to full potential.

Performers should be able to identify and understand the various differences of quality and features that apply to audio interfaces as a foundational component of the system, including bit depth, sample rate, latency, input and output options, and preamplifier quality. There are however, a number of other fundamental concepts

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[47] Michael Walsh, "Understanding Audio Interfaces: DACs, Bit Depth, Sampling Rate, Analog vs Digital," Dubspot, November 10, 2011, accessed on March 23, 2018, http://blog.dubspot.com/understanding-audio-interfaces/.

that relate to the use of this equipment that should be understood through study and careful exploration by any student of the tape repertoire.

Related Tools and Techniques

Even with a wide variety of features between different manufacturers and models of digital audio converters, there is obviously an inherent need to understand the function and workflow of whatever equipment is being used in order to foster a smooth and effective performance. Underpinning all of the specifics that belong to each individual tool used in electroacoustic music is a set of general fundamental concepts and skills. While these foundational concepts include understanding signal path, as has already been discussed, they also include setting up a gain structure and other skills such as cable management.

At its essence, gain structure is the set of relative signal strengths that affect the signal at each stage of signal flow, from beginning to end. While differences abound as to the specificities of audio interfaces, gain structure is a concept that is common and essential to all audio systems. Although it need not be difficult to set gain structure, which is also sometimes referred to as setting (volume) levels, the more steps present in the signal chain, the more complicated the gain structure becomes. Even though most tape pieces require only a very basic degree of level setting, it is a very important skill to master because other live processing and mixed electroacoustic works begin to dictate the need for a stronger technical foundation and understanding of how gain structure affects the sound. It is pedagogically more efficient to already have that skill developed from repertoire

that doesn't require as many peripheral technical demands of the performer. Tape repertoire affords the performer a great opportunity to develop these skills.

A complete signal structure for a performance of an electroacoustic work may include many different origins for different voices, or parts, of the complete signal chain, including microphones, electric instruments, software based instruments, and prerecorded music. Tape repertoire, however, typically only calls for an input or two of signal, which usually includes the prerecorded soundscape and sometimes a separate click track for monitoring by the performer. While it is not uncommon for tape works to specify or benefit from micing the live performer, such as in Alvarez's instructions in *Temazcal*, we are not covering that technique in this portion of the paper because it is not broadly essential to the repertoire of tape works, while it is generally essential to works that involve live processing.

A pedagogical approach to this concept involves encouraging the student to consider the implications of the volume levels as they relate to other basic ideals of musicianship and chamber music performance. Improperly set levels can result in poor audio quality and/or balance problems within the "ensemble" of the performer and prerecorded soundscape. With this in mind, let's examine an effective process for setting up a healthy gain structure.

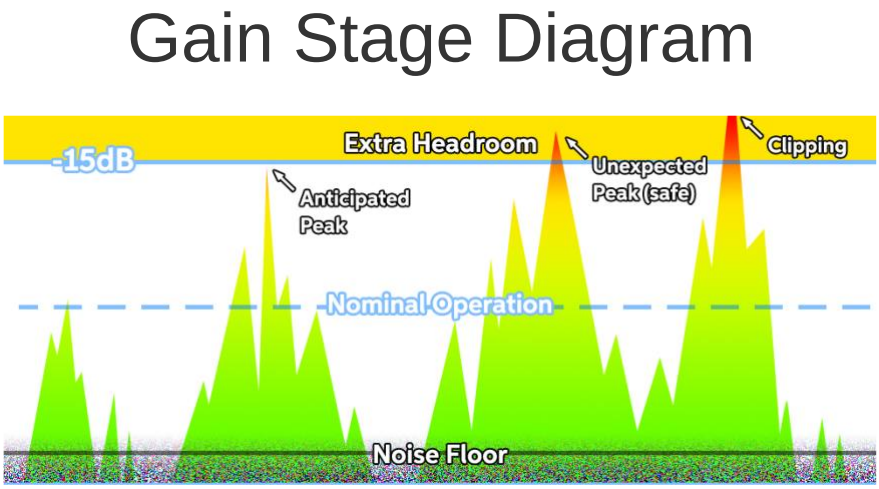
Generally speaking, three goals are at the heart of setting levels within the system. They include good relative balance between the voices, effective overall dynamic levels, and good sound quality with little chance of feedback or unwanted interference. The signal starts at its lowest level, but in order to achieve a favorable signal-to-noise ratio (S/N), which is associated with good sound quality, it is

important that the first audio signal level become as strong as possible, as soon as possible, without creating unwanted feedback within the signal chain. When the signal travels through the system, it picks up noise, which is amplified with the rest of the signal as the signal travels through the chain. The stronger the signal is from the beginning, the less strong the interference is in relation to the signal as it moves through the chain.

One way to demonstrate this concept is to do a comparative signal flow listening test. The first step of this process is to monitor the sound coming from a pair of speakers while the interface and DAW levels are set low with the amplifier volume set high, listening carefully for any hum or feedback in the signal. Next, while trying to match the final volume of the previous step, monitor the volume and sound quality of the signal with the levels turned up on the interface and in the DAW while the final amplifier level is turned down. The levels on the interface and DAW should be set to near 0 db on the meter, to help prevent signal distortion, also known as clipping, that arises from levels that are set too high. Through critical listening to the sound quality in both scenarios, it should become apparent that even with the noise mitigating aspects of an appropriately constructed system, there is a demonstrably higher quality sound in the second scenario than the first. *Headroom* is the amount of space that is left in the amplitude spectrum between the average signal level and the threshold of clipping. Managing headroom effectively allows for the volume to get louder without clipping and is critical to maintaining a high-quality gain structure. See figure 16. This exercise promotes students to connect the specific technique of setting level structure with fundamental concepts of

musicianship by appealing to the student's broader development through critical listening.

Figure 16. Gain Stage Diagram. [48]



In order to properly balance the live performer's acoustic sound with that of the prerecorded soundscape, a second listener is critical to offering perspective on levels from the audience's frame of reference. This allows the relative levels to be set efficiently and accurately. Similar to other forms of chamber music, having feedback on sound levels from an impartial and informed listener that is away from the instruments is very important. The difference with electroacoustic works, however, is that whereas both live performers in most chamber settings can adjust to live sonic conditions in real time, only a single person performing an electroacoustic work has this flexibility; this makes a sound check that much more

[48] Sweetwater, "Gainstaging Like a Pro," InSync, March 1, 2016, accessed March 23, 2018, https://www.sweetwater.com/insync/gain-staging/.

imperative to a successful performance. There are, however, current and developing technologies to address this need, using wireless networks. For example, many audio interfaces, such as Focusrite's Clarett line, and software programs, such as Ableton Live, offer applications that can be downloaded onto a smartphone or tablet. These tools allow audio level changes and other parameters to be set remotely using Bluetooth or a Wi-Fi network, away from the interface or computer, for accurate real-time adjustments of the settings by a person that is within the intended listening area.[49] While their use does slightly complicate the system, their benefits can significantly improve the efficiency of sound check time and create an extra sense of security during the performance if another person is able to handle the task.

Although it may seem trivial, proper maintenance and storage of the equipment is also something that must be considered to develop habits in the student that foster a disciplined and long-term approach to electroacoustic practice. While maintenance of equipment generally doesn't require more than an occasional backup and update of software and cleaning contact points of cables, storage requires a more organized approach in order to effectively serve the longevity of the equipment and its ease of use.

In the case of the larger components of a system, the term storage refers not only to how the items are physically placed when put away, but also when in use. By

[49] For a list of downloadable apps to control Ableton Live, follow weblink https://help.ableton.com/hc/en-us/articles/209071989-Apps-for-controlling-Live-with-an-iOS-or-Android-device. For more information about Focusrite's IOS control, please visit the website https://us.focusrite.com/apps/ios-control.

housing the units in an audio rack (see figure 17), parts of a system are not only protected and organized when they are not in use or in transit, but they are easily and readily available in an organized manner and protected when in use.

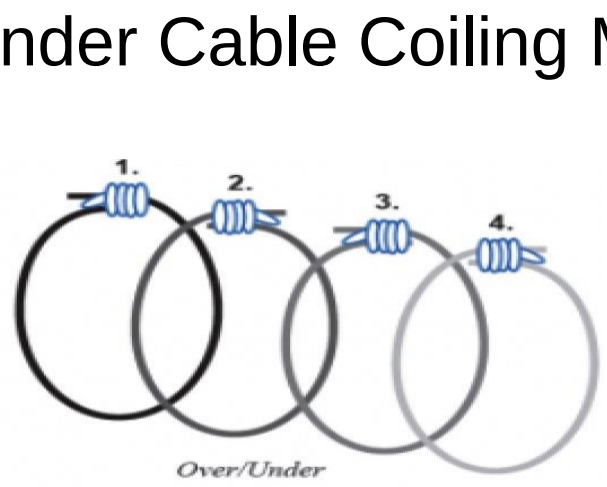
Rack sizes are usually measured in what is known as a rack unit, which is approximately 1.75 inches high, the general unit of height for most of these types of tools. While, it is wise to consider some extra room for expansion when purchasing a rack, most people do not want to carry around more weight and space than is necessary. A thoughtful deliberation of the setup's requirements will yield the best outcome in each situation.

Figure 17. Rack Case Examples.

Cable management is another aspect of managing a sound system that is easily overlooked but very relevant to any electroacoustic performer. When considering cable management, it is important to keep cables individually coiled, secured, and hung or placed neatly so that they do not wear out prematurely and

may be easily retrieved when needed. There are several styles of cord securities, with the most popular one being a wrap-around hook and loop fastener, although elastic clip-on models are popular also. Cables are prone to getting tangled when released after being stored and wrapped in a coil, so they are best wrapped using an "over-under" technique that helps prevent the coil tension that causes knotting and stress on the connectors. See figure 18. Furthermore, it is a good idea to label cables so that they are easily identifiable as to their length and function, using a cable specific labeler, if possible. For more complicated setups, it can be wise to have each end individually labeled as to what it should specifically be plugged into. Taking the time to prepare and store the equipment in this way is initially time consuming, but it more than pays for itself in saved time, energy, and equipment life over the long term.

Figure 18. Over-under cable coiling method.[50]



[50] Rick Chinn, "Chinn on Cable Wrapping," SynAudCon, March 10, 2010, accessed April 12, 2017, http://www.prosoundtraining.com/site/synaudcon-library/chinn-on-cable-wrapping/.

One other remaining tool relevant to a tape piece signal flow is a power conditioner. See figure 19. While this is not an essential element to an audio system, ideally all of the components in the system, or at the very least, the interface, any wireless systems, the computer, and any peripherals, would be routed through a power conditioner. A good power conditioner helps protect the investment in the system against power surges and other spikes that can harm audio equipment. Additionally, it can help keep unwanted noise from entering the system via the power supply and, because they usually contain several outlets, a power conditioner can ease the burden of finding enough outlets when simultaneously powering several components. This means that if components are housed within the same rack, they can stay plugged in, even during transport, which makes logistical considerations much simpler and easier.

Figure 19. Power Conditioner.

Power Conditioner

Pedagogical Steps Toward Developing a Set of Core Competencies

Below is a list of pedagogical goals relating to the tape repertoire, organized in the context of a set of core competencies. This list includes a few relevant

exercises that might be beneficial to the student. Since there are many variable considerations that go into developing an organized and effective approach to tape repertoire, the list below is by no means exhaustive. These guidelines are merely offered to serve as a launching point to develop pedagogical steps for a more meaningful inquiry into these topics.

1. Possess a comprehensive understanding of signal flow, including digital and audio signals, balanced and unbalanced signals, and relative signal strengths in the gain structure.
    - Students will create a detailed flow diagram complete with digital and audio level descriptions detailing balanced and unbalanced signals for any system used for any studied repertoire and/or setting up gain structure.

2. Possess a thorough understanding of the parts that go into the system, how they fit into the flow, and how to properly maintain them.
    - Students will expand and demonstrate relevant DAW capabilities, discuss various system components, physically house and store components within a rack or otherwise, and/or wrap and store cables.

3. Routinely use critical listening skills to be able to make sound choices.

- Students will demonstrate noise characteristics in the system, listen critically for balance within the ensemble of electronic and acoustic instruments.

4. Develop consistency, reliability, and comfort in interacting with the system.
    - Students will start working with the technology early in their study and practice of any electroacoustic work and have them develop effective practice techniques that utilize the technology to maximize rehearsal efficiency, such as using specific place markers to practice isolated sections of works.

5. Create a system that can be expanded on as needed, without changing the core system structure.
    - Students will identify the aspects of the system that make it a universally successful model and identify how it uses equipment that they likely already have (i.e. a computer) in a deeper and more efficient way.

6. Possess a performance model that is based on traditional solo and chamber music making principles such as balance, musicianship, and taste.
    - Students will perform, listen to, and study a wide variety of solo and chamber works with careful attention to nuance, phrasing, textural relationship, and other musical details.

7. Possess an instinct toward inquiry and logic (dialectic model) to address performance challenges and troubleshooting issues.
    - Students will logically troubleshoot system problems with a reasoned understanding of the system.

8. Understand descriptive units of sound volume and perception and implement steps to protect hearing by reducing risk and unnecessary and prolonged exposure to damaging sound levels.
    - Students will define and discuss decibels, frequency range, and the Fletcher-Munson human hearing curve[51], discuss signs of hearing fatigue and damage, understand how to safely isolate monitor mixes without competing with external sounds, and have students maintain safe listening levels that don't include dangerous levels of noise.

[51] The Fletcher-Munson Hearing Curve, also commonly known as the Equal Loudness Contour, indicates the ear's average sensitivity to different frequencies at various levels. For more information, refer to the article "Fletcher Munson Curves," Teach Me Audio, April 11, 2017, accessed March 23, 2018, https://www.teachmeaudio.com/recording/sound-reproduction/fletcher-munson-curves/.

CHAPTER FOUR:

DEVELOPING AN APPROACH TO LIVE PROCESSED WORKS

In contrast to tape works, which use prerecorded fixed media, live processing works use real time electronic effects that are applied to the live acoustic performance. The combinations and aspects of sound that can be manipulated or used to create electronic sound effects are nearly inexhaustible. As previously discussed in Chapter Two, Stockhausen's works, *Kontakte,* for electronics, percussion, and piano, and *Microphonie 1,* for amplified tam-tam, are both early examples of this type of repertoire involving percussion. Expanding on that beginning and further establishing a core of live processing percussion solo repertory, is the 1987 electroacoustic percussion staple, *Fabian Theory*, by Australian composer, Nigel Westlake.

Fabian Theory, by Nigel Westlake

Fabian Theory was commissioned by the percussion group *Synergy* with support from the Music Board Australia Council, and recorded by *Synergy* member, Michael Askill. The work is scored for an amplified low "A" marimba, three toms, and digital delay. The part was originally written for five mallets to be managed by the performer, to which an ossia part for four mallets was added in a later edition.

Digital delay is an echo-like electronic effect. In *Fabian Theory*, Westlake uses the digital delay to reflect and reinvent the marimba, expanding the definition of percussion by focusing inward reflection on one of concert percussion's core

instruments, while also spurring the performer to reconceive its sonic possibilities and manner of interaction. He carefully does this by crafting a marimba part that, when combined with the delay, creates an intricate and complex harmonic texture of ever-evolving polyrhythms, punctuated by the percussive intrusions of the toms. Westlake writes, in his notes that are included with the piece:

> An electronic delay system is employed throughout the piece serving to reproduce the "live" signal 566 milliseconds (about a half a second) after it has been played, thereby building a multi-marimba illusion and creating rhythmic counterpoint against a live performance.
>
> The player is requested to play in tight synchronization with the delay signal & by moving through a number of tempo changes, different rhythmic effects are achieved.[52]

In essence, when the strict instructions of Westlake's carefully crafted score are followed, the player presents the audience with multiple layers of texture that combine to present a kind of super-marimba.[53]

Many Paths to One Outcome

In order to ensure the close and proper correlation between the carefully calculated tempo markings and the digital delay, Westlake defines several parameters of the delay in the opening notes to the score. See figure 20. Of these parameters, the delay time of 566 milliseconds simply refers to the speed at which the echos occur. The regeneration, or feedback, of the delay, which is set at 30

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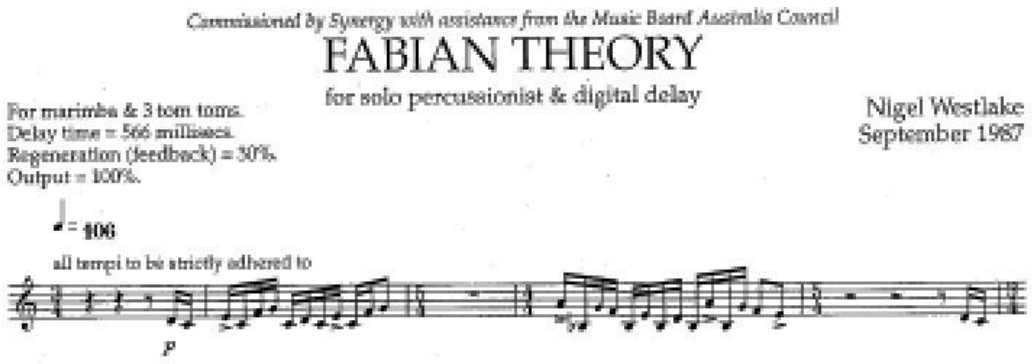
[52] Nigel Westlake, *Fabian Theory* (Turramurra, N.S.W., Australia: Rimshot Music, 2003), 1. All Rights Reserved. Used with permission.

[53] Brady Harrison, "Fabian Theory" (performance video), posted April 17, 2013, accessed March 23, 2018, https://www.youtube.com/watch?v=2sW3Opdk5mg.

percent, refers to the loudness of each subsequent echo. Output refers to the overall level of the effect in relation to the original signal, regardless of time.

Figure 20. *Fabian Theory* by Nigel Westlake, mm. 1-5.[54]



In an interview with percussionist Gary France, Westlake says of the work:

> *Fabian Theory* was written in 1987 & at that time, digital technology was in its infancy. I wrote it for a Roland SDE 3000 delay unit, which of course has been obsolete for years now. (I still have one actually!) Of course, percussionists approaching the work now have to find some way to overcome the problem of adapting the piece to more recent technology.
>
> … Though percussionists who play this piece seems to be able to find their own solution to this particular problem (percussionists being a particularly inventive & resourceful group of people!). Nowadays there are a number of computer programs and electronic devices that can be adapted to achieve these ends, such as the Kat midi mallet instrument and sampling devices that can be triggered from a laptop by footswitch & so on. You can also get very sophisticated digital delay systems. So I encourage players to find the current technology & manipulate it to their own ends.
>
> …**GF:** So, if I could paraphrase you for a minute. You're saying that as long as the performer captures the essence of the music, literally, that the

[54] Westlake, *Fabian Theory*, 2. All Rights Reserved. Used with permission.

technological medium is not important.

NW: Exactly. [55]

Westlake's position on the specific choice of technology being secondary to the musical outcome mirrors an often contended debate among classical musicans: technique vs musicality. Referring back to the opening of this paper, technique is the means or way that we use a tool (the technology) to a achieve a musical statement. To view technique and musicality in this paradigm is to recognize them as two separate things that are directly related, with technique being in the service of musicianship. This perspective, that technique serves musicality, seems to be inline with Westlake's views on technology, and provides a solid foundation upon which to build a pedagogical methodology. Technology and technique are important because they serve the development and expressive capabilities of the musician. In so doing, they provide a means to a meaningful musical event. Although technology and technique are inherently important to develop avenues of expression, there are often many different tools and techniques available to achieve a similarly desired musical outcome. *Fabian Theory* offers a good example of how a performer might go about using any one of a number of different options in realizing the same score. Let's begin an examination of a few of those options by first considering the device that the piece was originally written for.

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[55] Gary France, interview by author, "The Percussion Music of Nigel Westlake- An Interview with Gary France," Rimshot Music, 2004, accessed March 23, 2018, http://www.rimshot.com.au/article/the-percussion-music-of-nigel-westlake/.

As stated earlier, the Roland SDE 3000 (figure 21) was a multiple effects processor that Westlake had in mind when he originally wrote *Fabian Theory* in 1987. The following is a brief description of the SDE3000:

> The Roland SDE3000 is a rackmount mono delay, including delay phase, filter, modulation and feedback modulation. With an input attenuator and a variety of connection options, the SDE3000 is useful for almost any application. The front panel features delay feedback control, delay output level, modulation rate, modulation depth and delay time adjustments. The unit is a high quality specialized effects processor with user friendly patch editing.[56]

Figure 21. Roland SDE 3000.[57]

Roland SDE 3000

Although, without a doubt, the unit was state-of-the-art for the time, it must have had a number of inherent set backs for its application to *Fabian Theory* in the long run. First of all, it would have required either a pedal to start and stop the machine appropriately for the score, or it would likely have created the need for a

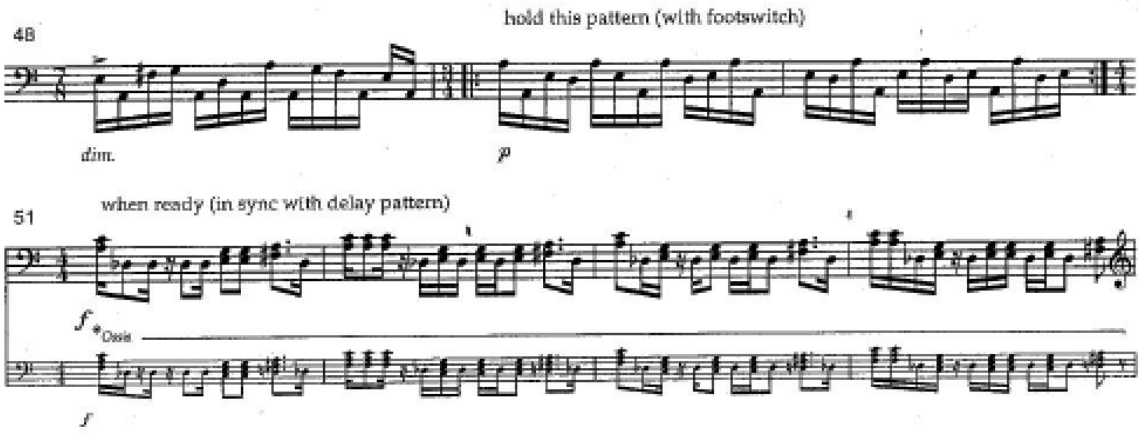
[56] "Roland SDE-3000," Advanced Audio, accessed March 12, 2017, http://www.advancedaudiorentals.com/products/details/productid/165.
[57] Ibid.

second person to run it. In addition, because the unit runs at what is known as unity gain (the level of the signal that goes in is equivalent to the level of the signal that goes out) it requires a separate preamplifier to boost the signal of any microphone(s) before entering the unit, which would have further necessitated extra equipment in the case of *Fabian Theory*. Furthermore, the live or prerecorded loop that starts in measure 49 (see figure 22) presents another technical challenge by Westlake that is more nimbly addressed by one of the SDE-3000's technological successors, the pedal looper. Westlake's website offers some insightful commentary and technical notes concerning this work, as follows.

> Over the years I have had many emails from percussionists all over the world requesting details of how to manage the technology associated with this piece.
>
> Here are a bunch of hints , [sic] suggestions , questions, answers & ideas from other percussionists concerning the performance of the piece…
>
> …Re: the "LOOP" created from measures 49 -50
>
> With some delays (i.e. the Roland SDE series, which I used when writing this piece, & which are probably now obsolete), [sic] upon the depression of a footswitch connected to the unit, the material that has just been "recorded" into the delay is "held" & repeated. I'll try to explain further.....
> The delay time = 1 quarter note & the idea of the loop is simply to catch a "quarter notes" worth of the stuff being recorded into the delay at this point, which repeats untill measure 87. If the figure in measures 49-50 is fed into the delay with the right feedback, this should result in an effect similar to that of 4 or 5 marimbas all playing that sequence of notes - but each part being delayed by a quarter note. By "capturing" (with the footswitch) the material in the delay at the end of measure 50 - you should end up with 1 quarter notes worth of this pulsating, multiple marimba effect. One problem that has been encountered by various players is that some delay lines produce a nasty sounding "click" at the moment the footswitch is depressed (which keeps repeating until the loop is turned off!). The "click" can be minimized with practice, but some players have constructed the "loop" as a

pre-recorded sample & triggered it (in sync) by some form of midi mallet device (i.e. KAT) . Percussionists the world over seem to be particularly rescourceful [sic] with regard to these kinds of issues.[58]

Figure 22. *Fabian Theory* by Westlake, mm. 48-54.[59]



In the 1990s and early 2000s a stream of innovative pedal based looping tools with improved and expanded options appeared on the market. These new devices enabled better control of both digital delay and longer real-time looping. Not only did this expand the musical boundaries of what was capable with real-time looping and other audio effects, but it also made implementation easier for previously conceived works. Early examples included the Boss RC-20 (figure 23), which eventually gave way to other looping pedals such as the RC-300 (figure 23), that hosted an array of other effects and could record and individually control multiple loops simultaneously. While these pedals provide a seemingly more organic way of triggering the loop by the performer, they also have an inherent limitation in that they are often noisy, are somewhat specialized, and they are

[58] Nigel Westlake, "Fabian Theory Technical Performance Notes" Rimshot Music, accessed March 23, 2018, http://www.rimshot.com.au/percussion/fabian-theory/.

[59] Nigel Westlake, *Fabian Theory*, 3. All Rights Reserved. Used with permission.

limited by the scope of the hardware because it offers few expansion opportunities as technology develops. A similar, yet more malleable option that supports the expansion opportunities offered by a computer based system, is a MIDI pedal controller.

Figure 23. Boss RC-20 and RC-300 Pedal Loopers.

MIDI (/'mɪdi/; short for Musical Instrument Digital Interface) is a technical standard that describes a protocol, digital interface, and connectors and allows a wide variety of electronic musical instruments, computers, and other related devices to connect and communicate with one another.[60] With the MIDI protocol, a nearly infinite number of parameters of sound may be identified and controlled using audio software, creating a great number of options for controlling various aspects of a live performance. While some MIDI controllers send information via pedals, such as a Behringer FCB1010 or the Keith McMillan SoftStep 2 (figure 24), there are many other types of devices that use MIDI, including various keyboards, tabletop controllers, and even motion activated devices. Many also offer multiple

[60] Andrew Swift, "A Brief Introduction to MIDI," accessed March 24, 2018, https://www.doc.ic.ac.uk/~nd/surprise_97/journal/vol1/aps2/, quoted in *Wikipedia,* s.v. "MIDI," accessed March 24, 2018, https://en.wikipedia.org/wiki/MIDI accessed March 24, 2018.

sensors on the same buttons. For example, the Soft Step 2, pictured on the right in figure 24, has pressure and direction sensitivity on each of its rubber pads, to offer the possibility to gradually adjust parameters such as volume, pitch, or any number of other aspects of sound that could occur along a continuum. To better understand how MIDI might be applied in a live music application, let's examine the use of one of these MIDI pedals with respect to *Fabian Theory*.

Figure. 24. Behringer FCB1010 and Keith McMillen Softstep 2 MIDI Foot Controllers.

To better understand how MIDI might be applied in a live music application, let's examine the use of one of these MIDI pedals to *Fabian Theory*. Since MIDI provides an avenue for a performer to take the same input (button, knob, slider, pedal, pad, key, gesture, etc.) and assign it to any number of different functions by using the software, there are many different viable solutions available through MIDI. Westlake offers an option that he had not originally considered in his technical performance notes online:

> Heres [sic] one particularly inventive solution to the "Loop issue" from a percussionist in West Virginia…
>
> "I recorded a few bars of the ostinato pattern at bars 49-50 into my laptop, then added the delay effect in an audio editing program. Then, I counted the total number of beats the ostinato should last (157 1/4-notes, plus an addtional 1/8th-note), and looped it that many times. (This avoids having to

> worry about turning off the sampled pattern---instead, it just ends at the correct time.) Finally, I used a DrumKat MIDI percussion controller to trigger the sampled pattern via MIDI (the sample plays back from the laptop). I have the DrumKat positioned right next to the bottom of the marimba, so I can easily trigger the sample with my left mallet.
>
> To turn off the delay effect in bar 49 (and back on again in bar 87) I use a simple footswitch connected to the delay unit's bypass jack.
> I don't know how others are doing it, but I perform the opening section of the piece (through bar 50) with 2 mallets, switching to 4 mallets when I trigger the recorded sample.[61]

In this scenario, the performer is using MIDI only to start a prerecorded clip, yet a multitude of other solutions exist. For example, instead of prerecording the clip, the performer could choose to record the clip live (real time looping), and then play it back in the context of the live performance. In doing so, it would make sense to assign one MIDI input as a signal to start recording, another input as a signal to end recording and begin playback, and yet another to stop the playback of the live recording. In that scenario, instead of incorporating a separately dedicated digital delay, one could apply the delay from the Digital Audio Workstation (DAW) or other computer based software. The stopping and starting of the delay itself could again be assigned to one of the existing pedal controls, even one that already has another function. In other words, using Fabian Theory as an example, "pedal A" could both begin playback of the recorded loop and simultaneously stop application of the digital delay effect, per Westlake's performance instruction, using the computer based system that was discussed in Chapter 2. Figure 25 shows this configuration of MIDI assignments (on the left) as they might apply to Fabian Theory, using the DAW,

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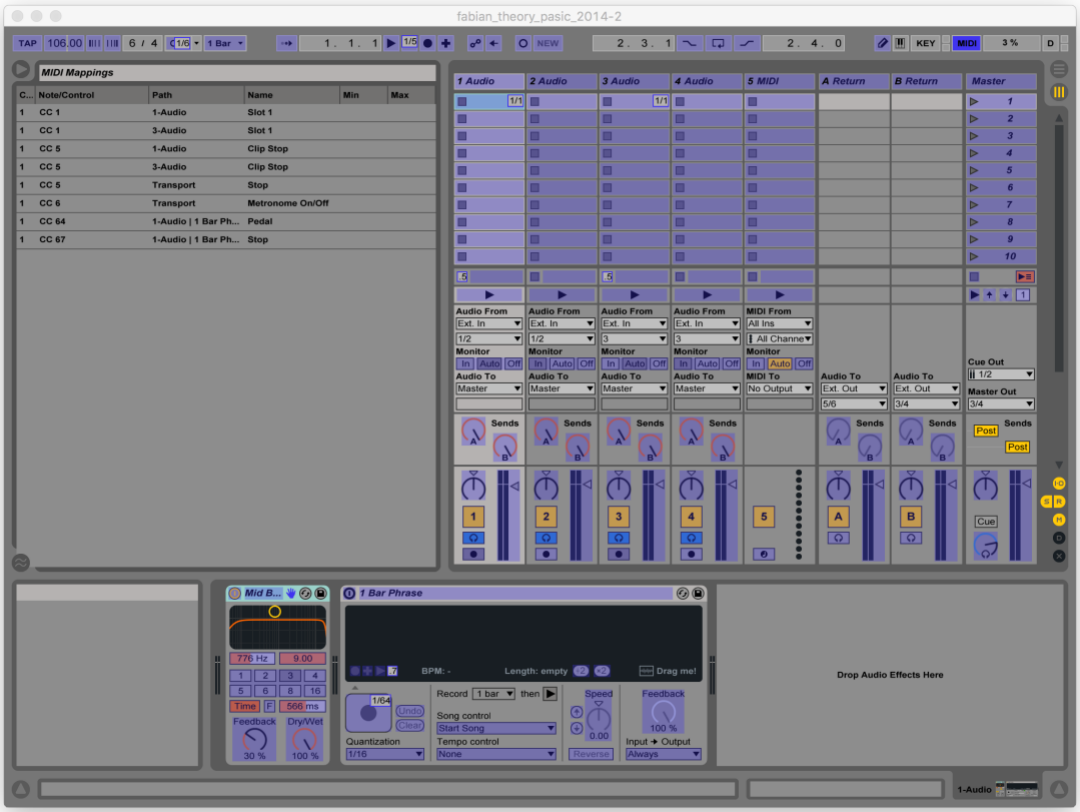
[61] Westlake, "Fabian Theory Technical Performance Notes".

Ableton Live. This combined technology gives the performer complete control over a wide variety of electroacoustic performance related tasks. This includes the recording, playback, and stopping of the loop, the stopping and starting of the digital delay, and extensive control over the metronome. This level of control, especially

Figure 25. Ableton Live Set by Brady Harrison for *Fabian Theory*, MIDI Mappings.



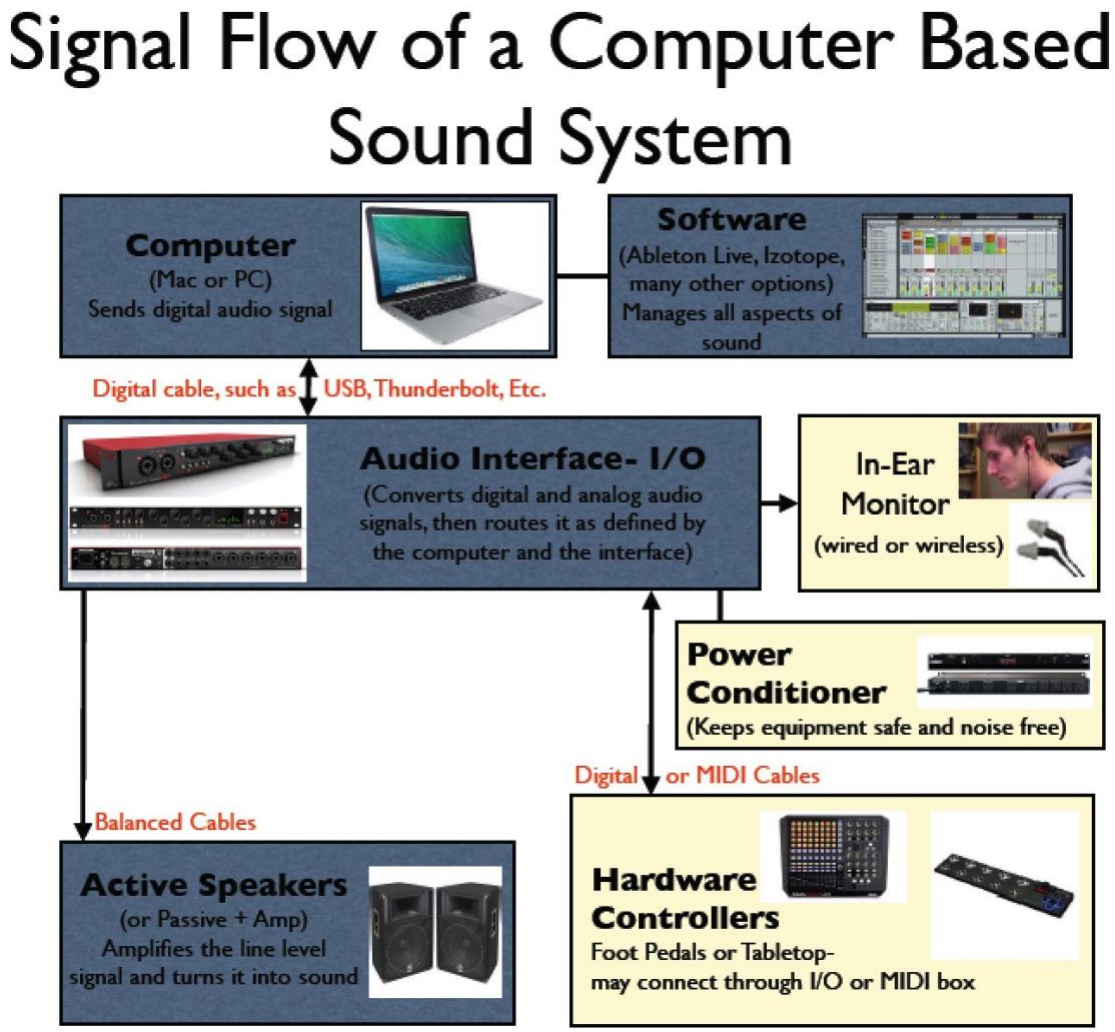
over the metronome during the actual live recording process, allows for a clean and complete recording of the loop. Notice in this particular set, that there are more commands (eight) than there are issued MIDI controllers (five). This indicates that a couple of the pedals are assigned multiple functions. The pedal controls in this case are identified as CC1, CC5, CC6, CC64, CC67.

For live processing works, the advantage of using assignable MIDI controllers, rather than dedicated effects modules, is that it requires minimal additions to the tools that have already been demonstrated to offer optimum sound quality and foundational setup for tape works. It does this while also demonstrating how to more efficiently and creatively make use of those same tools. Furthermore, it does so with the great flexibility and expansion possibilities that make this particularly malleable technology useful to a wide range of applications, both present and future. This flexibility increases the performer's tools' lifespan by keeping the tools relevant for a longer period of time, cutting down on unnecessary time spent toward learning how to use extra gear. Pedagogically, using this technology reinforces the values that underpinned earlier decision-making processes and a deeper level of critical inquiry. In fostering a methodical path toward a complementary development of skills, artist teachers can progressively build on the knowledge, means, values, outcomes, and skill sets that are essential to producing well-rounded musicians at the university level. With the addition of the MIDI hardware controller in mind with system, the overall workflow of the system now reflects the relationship represented in figure 26.

MIDI hardware controllers may use a variety of different connections to interface with the system. They may connect through a specialized MIDI interface, they may run through a MIDI port on an audio i/o device (as shown in figure 26), or they may be run directly into the computer using a wired or wireless digital protocol such as USB or Bluetooth. A MIDI interface can often act as a hub for several MIDI ports and typically directs the MIDI signals into the computer by way

of a USB, Thunderbolt, or other digital cable interface. Regardless of the means of transmission, MIDI data does not convey a direct audio signal. Actual audio transmission, which is central to live processing works, requires a different tool. Having previously covered most of the essential technical components of live processing signal flow relevant to *Fabian Theory*, there remains one untouched critical element yet-to-be covered: microphones.

Figure 26. Signal Flow of a Computer Based Sound System, Version 1.



While many components within a sound system play an important role toward the final outcome, microphones usually have the most immediate and profound effect on capturing an accurate acoustic sound. For this reason, it is important to develop a baseline understanding of the seemingly mundane variety of microphones in order to efficiently match the right tool to each application. This knowledge provides a launching point for students to begin a deeper exploration of sonic control that is ultimately guided by principles of musicianship that are developed through careful attention to sound and artistic intent.

When viewed from the paradigm of teaching percussion, choosing the appropriate mic is roughly analogous to choosing the right marimba mallet for a particular piece or passage of music. This comparison can be helpful for students as a way to offer some perspective and a similar framework for clarifying various types and qualities of implements. In the market of marimba mallets, there exists a dizzying array of options that can be overwhelming if one does not understand how each mallet's core, wrap, shaft, and weight, all affect the sound. For example, the knowledge that a marimba mallet with a soft core and a thick yarn wrap produces a thin, mealy sound on the thicker bars toward the upper range of the marimba, helps to inform a marimbist as to the most suitable mallet for a specific scenario.

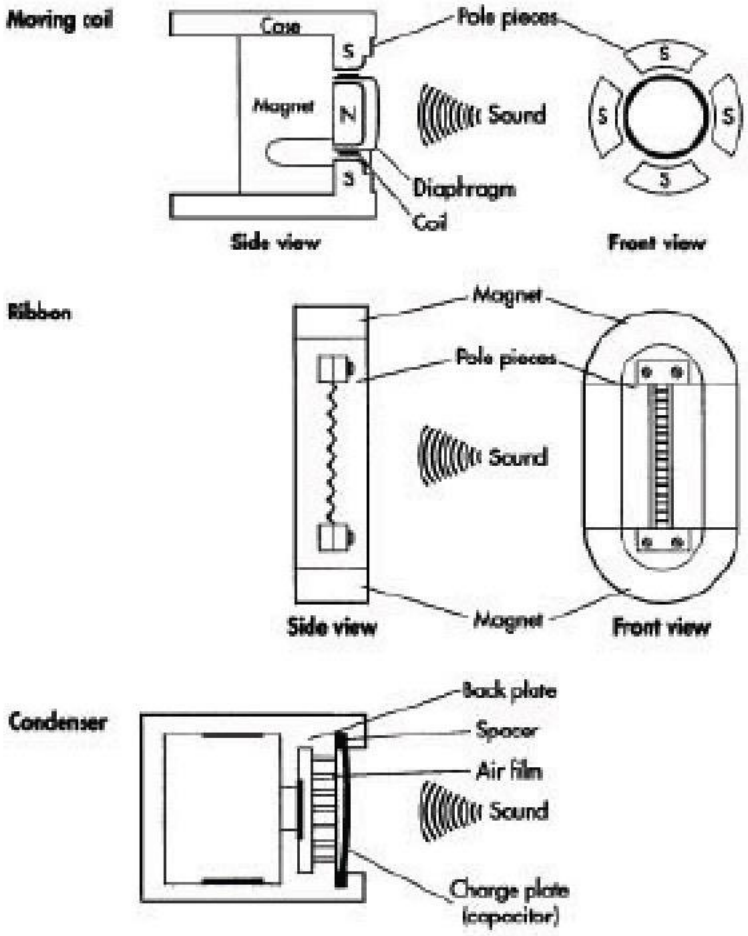
Many established university percussion studios keep a stock of mallets for students to try out in the context of lessons and practice. This practice helps the students with further critical inquiry and comparison to better arrive at the desired sound for a given musical application by using the correct implement. It should be noted that from a pedagogical perspective, that the teacher is not merely dictating a

specific mallet/implement model, but advocating for a thoughtful examination of the options from an informed perspective. Regardless of whether or not the student has access to a wide variety of options, it is from this same standpoint that we should approach teaching various aspects of microphones. Through pursuing critical inquiry, students are better able to develop a working knowledge of microphones that is relevant to performing electroacoustic music.

While one might think of microphones as simply replicating the exact sound that is picked up in their presence, every microphone adds some color to the sound. It becomes incumbent on the listener to understand this and make conscious choices regarding whether they are trying to obtain as close as possible a replication of the original acoustic sound, or allow for some intentional coloration of the sound (such as an increased high-end frequency to add shimmer to a performance or recording). Determining the intended artistic effect and purpose of the microphone is the first step in choosing the best fit for any given situation.

Microphones are primarily classified into three different categories, as determined by the design of their transducer, which converts audio energy into electrical energy. These three main types of microphones include dynamic microphones (also known as moving coil microphones), condenser microphones, and ribbon microphones. Dynamic and condenser mics are generally more popular than ribbon mics for most electroacoustic applications. Without going into much detail on the physical aspects of each microphone's transducer, a few generalizations can be made from their differing designs. See figure 27.

Figure 27. Microphone Construction Designs Diagram.[62]



The dynamic microphone is activated by a membrane that caps an electromagnetically induced coil of wire suspended around the magnets inside its capsule. As a result, it generally takes more acoustic energy to excite the microphone, which means that although it is more durable, it is generally less sensitive than condenser and ribbon microphones and better suited to close micing applications. In comparison, condenser microphones run off of a totally different

[62] "Microphone," How Products Are Made, accessed March 24, 2018, http://www.madehow.com/Volume-7/Microphone.html.

principle, called variable capacitance. With a variable capacitance microphone, an extremely thinly metal-coated plastic membrane that is highly reactant to acoustic energy carries an electric charge. As the delicate membrane moves reactively in response to sound waves, the electric charge loses and gains energy relative to its position between the two magnetized plates that flank the membrane. This design creates microphones that are typically highly sensitive and offer the quickest and most accurate reaction to fast attacks, transients[63], and detail, with generally the least amount of color added to the sound. They also require what is called phantom power to be supplied from a power source, usually the mixer or audio interface, to supply the electrical charge that fuels their process. Ribbon microphones, while operating under magnetic principles that are similar to moving coil microphones, are built around an extremely fragile ribbon that serves as its membrane, and tend to be the most prone to failure due to the delicate nature of the ribbon. For this reason, they might not be an excellent choice for a live micing situation where durability and uncontrollable environmental conditions may come into play.[64]

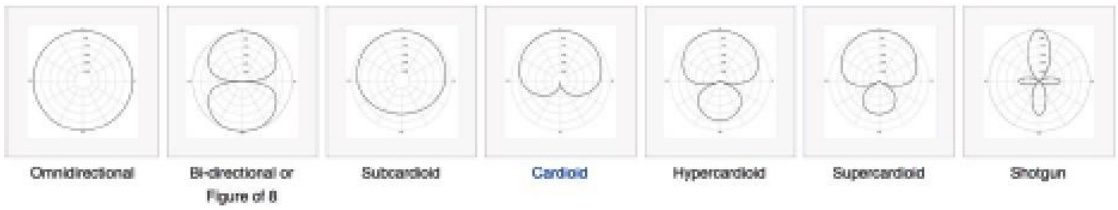
All of these microphone categories employ a variety of pickup patterns. The pickup pattern of a microphone describes the direction from which the capsule picks up sound. This pattern is generally depicted along a continuum from a shotgun pattern, which is very focused, to omnidirectional, which is a very diffuse pattern. See figure 28. The directionality of the microphone has a profound effect

[63] Transients are partials of a sound that typically occur at the front of the attack and often contain a great deal of high spectrum harmonic content that can drastically differ from the remainder of the sound, yet gives it a distinguishable character. Percussion oriented sounds typically are very transient rich.

[64] Bill Gibson, *The Ultimate Live Sound Operator's Handbook,* 2nd ed. (Hal Leonard Books, 2011), 151-153.

on matching the microphone to the proper application. Although most microphones have a fixed polar pattern, some microphones offer variable patterns.

Figure 28. Standard Microphone Patterns.[65]



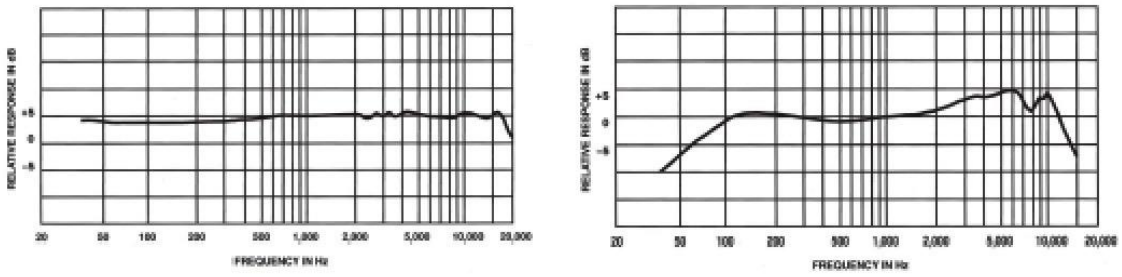
Adding to the complicated and unique technical qualities that govern the performance of each microphone is the fact that every microphone responds slightly differently to the spectrum of frequencies that it picks up, emphasizing certain frequencies more than others. This is known as frequency response, and is typically noted through a graphically charted specification for most models of microphone as seen in figure 29.[66] Notice that the two response graphs that are shown in the figure vary greatly as to what frequencies their respective microphones flatten or boost, and consequently these two microphones may have very different sound qualities in their replication of the same sound source. Frequency response can also change relative to the proximity and directional relationship between the sound source and

[65] Isaac, "Microphone Polar Pattern," A Pedagogical Guide to Audio Recording, March 7, 2015, accessed March 24, 2018, https://isaacfmp.wordpress.com/2015/03/07/microphone-polar-patterns/.

[66] David Rochman, "How to Read a Microphone Frequency Response Chart," Shure, February 5, 2015 accessed March 24, 2018, http://blog.shure.com/how-to-read-a-microphone-frequency-response-chart/.

the microphone as well, and this is often reflected in other specification data from many reputable microphone companies.

Figure 29. Two Different Frequency Response Graphs.[67]



Other microphone specifications that impact its effectiveness include noise rating, sensitivity rating, and maximum Sound Pressure Level (SPL)rating, among others. Every electronic component adds some amount of noise into the system, and the noise equivalency rating, also known as self-noise, is a measurement that describes the sound pressure level that is equal to the amount of noise that the microphone produces. A low self-noise rating is preferable for recording situations that require extreme sensitivity, although for some applications, like recording a snare drum in a contemporary performance setting, self-noise is not a primary concern.

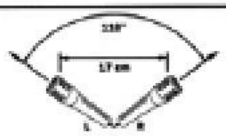
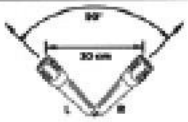
Because some applications for percussion require close micing drums that are very loud, it is important to understand maximum SPL rating. The sound pressure level is generally a description of how loud of a sound a microphone can

[67] Michael Baars, "Microphone Basics: Frequency Response," Shure, January 14, 2015, accessed March 24, 2018, https://shurebenelux.wordpress.com/2015/01/14/microphone-basics-frequency-response/.

respond to before distortion occurs in its signal output. Sensitivity rating, in seeming contrast, is a measurement of how much output signal is created from a microphone in response to a given input pressure level. The higher the microphone output signal is for the same input, the more sensitive the microphone. This is very important as applied to the extremely diverse world of percussion, which is commonly consumed by both the quietest of textural sounds as well as violent explosions.

There are a host of other aspects of microphone techniques that an electroacoustic performer should be aware of, including how to deal with proximity effect, and managing various boost and cut filters on many microphones that allow for customization for different applications. But perhaps no mic technique is more important for both live performance and studio applications than microphone placement. The same microphone can have widely differing results based on where it is placed in relation to a specific sound source. Just a few inches can make a profound difference as to what overtones are picked up, how much contact sound is present, and the depth of tone. Students should be encouraged to make sound comparisons in the context of a controlled environment to determine how differing placements achieve differing results. There are also a number of different ways to record or monitor in stereo that should be explored. See figure 30. However, in a live sound environment, there exists another, and often more important priority when determining microphone placement, namely the microphone's proximity to speakers and other sound sources.

Figure 30. Common Stereo Microphone Techniques. [68]

STEREO PICKUP SYSTEMS	MICROPHONE TYPES	MICROPHONE POSITIONS	
X-Y	2 - CARDIOID	AXES OF MAXIMUM RESPONSE AT 135° SPACING: COINCIDENT	
ORTF (FRENCH BROADCASTING ORGANIZATION)	2 - CARDIOID	AXES OF MAXIMUM RESPONSE AT 110° SPACING: NEAR-COINCIDENT (7 IN.)	
NOS (DUTCH BROADCASTING FOUNDATION)	2 - CARDIOID	AXES OF MAXIMUM RESPONSE AT 90° SPACING: NEAR-COINCIDENT (12 IN.)	
STEREOSONIC	2 - BIDIRECTIONAL	AXES OF MAXIMUM RESPONSE AT 90° SPACING: COINCIDENT	
MS (MID-SIDE)	1 - CARDIOID 1 - BIDIRECTIONAL	CARDIOID FORWARD-POINTED; BIDIRECTIONAL SIDE-POINTED; SPACING: COINCIDENT	
SPACED	2 - CARDIOID OR 2 - OMNIDIRECTIONAL	ANGLE AS DESIRED SPACING: 3-10 FT.	

In contrast to a studio where sound sources can be isolated and multi-tracked, a live performance contains many different simultaneous sound sources on stage. Moreover, any sound that is amplified in the same space offers the potential to create a self-cycling feedback loop that can cause terrible audio problems. When placing microphones, it is important to have an understanding of what instruments should be isolated from one another, and what level of bleed between sources is

[68] "In the Studio: Stereo Microphone Techniques," ProSoundWeb, February 15, 2016, accessed March 24, 2018, http://www.prosoundweb.com/topics/production/stereo_microphone_techniques/.

acceptable. This understanding is developed from a marriage between artistic vision, technical understanding, and acquired skill.

Among the first microphone choices that a performer must make in setting up a live electroacoustic work is what types of pickup patterns are appropriate for the particular application. Generally speaking, directional microphones are far and away the best choices to isolate bleed from other sources (such as speakers) and help prevent an unwanted feedback loop. But the placement of the microphones must be thought through in combination with the placement of the speakers, rather than purely in reaction to them. Generally speaking, the speakers should always be well in front of the microphones to avoid bleed, and stage wedges that are positioned on stage to function as stage monitors should be avoided. There are a number of other ways to combat feedback, including equalization and other effects, but generally the best approach is to thoughtfully design the system so that extra steps are not needed. *Fabian Theory* offers a good opportunity to consider many of these variables in direct application toward designing an optimally functioning system.

When working on *Fabian Theory*, one of the first choices that should be made concerning microphone and speaker placements is what type of microphone, or microphones, to use on the marimba. Because a typical concert marimba spans a range of eight to nine feet, a close microphone placement does not capture the range of the instrument evenly. This is due to the wide variance in bar positions in relation to the microphone, and will result in an uneven pickup of the marimba bars characterized by greater amplification of the bars that are near the microphone.

Considering that the piece requires a wide dynamic range that must be picked up by a microphone that is placed far enough away to offer an even pickup of the span of the instrument, the microphone needs to be relatively sensitive. Considering their design characteristics, most dynamic microphones are not very suitable for this purpose, and either a large or small diaphragm condenser microphone presents a better option. Furthermore, since the speakers are in the same space, it is risky to place the microphone far enough away from the instrument that it can evenly cover the instrument's entire range. This is because as the microphone is placed farther away from the instrument in an effort to capture an even distribution of sound, it is also generally exposed to more of the amplified sound in relation to the original sound source. This heightens the risk of unwanted feedback.

Therefore, two microphones are a better solution to evenly cover the full range of the instrument without placing the mic so far away from the marimba that it becomes difficult to balance between the marimba and the sound produced from the speakers. In this event, it then becomes optional to run the two microphones as a stereo pair or as a mono pair that feeds both sides of the performance space equally. Exactly how far apart the microphones are spaced, at what angle they are placed to the instrument, and any specific notes or part of the instrument they are focused toward, should all be considered in the placement. It is important to consider the entire pickup pattern, including the back of the microphone, to determine how the microphone and speaker placements can be best coordinated. Many microphone patterns pickup sound that is 180 degrees behind them exceptionally well even if they are hyper-directional toward the front of the

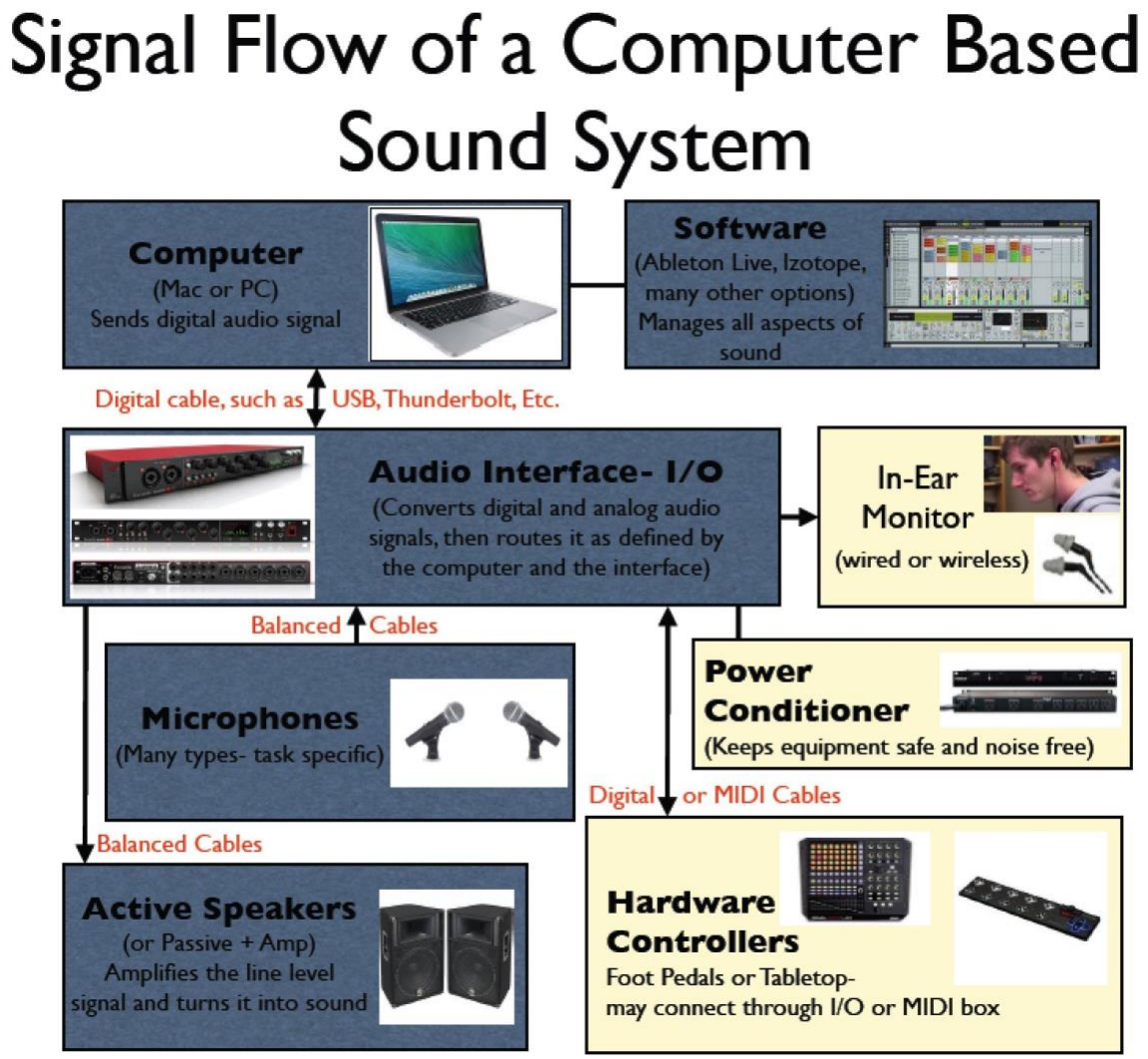
microphone (on axis). See figure 28. As a general rule, most performers would like to have the speakers as far in front and away from the microphone as possible, while still being in a suitable placement for the audience. There is always a compromise and balance to be found.

Although technical specifications are important to any proper delivery of an electroacoustic performance, they do not supersede the fundamentals of good musicianship. An informed performer ultimately relies on sound judgment, having a developed concept of sound, being sensitive to the performance environment, keeping a dedicated work ethic, maintaining creative and critical inquiry, and above all, critical listening skills, all determine the best performance decisions more than any specification. Keeping a methodical approach that ties together the many natural developments and strains of electroacoustic music by using common tools and musical principles helps to reinforce the foundational awareness of good musicianship, while making efficient use of the tools of technology to effectively serve those means. At this point our signal flow now includes microphones, and resembles figure 31. The art of music contains aspects of science, but it remains an art form.

One other tool that is often used for the performance of electroacoustic works, especially live processing works, is specialized software that performs functions beyond a typical Digital Audio Workstation. Of the several types of music processing software, perhaps the most flexible of all, are the programs that function as visual programming environments, such as MAX/MSP or Pure Data, commonly referred to as Pd. Both pieces of software use object oriented programming to offer

near limitless flexibility in creating routing configurations, effects, MIDI sequences, synthesis, and a host of other input triggered actions to coordinate with lights, video, and other media, using graphic icons instead of complex character based code.

Figure 31. Signal Flow of a Computer Based Sound System, Version 2.



Although they were both designed by the same programmer, Miller Puckette, the primary difference between Pure Data and MAX/MSP, aside from some

cosmetics, is that Pure Data is available free as a download online, and MAX/MSP is not. Of Pd, the Pure Data website states,

> Pd enables musicians, visual artists, performers, researchers, and developers to create software graphically without writing lines of code. Pd is used to process and generate sound, video, 2D/3D graphics, and interface sensors, input devices, and MIDI. Pd can easily work over local and remote networks to integrate wearable technology, motor systems, lighting rigs, and other equipment. Pd is suitable for learning basic multimedia processing and visual programming methods as well as for realizing complex systems for large-scale projects.[69]

These programs are generally designed to work independently, but there are versions, such as *Max for Live*, that are designed to run as a "plug-in", or a piece of software that runs within another piece of software in a complementary manner. There are multiple MAX/MSP patches that have been created for *Fabian Theory* as a way to manage the electronic effects in the work. Figure 32 is one such patch that was designed by concert percussionist and Head of Percussion Studies at Arizona State University, J. B. Smith. His description of the patch is as follows.

> MAX creates the echo effect that runs throughout and plays back a pre-recorded marimba loop in the middle of the piece. Originally the player would have pressed a pedal to start the loop record and released it to start the loop playback. To insure an accurate sample length and to avoid any problems on the loop repeats (clicks and pops are common) I recorded the part in advance and edited the wavetable to insure that the repeat was smooth.[70]

While these pieces of technology are comprehensive in many respects, they do not represent the totality of tools that may be called upon to perform this repertoire.

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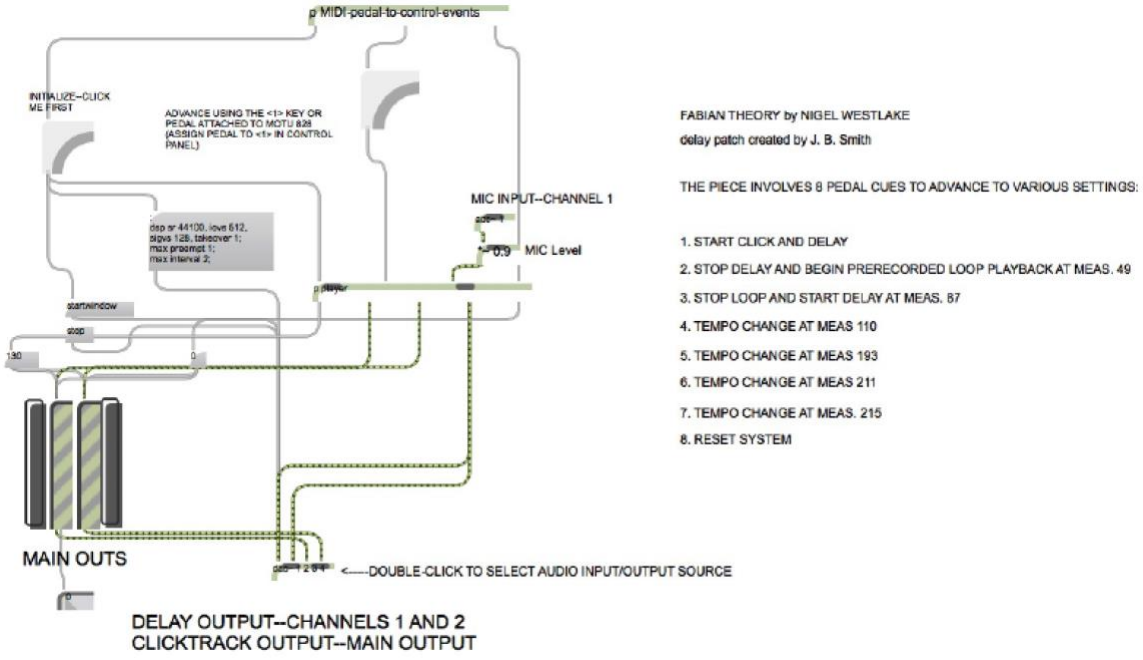
[69] "About Pure Data," Pure Data, accessed March 24, 2018, https://puredata.info.

[70] J. B. Smith, "Performance Patches for Percussionists," Arizona State University, accessed March 24, 2018, http://www.public.asu.edu/~idjbs/Patches.htm.

Figure 32. Fabian Theory Max/MSP Patch by J. B. Smith.[71]



Other Relevant Technologies

Although *Fabian Theory* is a reasonable piece to serve as a model to help develop pedagogical strategies with regard to electroacoustic percussion concert works, it is by no means exhaustive in its demands of technology. Many other expressive tools of music technology may be implemented and even required in different tape or live processing works.

Another widely used tool is simply known as a trigger. In drumming, a trigger is an electronic transducer that can be attached to a drum, cymbal or other instrument to enable it to control an electronic drum unit or similar device.[72] Triggers have been in use for over twenty years and are specific to a variety of

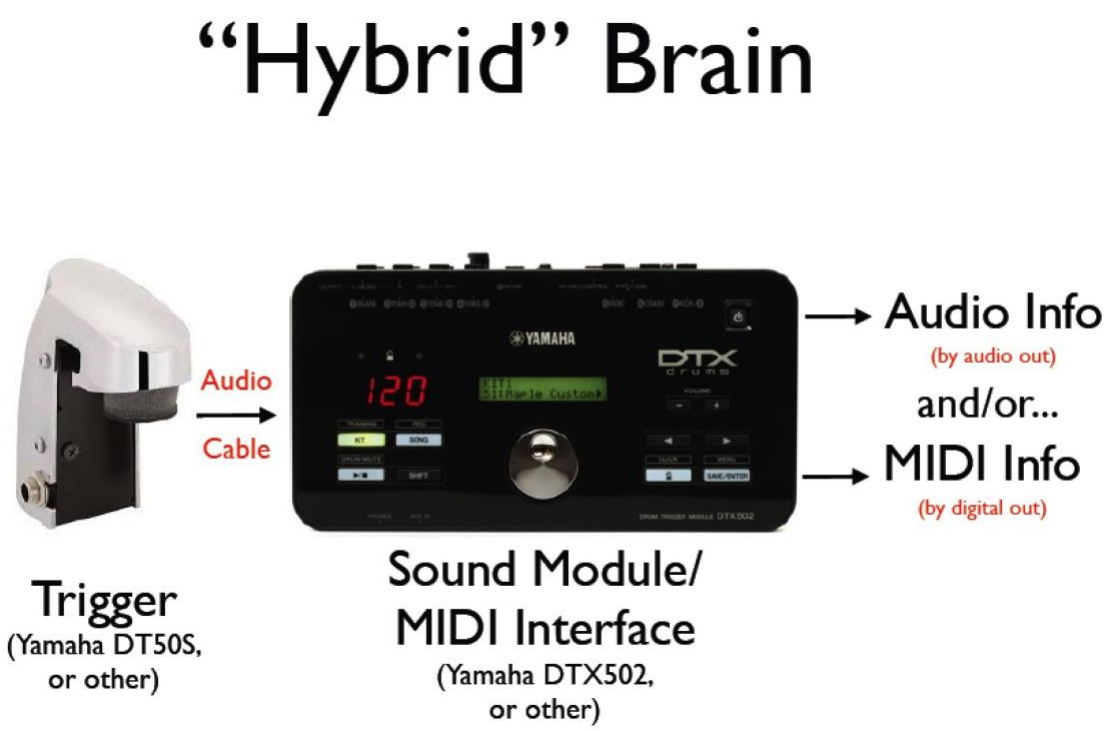
[71] Ibid.

[72] "Trigger (drums)," *Wikipedia*, accessed March 24, 2018, https://en.wikipedia.org/wiki/Trigger_(drums).

applications. A snare drum trigger, for example, typically has two different pickups on it to separately cover both the snare head and the rim, while tom specific triggers typically only have one trigger zone. While early triggers were often known for their false triggering and insensitivity, these problems have been thoroughly addressed in more recent iterations of the technology, and consequently their benefits outweigh any potential risks in many performance situations. A trigger's output signal can be directly turned into an audio signal or a MIDI signal by a specialized module or "drum brain". The MIDI signals can be used to trigger an event or to turn the signal into virtually any sound, based on the specific scenario. See figure 33. A few of the strengths of using triggers in addition to or in lieu of microphones include both the isolation of the signal, the decreased possibility of feedback problems, and the flexibility of the sound design, both live and in postproduction. This has also gained more popularity with the modern "hybrid" kit. Hybrid drum sets are collections of drums that regularly blend elements of electronics with acoustically based kits. The collection of instruments usually includes triggers on acoustic drums, or electronic drums within an otherwise acoustic set. While this is becoming increasingly popular for commercial music applications, it has context in many electroacoustic works as well.

In a work such as *Strands of Time*, which was covered in detail in chapter 2, the integration of a trigger on the Remo TSS alternative solution (again, to solve the issue of what to substitute in place of the no longer manufactured instrument) can create some interesting results. By including a trigger on the piccolo snare drum, which I chose as a replacement for the Remo instrument, the audience hears not

Figure 33. Hybrid Brain.



only the acoustic sound of the piccolo being played when the instrument is struck, but also the electronic snare sound coming from the speakers. In doing so, the distinctions between the acoustic world and the electronic sound world are broken down into a more seamless and artistically effective presentation. As the audience sees the performer play the acoustic drum, they hear not only the acoustic drum, but also the electronic sound from the speakers, which challenges the audience's very basis of perception as the two worlds merge. This is but one of many applications for triggers and drum modules.

Many other tools, such as do-it-yourself electronics, Arduino technology, Bluetooth MIDI controllers, Infrared MIDI and OSC controllers, control voltage converters, and other types of software could be explored as well. While still most

relevant to isolated examples of the electroacoustic concert percussion repertory, these tools are all continually developing a stronger presence in the repertoire of live processing and combination works on the whole.

Toward a Pedagogy

The wide variety of tools and techniques that one may draw upon to perform live processing works require an organized approach to teaching the repertoire that is flexible in its details but steadfast in relating consistent musical values. Flexibility is required in presenting the tools related to the repertoire because of the rapid and constant advancement of technology that continues to affect them. When deeper musical values are stressed over the specificities of the individual technologies, students are better able to find creative solutions to the challenges of the repertoire and are better able to deal with the inevitable changes that affect their tools because they possess a stronger guiding light on purpose for the instruments themselves.

A liberal pedagogical model evolves not just from the context of performing the actual repertoire, but from advancing some aspect of commonality and creating a path to develop the skills with a deeper awareness and understanding of purpose. With the myriad of specialized technological tools and techniques available today, it is easy to become hyper-focused and preoccupied with the actual technology itself, divorced from its actual musical context and space. In presenting these ideas specifically related to works that involve live processing, it is assumed that a foundational understanding of signal flow, etc., is already achieved from learning experiences associated with tape works. In developing a signature pedagogy, I offer

the following general considerations, processes, and outcomes with a focus toward incremental development and raising musical awareness via exploration of broad musical fundamentals.

1. Possess a comprehensive understanding of how to record solo and multiple tracks into a DAW using a microphone. Learning to do this is prerequisite to being able to thoughtfully listen and compare other performance details because it removes the performer from the immediate responsibility of execution and allows for critical reflection.
    - Students will record a solo instrument or voice into a DAW, then recording multiple tracks at the same time. Eventually students should be able to layer separately recorded tracks onto one another.

2. Possess a thorough understanding of various types of microphones and their different qualities, including the impact of the preamplifier on their signal. This would include dynamic, condenser, and ribbon microphones, with special attention to how each microphone's specifications color the sound.
    - Students will define, diagram, and discuss different types of microphones and how the specifications of noise rating, sensitivity, frequency response, and directional pattern all affect the way that they capture sound.
    - Students will render recordings of a variety of different microphones with the same placement and application in order to compare how the

design of microphone impacts the way that the sound is captured. Also, students will compare recordings of the same microphones using different preamps, if possible. In comparing the different recordings, discuss aesthetic principles and goals relevant to artistic vision. Discussion might raise questions such as should the goal be to capture audio in a way that the audience would hear it without amplification or is some greater (or lesser) amplification of detail desired? Is artificial color desired or unwanted at the point of capture, and if so, to what degree? To what degree should the performer need to change technique on their instrument in order to accommodate challenges or shortcomings in the recording process? This should all be discussed with strong attention to detail oriented critical listening.

3. Possess a thorough understanding of how mic placement with regard to the primary sound source and performance space critically impacts the microphone pickup.
    - Students will record the same sound source with the same microphone in the same space, but with the variable of microphone placement. Students will do a close mic recording (a foot away or less), a midrange recording (usually some feet), and a recording with the microphone placed far away from the sound source, toward the middle or back of the space. Students will compare how each microphone placement yields a different level of detail and color and

allows for a different interaction with the performance space that may or may not reflect the desired artistic intent. Students will explore how the placement of the microphone relates to any proximity effect, and how might that be countered in the recording process. Also, experiment with directional variability for the microphone, to demonstrate the relevancy of pickup pattern and off-axis response.

- Students will repeat the exercise in a different acoustical environment to demonstrate the effect of space on the final sound in each scenario.

4. Possess a thorough understanding of stereo microphone techniques, and develop a preference for a specific technique in a given application.
    - Students will define and discuss several of the different techniques of stereo micing, including their equipment requirements and relative differences with respect to the stereo field.
    - Students will make several A/B recordings using various different stereo microphone techniques and compare how they sound with respect to panning, depth of field, and inclusion of other room characteristics. How does the stereo image change when the sound source is very concentrated and compact, such as on a snare drum, versus on an instrument with a wider playing surface, such as a marimba? Is there more consistent coverage with any specific technique, and why or why not?

5. Develop an understanding of how speaker placement and other secondary sound sources interact with microphones in a live sound environment.
    - Students will setup microphones based on previous microphone exercises and use live monitoring in the space. In a moderate to large sized studio, the students will listen to the different outcomes of changing the speaker placements, experimenting with speakers placed behind the microphone/s, in front of the microphone/s, very close, midrange, very far, aimed differently, etc. Students will address some of the following questions. How does the speaker placement impact the sound quality? Perhaps experiment with different types of mics. What role does the type of microphone and pickup pattern of the mic make?
    - The students will perform the same or a portion of the same speaker/microphone stage setup in a different space. How is it different, if at all? What modifications need to be made to achieve the best live sound in these differing space and sound source scenarios?

6. Develop an understanding for MIDI and OSC messages, and an awareness and ability to apply the technology in different creative ways.
    - Students will discuss what MIDI and OSC is and its various implementations. This includes the differences between channels, the five different types of MIDI messages, routing options and hardware, MIDI clock control, and other related details. Have students identify

various MIDI controllers, including keyboards, electronic drums, pad controllers, and foot controllers, including Bluetooth or other wireless controllers.

- The students will setup a MIDI instrument and play it through a DAW.
- The students will create an event, such as record, playback, or other function, that is actuated by using a MIDI device as a controller. The students will link a number of different functions. Once MIDI assignments have been grasped solidly, the students will create a fluid sequence of MIDI commands, executed by different MIDI messages.

7. Develop an understanding of basic audio effects and how to implement them using software. These effects include basic types of reverb, equalization, delays, reverbs, choruses, flangers, phasers, limiters, compressors, low and high pass filters, band pass filters, noise gates, and distortion, among others. Students should be able to group effects into broad categories based on their nature, such as dynamic effects, time-based effects, filter effects, and pitch-based effects. In categorizing effects, students should better understand how the effect works and the hardware origins of the effect. Students should have an awareness of the different options of how to run the effect within as part of a DAW, as a separate plug-in within a DAW, or as a stand-alone piece of

software. Students should also be able to link a MIDI or OSC controller to the effect.[73]

- The students will study and discuss audio effects in groups of effects. This would include first naming the effect, describing the sound related to the effect, and explaining how the effect works from an audio production perspective.
- The students will implement each effect on a common group of sound files, exploring each effect's parameters. How do the different parameters of each effect affect the different sounds?
- The students will setup and execute a MIDI controller to trigger and manipulate various effects and their parameters.

8. Develop a fluid understanding of triggers and percussion modules, or "brains".
    - The students will discuss the various types of triggers for acoustic instruments, including various types of drum triggers, including ones for snare drum, toms, and bass drums, noting their differences.
    - The students will setup a trigger on an acoustic instrument. The students will feed an analog signal from the module into the interface, changing the sound with the module. Then, the students will use the MIDI signal from the interface to access the computer's sounds. In

[73] "Understanding Audio Effects: An Overview of Types and Uses," Dubspot, July 7, 2016, accessed March 24, 2018, http://blog.dubspot.com/understanding-audio-effects-an-overview/.

both cases, the students will listen to the blend between the electronic and the live acoustic sound. What effect does it have as a listener?

9. Develop a rudimentary understanding and awareness of music related object-oriented software, such as Max/MSP and/or Pure Data. Be aware of the differences of running it as a standalone software or within the context of another DAW, such as Max for Live. Understand how it can work in tandem with more sophisticated OSC routing, using software such as OSCulator.
    - Students will research the software online and describe the capabilities, advantages, and disadvantages for various applications.
    - Students will download and run a basic script using either PD or a version of Max.
    - Using a preconceived template for a device, students will alter some of the device to understand how the device is created.
    - As a final project, students will create a device, such as a basic audio effect or set of action/consequence triggers and route this using OSCulator.

CHAPTER 5

EXTENDED ELECTRONIC AND ACOUSTIC INTERACTIONS

Electronic Works

While the majority of electroacoustic works for concert percussion tend to be thought of as variants of either tape or live processing works, it is worth noting that there exists another category of works that is best described as purely electronic in nature. Although many of these works require no acoustic sound source, these works may be considered in the context of electroacoustic repertoire because they are born from a Western classical tradition of composition and percussion performance discipline. Such works include pieces such as Graham Fitkin's *Chain of Command*, for Xylosynth and sampler, and purely electric versions of Steve Reich's *Violin Phase*, which can also be performed on a mallet controller guided by alternative performance instructions by Reich, to name only a couple of pieces.

While the foundation for the informed performance of this body of repertoire is already developed in the sequence previously outlined with relation to tape and live processing works, there are a few other tools that are often additionally necessary for the performance of purely electronic works. The first additional tool comes from the wide variety of electronic instruments. Electronic instruments cover a very wide range of devices and are constantly being newly created and developed. Of special relevance to percussionists, are electronic drums and electronic mallet instruments, in addition to other pad controllers. See figure 34. While these largely fall under the category of MIDI instruments, students should

already be aware of how to incorporate this technology into their setups. It should be noted once again, that some of these instruments have their own onboard sounds within their module, or brain, while others simply use sounds that originate from computer software that is informed by incoming MIDI signals sent from the instrument or brain.

Figure 34. Various MIDI Electronic Drum and Mallet/Percussion Controllers.

Sampling and sound design are a couple of other skills that a few electronic works may ask performers to explore in greater depth. Sampling may be required of the performer, or more likely, as in *Chain of Command*, the performer may be

called upon to play a variety of prerecorded samples from an electronic instrument. In such cases, a dedicated sampler player, an object-oriented software script, or a simple software drum rack filled with the samples may be utilized.

Sound design deals more specifically with aspects of the electronically created sound that is produced for an application, although it is also often applied to acoustically original sounds. Taking an example such as *Violin Phase,* as performed on a malletKAT controller, the sound that is generated is determined by the performer, and is wide open to interpretation.[74] While an electronic sound should yield some of the sustain and overtone properties that make the work effective on violin, a percussive quality lends a clarity to the texture. Further expanding on the possibilities availed by technology; effective sound design can be used, for example, to make a differentiation between the "building" line and the static lines of the phase by creating a sound that triggers different timbral qualities depending on the velocity at which the controller is being played.

Sound design can also concern itself with how sound is distributed around a space. Sometimes electronic works that have multiple layers of sound can sound one-dimensional because the final product comes directly from one or two speakers. For this reason, performers should be encouraged to experiment with spatialization of the sound in a performance space, where the composite sound is distributed among multiple speakers in the space, sometimes assigning each speaker a specific voice, giving it more depth and articulation. Again, *Violin Phase* is a great example of

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[74] Brady Harrison, "Violin Phase" (performance video), posted April 17, 2013, accessed March 25, 2018, https://www.youtube.com/watch?v=Iyr_Gs0OGOY.

how a thoughtful approach to spatialization can greatly impact a performance. With each voice of the violin quartet coming from a different speaker, the composite product has a depth and clarity that is simply not possible on one or two speakers. Perhaps ironically in this case, in contrast to just having the sound come from one or two speakers, the spatial distribution of the resultant parts between four different speakers is more closely aligned to the original acoustic version of the score for four different violins, which are all heard as independent sound sources. While the full depth and effect of comprehensive sound design may not be fully realized until exploring some electronic works, all of the groundwork for routing these signals is first learned through exposure to tape works.

Combination Works

Although it is relatively easy to categorize different electroacoustic repertoire based on modality of interaction with the technology, many works in the genre actually combine performance elements of tape and live processing and/or electronic instruments. Having a foundation that is developed methodically prepares performers for the challenge of bringing together some of these technical skills in a work that draws on a wide variety of electroacoustic skill sets.

One of the "earliest masterworks for electroacoustic concert percussion"[75], *Prison Song*, by Hans Werner Henze, exemplifies the way in which an electroacoustic work can draw on a wide variety of skills. The work was written in 1971 as an

[75] Brady Harrison, quoted in Andrew Bliss, "Focus Day: Celebrating the European Avante-Garde." *Percussive Notes*, September 2016, 10.

outgrowth of a larger set of 22 songs titled *Voices*, which were originally scored for two singers, electronics, and a small chamber orchestra that use an enormous variety of instruments. Of the set, *Prison Song*[76] is the only song that was re-scored by Henze as a stand-alone solo work for percussion/speaker. Although the work's title page describes the work as being scored for percussionist and tape, there is much more to the production of the piece. Henze's instructions for the work are as follows.

> The tape for PRISON SONG should provide a stereophonic or quadraphonic reproduction of the sounds indicated in the score. During the performance [sic] the player responds to the happenings on the tape. The sounds include breathing noises of someone sleeping as a kind of ostinato. The effect can also be achieved by the noise of a yo-yo in action. The other sounds are inserted into this organ-point and, without exception, should be given with reverberation. Some piano chords and individual notes should be produced without the percussive noise. + means piano strings plucked. The pedal should be sustained for as long as possible particularly for these pizzicato, for glissandi and glass-marble effects. As far as the execution of the majority of effects is concerned, the producer of the tape is at liberty to expand or alter them according to his own judgment by which I mean that ideally the player himself will be the producer.[77]

Prison Song has a special place in the early concert percussion repertoire for its forward thinking use of electronics and unique performance and execution challenges that come together to create a kind of percussion dramatic theatre. The performer is called upon to Sprechstimme[78] the text that comes from the prison diary of revolutionary communist leader and President of the Democratic Republic

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[77] Hans Werner Henze, *Prison Song*, (Mainz, Germany: B. Schott and Sons, 1977), 1.

[78] *Encyclopedia Brittannica*, s.v. "Sprechstimme Music," accessed March 25, 2018, https://www.britannica.com/art/Sprechstimme. Sprechstimme (German: "speech-voice") in music is "a cross between speaking and singing in which the tone quality of speech is heightened and lowered in pitch along melodic contours indicated in the musical notation."

of Vietnam, Ho Chi Minh, the delivery range of which nearly necessitates the use of a wireless headworn microphone. The work is notated using graphic notation with watercolors and a timeline style layout, with time dictated as seconds as a way to outline its temporal progression for both the tape and live performance synchronization.

In order to encapsulate the broader scope of the entire chamber version, as well as to best compliment the sonic character of the work, Henze provides a very detailed script of how, ideally, the performer is charged to actually create the accompanying soundscape recording for this solo version. In addition to instructing the recording and extensive editing of a host of sound effects including breathing, footsteps, doors, shouts, chains, and various effects inside a piano (i.e., rolled marbles, plucked stings, and glissandos) throughout the score, Henze also indicates the use of live processed effects. One live echo effect that occurs during the second half of the work requires the live performance to be "recorded, then played back (filtered) 5 sec. later"[79], creating a dark and eerie soundscape. While often being extremely specific, Henze's notes encourage artistic creativity and are careful to say in the performance instructions that "ideally the player himself will be the producer."[80] In this respect, the highly specific and detailed score yields a slightly different performance outcome for each performer, based both on the pre-performance soundtrack preparations as well as the live individual performance. [81]

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[79] Henze, 3.
[80] Henze, 1.
[81] Brady Harrison, "Prison Song" (performance video), posted May 23, 2017, accessed March 25, 2018, https://www.youtube.com/watch?v=mIN8FcpZemc.

The live processing in the latter half of the work requires a level of delay in the echo that is beyond the parameters of most prefabricated delay effects, which may prompt the creation the creation of a MAX or PD patch to accomplish the effect. However, perhaps the greatest technological challenges that lie within *Prison Song* surround the process of creating the actual prerecorded soundtrack.

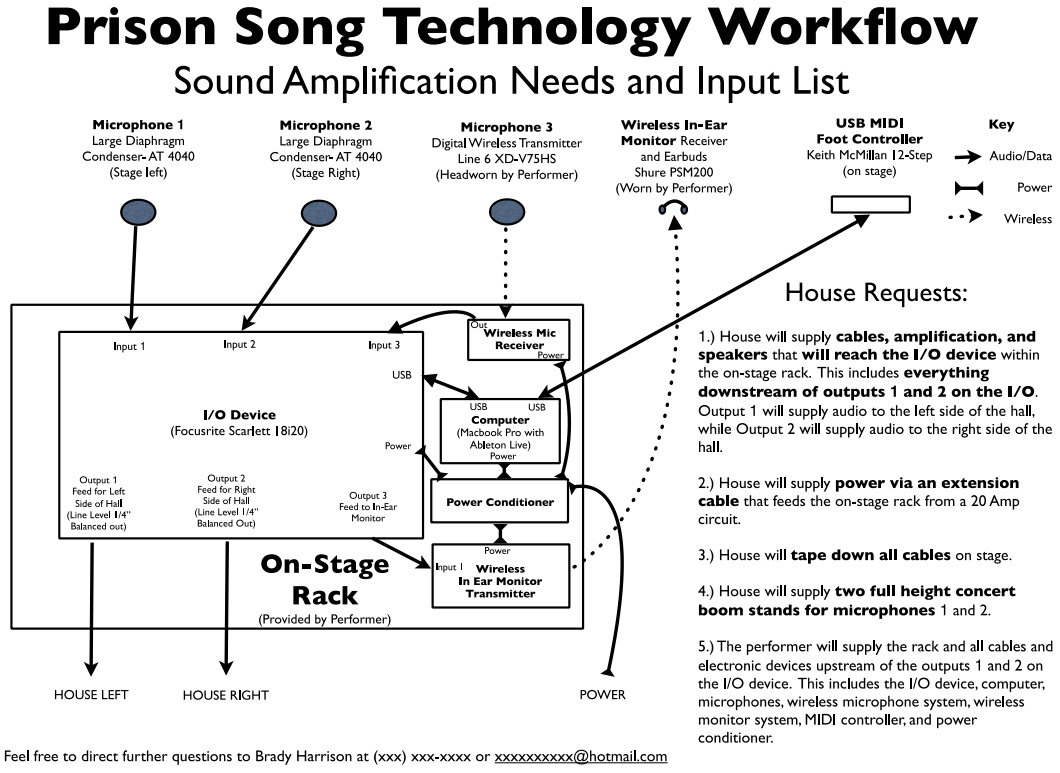
In designing the soundtrack to the work, it is useful to incorporate stock sound files that are available online at web based sound databases such as freesound.org in addition to any first-hand recording. This is in order to efficiently weave the tapestry of the soundtrack with the diversity of Henze's instruction. The sheer volume of the entries into the soundscape require a multi-track recording that might even have upwards of 100 different tracks feeding it in the mix process. These are best mixed using a high quality and transparent studio monitor system. In addition, a performer/producer may find it advantageous to create or embed other useful performance landmarks, such as a click track or isolated countdowns, in the context of creating the soundscape. As in some select tape works, this allows for the alignment of the live performance with the prerecorded audio and might require a separate audio file for the performer's monitor.

A working knowledge of and facility with effects is useful not just for application to each individual track to create the appropriate musical atmosphere, but also between the tracks to create musical cohesion, presence, and balance for the whole. This final act of postproduction that involves the whole is known as mastering. Essentially, mastering requires a deeper level of exploration of previously introduced audio effects and especially tends to focus on an audio effect

known as compression, which adjusts the dynamic range of the track so that the final product has a greater presence than it would otherwise have.

Even with the technical complexity of a work such as *Prison Song*, the skills that apply to the vast majority of the piece are best learned through a stepwise progression that originates with tape works. A standard signal flow diagram of the

Figure 35. Technology Workflow for *Prison Song*.



complicated piece demonstrates how the work builds upon these early foundational skills. See figure 35. While there are certainly many differences between all works of the electroacoustic genre, the works falling under the composite category

generally differ from their more narrowly defined counterparts, such as tape works or live processing works, not due so much to vastly different technological skill requirements, but to their broader application and more comprehensive use of technology. For this reason, when undertaking composite electroacoustic works, a slow methodical approach that is grounded in the other styles of electroacoustic repertoire provides a fertile foundation for the best result.

CHAPTER 6

ADDITIONAL PEDAGOGICAL CONSIDERATIONS

Financial Considerations

With the plethora of different tools and devices that can be incorporated into electroacoustic music it might be easy to assume that its study requires a vast amount of resources that could potentially eat into any percussion purchasing budget. Although a list of electroacoustic tools may seem daunting at first glance, the base requirements are certainly not elaborate as compared to the inventory of a well-stocked percussion studio, and many of these tools are available at little or no financial investment. The following list (Figure 36) offers relative price ranges for the equipment outlined. Clearly there can be deviation well beyond the boundaries of this list, both with respect to cost and desired equipment.

As we have already explored, not all parts of the system are necessary for all electroacoustic applications. However, in order to create a system that is modular and adaptable, the components at the top of the list (i.e. computer, speakers, interface, cables, etc.) should be given higher priority than those nearer to the bottom of the list. Aside from the computer, the speakers and interface are probably the most important pieces of equipment on the list.

Considering that a computer is incidentally present in most teaching studios, then the overall cost for the system is relatively small when placed in the broader context of the relative cost for percussion instruments. In the case of a very economical approach, for less than $1,200, a studio could be put in place. In a more moderate

scenario, for under $8,000, one could have a very well stocked set of electronic audio tools that could capably address most any piece in the repertoire, and be useful for a very wide variety of applications. This is far less than the cost of a typical 5-octave concert marimba, yet can be used with all of the other instruments in a university percussion studio, as a recording tool, a playback device, or to enable extended electroacoustic playing techniques.

Figure 36. Approximate Cost Breakdown for Electroacoustic Tools.

Equipment	**Low**	**Medium**	**High**
Computer (in current US Dollars)	$400	$2,200	$4,400
Speakers (pair)	$200	$700	$4,000
Interface	$150	$1,000	$5,000
Cables	$50	$350	$1,200
DAW	$0	$350	$1,200
Microphones	$200	$2,000	$20,000
Power Conditioner	$30	$160	$1,000
In-Ear Monitor System	$20	$800	$5,000
Rack	$100	$250	$700
MIDI Controllers	$50	$600	$6,000
Drum Module/Brain	$200	$270	$2,400
Triggers	$20	$90	$300
External Hard drive	$70	$200	$600

Studio Monitors	$80	$700	$8,000
Other Software	$0	$600	$6,000
Other related DIY Materials	$0	$260	$1000
Total Expenditure (In current US Dollars)	$1,570	$10,530	$66,800

Because a practical approach toward acquiring gear should be to prioritize getting quality equipment for the most important parts of the system rather than purchasing a more complete list of items at lower quality, having little financial resources need not be a reason to avoid studying the repertoire all together. Much like many student percussionists who build their instrument inventory on a small budget, the student starting electroacoustic study merely needs to start from a place of basic necessity, such as an audio player and a speaker. While resources may be an important guiding factor, they don't define the issue.

In some schools that already have mature electronic music programs, it may be possible to obtain access for percussion students to the electronic music tools that the school already owns, through working out an arrangement with the area that has control over those tools. This access might be a regular time that is set aside for the students to work with the equipment, or perhaps could be setup on an as-needed basis to supplement an established foundation of tools that are present in the percussion studio.

From a funding perspective, it may be considered a benefit that this gear can be considered as more closely related to general technology than traditional percussion instruments. Because technology is often widely and generously

supported at university and college campuses around the country, it opens the increased possibility that outside funding sources may be available to assist with its purchase. Most schools recognize and place value on the need to keep up with technological developments, which are viewed as necessary to keep up-to-date tools for faculty and students, as well as to maintain a forward-looking vision for potential students. As such, most schools maintain a regular rotation of new computers and software and often some peripheral devices. Even outside of the sphere of the typical office computer, special funding may be available to provide for the financial resources required to purchase electronic music tools if a strong case can be made and tied to the student's learning outcomes. For example, I was able to secure a sizable grant through our Provost office that served as seed money for a host of electronic music making tools because a compelling case could be made for the equipment's demonstrated need. Many funding opportunities exist both from within as well as outside the educational campus, but they require the effort involved in seeking them out.

Finally, one of the strengths of a software-based system is that it allows for expansion with the option of easily adding components as there becomes a more demonstrated need. In the context of amassing the resources required to build a comprehensive studio, this has some benefit because all of the prior equipment acquisitions remain relevant in a software configuration. This offers a great amount of flexibility as greater focus and understanding of the system naturally drives future purchasing choices.

Storage and Access

The presence of this equipment within a school studio environment requires the logistical management of the tools to become of paramount importance, otherwise the equipment has a greater risk of becoming damaged through mishandling or potentially stolen. This may require that all students go through an introductory process of understanding the organization, care, maintenance, and accessibility expectations concerning these tools, much like is typically addressed with respect to all percussion instruments within the studio. In certain settings, it may be prudent to encourage students to use their own computers with the other peripherals that the university studio offers, in order to protect and preserve the studio computer, and promote students to develop a gradual sense of investment and familiarity with the equipment. This is similar to the way many percussion programs require students to bring their own peripheral parts, such as a bass drum pedal (or sticks and mallets), to complete a drumset that is otherwise furnished by the school. Considering the personal nature of in-ear or over-the-ear monitors, students should be required to provide those as well, to plug into the sound system provided by the school.

In an ideal situation, the primary teaching studio houses a comprehensive collection of electronic musical equipment that facilitates high quality recording, playback, and monitor routing through an interface, along with other input and controller options. Additionally, a separate space houses a duplicate of this equipment, allows for space to leave electroacoustic setups intact that are currently in progress, and provides proper storage for all gear that is not currently in use. In

this sense, the secondary electronic music space functions much like a "setup room", which is a practice room commonly found in many university percussion studios that provides a space for large or intricate multi-percussion setups to remain intact, thereby saving setup time while they are being prepared and practiced daily. It is imperative that all gear, including cables, is labelled so that it is easily identifiable if accidentally mixed up with other cords and units that look alike. Additionally, each space should have access that is controlled by some kind of key or keycard, with only currently active students with clearance able to gain access. In larger programs, it may be necessary to create a sign out system for room availability.

Considering limitations on space and equipment, it is logistically advantageous to have multiple students working simultaneously on pieces that use the same or similar electronic requirements and workflows. Given that the electroacoustic repertoire is somewhat limited in this sense, this is potentially an area for the literature to develop works designed to be played in tandem within the studio. Ultimately though, the details of size, access, and other resources that are unique to each individual studio will help guide a customized solution that fits the needs of any university teaching environment.

Timeline Expectations

Given the wide variety of instruments, styles, and genres that are essential to comprehensive percussion study at the university level, it is important to be thoughtful about the introduction and developmental progression of each area of percussion study. Although some pedagogical timelines frequently allot time for

focus primarily on one particular area of percussion at a time, often a more successful timeline for development is not always succinctly defined to one time period, area, or set of events, but more broadly fostered over a large period with many tangentially related events that are developmentally impactful. This approach allows for multiple areas of percussion study to be concurrent within a general timeframe in such a way as they can be understood to be beneficial and relevant to one another.

Although perhaps less fundamentally related to a percussionist's development than, for example, snare drum, the study of musical applications for technology within the context of performing is best done over a long period. Although many of the group of exercises that are previously outlined might be attempted in a short time span, decompressing the learning experience by lengthening the exposure time that students have to these tools and concepts fosters more of the reflection and retention that is associated with a liberally grounded education.

One way to do this is to offer one or two introductory classes for new students toward the beginning of the schoolyear that introduces them to basic audio recording and playback skills in order to be able to use electronic tools on other projects throughout the year. This way, students are then equipped to record themselves playing other lesson materials, solos, etudes, or otherwise, on a regular basis. A monthly requirement of the student recording themselves fosters not only a facility with the music technology tools, but offers a meaningful opportunity for them to perform, assess, and reflect critically on their performance in another area

of percussion, such as snare drum, keyboard, or timpani, since a third-party perspective fosters critical thinking and analytical problem solving.

This approach also creates a familiarity with related tools and techniques that paves the way for a deeper level of study of electroacoustic repertoire in the second, third, or fourth year of a four-year program. Being that there seems to exist a best practice of exposure and development to the various types of electroacoustic interactions that a student might encounter (tape works, live processing works, and other), then it makes sense to advance methodically in that order. Second-year student could prepare a tape work, while a third-year student could go through the process of preparing and performing a live processing work, reserving time later in the Junior or Senior year for further exploration. Some students naturally show a greater interest and proclivity toward this repertoire and will consequently be drawn to explore this repertoire at a greater depth or an earlier stage in their personal development. Although a comprehensive university percussion curriculum certainly does not have the time to dedicate an entire academic year solely to an immersive study in electroacoustic music, by organizing the study of electroacoustic techniques with and around that of other primary areas of percussion, a relaxed timeline is able to be administered that also fosters growth in all areas of musicianship. This relates the study of technology to a wider community of both thought and application.

CHAPTER 7

FINAL THOUGHTS

Further Opportunities for Development

While this document addresses some of the pedagogical issues that surround teaching electroacoustic performance practice within the structure of an undergraduate percussion studio, there are a host of other closely related research initiatives that could also strongly impact this area of study. Most closely related to the work in this paper, is an opportunity that I recently became aware of as the newest Chair of the Percussive Arts Society's Music Technology Committee, a position that I accepted long after the start of the document. As Chair, I have been approached by the Electronic Percussion Industry Council (EPIC), whose membership includes companies such as Yamaha, Roland, and Alesis, among others, to develop a codified set of educational guidelines that relate to electronic drums and percussion. If such guidelines were adopted by PAS, they could perhaps function as a common developmental reference which could be used by technology companies and educators alike, much like the NARD list of 26 standard rudiments and extended rudiments have functioned for decades for countless drummers.[82]

Another closely-related initiative that could have a major impact on the full integration of technology within the context of a university percussion curriculum is the creation of a method book that directly addresses relevant music technology

[82] "Welcome to NARD," National Association of Rudimental Drummers, accessed March 25, 2018, http://nard.us.com/Home.html. NARD stands for National Association of Rudimental Drummers, which is an organization whose mission is to protect and preserve a system of standardized rudiments as an anchor for all marching, concert, and drumkit drumming.

tools, techniques, and implementation for a college level percussionist. Although this document presents a thoughtful consideration of these tools, their basic techniques, some possible core competencies, teaching strategies, and its relevance to the world of percussion, it does not serve the need met by a comprehensive method book. Such a text would contain a more concise breakdown of the tools and techniques and include a set of developmentally progressive exercises and etudes that could act as a major addition to the repertoire, citing other similar examples from the canon for each section. Conveniently availing multiple options for repertoire that uses the same or similar electroacoustic setup better enables percussion studios to make more efficient use of practice room space by facilitating multiple students to study different works that use the same instrument and technology setup requirements. A method book on electroacoustic percussion could be a significant educational resource and, ideally, also provide online access to performance software patches and live demonstration and performance footage, perhaps in the context of an e-book.

In addition to adding to the growing body of music that includes both solo and chamber electroacoustic percussion works, there exists an increased need to succinctly catalogue this genre of percussion literature in a place that can be accessed as a reference for students, teachers, and professional performers alike. Currently, the PAS Music Technology Committee is working toward the inclusion of a large database of this repertoire which has taken years to develop to be included as part of a new, much larger database of concert percussion works, which will be known online as the Jeff Moore Database, named after the University of Central

Florida pedagogue who supplied the original core of the concert percussion list as a whole. The database will go live on Monday, November 20, 2017 as a beta test, and will offer a number of different search tools and details about the repertoire as well as a framework to preserve, organize and add to the list as time goes on. The inclusion of electroacoustic works as a distinct category will offer both legitimacy and an easy reference for students and educators around the world.

A Tool for the Teaching Toolbox

Beyond a direct application to the performance of electroacoustic works and a means of developing chamber music skills, these tools and techniques have a broad variety of other important and useful applications, not the least of which is toward the creation of an accurate and professional quality self-produced recording. This is useful in the context of preparing audition recordings for festivals, schools, and other professional opportunities, and perhaps more importantly also helps refine an act that is profoundly important to a musician's development- critical self-listening. When students are in a position to be able to clearly and objectively listen to their sound without having to be engaged with direct performance responsibilities, they are far better able to assess the information and assimilate it in a meaningful and critical way. Reconciling the differences between a performance as heard from an objective recording versus the performer's perception of sound while engaged in the act of performing, is one of the most critical developmental milestones of performance maturity. The opportunity for self-reflection by way of a personal recording can lead to a much deeper level of productive self-awareness.

The ability to maintain a healthy and consistent sense of awareness, both from the stage and audience perspective, produces more connected, expressive, and effective musicians and teachers.

Pedagogy from a Liberal Arts Tradition

University educators within a liberal arts tradition are tasked with providing more than just information. Regardless of any issues of technology, with so many aspects of musicianship to cover as a percussionist in a university music program, the pedagogy surrounding percussion directly appeals to Herbart's previously discussed concept of *moralität*, which is closely related to a "many sidedness".[83] In this many sidedness, different areas of interest make up the whole of the person. To best be able to explore this many sidedness, value must be placed on the concept of freedom. Because liberal academic freedom stands on developing skills, critical thinking, creativity, and internal discipline, in valuing freedom educators can better enable their students to lead a virtuous life through developing the tools that will enable students to confidently stand apart from the teacher once they have left school. In a vast and ever-changing musical landscape, students today need the tools to critically wade through everything before them so that they can make thoughtful, informed decisions on their own. In essence, by following a thoughtful pedagogical model that marries both an academic, or theoretically and knowledge-

[83] Alan Kim, *The Stanford Encyclopedia of Philosophy,* ed. Edward N. Zalta, (Winter 2015 ed.), s.v. "Johann Friedrich Herbart," accessed March 25, 2018, https://plato.stanford.edu/archives/win2015/entries/johann-herbart.

based orientation with a professional, or skill and practice-based orientation, university pedagogues can foster a lifetime of learning by helping students become their own best teachers.

The pursuit of a dialectic signature pedagogy in a modern percussion curriculum requires that educators employ models that alternate experiential and reflective phases of instruction to better create apperception, or the act of actually assimilating learned material into practice. The projects and learning outcomes that I have created throughout this paper merely serve as a set of guidelines that should be considered to facilitate a developmentally efficient and effective approach to teaching electroacoustic percussion at the level of a university undergraduate. It is not intended to be taken as an inflexible directive. Every music program will have a slightly different set of needs, focus, and other issues that affect curriculum content and administration, and should be customized and overseen by the primary teacher. It is my hope that in using a thoughtful signature pedagogy, students might emerge at the end of a four-year degree program with a level of practice and understanding that reflects somewhere between "competent" and "proficient" as relating to electroacoustic aspects of percussion, yet probably less than "expert", as described on Brenner's five-stage professional education development model. In doing so, the student leaves a rigorous program with both a developed skill set that will serve them appropriately in the professional world, combined with a developed theoretical understanding that is based on critical thought and reflection.

The gravity and bearing as to why to adopt a learning process that embraces electroacoustic percussion music further lies in broader questions of music's

function and purpose. When viewed in the context of the more important role of *musician* rather than *technician*, percussionists find the core meaning of their work in being able to share artistic creation. The act of creative expression, which elevates humanity and increases awareness through a meaningful dialogue, is partially conducted by the direct and indirect crafts involved with percussion. A thoughtful approach toward developing the skills that enable awareness, universal appeal, and creating a bridge to broader art forms should therefore be foundational to any thorough course of musical study.

Beyond a Repertoire

As basic aspects of culture and society develop new and different aesthetics while classical music grows increasingly far apart from its origins, proponents of a classical ideal must find ways to remain current that preserve the control, discipline, refined expression, and critical thought that provide its foundation. Percussionists have long since been responsible for the study and execution of an enormous variety of instruments and styles to forge an overreaching and versatile composite voice. By extension, electronic tools and techniques serve as but one more contributing voice for the contemporary percussionist to develop that expand our forms of expression. By not divorcing modern forms and processes of music making from the traditional principles and ideals of classical music, fully informed percussionists extend classical music's relevancy into the 21st century and beyond.

PART TWO

PROGRAM NOTES

As partial fulfillment of program requirements for the Doctor of Musical Arts Degree in Performance at the University of Kentucky, each candidate must present three recitals. The following extended recital program notes provide comprehensive information about each work performed. The notes include repertoire from the following recitals: DMA Solo Percussion Recital on April 4, 2013, DMA Chamber Percussion Recital on October 27, 2018, and the DMA Lecture Recital on April 3, 2015.

Strands of Time by Brian Blume

Brian Blume's innovative 2010 work, *Strands of Time*, is written for solo marching snare drum, Remo TSS, and digital soundscape. *Strands of Time* exemplifies the ever expanding and evolving role that technology plays in redefining the western paradigm of classical percussion with the reinvention of one of the most foundational of percussion instruments, the snare drum. While it may be difficult or surprising to consider a modern marching drum as an instrument suitable to the concert hall rather than a football field, the treatment of the instrument as such truly creates an interesting and unique sonic experience, of which there are few other direct parallels in the concert repertoire. It is probably for this reason that the work has so quickly garnered such a strong reputation as being one of the defining new staples of electroacoustic concert percussion repertoire. This is easily

evidenced by a simple Youtube search, which turns up many performances of the relatively young piece.[84]

It is somewhat ironic, given the composition's fairly recent date, that the Remo TSS pad for which it was originally written is already out of production. This creates an interesting new challenge for the performer to find another musically appropriate instrument on which to interpret the work. In my interpretation, I choose to use a triggered acoustic drum, thus blending the acoustic and electronic sound world in an interaction that skews the perception of the listener concerning both where the sound is coming from and how it should sound. Beyond that, a simple footswitch controlled lamp is integrated into the performance, underscoring Blume's strange and frenetic sonic soundscape. Of the work, Brian states:

> I have often felt that there is a lack of contemporary rudimental snare drum solos written for the concert percussionist and the concert hall, and I hope that *Strands of Time* may be a step in compensating for this lack. This work for marching snare drum, TSS (or smaller snare drum), and CD presents musical challenges that other modern solos might not. The title refers to the idea of multiple strands or threads of music (live and electronic) that interweave and integrate to create a unified whole.[85]

Percussionist, composer, and educator Brian Blume (b. 1985) has performed as a soloist, chamber musician, orchestral player, and studio percussionist. Brian currently serves as Assistant Professor of Percussion at Southeastern University, where he teaches applied percussion, percussion techniques, music theory, world

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[84]Brady Harrison, "Strands of Time" (performance video), posted April 17, 2013, accessed March 23, 2018, http://www.youtube.com/watch?v=kowqsuwaYMA.

[85] Brian Blume, *Strands of Time* (Portland, OR: Tapspace Publications, 2010), 2.

music, and the school's first ever drumline, the Fireline. Prior to his appointment at SEU, Brian taught percussion at Center Grove High School (Greenwood, IN), who boasts one of the nation's premiere high school percussion programs. Brian has also taught several drum corps and the Indiana University Drumline. He is a sought after adjudicator and clinician and has presented at the Percussive Arts Society International Convention, state PAS Day of Percussion events, and several universities and high schools around the country. Brian's compositions for percussion are performed regularly across the country and abroad and are published by Tapspace Publications, PercMaster Publications, and drop6 media. His work for TV broadcast has been aired nationwide on ESPN, CBS, Big Ten Network, and MTV.[86]

Fabian Theory by Nigel Westlake

Fabian Theory is a 1987 electroacoustic percussion work by Australian composer Nigel Westlake. *Fabian Theory* was commissioned by the percussion group *Synergy* with support from the Music Board Australia Council, and recorded by *Synergy* member, Michael Askill. The work is scored for an amplified low "A" marimba, three toms, and digital delay and was originally written for five mallets to be managed by the performer, to which an ossia part for four mallets was added in a later edition.

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[86] "Bio," *Brian Blume Music,* accessed October 6, 2018, https://www.brianblumemusic.com/bio.

In *Fabian Theory*, Westlake uses an echo-like effect, known as digital delay, to reflect and reinvent the marimba, expanding the definition of percussion by focusing inward reflection on one of concert percussion's core instruments, while also spurring the performer to reconceive its sonic possibilities and manner of interaction. He carefully does this by crafting a marimba part that, when combined with the delay, creates an intricate and complex harmonic texture of ever-evolving polyrhythms, punctuated by the percussive intrusions of the toms. Westlake writes, in his notes that are included with the piece:

> An electronic delay system is employed throughout the piece serving to reproduce the "live" signal 566 milliseconds (about a half a second) after it has been played, thereby building a multi-marimba illusion and creating rhythmic counterpoint against a live performance.
> The player is requested to play in tight synchronization with the delay signal & by moving through a number of tempo changes, different rhythmic effects are achieved.[87]

In essence, when the strict instructions of Westlake's carefully crafted score are followed, the player presents the audience with multiple layers of texture that combine to present a kind of super-marimba.[88]

This classic work is a great example of technology expanding the definition of percussion by reframing both the immediacy of what these instruments sound like and how they can interact, especially texturally. At the time this work was written, electoacoustic works, rare but present though they were, tended to focus more on

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[87] Nigel Westlake, *Fabian Theory* (Turramurra, N.S.W., Australia: Rimshot Music, 2003), 1. All Rights Reserved.

[88] Brady Harrison, "Fabian Theory" (performance video), posted April 17, 2013, accessed March 23, 2018, https://www.youtube.com/watch?v=2sW3Opdk5mg.

sonic possibilities that were more centered around the technology or uncontrollable aspects of the process, rather than a new or different reflection of what the original acoustic instrument was at its essence. What might be ironic is that the formidable set of peripheral materials that were needed to perform this work at its inception (digital delay, looping device, etc) are all now succinctly within the confines of a well-equipped laptop computer.

Composer, conductor, and clarinetist Nigel Westlake's career in music has spanned more than four decades. He studied the clarinet with his father, Donald Westlake and subsequently left school early to pursue a performance career in music. From the age of 17 he was touring Australia and the world, performing as a freelance clarinetist, bass clarinetist and saxophonist with ballet companies, a circus troupe, chamber music ensembles, fusion bands and orchestras.

He studied bass clarinet and composition in the Netherlands, served as resident clarinetist with Australia's leading chamber group the Australia Ensemble, and went on to join guitarist John Williams' group Attacca as a composer and performer.

His compositions have earned numerous accolades, including the Gold Medal at the New York International Radio Festival and 15 APRA awards (Australasian Performing Right assoc.) in the screen and art music categories. His song cycle for solo voice & orchestra, *Compassion*, won the 2014 ARIA Award for Best Classical Album.

As a composer for the screen, his film credits include the feature films *Ali's Wedding* (2017), *Paper Planes*, *Miss Potter*, *Babe*, *Babe: Pig in the City*, *Children of the Revolution*, and *The Nugget*, plus the Imax films *Antarctica*, *The Edge*, *Imagine*, *Solarmax* and numerous others. His television credits include documentaries, telemovies, news themes and station idents. The feature film *Babe* won the Golden Globe Award in 1996 for best feature musical/comedy, and his romantic score for *Miss Potter*won Feature Film Score of the Year and Best Soundtrack Album at the 2007 APRA / AGSC Screen Music Awards.

His secular mass *Missa Solis - Requiem for Eli* was winner of the prestigious 2013 Paul Lowin Orchestral Prize, won the 2011 Limelight Award for Best New Composition, was named Orchestral Work of the Year at the 2012 APRA Art Music Awards, and was released to critical acclaim on the ABC Classics label by the Melbourne Symphony Orchestra, conducted by the composer.

Other notable conducting credits include the Queensland Symphony Orchestra, Melbourne Symphony, the New York Philharmonic, and the ABC National Radio in the Netherlands.

He is founder of the Smugglers of Light Foundation in memory of his son Eli, to promote cultural awareness and empowerment through education via the mediums of music and film in youth and indigenous communities.[89]

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[89] "Nigel Westlake: Represented Artist", *Australian Music Centre,* accessed October 6, 2018, https://www.australianmusiccentre.com.au/artist/westlake-nigel.

***Temazcal* by Javier Alvarez**

One of the first truly indisputable, classic, and quintessential examples of electroacoustic solo percussion repertoire is Javier Alvarez's, *Temezcal,* for maracas and tape. Alvarez wrote this work in 1983 and 84 while he was studying composition and electroacoustic production techniques at the Royal College of Music in London. The work is scored for maracas and a prerecorded soundscape, for which he supplies an elaborate graphic score along with very specific performance instructions that govern not only the style of the percussion playing, but also the live audio playback. Of the piece, Alvarez writes,

> Temazcal (Alvarez, 1984) stems from the Nahuatl (ancient Aztec) word literally meaning "water that burns." The maraca material is drawn from traditional rhythmic patterns found in most Latin – American musics, namely those from the Caribbean region, southeastern Mexico, Cuba, Central America and the flatlands of Colombia and Venezuela. In these musics in general, the maracas are used in a purely accompanimental manner as a part of small instrumental ensembles. The only exception is, perhaps, that of the Venezuelan flatlands, where the role of the maracas surpasses that of mere cadence and accent punctuation to become a soloistic instrument in its own right. It was from this instance that I imagined a piece where the player would have to master short patterns and combine them with great virtuosity to construct larger and complex rhythmic structures which could then be juxtaposed, superimposed and set against similar passages on tape, thus creating a dense polyrhythmic web. This would eventually disintegrate clearing the way for a traditional accompanimental style of playing in a sound world reminiscent of the maracas' more usual environment.
>
> The sound sources on tape include harp, a folk guitar and double bass pizzicatti for the tape's attacks, the transformation of bamboo rods being struck together for the rhythmic passages and rattling sounds created with the maracas themselves for other gestures.

> The piece is dedicated to Luis Julio Toro who first performed it at the East Mountain Artist Series in London in January 1984. [90]

Since receiving an honorable mention at the 1985 Bourges Electro-Acoustic Music Festival, *Temazcal* has become part of the contemporary percussion repertoire and is regularly performed and broadcast worldwide.

Although the original work was first produced using traditional tape techniques at the time, the work has since been transferred to a digital format and both the music and soundscape are sold and distributed today as an online package of electronic files, available through his website, www.temazcal.co.uk.

There are many unique and specific performance challenges to this piece besides managing the electronics. A few challenges include developing the technique and musicality of Venezuelan Joropo style maraca playing, being able to improvise effectively in multiple idioms, and interpreting a graphic score.

The score of *Temazcal* represents an outline of the maraca part as well as a graphic depiction of the computer-generated tape that the performer interacts with during the performance. See figure 1. Even a cursory examination of the score reveals how extremely intricate the electronic soundscape is. The performer's job then becomes to perform the maraca part, both preconceived and improvised, in close coordination and reaction to the soundscape, using the Joropo inspired cells that the composer offers as building blocks (see figure 2). Once the prerecorded tape dissolves into Joropo folk music near the end of the work, the listener is

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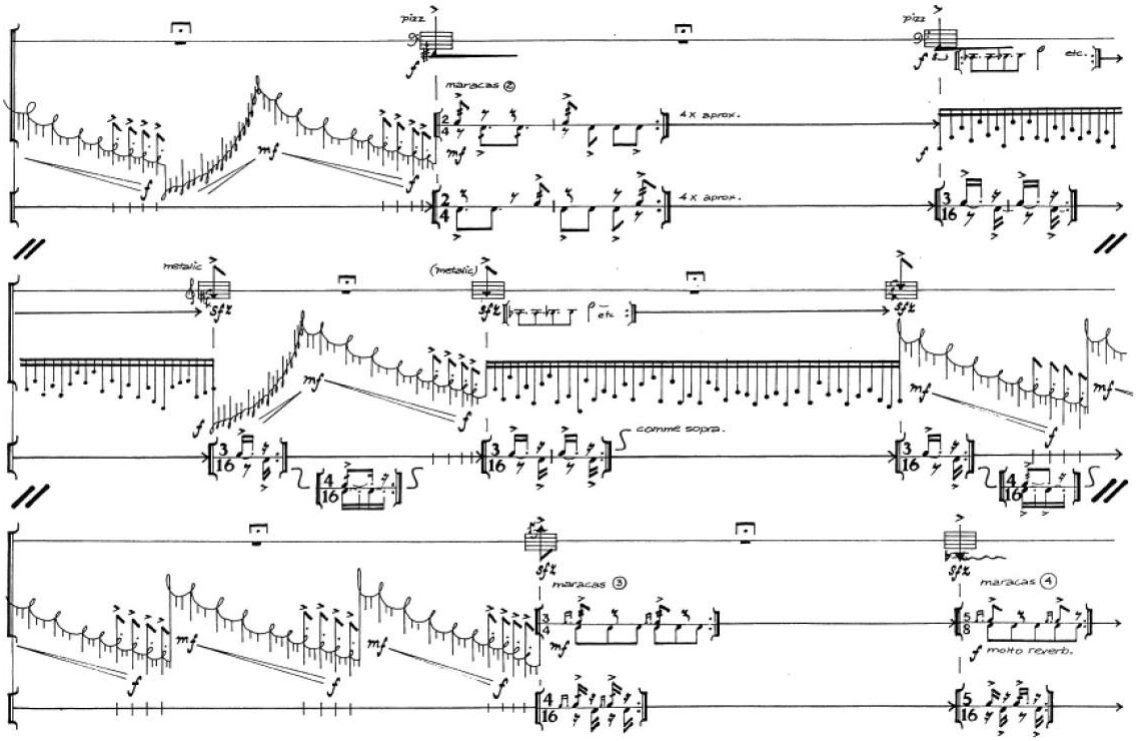
[90]Javier Alvarez, "PASIC Tech Day Performance Notes and Session Abstracts," *The Donald Tavel Arts and Technology Research Center,* accessed March 23, 2018, http://music.iupui.edu/research/uncategorized/pasic-tech-day-abstracts-and-program-notes/.

transported from an alien sound to a very simple and grounded musical style, with the common thread of the maracas cleverly and unpretentiously bridging the gap between the two. When a performer looks at the relationship between the electronic recording and the maraca part from a musical perspective, it seems clear that more than being a solo work, the essence of the piece is actually chamber music, and more specifically, a duet.[91]

Figure 1. Javier Alvarez, Temazcal, P. 5.[92]



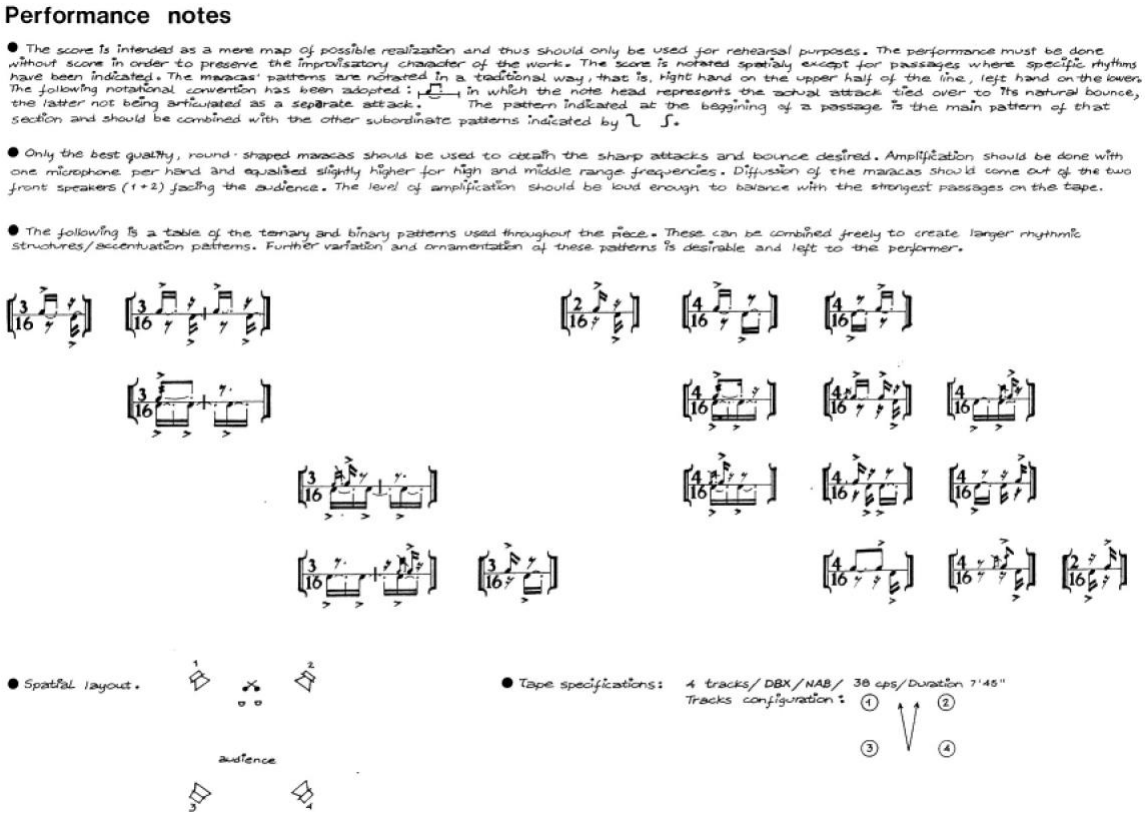
Furthermore, the marriage of the folkloric and the almost alien quality of this work can be even better expressed through an effective visual interpretation. Using

[91] Brady Harrison, "Temazcal" (performance video), posted April 19, 2013, accessed March 23, 2018, https://www.youtube.com/watch?v=GW8vC4NF4oQ.

[92] Javier Alvarez, *Temazcal* (London: Black Dog Publications, 1984), 5. All Rights Reserved. Used with permission.

a cost-effective scrim screen and lights, I merge a lighted backdrop of the physical gestures that are being executed live with a video that was made expressly to accompany the work into one cohesive visual component that works seamlessly with the score. http://www.youtube.com/watch?v=GW8vC4NF4oQ

Figure 2. Javier Alvarez, *Temazcal*, Performance Notes, P. 2.[93]



[93] Javier Alvarez, *Temazcal*, 2. All Rights Reserved. Used with permission.

Javier Álvarez Fuentes (born May 8, 1956, Mexico City) is a Mexican composer who is known for creating works that combine a variety of international musical styles and traditions that often utilize unusual instruments and new music technologies. According to composer John Adams, "The music of Javier Alvarez reveals influences of popular cultures that go beyond the borders of our own time and place." Álvarez is one of the best-known Mexican composers of his generation and many of the works in his prolific oeuvre combine music technology with diverse instruments and influences from around the world.[94]

Violin Phase by Steve Reich

Steve Reich's 1967 classic, *Violin Phase,* is originally scored for four violins, although Reich also includes instructions as how one violinist might realize the work using a sound engineer and a set of prerecorded tapes. As is the case with many of Reich's early phase works, this literature is often performed on different instruments. Taking the original performance instructions into strict accord, I realize the entire work as a soloist using all real-time looping techniques using Ableton Live and a MIDI foot controller. Other additional performance choices for a modern electronic interpretation of the piece could include not only what instrument to perform it on, but what sounds to use and how they might be manipulated taking into consideration the work's origins. Additionally, the quadraphonic spacial assignments allow each of the four parts to be individually

[94] "Javier Alvarez," *Wikipedia*, accessed October 7, 2018, https://en.wikipedia.org/wiki/Javier_Álvarez_(composer).

distinctive in a way that only technology can offer, yet blend seamlessly into the transparent and trancelike composite that is the essence of this style of music. http://www.youtube.com/watch?v=Iyr_Gs0OGOY Of the work, the composer states:

> Late in 1967 I became clearly aware of the many melodic patterns resulting from the combination of two or more identical instruments playing the same repeating pattern one or more beats out of phase with each other.
>
> As one listens to the repetition of the several violins in *Violin Phase* one may hear first the lower tones forming one or several patterns, then the higher notes are noticed forming another, then the notes in the middle may attach themselves to the lower tones to form still another. All these patterns are really there; they are created by the interlocking of two, three, or four violins all playing the same repeating pattern out of phase with each other. Since it is the attention of the listener that will largely determine which particular resulting pattern he or she will hear at any one moment, these patterns can be understood as psychoacoustic by-products of the repetition and phase-shifting. When I say there is more in my music than what I put there, I primarily mean these resulting patterns.
>
> Some of these resulting patterns are more noticeable than others, or become noticeable once they are pointed out. This pointing-out process is accomplished musically by doubling one of these preexistent patterns with the same instrument. The pattern is played very softly, and then gradually the volume is increased so that is slowly rises to the surface of the music and then, by lowering the volume, gradually sinks back into the overall texture while remaining audible. The listener thus becomes aware of one pattern in the music that may open his ear to another, and another, all sounding simultaneously in the ongoing overall texture.[95]

"Sound Off!" from 14 Modern Contest Solos for Snare Drum by John S. Pratt

Sound off! by John S. Pratt is a classic rudimental solo from his vitally important 1959 collection of rudimental solos, book *14 Modern Contest Solos for*

[95] Steve Reich, *Writings on Music- 1965-2000,* (Oxford University Press, 2002), 26.

Snare Drum. It is a quintessential example of the concept of "open" snare drum performance paradigm, and although militaristic in its performance style, the piece, similar to all traditionally rudimental solos, has a flow that underpins its proper and stylistically appropriate performance. While rudimental drumming is often seen as being counter to the aesthetics of concert (closed style) performance, the foundational development that is gained from its practice of open/double stroke rolls is crucial to the development of high level concert snare drum performance and overall musicianship.

John Pratt is one of the foremost progenitors of classic rudimental snare drum performance. He is author to many published rudimental works, and served as an active member of the U.S. Army's Field Music Unit, known as the "Hellcats" where he eventually became an instructor and arranger over his twenty-year service. He has taught and adjudicated many drum corps over his extensive career and has remained active in the rudimental percussion community as a composer, teacher, and performer.

Etude 9 **by Jacques Delecluse**

Etude 9, from Jacques Delecluse's *Twelve Pieces for Snare Drum* (1964), is well regarded as a challenging staple of the concert snare drum repertoire. Hallmarks of his style include extreme contrasts of dynamics and virtuosic technical demands. Often rhythmically disorienting, his work exemplifies the French style of concert snare drum that has become a musical cornerstone to modern concert snare drum performance.

Delecluse was born in 1933 and passed away in 1915, at age 82. He had a prolific and varied musical career. As a composer, he is responsible for an enormous output of monumentally important percussion method and etude collections. He taught for decades at the Paris Conservatory, where he was an immense influence on the multitude of students that emerged from their program. He was a long-standing member of both the Paris Opera as well as the Orchestra of Paris.

Scheherazade, Mvt III and Mvt IV Snare Drum Excerpts

Scheherazade, Op. 35, is a symphonic suite composed by Nikolai Rimsky-Korsakov (1844-1908) in 1888 and based on *One Thousand and One Nights* (also known as *The Arabian Nights)*.[96] Because the dense orchestral work's lush texture and rich thematic materials so strongly evoke impressions of the Indian and Arabic folk tales that are well known to have inspired the music, it is often regarded as an archetype for program music's story telling qualities.

From a pedagogical perspective, the excerpted selections from this performance of the snare drum part of Scheherazade demonstrate well the rationale for studying both open and closed style snare drum performance practice as well as a broader reason to explore solo snare drum literature in general. Given the specific notation and the historical performance practice of the piece, both military precision and execution as well as closed concert artistry are necessary to an

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[96] *Julius H. Jacobson; Kevin Kline, The classical music experience: discover the music of the world's greatest composers. New York: Sourcebooks, 2002, 181. ISBN 978-1-57071-950-9.*

informed and meaningful performance of the work. More importantly though, this excerpt exemplifies a main reason that the solo snare drum study has meaning to begin with, which is to facilitate thorough preparation for broader collaboration with other voices in the context of a greater musical achievement.

Bourree in D Minor by J. S. Bach

The *Bourree in B Minor* is the last movement from the *Partita 2, in B Minor*, which is one of the collection of six solo violin works written by J. S. Bach (1685-1750). Even after nearly three hundred years from its publication in 1720, Bach's three violin and sonatas and three partitas constitute some of the most important solo violin repertoire in the literature. This partita form uses not only a series of dance movements (Allemanda, Corrente, Sarabande, and Tempo Di Borea), but also explores variation in each movement in the form of a double for each movement, which functions as a musical outgrowth of previous material. Given that this solo violin repertoire was originally written for a different instrument so long ago, it may seem odd that this work might relevant enough to contemporary percussion performance to be chosen as suitable material for a percussion recital. However, Bach's music has lasting and profound benefits from its study that includes not only the satisfaction of playing great repertoire, but developing expression and fostering the ability to think intelligently from a different musical perspective, which makes for a more sensitive, informed, and developed musician.

***Three Designs for Three Timpani*, Op. 11, No.2, by Robert Muczynski**

Three Designs for Three Timpani is a set of three short pieces for timpani, composed and published by Polish-American composer Robert Muczynski (1929-2010) in 1961. Each movement is a brief character sketch, evoking a contrasting mood from the others. The first movement, *Allegro Moderato*, uses rhythmic interplay and glissandos to create a bold musical statement, while the second movement, *Allegretto*, explores delicate nuance of touch within the context of a stately waltz. The final movement, *Moderato, Allegro Molto*, is a driving work that explores the sonic possibilities of the instrument through the use of a perpetual motion motive and syncopated accents, as well as nontraditional playing techniques, including altering the beating spot on the drums. Again, this program asks the question of what the relevance of the study solo timpani literature has in the context of a university percussion program structured for the twenty-first century. I believe this literature demonstrates the continued relevance of the application of this repertoire not as a means to an end unto itself, but in the broader context of preparing musicians, being more than just percussionists, for the broader world of music making. The ability to thoughtfully and commandingly deliver a musical statement remains relevant in an ever-evolving music marketplace.

***The New Virginia Reel* by Brady Harrison**

I wrote The New Virginia Reel in 2015 as a multiple percussion piece for snare drum, bones, Tibetan cup gong, and wood block that explores each individual instrument's function in nontraditional ways. By taking each instrument out of its

traditional setting and role, the combination creates a new identity for all of the instruments within a collectively new vehicle for expression. The setup is intentionally designed to consume a relatively small footprint for a multiple percussion work, making the logistics more manageable when traveling. The snare drum acts as the table for both the woodblock and the cup gong, while the bones are played in one hand. Each of the four instruments represents a different natural physical material that is often represented in the context of percussion instruments; most commonly skin, wood, and metal, and less commonly, bone. Each instrument has deep roots in its own right. For example, I brought the Tibetan cup gong back from India when I was visiting the headquarters of the Tibetan government in exile in Dharamshala following a concerto performance that I had with the Bombay Chamber Orchestra. There in India, the role of the cup gong was one of focused meditation, generally without it being accompanied by any other intentional sound. When paired with these other instruments, especially snare drum and bones, which each are also steeped in very different histories and performance practices, it takes on a new persona and perhaps an even deeper meaning. The name for *The New Virginia Reel* comes from a reference to the reimagining of a traditional Irish jig, which the bones are traditionally tied to. I also found the sounds of Stravinsky's *L'Histoire Du Soldat* and David Lang to be influential, so, as a result, it's quite possible that one might hear what could be imagined would be the outcome if David Lang wrote a meditative multi-percussion jig in the style of Stravinsky. Hopefully, The New Virginia Reel provides an example of how as percussionists we make forward progress not only in continuing to refine our current techniques or in

developing new sounds and instruments, but also in reinventing our existing instruments in new ways to find an ever-expanding voice that embraces the beautiful diversity of percussion. In this way, our art form continues to remain consistently adaptable.

21 by Andy Akiho

21, originally written for cello, electronics, and steel pan, also requires the performers to use a variety of other percussion sounds, including bass drum, tambourine, hand claps, and striking nontraditional parts of the marimba, such as the resonators. This is a marimba adaptation of the original work, and for the performance today I have chosen to play some of the open choice sounds on metal instruments including a long black iron pipe, a cowbell, and a brake drum. To execute the loops, we are using Ableton Live, as triggered from a foot pedal that we are using on stage. Of the work, the composer states:

> "21" was written for Mariel Roberts in October 2008. After meeting Mariel at the Bang on a Can Summer Music Festival, I was impressed with her effortless sense of rhythm and musicality on the cello. I first realized her talent when we performed "I *falle*N T*w*O" for string quartet and steel pans. Amazed by her technical virtuosity and vivid musical interpretation of the piece, I was inspired to write a new duet for cello and steel pan. The cello part requires the performer to play a kick drum and operate a loop pedal while simultaneously playing the cello. The pan part requires the performer to play one regular tenor pan, an option prepared bore pan with rubber bands (mimicking Bartók/snap pizzicatos), and a tambourine with the foot. The title "21" refers to the twenty-first measure of the Fugue movement in J.S. Bach's *Violin Sonata #1 in G minor*. The harmonic chords of this measure are the inspiration of the sequence of

notes for "21." Coincidentally, Mariel Roberts was 21 years old when the piece was written and premiered.[97]

Andy Akiho, born 1979, is one of the young composition visionaries of our time. Growing up in Columbia, South Carolina, he attending school at USC, Manhattan School of Music, Yale, and Princeton. His early professional work is as a percussionist whose primary instrument is steel pan, although his work as a composer has become a focal point of his output. He has scores of compositions to his name for mixed ensembles and holds a dizzying array of accolades for his work, including the prestigious Luciano Berio Rome Prize, the Lili Boulanger Fund, and the Horatio Parker Award, among others. Andy currently resides in New York city and remains active in new composition projects as well as performance.

Things We Dream About by Ivan Trevino

Things We Dream About, by Ivan Trevino, is a four-movement work for flute, percussion, and electronics. Each of the short movements is built on and characterized by a specific theme related to dreams, and the composer sometimes calls for electronic effects to be applied to the live flute performance to enhance some of the dream-like qualities of the piece. The composer offers the following program notes:

"In dreams, emotions are overwhelming."
- From Michael Gandry's film The Science of Sleep

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[97] Andy Akiho, "21", *Andy Akiho Music,* accessed October 8, 2018, https://www.andyakiho.com/store/p18/21.html.

> Dreams are both bizarre and beautiful, and I'm reminded of this each time I see Gandry's film, (and each time I wake from a weird-ass dream!) Dreams often times exaggerate our emotions and sometimes help us experience things we cannot experience in real life.
>
> Love, success, clairvoyance, and happyness are four things we all dream about, and four sources of inspiration for this piece.
>
> I. Love
> We all long for it. Sometimes we find it. Sometimes we loose it. We never forget the first time we fall in love, or the last time we fall in love.
>
> II. Being a Rock Star
> Growing up as a young classical percussionist, I often hoped and dreamed that Radiohead had a "marimba" vacancy. It never happened, but that didn't stop me from dreaming about it.
>
> III. Ghosts
> Inspired by the opening scene of Gandry's film. I often dream about dead relatives and loved ones. Talking to them, embracing them, wishing they were still here.
>
> IV. Fun!
> Ever wake up from a dream, smiling and laughing? Those are the best! This is a pop tune inspired by Matt & Kim, a keyboard and drum duo I like from Brooklyn.
>
> Things We Dream About was commissioned by A/B Duo in 2013. It's a duo for a flutist and percussionist, and is scored for amplified C-flute, bass flute, vibraphone, and drum set.
>
> - Ivan Trevino, July 2013[98]

Ivan Trevino (b.1983) is a Mexican-American composer and percussionist who has become a recognizable voice in the percussion community. His honest blend of contemporary, percussive and indie-rock compositions have become standard repertoire in the field of percussion and are regularly performed around

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[98] Ivan Trevino, *Things We Dream About* (Ivan Trevino, IvanDrums.com, 2013), 1. All Rights Reserved.

the world. He is a multi-award winning recipient of the Percussive Arts Society's International Composition Contest and has over 70 compositions and songs to his name, many of which were commissioned by leading performers and institutions in the field.[99]

Once Removed by John Fitz Rogers

Once Removed, by John Fitz Rogers, is a unique work for two marimbas written in 2003. The overriding musical premise of the work is that the two instruments play exactly offset from one another by one sixteenth note for the entire piece, thus creating a ten minute hocket that requires a click track for proper coordination. The title refers to the aspect of having to be removed from the typical listening relationship when playing a duet with another instrument, instead, focusing on the click track (rather than the actual performer) in order to play with the duet partner. Of *Once Removed*, the composer says:

> "Once Removed" is based on a simple premise: two marimbists play the same or related music at a fairly fast tempo, but they almost never play together. Individually, each performer must execute fairly simple patterns with great rhythmic precision, and to help, each listens to a click track over headphones supplied by an audio CD. However, what is recorded on the CD are two different click tracks on the separate left and right stereo channels (one performer listens to the left channel, the other to the right channel). Though both click tracks proceed at the same tempo, one track stays at a fixed distance behind the other, which mean that one performer is always slightly "behind" the other performer. When their individually simple patterns are combined in performance, the resulting mosaic is both very fast and quite complex—something

[99] Ivan Trevino, "Bio", *Ivan Trevino,* accessed October 8, 2018, https://ivandrums.com/biography/.

> that sounds more like one "super marimba" than two individual lines. Of course, the conceptual challenge for the performers is difficult, even though the patterns themselves are not overly virtuosic. Musicians are trained to communicate and to play together, yet in some ways this work entails not listening to each other. Though the technology of multiple click tracks creates new possibilities of texture and ensemble precision, the trade-off in "Once Removed" is that each player remains somewhat isolated from the instrument he or she plays, and more importantly, musically separated from the other performer, like two people trying to reach one another from opposite sides of a thin glass pane.[100]

Composer John Fitz Rogers's music has been performed by ensembles, festivals, and venues such as Carnegie Hall, Bang on a Can Marathon, Pittsburgh New Music Ensemble, Los Angeles County Museum of Art, National Cathedral, the Albany, Louisville, Charleston, and Tulsa Symphony Orchestras, New York Youth Symphony, Eastman Wind Ensemble, the MATA, Rockport, Bumbershoot, Bowling Green, and Keys To The Future festivals, Festival of New American Music, Phillips Collection Concert Series, and the College Band Directors National Association national conference, as well as by individuals and chamber ensembles such as Antares, New Century Saxophone Quartet, Capitol Quartet, Lionheart, Composers, Inc., Opus Two, Meehan/Perkins Duo, Bent Frequency, Ambassador Duo, guitarist Michael Nicolella, pianist Marina Lomazov, and bassoonist Peter Kolkay.

A dedicated advocate for contemporary music, Rogers founded and directed the Southern Exposure New Music Series, which received the 2005-06 Chamber Music America / ASCAP Award for Adventurous Programming. He holds degrees in music from Cornell University, the Yale School of Music, and Oberlin College, where he studied composition, piano, and conducting; his composition teachers included

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[100] John Fitz Rogers, *Once Removed* (Columbia, SC: Base Two Music Publishing, 2003), 2.

Steven Stucky, Roberto Sierra, Martin Bresnick, and Jacob Druckman. Rogers has served on the faculties of Cornell University and the Longy School of Music, as composer-in-residence for the Chamber Music Conference and Composers Forum of the East, Conductor's Institute of South Carolina, and the Southeastern Piano Festival, and as visiting faculty for the Composition Intensive Program at the Yellow Barn Chamber Music Festival. Rogers is currently Professor of Composition at the University of South Carolina School of Music and visiting faculty at the Vermont College of Fine Arts. His work is published by Base Two Music Publishing.[101]

Movement 1: "Mom's Wisdom", from *Hair, Cloth, and Thread* by Valerie Coleman

Hair, Cloth, and Thread is a 6-movement work for percussion and flute that Heather and I were part of a commission consortium for in 2016. Because of the extended length of the entire set, we are only performing the first movement today, and will segue without pause, into the following piece, *Flute and Bongos 1*, by Alec Wilder. The first movement of Coleman's work, titled, *Mom's Wisdom*, paints an almost mystical image using bowed vibraphone, rattles, and a very lyrical and exotic flute part that offers options for bass, contrabass, alto, or C flute. The work has accompanying images to frame the inspiration of each movement. Of the work, the composer states:

[101] "Bio", *John Fitz Rogers,* accessed October 9, 2018, http://www.johnfitzrogers.com/bio.html.

> Hair, Cloth, and Thread is a 6-movement suite with multi-disciplinary option that merges the works of visual artist Sonya Clark with a tapestry of sounds and colors made possible through various instruments from the flute family and percussion duo. The piece honors hair styles as a veritable art that challenges conventional usage of textiles for installation pieces. Like Clark's collection, the soundscape expresses the complicated history of textile production in the United States from slavery to the modern era and translates the discussion of race into an earthy, vivid edgy musical palette of orchestral colors and rhythm. Percussion instruments include: Marimba, Vibraphone, Congas, Bongos, Drum Kit, Crotales and a variety of hand held percussion.
> The work will be performed starting in 2016 through a consortium led by the Aark Duo: Virginia Commonwealth Faculty members Tabitha Peters and Justin Alexander.[102]

Described as one of the "Top 35 Female Composers in Classical Music" by critic Anne Midgette of the Washington Post, Valerie Coleman (B. 1970) is among the world's most played composers living today. Whether it be live or via radio, her compositions are easily recognizable for their inspired style and can be throughout venues, institutions and competitions globally. The Boston Globe describes Coleman as a having a “talent for delineating form and emotion with shifts between ingeniously varied instrumental combinations” and The New York Times observes her compositions as “skillfully wrought, buoyant music”. With works that range from flute sonatas that recount the stories of trafficked humans during Middle Passage and orchestral and chamber works based on nomadic Roma tribes, to scherzos about moonshine in the Mississippi Delta region and motifs based from

[102] “Projects,” *Valerie Coleman Flutist and Composer*, accessed October 9, 2018, https://www.vcolemanmusic.com/projects.html.

Morse Code, her body of works have been highly regarded as a deeply relevant contribution to modern music.[103]

Flute and Bongos No.1 by Alec Wilder

Like several of the works that Alec Wilder (1907-1980) wrote for wind instruments and percussion accompaniment, *Flute and Bongos No. 1* (originally written in 1958, published in 1976) requires the percussionist to improvise on an instrument of their choice, as there is no written percussion part. This fact makes each performance of the work highly customizable, and for today's performance, I will be playing on an amplified Udu drum that is being run through an effects processor. The wispy quality of the opening, leading to a more driven, groove oriented body, make this an effective pairing with Valerie Coleman's *Mom's Wisdom*, and as such we will be performing these two works today as part of a set, without break.

Garage Drummer by James Campbell

Garage Drummer was original composed as a multiple percussion solo with soundscape accompaniment. The version that we are playing today was rescored in xcv for percussion ensemble and percussion soloist, where the prerecorded parts from the original version have been scored onto the percussion ensemble of six players. The ensemble members perform on a variety of instruments, including

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[103] "Biography," *Valerie Coleman Flutist and Composer*, accessed October 9, 2018, https://www.vcolemanmusic.com/about.html.

mallets instruments, auxiliary percussion, drum set, and timpani. Of the work, James Campbell states:

> *Garage Drummer* was inspired by my memories of rock band jam sessions (commonly known as garage bands) held in various household basements and garages. The occupants of the host household, at first, notice little more than random noises and feedback seeping through the walls of their living room. As the jam session unfolds, the drummer's experiments with sounds, grooves, and fills increase with confidence and join a cacophony of wild guitar, bass, and keyboard riffs. As usual, the drummer not only ends up driving the band, but also drives the occupants out of the house! I have to say that I've served on both ends of the experience as a drummer and a parent.
>
> Garage Drummer won first place in the 2005 PAS Composition Contest and was premiered by Rob Parks.[104]

James Campbell has received worldwide recognition as a performer, pedagogue and author, and is a figure in the development of the contemporary percussion ensemble. He has toured extensively throughout The Americas, Europe, and Asia. Currently Provost's Distinguished Service Professor of Music and Director of Percussion Studies at the University of Kentucky in Lexington, he also holds the positions of Principal Percussionist with the Lexington Philharmonic, drummer with the Kentucky Jazz Repertory Orchestra, and Past President of the Percussive Arts Society. He has numerous accolades for both his performing and his teaching, and among his award-winning works for percussion, Jim has published with Meredith Music, C. Alan Publications, Innovative Percussion, Row-Loff Productions, Bachovich Music Publications, Alfred Publications., and Tapspace Publications. Jim is an artist

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[104] James Campbell, *Garage Drummer* (Innovative Percussion, 2006, rev. 2011), 1.

and endorsee for Innovative Percussion, Evans Drumheads, Meinl Percussion, and a member of the Black Swamp Percussion Educator Network. He is an Artist and Educator for the Avedis Zildjian Cymbal Company and a Performing Artist for Yamaha Corporation of America, Band & Orchestra Division, who recently presented him with their Legacy Award.[105]

[105] "James Campbell," *Innovative Percussion*, accessed October 9, 2018, http://www.innovativepercussion.com/artists/james_campbell).

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Young, Rob. *Undercurrents: The Hidden Wiring of Modern Music.* London: Continuum, 2002.

WILLIAM BRADY HARRISON II

SELECT CURRICULUM VITAE

Educational Institutions and Degrees Awarded

2012-2019 University of Kentucky, School of Music, Lexington, Kentucky
Doctor of Musical Arts Degree in Percussion Performance
TORA Scholar full tuition award
Dissertation Topic: *Finding the "Tech" in Technique: Developing a Pedagogical Approach to Electroacoustic Concert Percussion Performance*

1996-1998 University of Cincinnati College-Conservatory of Music (CCM), Cincinnati, Ohio
Master of Music Degree in Percussion Performance
Full Merit Based Scholarship

1992-1996 Vanderbilt University, Blair School of Music, Nashville, Tennessee
Bachelor of Music Degree in Percussion Performance, Concentration in Composition
Blair Honor Scholarship, Dean's List, Vice President of Graduation Class

2018 The Recording Workshop
CORE and Advanced Program
Honors Graduate. Covered all aspects of recording engineering, music production, and live sound engineer in a comprehensive and immersive campus based setting with state of the art studio facilities.

Professional Teaching Positions Held

2005-19 **Adjunct Professor of Music, Director of Percussion Studies, Xavier University**, Cincinnati, Ohio

2018-19 **Adjunct Professor of Music, University of Dayton**, Dayton, Ohio

2005-15 **Instructor of Percussion, University of Cincinnati College-Conservatory of Music (CCM), Preparatory Department**, Cincinnati, Ohio

2004-19 **Private Studio Executive Coordinator and Teacher, The Studio**, Cincinnati, OH

2007-2011 **Percussion Instructor, Steelband Director, and Substitute Band Teacher, Cincinnati Hills Christian Academy**, Cincinnati, Ohio

Professional Orchestral Positions Held

Principal Timpani	Lexington Philharmonic	1999-2019
Section Percussion	Louisville Orchestra	2004-2019
Principal Timpani, Substitute	Columbus Symphony	2019
Principal Percussion	Louisville Ballet	2016
Section Percussion	Cincinnati Ballet	2016
Principal Percussion	Lyrique En Mer Festival, Belle Ile, France	2004-2009
Extra Percussion	Cincinnati Symphony Orchestra	2005-Present
Extra Percussion	Cincinnati Pops Orchestra	2005-Present
Principal Percussion	Clermont Philharmonic	2008-Present
Percussion	Springfield Symphony	2003-2006
Extra Percussion	Dayton Philharmonic Orchestra	2005-2008
Percussion	Kentucky Symphony Orchestra	1998-2005
Percussion	Peninsula Music Festival	2003
Extra Percussion	Richmond Symphony	1999-2009
Principal Perc/Timpani	Rome Festival Orchestra, Italy	1994

Scholastic and Professional Honors

Solo Recital, Mini Desk Concert, University of Dayton	Dayton, OH	2019
Sō Percussion Concert, Guest Performer	Lexington, KY	2018
Percussion Chamber Recital	Lexington, KY	2018
Featured Chamber Musician, Christ Church Cathedral	Cincinnati, OH	2018
Panel Moderator, PASIC	Indianapolis, IN	2018
Featured Artist, Percussive Arts Society International Convention	Indianapolis, IN	2017

Guest Artist, Campbellsville University Percussion Ensemble Festival	Campbellsville, KY	2017
Guest Artist and Clinician, Ohio Day of Percussion	Toledo, OH	2017
Solo Performance, Percussive Arts Society's International Convention	Indianapolis, IN	2016
Guest Artist, Xavier University Men's Chorus	Cincinnati, OH	2016
Guest Artist, American School for Indian Art	Cincinnati, OH	2016
Guest Artist, Cincinnati Boys Choir	Cincinnati, OH	2016
Featured Faculty Soloist, Xavier University Concert Choir	Cincinnati, OH	2016
A. Frank and Bethel C. Gallaher Memorial Music Performance Competition, Adjudicator	Morehead, KY	2016
Featured Faculty Soloist, Xavier University Men's Chorus	Cincinnati, OH	2015
Guest Artist, National Flute Association Convention	Washington DC	2015
Guest Artist, University of Cincinnati College-Conservatory of Music	Cincinnati, OH	2015
Guest Panelist, PASIC	Indianapolis, IN	2015
Solo Recital, James Madison University	Harrisonburg, VA	2015
Solo Performance, Kentucky Day of Percussion	Lexington, KY	2015
Concertino Soloist, *Crouching Tiger Concerto for Cello, Percussion, and Chamber Orchestra*, Lexington Philharmonic Orchestra	Lexington, KY	2015
Featured Guest Soloist, Xavier University Honor Band	Cincinnati, OH	2015
Solo Performance, Percussive Arts Society International Conference	Indianapolis, IN	2014
Music in the Museum Series w/ Peter Richard Conte, Museum Center	Cincinnati, OH	2014
Solo Performance, Percussive Arts Society International Conference	Indianapolis, IN	2013
Solo Recital, University of Kentucky	Lexington, KY	2013
Guest Artist, Knox Music Series	Cincinnati, OH	2013
Guest Artist, Cincinnati Boychoir and Cincinnati Youth Symphony	Cincinnati, OH	2013
Solo Recital, Xavier University	Cincinnati, OH	2013
Regularly Featured Performer with Concert:Nova Chamber	Cincinnati, OH	2008-

Ensemble		13
Soloist with MSCMS for Lexington Philharmonic Orchestra, Audible and Edibles Series	Lexington, KY	2007
Soloist with MSCMS for Xavier University Spring Music Festival	Cincinnati, OH	2007
Featured Performer for Music at Covenant Series	Cincinnati, OH	2006
Performer for National Flute Association Convention	San Diego, CA	2005
Concerto Soloist, *The Glory and the Grandeur*, Lexington Philharmonic Orchestra	Lexington, KY	2005
Guest Performer on New Music X Festival	Cincinnati, OH	2005
Staff Accompanist, Cincinnati College-Conservatory of Music	Cincinnati, OH	97-06
Staff Accompanist, School for the Creative and Performing Arts	Cincinnati, OH	04-05
Composer of and Soloist on *Ballet Der Sprecht*, University of Cincinnati College-Conservatory of Music's Dance Division Faculty Spring Concert	Cincinnati, OH	2004
Guest Artist, Cincinnati Ballet	Cincinnati, OH	2003
Featured Performer on All Crumb Concert, with George Crumb at University of Dayton	Dayton, OH	2003
Finalist, for all of the following elite DC area based service bands- President's Own Marine Band, The U. S. Army Band Pershing's Own, U. S. Navy Band, U. S. Army Field Band	Washington DC	2001-03
Featured Performer on Timpani Performance Forum, Percussive Arts Society International Convention	Nashville, TN	2001
Concerto Soloist, Bombay Chamber Orchestra	Mumbai, India	2000
Performer and Composer for Contemporary Dance Theater's *Choreographers Without Companies*, Aronoff Center	Cincinnati, OH	1999
Performer and recording artist for *Strange and Sacred Noise*, by John Luther Adams, recorded on Mode Records with The Percussion Group Cincinnati	Cincinnati, OH Oberlin, OH	1998
Featured Performer, Lisbon Cultural Exposition Chamber Concert Series	Lisbon, Portugal	1998
Concerto Soloist on the Orchestral Premier of Ney Rosauro's,	Nashville, TN	1995

Rhapsody for Solo Percussion and Orchestra

Performer National Endowment for the Arts Benefit	Nashville, TN	1995
Spirit of Atlanta, Section Leader, Outstanding Percussion Performer of the Year	Atlanta, GA	91-92

Professionally Published Audio Recordings

Russian Nights, Cincinnati Pops Orchestra, Erich Kunzel conductor, Telarc International Corporation, catalog #60657, 2007.

Bartok and Lutoslawski: Concertos for Orchestra, Cincinnati Symphony Orchestra, Paavo Jarvi conductor, Telarc International Corporation, catalogue #80618-25, 2006.

John Luther Adams: Strange and Sacred Noise, The Percussion Group Cincinnati, Mode Records, catalogue #153, 2005.

The Orpheus Oracle, soloist with Cincinnati Philharmonia Orchestra, Vienna Modern Masters, catalogue #vmm3046, 2004.

-William Brady Harrison II