BEYOND “PUSHING PLAY”: THE IMPLICATIONS OF TECHNOLOGY ON MUSIC COMPOSITION AND PERFORMANCE

A Thesis by

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Submitted to the School of Music and the faculty of the Graduate School of Wichita State University in partial fulfillment of the requirements for the degree of Master of Music

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BEYOND ‘PUSHING PLAY’: THE IMPLICATIONS OF TECHNOLOGY ON MUSIC COMPOSITION AND PERFORMANCE

The following faculty members have examined the final copy of this thesis for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Music in Music History/Literature.

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Aleksander Sternfeld-Dunn, Committee Chair

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Mary Channen Caldwell, Committee Member

________________________
Robert Bubp, Committee Member
DEDICATION

To my wife, Allison…we did it!
“Music is the mediator between the spiritual and the sensual life.”
— Ludwig van Beethoven

“If you had a sign above every studio door saying, ‘This Studio is a Musical Instrument,’ it would make such a different approach to recording.”
— Brian Eno
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ABSTRACT

Some purveyors of traditional music may see the introduction of electronics and electronic instruments as stains on the grand tapestry of music; yet there are many composers and performers who have embraced the possibilities that can emanate from technology and deftly woven those threads into this aural tapestry. Beyond the realm of the elite lies the concept that humans possess an “inherent musicality” – that we have the potential to be musically creative. If everyone is inherently musical, what if they don't possess the means and tools to realize that musicality? What could be a solution? I believe technology is one way that people from all walks of life can compose and perform music. This thesis seeks to explore ways in which technology has and is influencing the composition and performance of music in the early twenty-first century by exploring the use of technology in extending cognitive ability, the use of technology with gesture and extending physical ability, and the evaluation and assessment of technologically-composed and -performed music.
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CHAPTER 1
INTRODUCTION

Prelude to a Thesis

I come from a musical family, but not how you might typically think. Yes, my parents both learned piano and guitar and sing beautifully, as does my sister, however my love of music was not originally tied to any of the instruments I or my family play – it was tied to a technology: the radio. My grandfather, Dr. David R. Mackey (affectionately known by family members as “David R.”), had a long, illustrious career in broadcast journalism and higher education; among other things he was the first adviser for WDFM 91.1, the college radio station at Pennsylvania State College (now University), in State College, Pennsylvania, taught broadcast journalism at three universities, and was the general manager at an AM radio station (1260 KWHK) in my original hometown of Hutchinson, Kansas. My father, Robert, and my aunt, Martha, both worked for David R. at KWHK in their late teens/early twenties.

After David R. passed away, my father, along with my mother, Shirley, traveled around Kansas as Mom continued her education and Dad worked at a few different radio stations. Shortly after I was born my family returned to Hutchinson, where Dad worked at two radio stations: KWHK and KHCC, a local NPR station sponsored by Hutchinson Community College. I have many fond memories of accompanying Dad to the stations (especially KWHK), watching him announce the news, introduce songs, splice reel-to-reel tape, and record voiceovers, among other things. Occasionally Dad would turn the microphone on my sister, Lacey, and I, allowing us to experience what it was like to be “on the air.” The radio station and the home, in addition to the Church, were where I received my earliest exposure to music; my musical education was simultaneously being informed by academia and my familial, cultural, and sociological
Looking back on my life to this point I can see a number of things that set my path from radio station kid to my current role as a professor of music history and technology: from Dad buying his first keyboard synthesizer to me buying my first electric bass guitar, from my family purchasing its first desktop computer to me discovering house music. Interestingly enough all four of those things have at least two common elements: technology and music. I made demo cassettes of original and cover songs with my friends during high school and took an introductory recording technology course my freshman year of college. I was hooked; I had to be involved with music and technology in whatever means were available to me.

During high school and college I was working with MIDI (Musical Instrument Digital Interface) notation software that came with that first family computer; after graduating from college I graduated to computer-based recording software. My musical output fell into one of two camps: the acoustic, singer/songwriter style my parents loved (including James Taylor, Carole King, John Denver) or the electronica music I had discovered in high school and college (including Robert Miles, Moby, Fatboy Slim). Over the course of seventeen years (1994-2011) I sat in houses, offices, schools, churches, hotel rooms, and even proper studios across the United States composing music and working on projects. Even though I have worked in both acoustic and electronic genres since 1994, by 2008 my compositional tastes gravitated towards the electronic side of the spectrum.

In 2011 I reached a minor professional crisis; I was tired of my electronic music being confined to a CD or MP3 player – I wanted to be able to perform it in public. I knew performing electronic music live was possible – I had watched musicians and bands do it for years, but I didn't know how they did it. I told my wife, Allison, if I couldn't figure it out in short order I was
going to put electronic music on the shelf. Later that same year I was watching performance videos of the French duo Daft Punk and English electronic musician Tim Exile; I noticed they were both running some of the same music gear. I did my research, discovered what they used, and ordered a couple pieces. Allison even ordered me a small, hand-held synthesizer as a “seed” to inspire future work.

Fast-forward to the present day: I have played electronica gigs and lectured in several cities and three states, playing both solo sets and collaborative gigs, in locations ranging from coffee houses to warehouses to concert halls to produce markets. After twenty years of producing music electronically and a handful of years of performing it in public I began to contemplate how technology has affected and influenced the ways and means by which we compose and perform music. As often happens I was not alone in my contemplation. Also in 2011 I was searching YouTube for videos of my favorite musician, the British singer/songwriter and electronic musician Imogen Heap. She had announced that she would be working on a new album over the next few years and I wanted to see what I could find about her latest efforts. What I found would change my musical life.

I discovered a video of Heap on a small stage at a technology conference. She had her usual panoply of acoustic instruments around her, including percussion and the like. I knew she occasionally used small lavalier microphones strapped to the underside of her wrists to amplify the sound of her playing the water glasses or mbira, as well as one worn from an ear like in Broadway to capture her voice, so I wasn't surprised to see those; I was surprised to see her wearing two black gloves attached to a series of LEDs and wires. Heap was singing and playing acoustic instruments and recording the sounds via the microphones; she then manipulated the audio in real-time by moving her hands through the air and making various gestures with them.
I was floored. What was this? Where did she get this? Where could I get it? What else is out there? These are only a few of the questions I have asked over the past four years as I have sought to further my knowledge of music technology, especially concerning the composition and performance of electronic music, hence this thesis.

Context for a Thesis

My former choir and voice teacher, Dr. Alan Gumm, was famous for saying, “Anyone can sing.” He loved helping people realize their desire to sing by tapping into the “inherent musicality” he thought we all possessed. The idea of everyone being musical fueled my thoughts throughout this project: What if everyone is inherently musical, but they don't possess the means and tools to realize that musicality? What could be a solution? I believe technology is one way that people from all walks of life can compose and perform music.

Chapter I is the Introduction. This section sets the stage for the thesis and outlines the other sections of the thesis.

Chapter II discusses how technology can extend human cognitive ability. Topics of cognition in music are introduced and suggestions of how technology can extend cognitive ability where music is concerned are offered using a two-part case study as an example. Chapter III considers how technology can extend human gesture. Musical gesture is discussed and case studies of how physical ability is currently being extended through the use of various devices are offered. The section also touches on technical matters and contemplates skill(s) required.

Chapter IV examines the evaluation/assessment of music composed and performed with technology. Suggestions of potential issues with defining an electronic composition are made. The section also addresses skills for composition and performance, presents thoughts on
assessment and evaluation (from a primarily academic standpoint), and postulates on musical literacy. Chapter V is used to relay findings from the previous three sections. Opinions and views on what has been discovered during this thesis will be presented; potential difficulties will and ideas for moving forward with electronic music are made.
CHAPTER II
EXTENDING COGNITIVE ABILITY

Music is woven into the pages of writings by the most highly-esteemed Greek philosophers.\(^1\) Therefore, it should come as no surprise that cognition plays a crucial role in the composition and performance of music; from the “Mozart effect” to the “Doctrine of Ethos” and all points between, there exists a connection between music and psychology.\(^2\) A problem comes in the fact that

Not all the cognitive processes we describe are explicit ones, accessible to conscious awareness. In fact, most of the processes involved in hearing and comprehending music are implicit and unconscious.\(^3\)

Despite the inherent implicitness of music, we must attempt to understand how music and cognition work together, especially, in the case of this thesis, at the intersection of music and technology. In this section topics of cognition in music will be introduced and suggestions of how technology can extend cognitive ability in music will be proposed using a two-part case study as an example.

Discussion of Cognition in Music\(^4\)

Every culture that has been scientifically studied has some social mores which are musical in nature.\(^5\) This indicates that a cognitive process about music exists in all those cultures,

\(^2\) “The musical and the psychological are mutually illuminating: The study of musical patterns tells us something about the mind, and the study of the mind tells us something about the forms of music. Musical form illumines our understanding of the mind because all people everywhere seem always to have had music, and so music takes its place beside language as a basic and universal cultural pattern.” W. Jay Dowling and Dane L. Harwood, *Music Cognition* (Orlando, FL: Academic Press, Inc., 1986), x.
\(^3\) Ibid., ix. “Experience demonstrates that the process of comprehension is not immediately obvious.” Ibid., 2.
\(^4\) I would like to offer the following as a beginning definition of cognitive ability: “Cognitive ability is the capacity to perform higher mental processes of reasoning, remembering, understanding, and problem solving.” Douglas A. Bernstein, Louis A. Penner, Alison Clarke-Stewart, and Edward J. Roy, eds. *Psychology*, 6th ed. http://college.cengage.com/psychology/bernstein/psychology/6e/students/key_terms/ch10.html.
\(^5\) This indicates that a cognitive process about music exists in all those cultures,
proving Dowling and Harwood’s idea: “Music is a universal human mode of behavior and cognition.” Since music is a universal cognitive concept, then it stands to reason that all people groups, and the people within them, are inherently musical. This inherent musicality may be something that is solely rooted in enculturation or something that has been nurtured, whether by volition, education, or exposure.

What happens if an individual reaches the end of their cognitive, musical capabilities? What if playing a trumpet or learning music theory does not make sense to them? Are they condemned to a life of lesser musical productivity? Not necessarily. There are ways to supersede gaps in knowledge and ability; I propose technology is a primary way by which cognitive ability in music can be extended.

Philip Bray, in his work on “theories of technology as extension,” defines the technological extension of cognitive ability as “technical objects [which] extend the human
organism by replicating or amplifying bodily and mental abilities.”

Bray's citation of David Rothenberg’s three extensions of thought hones this definition for our uses here:

1) artifacts that improve the senses by directly extending perception, such as telescopes, microscopes, telephones, radios, communication satellites, wires, and television
2) ‘tools of abstraction’, which are instruments that extend cognitive dexterity by extending abstract thought and language functions. These technologies include devices such as computers and calculators, but also 'immaterial' technologies such as natural languages, numerical systems, and formal languages such as those of mathematics, symbolic logic, and computer programming
3) material extensions of memory, which are material means by which experience can be encoded, stored and retrieved....These devices include storage media such as photographs, video tapes and sound recordings, and corresponding equipment for recording and retrieval.

Of Rothenberg’s three extensions, artifacts ("hardware" technology, such as computer interfaces) is probably the one most people would associate with the extending of technology; however, tools of abstraction ("software" technology, such as audio recording programs) and material extensions of memory (such as audio recordings, whether physical or digital) can increase the capabilities and effectiveness of artifacts by giving artifacts a wider, deeper cache from which to draw. Armed with the exponential ability of Rothenberg’s three extensions I would like to give specific examples of artifacts and tools of abstraction and how they can extend cognitive ability.

Technology and the Extension of Cognition in Music

In their paper on “assistive technologies for cognition (ATC)” Gillespie et al. state, “The defining feature of technology...is that it extends human ability.”

There are no parameters given for this extension of human ability, only that technologies are designed to do just that: allow

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11 Ibid., 5.
human beings to push beyond that of which they are normally capable. Gillespie et al. go on to point out that an ATC need not be overly complex or even digital; an ATC can be as basic as a writing utensil and a sheet of paper or an instruction manual.\textsuperscript{13} Some people think that when technology and intelligence are discussed together that it must be within the context of artificial intelligence. In their article on the technology-aided extension of human intelligence, Salomon et al., are quick to highlight many technologies that would not be considered instances of artificial intelligence are intelligent technologies in our sense. The ordinary hand calculator is an example. Although not artificially intelligent, it undertakes significant cognitive processing on behalf of the user and thus is a partner...\textsuperscript{14}

The example of a simple calculator shows us that the world around us, in fact, contains many ATCs, whether or not we realize that is what they are. This subsection will present technology as a key to the extension of cognitive ability, particularly for the composition and performance of music.\textsuperscript{15}

\begin{flushright}
\footnotesize
\textsuperscript{13} Ibid.
\textsuperscript{15} “The idea that technology is an extension of the human organism is encountered regularly in the history of thought about technology.” Brey, 1. Gillespie et al. break down their analysis of “intelligent technologies”: “With these points in mind, we turn to the influence of intelligent technologies on human intellectual performance and ability. In what follows, we outline a conceptual framework incorporating several crucial distinctions. First, we distinguish between two kinds of cognitive effects: Effects \textit{with} technology obtained during intellectual partnership with it, and effects \textit{of} it in terms of the transferable cognitive residue that this partnership leaves behind in the form of better mastery of skills and strategies. We notice that cognitive effects with computer tools greatly depend on the mindful engagement of learners in the tasks afforded by these tools and that there is the possibility of qualitatively upgrading the performance of the joint system of learner plus technology.” Gillespie et al., 2.
\end{flushright}
One ATC that has become somewhat commonplace in contemporary music is a keyboard-based synthesizer. Keyboard-based synthesizers allow people with experience playing a keyboard instrument, i.e. piano or organ, to “play” a variety of instruments without ever studying technique or music theory specific to those particular instruments. Companies such as Yamaha, Moog, Roland, and Kurzweil have been crucial in the development of this ATC.

While keyboard-based synthesizers have been popular since the 1970’s, the lack of ease in portability and restriction to proprietary internally-encoded voices has been seen as a detriment. These factors played into the development of virtual studio technology (hereafter referred to as VST). Steinberg, a software design firm based out of Germany, moved the realm of audio synthesis from hardware-based products to software-based products with the development of VSTs. VSTs can simulate acoustic instruments, provide a wide palate of

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16 “[Even] though their prices have continued to decline, the new electronic synthesizers have experienced an 883 percent increase in sales between 1978 to 1987. In part their appeal is that they are efficient, portable, and require no tuning or other expensive maintenance. Coupled with the variety of sounds, including the replication of traditional music instruments and the multiplicity of uses, this tends to make synthesizers cost effective over a wide range of contractual engagement.” Carl M. Colonna, Patricia M. Kearns and John E. Anderson, “Electronically Produced Music and Its Economic Effects on the Performing Musician and Music Industry,” Journal of Cultural Economics 17, no. 2 (December 1993), 71. http://www.jstor.org/stable/41810494, accessed December 22, 2014. The National Association of Music Merchants (NAMM) reported that, “More than 130 brands that produce synthesizers and related equipment will exhibit at the upcoming global music products trade event. This represents a 20% increase in the segment’s NAMM Show brand presence compared to 2014. The synthesizer market has nearly doubled its show floor square footage since last year, making this one of the show’s fastest-growing segments.” The report goes on to state, “Since 2009, retail sales of keyboard synthesizers have increased 15.9%, propelled by an increase of 13.5% in 2013 alone. The number of synthesizers sold annually is up more than 32% in the last decade.” NAMM, “Synthesizer Brands Storm 2015 NAMM Show,” December 18, 2014, accessed December 22, 2014. Additionally, the keyboard-based synthesizer would be equivalent to Rothenberg’s “artifact.”

17 It could also be noted that many of these synthesized voices have no real-world analog (i.e. sounding like an acoustic instrument. While controllers of other shapes and styles are being utilized the keyboard-based synthesizers continue to be popular, as is evident by the numbers shown in footnote 18.

18 This would be representative of Rothenberg’s “tools of abstraction.”

19 “…improvements in the speed of personal computers led other manufacturers to explore the possibility of developing both real-time and nonreal-time plug-ins that could operate without the assistance of any additional hardware. Steinberg realized that its commercial future in this regard lay in developing plug-in facilities for Cubase. Accordingly, in 1996 it launched its own plug-in protocol, known as Virtual Studio Technology or VST, designed specifically to work with native processors. Having embedded this hosting facility in Cubase version 3.2, Steinberg released its first series of VST plug-ins for the Intel PC in 1997. Although initially they offered a relatively modest range of functions, intended for the first instance for home enthusiasts, they were soon developed to embrace also the expectations of professional users.” Peter Manning, Electronic and Computer Music (Oxford: Oxford University Press, 2004); and Thom Holmes, Electronic and Experimental Music, 4th ed. (New York: Routledge, 2012), 398-9.
synthetic sounds, integrate audio effects, such as reverb, delay, or a vocoder, and integrate third-party/non-proprietary voices. The first VSTs were a trio of effects included as part of Steinberg's flagship computer-based digital audio workstation (DAW), Cubase, in 1996. Since that time Steinberg has allowed VST programming to become open-source, allowing companies and programmers from around the world to push the limits of digital audio synthesis; musicians can find VSTs of all manners, whether instruments or effects plug-ins, to suit their aural vision for their project. While VSTs are amazing inventions, they serve as one component in computer-based, software digital audio workstations (DAWs); that is where a VST’s potential can be more fully realized.

The realm of software design has been particularly involved in musical ATC development. I see this first-hand almost every fall semester when I teach an Introduction to Music Technology course. My students utilize Apple’s GarageBand software DAW to record and produce music. More often than not there is at least one student in my course that is not a musician but enjoys music and is looking for a humanities credit. One of their assignments is to compose a piece of music by utilizing a series of “loops,” prerecorded samples of audio, and MIDI files to create an original work. It amazing how creative the projects from the non-music majors are; sometimes they inadvertently stumble onto complex harmonies and polyrhythms that make my music

20 For a short list of currently popular VSTs, see Splice, “Top Plugins,” Splice, https://splice.com/plugins, accessed March 26, 2015. “The popularity of VST plug-ins was further enhanced by the positive encouragement and support given to third-party developers, thus ensuring an extensive and ever-growing library of options. A major development, soon to be copied by rival plug-in environments, was an expansion of the protocol in 1999, which allowed plug-ins that generated instrumental voices to be directly controlled by MIDI. Sometimes known as VSTi plug-ins, these resources materially underpinned the development of the DAW as a software-based alternative to the hardware-based MIDI synthesizer market sector…” Manning, 399.

majors sit up and take notice. This reinforces Dowling and Harwood’s idea of the universality of musical cognition and Bobby McFerrin’s idea of inherent musicality.

Case Study

This subsection contains a two-part case study. The first part will introduce the ATC software Hyperscore; the second part will relay the implementation of Hyperscore and how the ATC itself was extended beyond its original design.

Case Study, Part One: Hyperscore

One musical ATC that has received a fair amount of press in the past decade is Hyperscore. Hyperscore is a music composition software based around a graphic user interface (GUI). Developed by graduate students at the MIT Media Laboratory and Trinity College-Dublin, the idea behind Hyperscore is intuitive, sketch-based musical composition which requires little to no experience and/or training in traditional music composition or performance. Tod Machover, Professor of Music and Media at the MIT Media Laboratory, gives this summary of Hyperscore: “It allows you to compose a piece of music...without knowing anything about the rules of music.

22 When I taught MU-MS 371 Electronic Music Production at Central Christian College of Kansas during Winter 2013 I had non-music majors who took the course because they needed a humanities course and they had friends in the course. Many of them had little to no experience with music technology, yet many of them inadvertently produced some very harmonically and rhythmically complex pieces of music. While these pieces may not be considered “Top 40” material, they were sufficient to catch the attention of their classmates and garner accolades from their more musical peers and a good grade from their professor. When I taught PA220 Music Technology at McPherson College during Spring 2008 I had a student named Jessica Foulke. Ms. Foulke was an Education Major who took the course as an elective. Despite the fact that she sang in the college choir and even did some musical theatre she had no background in recording technology or arranging. She produced the best individual recording that semester: a piece for voices and piano in which she sang all the vocal parts. It was excellently executed and demonstrated how Ms. Foulke’s cognitive musical capabilities were able to go to another level by being combined with two of Rothenberg’s extensions, in this case two artifacts (a mixer and a microphone) and a tool of abstraction (multi-track digital recorder).

or without knowing musical notation.” Hyperscore, which would be classified as a “tool of abstraction,” could be seen as a sort of “visual” DAW: a hybrid of GarageBand and the popular notation software Finale.

Hyperscore contains the rules of music theory as a series of algorithms. A person uses a computer mouse to draw, using various colors, shapes, and lengths, in the Hyperscore GUI; those drawings are interpreted as graphic “musical scores.” These interpretations can then be played back over speakers using MIDI and even reproduced for performance by live musicians. According to Machover the simple concepts of line and color can be used to compose very complex, intricate music. Not only can these simple concepts be used to compose complex musical passages they can also be used to determine the overall architecture or form of a musical work.

Hyperscore is not limited to individual melodic lines. One of the key features, one that fleshes out the assistive nature of Hyperscore, is the ability to determine the harmonic style of a

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24 Tod Machover, “Transforming Music: Tod Machover,” The Aspen Institute, July 2, 2009, library.fora.tv/2009/07/02Transforming_Music_Tod_Machover, accessed December 22, 2014. “The Hyperscore application provides a composition experience that is very different from traditional composing. Rather than working through music notation, rules of orchestration and harmony, Hyperscore allows the composer to draw musical material as a series of lines and curves. Lines serve as abstractions of complex harmonic and melodic concepts. By manipulating lines, the user is able to create a musical score for string orchestra, complete with well-organized harmonic content. Hyperscore’s overall effectiveness as a tool for composition novices lies in its ease of use, and a balance between what the system does to organize your musical material and what parameters of creative control are left solely to the composer.” Adam Boulanger, “Autism, New Music Technologies and Cognition,” Master’s Thesis, Massachusetts Institute of Technology, 2006, 46.

25 “Hyperscore objects can be saved as MIDI files and in turn can be read into a notation program such as Finale or Sibelius. This makes it possible to go from Hyperscore format to musician-readable format, giving a composer the option of sketching out a composition in Hyperscore and then editing in staff notation.” Morwaread Farbood, Henry Kaufman, and Kevin Jennings, “Composing with Hyperscore: An Intuitive Interface for Visualizing Musical Structure,” in Proceedings of the 2007 International Computer Music Conference, San Francisco: ICMA, 2007, 114.


27 “Many children have been excluded from active participation in music because of its technical and theoretical difficulty, and this has been especially problematic with composing one’s own original music. Although most preschools in the world invite children to explore the visual world by developing freeform projects derived from basic materials such as cutting, pasting, colouring, touching, etc, the same has generally not been available for creating music. Hyperscore, developed especially for Toy Symphony, changes this by combining an intuitive visual interface — allowing anyone to imagine the details and overall shape of a composition, with intelligent algorithms, providing theoretical ‘training wheels’ for harmony, simultaneity, and continuity.” Tod Machover, “Shaping Minds Musically,” BT Technology Journal 22, no. 4 (October 2004), 173, accessed December 22, 2014, http://opera.media.mit.edu/publications/machover_btech2004_shaping_minds_musically.pdf.
work. This is accomplished via two components: a user-designated harmony style(s) and the
“harmony line.” A composer can go about designating harmony in at least three ways: they can
use “a single chord without a reference point,” “add individual chords consisting of three
simultaneous voices,” or select from four harmonic styles (none, diatonic, major/minor, and
fourths). After the composer designates their harmonic style, they can use the harmony line to
draw in a plan, or “path,” of harmonic progression. A description of this is as follows:

By default, every sketch window comes with a flat harmony line. Clicking and dragging
actions shape the line. Color bands appear to indicate the line’s parsing. Flat areas are not
colored and represent regions with stable (or functionally tonic) harmonies in the current
key. Upward areas, colored red, result in unstable or subdominant/dominant harmonies.
Downward areas, which naturally follow upward areas, resolve the previous unstable
harmonies.

In addition, the composer can change keys just as easily as they have changed chords. If the
composer draws a “point” or “spike” in the harmony line it will change the key/tonal center;
according to Farbood et al., “The y-value of the tip of the spike determines the new key.”
This algorithmic harmony can act as both a tool of abstraction and a material extension of memory
within Hyperscore, enabling people of varying cognitive abilities and states to compose with less
effort.

The Hyperscore's original intended audience of novice composers included children.
Machover and his team in the MIT Media Laboratory utilized Hyperscore in their musical
collaboration Toy Symphony. Toy Symphony was a series of workshops held over the course of
three years which gave children from around the world an opportunity to interact with

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29 “One reason for having a graphical notation system in the form of freehand drawing is to provide the user with an
expressive means of shaping musical direction. Drawing a contour is a simple and intuitive way to depict areas of
harmonic tension and resolution.” Ibid.
30 Ibid.
31 Ibid. Farbood et al. note, “The center is mapped to C major; moving the point up adds sharps and moving the
point down adds flats.” Ibid.
professional musicians and composers. Children were given access to Hyperscore and specially-designed electronic instruments (Beatbugs and Music Shapers) to compose and perform new musical works. Some of those compositions were then printed into standard sheet music and performed by a local orchestra. Since that time children and adults, those with no musical knowledge and those with extensive musical knowledge, and those who have cognitive difficulties and those who have full cognitive functions have tested and used subsequent versions of Hyperscore.

**Case Study, Part Two: Tewksbury Project and Dan Ellsey**

Machover and Dr. Adam Boulanger, at the time a formal postdoctoral associate at the MIT Media Laboratory, harnessed the power of Hyperscore as part of their work and research at the Tewksbury Hospital in Tewksbury, Massachusetts. Machover, whose work with Tewksbury Hospital began in 2004, had a goal to “test the effectiveness of patient manipulation of musical structures, as well as to investigate the use of individual musical composition for improving cognitive and physical conditions in a wide variety of contexts.” For four months Machover and his colleagues and students from MIT, along with students from the Department of Music Therapy at Berklee College of Music, worked with Tewksbury Hospital staff and administration to see if musical composition, via Hyperscore, could play a part in the health of residents at Tewksbury Hospital.

32 “Hyperscore has provided the primary vehicle for composition activities for Tod Machover’s Toy Symphony, a large project involving children, orchestras, and technology. During the course of the project, children in Europe (Dublin, Glasgow, and Berlin) and the US (Boston and New York) have worked with the software to compose pieces for string orchestra, some of which local professional orchestras or string quintets then performed in concert. Hyperscore workshops in each of the five Toy Symphony locations consisted of five sessions involving between seven and twelve children. Composers, musicians, and music educators acted as mentors who introduced children to the software and guided them through the composition process.” Ibid., 53. For more information please see http://www.toysymphony.org/.

The study was divided into two groups of residents, those from the mental health unit and those from the physical health unit. After a brief introduction to, or reminder of, Hyperscore residents were asked to compose their own works. Many of the hour-long sessions concluded with a time of reflection and discussion on the compositional process and the resulting pieces of music. From all the pieces composed by residents four were selected and transcribed for public performance by the Lowell Philharmonic Orchestra at Tewksbury Hospital's sesquicentennial celebration, May 1, 2004.

Boulanger, whose research and writing has included work in Alzheimer’s disease, autism, spatial perception, and music interfaces, took the Hyperscore concept to the next level. In his work alongside Machover, Boulanger realized some of the residents with whom they worked not only had diminished cognitive faculties but they also had diminished physical faculties. This combination could make the concept of “self-expression” even more difficult; Boulanger sought a means to empower those residents.

Boulanger's solution was to create an infrared device that could be attached around the forehead of a resident that would track the resident’s most minute movements. Boulanger captured this idea in a 2008 paper: “...whereas hyperscore [sic] provides an interface for any novice user to compose music, we also wanted to develop a specialized interface that would

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34 “The first group consisted of approximately ten patients from the residential mental health unit of the hospital. Most of the mental health unit patients had prior serious suicide attempts and diagnoses ranging from eating disorders, to bipolar depressive disorder and schizophrenia. Several had significant periods of homelessness before coming to Tewksbury. The second group consisted of approximately ten patients from the physical health unit. Many of the physical health unit patients had been long-term residents at the hospital, with a wide range of functional limitations stemming from diseases such as spina bifida, severe cerebral palsy, Parkinson’s and Huntington’s Disease, Alzheimer’s Disease. Each session was an hour long, beginning with a five to ten minute introduction. This introduction served to teach fundamental aspects of the program’s functionality, or basic concepts of music compositions and organisation.” Ibid.

35 “The Tewksbury Project” website, accessed 13 November 2014, opera.media.mit.edu/projects/tewksbury.html. “Users can save Hyperscore pieces as MIDI files, a standard format that can be read into any notation program, such as Finale or Sibelius. This makes it easy to go from Hyperscore format to musician-readable format, giving a composer the option of sketching out a composition in Hyperscore and then editing in standard notational format.” Farbood et al., “Hyperscore: A Graphical Sketchpad for Novice Composers,” 52-3.
allow a severely disabled individual to control the performance of a piece of music in real-time.”

The movements tracked by this expressive gesture controller (a Rothenberg “artifact”) could then be amplified by Hyperscore, thereby allowing the resident to create intricate melodies, complex rhythms, and wide dynamic contrasts.

This was brought to bear when Machover delivered a lecture titled “Inventing Instruments that Unlock New Music” at a TED conference in 2008. Machover and Boulanger were accompanied on the TED stage by Tewksbury Hospital resident Dan Ellsey, a man with cerebral palsy for whom Boulanger had made the expressive gesture controller, to demonstrate the performance capabilities of Hyperscore. When Ellsey greeted the TED audience via his speech computer he told them, “I have always loved music and I am excited to be able to conduct my own music with this new software.” Not only did the TED audience hear a piece which Ellsey had composed they had the great fortune of watching Ellsey conduct the piece, titled “My Eagle Song,” in real-time via his expressive gesture controller and Hyperscore.

For some it is enough to leave music as notes on a page or a recording on a shelf, but what about those who want to realize that music for an audience? Before Ellsey conducted his composition, Boulanger stated, “It's not [just] that our technologies, they provide access, they allow us to create pieces of creative work – but what about expression? What about that moment when an artist delivers that piece of work?...Do our technologies allow us to express?”

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37 Ibid.
40 The extension of gesture will be addressed in Section III.
41 Machover and Ellsey, “Inventing instruments that unlock new music” transcript, TED.
Boulanger provides a point of segue: musical creativity demands to be expressed and technology can fill in, extend, and/or compensate for gaps in mental and/or cognitive ability or knowledge. The next section will examine technology and its ability to combine with gestures to extend physical ability.
Oftentimes when people think of music composers they imagine people sitting at desks with sheets of staff paper and a mess of sharpened pencils. Oftentimes when people think about a performing musician they are likely to imagine a singer, pianist, guitarist, or other traditional instrumentalist. These are valid typologies. David Wessel and Matthew Wright offer a salient challenge to the traditional conversation of music performance typology: “When asked what musical instrument they play, few computer musicians respond spontaneously with ‘I play the computer.’ Why not?”42 As odd as claiming the computer as your primary instrument may seem, the reality is computers and electronic instruments have moved from getting their foot in the door to being in the room with the panoply of traditional instruments.43

With new instruments come new possibilities, the “potential to create a new kind of music.”44 With those new instruments and new kinds of music come the developments of new ways to compose and perform music; this is especially true regarding technology in music.45

43 “Actually, most computer music performers still seem shyly reluctant to consider the computer as a regular instrument, but nonetheless, the computer is finally reaching the point of feeling as much at home on stage as a saxophone or an electric guitar.” Sergi Jordà, “Interactivity and live computer music,” The Cambridge Companion to Electronic Music, Nick Collins and Julio d’Escriván, eds. (Cambridge: Cambridge University Press, 2007), 89.
44 “An ambitious goal for any new instrument is the potential to create a new kind of music. In that sense, baroque music cannot be imagined without the advances of sixteenth- and seventeenth-century luthiers, rock could not exist without the electric guitar, and jazz or hip-hop, without the redefinitions of the saxophone and the turntable.” Ibid.
45 “The definition of technique in musicianship must now be extended far beyond the development of physical and proprioceptive skills in the performance of specific musical vocabularies to include the imbedding and activation of formal structures and entire musical models in an often spontaneous musical context. We can now conceive of the design of instruments which can contain a stored repertoire of complete models of musical reality, are heuristic and adaptive, are capable of doing instantaneous research on an input stream being received to extract salient features with which to differentiate among potential outputs, and of disseminating information around a network of shared resources serving the high-level, real-time needs of an evolved ensemble of human performer.” David Rosenboom, “A Program for the Development of Performance-Oriented Electronic Music Instrumentation in the Coming Decades: ‘What You Conceive Is What You Get,’” Perspectives of New Music 25, no. 1/2, 25th Anniversary Issue (Winter-Summer 1987), 569, http://www.jstor.org/stable/833135, accessed October 3, 2014.
This chapter will give an overview of musical gesture and offer case studies of how physical ability is currently being extended through the use of various devices, touch on technical matters, and discuss skill(s) required.

A Brief Discussion of Musical Gesture

When discussing the concept of gesture in music one must begin from a gestural framework. A predominant theme from many of the articles used in this thesis is that musicians, engineers, and computer scientists agree the gestures utilized should be as natural, or “human,” as possible. Mainsbridge and Beilharz state,

The notion of body as instrument, unconstrained by the physical constraints of a tangible interface or screen-based controller, reflects a body-centric approach to examining how performers adopt gestural sensor technology in their own practice.

According to Dan Overholt et al. “[t]here are three commonly accepted types of music performance gestures: performative, communicative, and ancillary.”

Performance gestures are

46 Jensenius et al. point out that “a gestural typology, like all other typologies, is not intended to create an absolute classification system, but rather to point out some of the different functions of gestures.” Alexander Refsum Jensenius, Marcelo M. Wanderley, Rolf Inge Godøy, and Marc Leman, *Musical Gestures: Sound, Movement, and Meaning*, Rolf Inge Godøy and Marc Leman, eds. (New York: Routledge, 2010), 25.

47 The following statement by Justine Cassel summarizes this: “I don’t believe that everyday human users have any more experience with, or natural affinity for, a ‘gestural language’ than they have with DOS commands. We have plenty of experience with actions, and the manipulation of objects. But the type of gestures defined as (Väänänen & Böhm, 1993) ‘body movements which are used to convey some information from one person to another’ are in fact primarily found in association with spoken language (90% of gestures are found in the context of speech according to McNeill, 1992). Thus if our goal is to get away from learned, pre-defined interaction techniques and create natural interfaces for normal human users, we should concentrate on the type of gestures that come naturally to normal humans.” Justine Cassel, “A Framework for Gesture Generation and Interpretation,” in *Computer Vision in Human-Machine Interaction*, R. Cipolla and A. Pentland, eds. Cambridge University Press, in press, 1. “To develop a paradigm that allows performers to interact as naturally and subtly with automated digital systems as they do with other human performers, an interface design must allow performers to play their instruments untethered, using only natural cues and body language to control computer information.” Dan Overholt, John Thompson, Lance Putnam, Bo Bell, Jim Kleban, Bob Sturm, and JoAnn Kuchera-Morin, “A Multimodal System for Gesture Recognition in Interactive Music Performance,” *Computer Music Journal* 33, no. 4 (Winter 2009), 69.


49 Overholt et al., 71. Jensenius et al. enumerate four categories of musical gesture: “sound-producing gestures,
defined as those that “produce sound;” communicative gestures are those that would be used between performers (“nods, eye contact, and similar cues”); ancillary gestures are those that an audience or performer would observe as “[communicating] musical meaning.” While all three gesture classifications are useful for musical performance many studies have focused primarily on performative gestures, due likely to reasons of immediacy and accessibility of the gestures.

The gesture set listed above would be those associated with traditional instruments (e.g. violin, guitar, piano); Halmrast et al., in discussing sound-producing gestures, suggest that the typology changes when the instruments in question move from traditional instruments to electronic or computer-based instruments. The change in typology comes, primarily, from the

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communicative gestures, sound-facilitating gestures, and sound-accompanying gestures.” Jensénius et al., 23. Jensénius et al. break down the four primary gestures as such: “Sound-producing gestures are those that effectively produce sound. They can be further subdivided into gestures of excitation and modification. Sound-producing gestures are called instrumental gestures in (Cadoz 1988), and effective gestures in (Delalande 1988). Communicative gestures are intended for communication...such movements can be subdivided into performer-performer or performer-perceiver types of communication. Communicative gestures are called semiotic gestures in (Cadoz and Wanderley 2000). Several of these can also be considered gestures in the way Kendon (2004) and McNeill (1992) use the term. Sound-facilitating gestures support the sound-producing gestures in various ways...such gestures can be subdivided into support, phrasing, and entrained gestures. Sound-facilitating gestures are called accompanying gestures in (Delalande 19880, non-obvious performer gestures in (Wanderley 1999), and ancillary gestures in (Wanderley and Depalle 2004). Sound-accompanying gestures are not involved in the sound production itself, but follow the music. They can be sound-tracing, i.e. following the contour of sonic elements (Godøy et al. 2006a), or they can mimic the sound-producing gestures (Godøy et al. 2006b).” Ibid., 23-4. Although there is a discrepancy in the number of categories between Overholt et al. and Jensénius et al., I don’t perceive an issue in proceeding with one set of gestures over another. I have chosen Overholt et al. due to the fewer categories as it might be easier to comprehend. I will continue to reference Jensénius et al. as needed for clarification or emphasis.

50 Overholt et al., 72.
51 “In recent work on gesture, ‘gesture’ is often used to denote bodily actions that are associated with speech, particularly hand movements and facial expressions. This definition of gesture as ‘visible action as utterance’ (Kendon 2004) is most commonly used in linguistics, psychology and behavioral studies. In particular, Kendon (1972) used the term ‘body mother and later, ‘gesticulation’ (Kendon 1980), before finally settling on the work ‘gesture’ (Kendon 1982).” Jensénius et al., 14.
52 “There are several elements that are common to all the examples of sound-producing gestures we have seen so far in this chapter, including: The transfer of energy from the human body of the performer to the instrument, cf. the aforementioned element of impedance…The role played by touch in the sound-producing and sound-modifying gestures of the performer, which affect the physics of the resonating objects either directly, through fingers, hands, lips, etc. or indirectly, through mallets, bows, plectrums, etc....The haptic feedback given by each instrument in addition to the auditory feedback...The limitations on each instrument as to its possible behaviors, meaning that there are certain sounds that cannot be made on a particular instrument, no matter how hard we try. We could summarize these elements as a set of constraints at work in sound production, meaning that there are certain limits as to what can be done when playing on any kind of instrument. This would also hold true for any new musical instrument that we might construct, as long as we are talking about real physical objects that we play with our bodies. However, if we consider electronic instruments, these constraints no longer apply.” Tor Halmrast, Knut
The fact that the performative gestures of a traditional, acoustic instrument include a level of excitation, that of a string, membrane, resonator, etc.; in electronic and computer-based instruments the performative gestures are

[what] we would call a control gesture: it does not by itself transfer energy from our body to any instrument of sound-production, nor can such a gesture modify any feature of the sound apart from its volume. Moreover, whatever haptic feedback we get from [turning a] dial is the same no matter how loud or soft the sound is.\(^{53}\)

This shift in typology has been a bone of contention for many musicians, audiences, and musicologists in their efforts to debunk or affirm the place of electronic and computer-based music performance.\(^{54}\)

Halmrast et al. come to the aid of this typological shift by stating there is one thing that electronic and computer-based instruments have as distinct and positive in their typology: mapping. Mapping is when certain gestures, whether performative or control, are tied to the activation or triggering of a certain event within an electronic or computer-based instrument (normally one that relies upon software). These mappings are usually sent via Musical Instrument Digital Interface (MIDI) signals from the instrument to the software; the software

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\(^{53}\) Ibid., 208.

\(^{54}\) Primus Luta, in an article on developing a live electronic music performance typology, writes this, “[there is] lack of a language for evaluating electronic music. It is impossible to defend an artist who has been called a hack without the language through which to express their proficiency. Using Miles Davis as an example—specifically a show where his back is to the audience—there are fans that could defend his actions by saying the music he produced was nonetheless some of the best live material of his career, citing the solos and band interactions as examples. To the lay person, however, it may just seem rude and unprofessional for Davis to have his back to the audience; as such, it cannot be qualitatively a good performance no matter what. Any discussion of tone and lyrical fluidity often means little to the lay person. The extent of this disconnect can be even greater with electronic performances. With his back turned to the audience, they can no longer see Miles’ fingers at work, or how he was cycling breath. Even when facing the crowd, an electronic musician whose regimen is largely comprised of pad triggers, knob turns, and other such gestures which simply do not have the same expected sonic correspondence as, for example, blowing and fingering do to the sound of a trumpet. Also, it is well known that the sound the trumpet produces cannot be made without human action. With electronic music however, particularly with laptop performances, audiences know that the instrument (laptop) is capable of playing music without human aid other than telling it to play.” Primus Luta, “Toward a Practical Language for Live Electronic Performance,” *Sounding Out!*, April 29, 2013, http://soundstudiesblog.com/2013/04/29/toward-a-practical-language-for-live-electronic-performance/, accessed March 17, 2015.
recognizes the gesture and activates or triggers the appropriate response, whether it is a sound, note, or change in timbre.\textsuperscript{55}

In a paper on the importance of mapping, Hunt et al. contend that how an electronic or computer-based instrument is mapped can determine its “character” or “essence.”\textsuperscript{56} The way in which the mapping is routed can “[bring] an interface to life,” allowing the musician/performer to be as expressive with their instrument as their acoustic/traditional counterparts.\textsuperscript{57} The trick then becomes in how the musician/performer customizes their mapping, if they use multiple layers of mapping, etc.\textsuperscript{58} Both Halmrast et al. and Hunt et al. conclude their writings with the

\textsuperscript{55} For an example of this see 14:48-15:03 from MiMu Gloves, “Mi.Mu Gloves,” YouTube, March 17, 2015, https://youtu.be/y2ylSOmBlox, accessed March 19, 2015. “What is emerging now is an awareness of the need for developing control interfaces for timbral features of sound that are less abstract or disembodied and more in accordance with causal schemes as found in traditional instruments...The topic of mapping control input to sound features has also received much attention.” Halmrast et al., 208.

\textsuperscript{56} “In this paper we challenge the assumption that an electronic instrument consists solely of an interface and a sound generator. We emphasise the importance of the mapping between input parameters and system parameters, and claim that this can define the very essence of an instrument... In an acoustic instrument, the playing interface is inherently bound up with the sound source. A violin's string is both part of the control mechanism and the sound generator. Since they are inseparable, the connections between the two are complex, subtle and determined by physical laws. With electronic and computer instruments, the situation is dramatically different. The interface is usually a completely separate piece of equipment from the sound source. This means that the relationship between them has to be defined. The art of connecting these two, traditionally inseparable, components of a real-time musical system (an art known as mapping) is not trivial. Indeed this paper hopes to stress that by altering the mapping, even keeping the interface and sound source constant, the entire character of the instrument is changed. Moreover, the psychological and emotional response elicited from the performer is determined to a great degree by the mapping.” Andy Hunt, Marcelo M. Wanderley, and Matthew Paradis, “The importance of parameter mapping in electronic instrument design,” Proceedings of the 2002 Conference on New Instruments for Musical Expression (NIME-02), Dublin, Ireland, May 24-26, 2002, 1.

\textsuperscript{57} “In this section we emphasise the dramatic effect that the style of mapping can have on ‘bringing an interface to life’. We focus on our own experience in designing digital musical instruments and comment on several previous designs.” Ibid.

\textsuperscript{58} “The mapping ‘layer’ has never needed to be addressed directly before, as it has been inherently present in acoustic instruments courtesy of natural physical phenomena. Now that we have the ability to design instruments with separable controllers and sound sources, we need to explicitly design the connection between the two. This is turning out to be a non-trivial task. We are in the early stages of understanding the complexities of how the mapping layer affects the perception (and the playability) of an electronic instrument by its performer. What we know is that it is a very important layer, and one that must not be overlooked by the designers of new instruments.” Ibid., 5-6. “The topic of mapping control input to sound features has also received much attention...A central motive of this research has been to forge links between gestures and timbral features, links that both make sense to the performer and allow for the desired level of detail control. Schematically, such links can be organized into one-to-one, one-to-many, many-to-many, and many-to-one types of mappings. In a one-to-one mapping, a gesture is used to control just one feature, such as a foot pedal used to control the overall volume of an instrument...As a similar example of a one-to-many mapping on sustained sounds, consider the use of the so-called ‘aftertouch’ on MIDI keyboards (i.e. the continuous pressure on the key after the initial depression of the key). This pressure may control the overall

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confession that electronic and computer-based instruments and their respective mappings are complex and developing entities and that more time will need to pass before a decision can be reached.  

As the concept of musical gesture has been addressed, this section will move from theory to praxis. The following subsection will present a series of case studies in which individuals and entities have forged various paths between music and technology, all in an effort to transmute audiation from synapses to stage.

Case Studies

As much research and development has been done in the area of developing technology for extending ability there are a multitude of different devices and individuals that could be included in this paper. This subsection will highlight notable electronic performance devices produced since 2005 in the following categories: movable controller, extending physical gestures–fully-able human, extending physical gestures–differently-able human, and extending the human voice.  

amplitude and the harmonic content of the sound in parallel so that an increase in amplitude is coupled to an increase in the harmonic content of the sound…In a many-to-many timbral control scheme, the point is to have alternative controls for several dimensions, by, for example, using the aftertouch to control both the filter and the overall amplitude, and using another controller, e.g. the so-called ‘modulation wheel’ to likewise control both the filter and the overall amplitude. Finally, in a many-to-one timbral control scheme, the point is to let a number of different gestures control the same timbral dimension. For example the overall quantity of motion of many different gestures (captured by an accelerometer or video camera) could regulate the overall high-frequency content of the sound.” Halmrast et al., 208-9.

“There can be no doubt that skilled musicians have a rich and nuanced repertoire of timbral expression, acquired through years and years of practice. The challenge for future research is to explore further the complex interactions between musicians’ gestures and musical timbre and, with the use of increasingly sophisticated technology, to apply this knowledge to the development of better interfaces for electronic instruments.” Halmrast et al., 209. “From the evidence presented above in both informal and controlled experiments, there is definitely a need to come up with better-designed mappings than simple (engineering style) one-to-one relationships. General models of mappings have been proposed and expanded to incorporate multimedia control, but also to fit several levels of performance, from beginners to highly skilled players… We therefore welcome comments and criticism on issues related to mapping so as to push the discussion on this essential—although often ignored—topic.” Hunt et al., 5.

Credit goes to Randolf Reimann of the band Tralala Blip for using this description.
Case Study: Movable Controller

Many MIDI controllers invented during the 2000s and early 2010s are what will be called a “static” controller, meaning they traditionally sit on a table or stand. While many “controllerists” (musicians whose primary instrument is a MIDI controller of some type), including myself, utilize a static controller, there are some companies who have been fighting to give the controllerist more freedom to move. This case study will examine one of the first MIDI controller meant to be moved: the Midi Fighter 3D.

The Midi Fighter 3D, designed by DJ Tech Tools, is among the first wave of static controllers to embrace gesture and movement as part of its design. Based on its predecessor, the original Midi Fighter, the Midi Fighter 3D features a 4-by-4 grid of arcade-style buttons, four bank buttons (to give you access to a total of 64 sounds), six side-mounted shift buttons, and “a gyroscope, accelerometer and compass” for three-dimensional movement tracking. The creators at DJ Tech Tools wanted to add a layer of expression previously unseen in static controllers, so much so that they added a hand strap so musicians could more easily hold and carry the Midi Fighter 3D for full 360-degree expression.

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61 The primary feature for these controllers is a series of buttons laid out in a grid pattern. These buttons may vary in shape, size, and functionality (they may be “on/off” or velocity sensitive, multi-touch, made of silicone or arcade-style). Some controllers may have various knobs or rotary encoders, faders, a DJ-style crossfader, transport controls, touch strips, jog wheels, or other buttons.

62 The musical performance by controllerists is called “controllerism.” This performance style is becoming more popular and a community website to promote controllerism (www.controllerism.com). Matthew Moldover is credited with coining the term controllerism; he and Ean Golden of DJ Tech Tools are credited with popularizing controllerism as a performance style. For more on this consult my paper: Ryan Mackey, “Not Just ‘Pushing Play’: an Examination of Controllerism and the Live Performance of Electronic Music,” (unpublished, 2014). Don Muro described such people as “synthesists”: “An electronic music synthesist creates, modifies, and controls sound electronically. Although he or she generally uses a keyboard to do this, a synthesist may adapt and use almost any acoustical instrument to control a synthesizer. With some additional training, virtually any musician can, in effect, become an electronic music synthesist, opening up career opportunities in education, performance, composition, production, software design, and electronic hardware design.” Don Muro, “Synthesist,” Music Educators Journal 69, no. 2, Careers and Music (Oct. 1982), 73. http://www.jstor.org/stable/3396115.


An added result of this level of portability is the opportunity for a musician to move out from behind a table and let their audience see more of them and the performative gestures “making” the music. Multimedia artist Aaron Wirtz has suggested technology that allows musicians “to get out from behind the light walls and smoke” is a good thing as it allows for more interaction between musicians and fans. Since the Midi Fighter 3D debuted back in 2012 other companies have entered into the movable controller market, including the Numark Orbit, LIVID Guitar Wing, and Alesis Vortex, each controller having a different spin on, or market for, their product.

The Midi Fighter 3D and the other movable controllers mentioned come in a variety of shapes and sizes, yet they are not the most ergonomic of devices. What if we engaged and enabled the human body and its natural gestures and range of movement to become a controller? What if *musica humana* was taken to the next level?

**Case Study: Extending Physical Gesture – Fully-Able Human**

Before the debut of the Midi Fighter 3D engineers and musicians had been contemplating the idea postulated by Mainsbridge and Beilharz of “[the] body as instrument, unconstrained by the physical constraints of a tangible interface or screen-based controller…”

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65 Author’s interview with Aaron Wirtz, February 6, 2015, Wichita, KS. “Why should a performer stay behind a laptop, controlling multimedia through the standard interaction paradigms of a computer, or be overwhelmed by giant projections and sound that have no direct connection to the live performance? What tools and techniques are needed to create technologically-enhanced performance works that not only retain but actually enhance the expressivity of a live performer?” Elena Jessop Nattinger, “The Body Parametric: Abstraction of Vocal and Physical Expression in Performance” (Ph.D. diss., Massachusetts Institute of Technology, 2014), 17.
66 The Numark Orbit is a wireless, hand-held controller marketed to DJs, audio engineers, and producers; the LIVID Guitar Wing is a wireless controller which mounts to electric guitars and electric basses; the Alesis Vortex is a wireless “keytar” with additional drum pads and a built-in accelerometer.
67 As per Boethius, *De institutione musica*.
68 Mainsbridge and Beilharz, 110.
musicians have tried various solutions to make this idea a reality. In this case study I will look at three different approaches: body-mounted, non-body-mounted, and hybrid.

Inspired by earlier incarnations of a body-mounted audio controller, Dr. Elena Jessop Nattinger created the Vocal Augmentation and Manipulation Prosthesis (VAMP). The VAMP is a glove-shaped controller, which extends from the fingertips to past the elbow, similar to a lady’s evening glove. The VAMP is wired with flex sensors at the elbow and wrist joints, an accelerometer, and a pressure sensor on the index finger. Data from the VAMP is interpreted via a customized mapping patch in a computer program called Max/MSP. The VAMP’s mapping patch allows its user to control various parameters of audio manipulation in real-time. The idea is for a vocalist to sing into a microphone, which is also plugged into the computer running Max/MSP, and have the ability to manipulate the resulting sound with the VAMP and the patch.

The VAMP’s patch allows a performer to do a few things with their voice: 1) the performer can use their gloved forefinger and thumb to “catch” a note, via the aforementioned pressure sensor, and sustain it even after the performer has stopped singing. 2) The performer can take the sustained note and cause it to pulse to a real-time tempo, as well as control dynamic levels (crescendo, decrescendo), via the flex sensors in the elbow and wrist responding to a conductor-like gesture. 3) The performer can also add a harmony note to the captured note. The patch is connected to a sub-patch which analyzes the harmonic fundamental frequency of the captured note; the performer can then adjust the pitch of the second note with pre-mapped bend of the wrist. Part of Nattinger’s initial implementation of the VAMP was in Tod Machover’s 2010 opera Death and the Powers. In the opera one of the characters, a man named Nicholas, has a prosthetic arm. The arm is a VAMP for which mappings were devised to “take advantage of his

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69 “Numerous wearable music controllers that capture gestures through a variety of sensors have been created...” Elena Jessop, “The Vocal Augmentation and Manipulation Prosthesis (VAMP): A Conducting-Based Gestural Controller for Vocal Performance,” NIME, 2009, 1.
particular vocal technique, produce the musical effects desired by the composer, and still retain the intuitive sensibility of a conductor's gesture.”

Almost ninety years before Nattinger developed the VAMP, a Russian scientist named Lev Sergeyevich Termen (a.k.a. Leon Theremin) was experimenting with concepts of gesture, proximity, and musical production. The resulting instrument from Theremin’s work, a device with something resembling a car antennae protruding from the top and a dogleg-shaped metal hoop to the performer’s left side, “initiated an unusual performance method involving no physical contact: the performer moves the hands in proximity to two antennas in order to control pitch and volume.” The “theremin” (also known as the “termenvox” or “thereminxvox”) was among the first commercially produced electronic instruments.

Theremin’s invention laid the groundwork for a series of non-body-mounted, gesturally-controlled, electronic devices; among those is the Kinect, developed by Microsoft. Originally released in 2010 and dubbed “Project Natal,” the Kinect is a hands-free, wireless sensor that “[combines] an RGB camera, depth sensor, multi-array microphone and custom processor running proprietary software all in one device…unlike other devices, the ‘Project Natal’ sensor…can recognize you just by looking at your face, and it doesn’t just react to key words but

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70 Ibid., 4.
71 In reality music was not the only thing on Theremin’s mind with regards to the technology’s use. According to Natalia Nesturkh, “…the range of [Theremin’s] talents is reflected in the uses he found for his concept: alarm systems, a device for the dielectric constant measurement of gas and a musical instrument…” Natalia Nesturkh, “The Theremin and Its Inventor in Twentieth-Century Russia,” Leonardo Music Journal 6 (1996), 57.
72 Ibid.
73 Ibid.
74 Which included several adaptations or versions of the theremin, notably “Koroliov's Contemporary Theremin” (which included a foot-controlled volume pedal and a visual pitch-finding reference), “Maximov’s Tonica” (a child-sized theremin), and “Pavlov’s theremin” (which harnesses the power of infrared sensors). Ibid., 58-9. Which included several adaptations or versions of the theremin, notably “Koroliov's Contemporary Theremin” (which included a foot-controlled volume pedal and a visual pitch-finding reference), “Maximov’s Tonica” (a child-sized theremin), and “Pavlov’s theremin” (which harnesses the power of infrared sensors). Ibid., 58-9.
understands what you’re saying.”

In keeping with the DIY aesthetic of music pioneers such as Dave Davies of The Kinks, musicians and software engineers began to hack Kinsects and design software to allow them to use the Kinect to control musical parameters via gesture and proximity, similar to the theremin.

One performer who has been harnessing this power is Aaron Wirtz, better known by his stage name CutterJ the Absurdist. Wirtz, whose background includes dance, theatre, and music, has coupled the Kinect with software programs such as Ableton Live, Pure Data, and Max/MSP, video clips from old B-movies and video games, a video camera, and cadre of electronic music genres to create an audio-visual feast. Wirtz sees his “electronic music as a platform for performance art;” a performance art he has christened “a living collage.” Using the Kinect allows Wirtz to control any number of devices or effects with movements and gestures. In one unnamed piece Wirtz uses the Kinect in an x-y axis configuration with the y-axis controlling the pitch of a digital synthesizer and the x-axis controlling the modulation of the synthesizer. He dances in such a way that his left arm controls the y-axis and his right arm controls the x-axis. Additionally, Wirtz uses the Kinect as a kind of “video DJ deck,” allowing him to mix various video clips.

When the stories of multiple people converge in one location it is possible to see some overlap of ideas, starting points, or paths of their respective journeys. While Nattinger and Wirtz

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76 In the early 1960’s Davies famously cut the cone of his guitar amplifier with a razor blade, thereby intentionally distorting the sound. This sound was popularized after the release of The Kinks’ song “You Really Got Me” in 1964.


78 Please see knobfest’s channel, “Cutter J, the Absurdist first performance using the X-box Kinect,” November 8, 2011, https://www.youtube.com/watch?v=1CkE9Yq0UbE. This ties back to Mainsbridge and Beilharz’s idea on gesture: “The notion of body as instrument, unconstrained by the physical constraints of a tangible interface or screen-based controller, reflects a body-centric approach to examining how performers adopt gestural sensor technology in their own practice.” Mainsbridge and Beilharz, 110.
were developing or on their respective journeys British singer/songwriter Imogen Heap was looking for the next stage of developing her musical composition and performance capabilities. Heap has utilized technology in her performances since the first phase of her career; keyboards, laptops, and static controllers, and wrist-mounted, wireless lavalier microphones have all been employed in her stage performances. While Heap saw technology as an asset she knew that she wanted to get away from static controllers, either as they are or in a co-opted state. After seeing Nattinger’s V AMP glove on a 2009 visit to the MIT Media Lab, Heap called on the expertise of Dr. Tom Mitchell, Senior Lecturer in Computer Music at University of the West of England (Bristol), to help her make a pair of gloves that would allow her to take the V AMP concept to the next level.

In a paper presented at the 2011 NIME conference, Mitchell noted the gloves, initially called “SoundGrasp,” later known as “Mi.Mu gloves,” had to be crafted to Heap’s performance

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79 Heap was in a short-lived electronic duo named Frou Frou with British musician Guy Sigsworth. They released one album, Details, which was highly praised and included the single “Let Go.” Even though Frou Frou disbanded in 2003 the band experienced resurgence in popularity after actor/director Zach Braff featured “Let Go” in the soundtrack of his 2004 independent film Garden State. See also KCRW, “Frou Frou,” Morning Becomes Eclectic (blog), September 27, 2002, http://www.kcrw.com/music/shows/morning-becomes-eclectic/frou-frou.

80 “If you've seen Imogen play live, you'll have noticed a shed load of tech and wires, some attached to her, some not, with her, racing about between various pieces of gear with small microphones attached to her wrists and a headset mic, singing, looping, playing percussion, keyboards, and of course applying effects to all as she goes. It's great fun to watch, but she always felt frustrated, adapting music to the tech, rather than the other way around and making the best she could with off-the-shelf devices available in the rushed time between album and touring cycles…Over the years, she has accumulated more and more complex systems to try to free her up on stage using wireless midi and radio mics attached to her wrists, with various wireless keyboards in tow to control her harmonisers [sic], computers, samplers and sequencers. ‘I feel tethered to a keyboard or other control surface for computer duties and when you're 'stretching' a sound or changing its pitch, a button, wheel or fader just never really cuts it. I always longed for more expressive control of the tech in studio and on stage, something I could wear and create sound fluidly with, more organically, humanly somehow.’” Imogen Heap, “The Gloves: the Story,” Imogen Heap, accessed February 19, 2015, http://www.imogenheap.co.uk/thegloves/. Heap also explained this during a talk and performance at the Wired UK 2012 conference, January 2012, https://www.youtube.com/watch?v=6bFO6RRD9k.

81 “In 2009, when Kelly Snook invited Imogen to visit to MIT’s Media Lab, she realised the tech had now made this possible when she tried on Elly Jessop's musical glove. ‘Elly's glove could record and loop the voice with a few intuitive hand gestures. A million possibilities flooded my imagination! I was quite emotional and as soon as possible I changed my touring and recording life cycle to get to work on creating my dream setup that felt ever closer than before.’” Heap, “The Gloves: the Story,” Imogen Heap, accessed February 19, 2015, http://www.imogenheap.co.uk/thegloves/.
style which “[incorporates] the live sampling of vocals and acoustic instruments.”

Mitchell cited three ideas around which the gloves were designed:

1. The musical processes should be controlled without having to defer performativity to engage in machine interaction.
2. There should be a transparent mapping between the input to the gestural controller and the outgoing musical events.
3. Instrumental virtuosity should be compromised as little as possible.

Additionally, the SoundGrasp system was designed around three core components: a “gestural controller,” “gestural mapping,” and an “audio processing unit.”

The original gestural controller was a combination of a single glove and a wrist-mounted, wireless lavalier microphone. The gestural mapping involved three components: “data processing, posture identification and audio control.” The posture identification and the audio control components were tailored to Heap’s body.

The original posture vocabulary contained eight postures, some

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83 Ibid.

84 “Gestural music devices are widely represented as a three part system: the gestural controller, the audio processing unit and the mapping that exists between the two.” Ibid.

85 “The work included focuses on the first step of this project: the composition and performance of live music using hand gestures captured using a single data glove… The wearable components of the presented work… a fingerless data glove with a wristmounted [sic] microphone. This arrangement has minimal constraints on dexterity and unites the gestural controller with the sound capture device. This enables proximal sound sources to be sampled using a grasping metaphor: recording commences when the hand is opened and concludes when the hand is closed. Thus the sound appears to be ‘caught’ by hand.” Ibid., 465-6.

86 Ibid., 466.

87 Mitchell points out, “Previous efforts have been made to formalize [sic] universal sets of gestures, see for example Henze for gestures associated with media playback. Many of these studies indicate a lack of consensus amongst participants. Consequently, the vocabulary of hand postures adopted for this work has been chosen pragmatically to be identifiable distinct and to enable the use of metaphor in the control mapping.” Mitchell and Heap, 466. Indeed, Henze et al. in their paper “Free-Hand Gestures for Music Playback: Deriving Gestures with a User-Centred Process” collated their results into “static” gestures and “dynamic” gestures. They wrote, “The third step of the process is to formalize the proposed gestures and to define consistent sets of gestures. We found manifold gestures in the user study. Based on these gestures we define two consistent sets of gestures. To define consistent sets the first set consists of dynamic gestures only and the second set consist of static gestures. Most gestures were taken from the gestures proposed by the participants in the previous user study. Since we aimed at defining consistent gestures sets some gestures were chosen because they fit consistently with the other ones although the exact gesture was not proposed.” Niels Henze, Andreas Löcken, Susanne Boll, Tobias Hesselmann, and Martin Pielot, “Free-Hand Gestures for Music Playback: Deriving Gestures with a User-Centred Process,” Proceedings of the 9th International Conference on Mobile and Ubiquitous Multimedia, Association for Computing Machinery, December 2010, 7. http://dl.acm.org/citation.cfm?id=1899475.1899491&coll=DL&dl=GUIDE&CFID=480741759&CFTOKEN=
of which resemble letters from the American Sign Language alphabet.\textsuperscript{88} These postures were combined with series of gestural commands, both “audio control gestures” and “state/mode control gestures.”\textsuperscript{89} While the audio control gestures are the demonstrative part of SoundGrasp, it is the state/mode control gestures that allow them to be such. By cycling through the different state/mode control gestures Heap could access different transport controls (i.e. record, play, stop, etc.) and effects (reverb, delay, EQ filters), which could then be controlled by the audio control gestures.\textsuperscript{90} At the end of the of their 2010 paper Mitchell and Heap revealed that “[immediate] development will incorporate an additional glove and the use of position, orientation and/or acceleration sensors.”\textsuperscript{91} This moved the SoundGrasp glove into its next generation: the Mi.Mu gloves.

After two more years of trial and error Heap and her “Gloves Team” arrive at the dual-glove, Mi.Mu configuration. The gloves are connected to a “sensor management and audio control” unit that gathers incoming data signals from the gloves and translates them into pre-determined audio signals (live audio, MIDI audio) and effects.\textsuperscript{92} The Gloves Team established five modes for the Mi.Mu gloves: “voice, wrist, effects, synthesis, and drum.”\textsuperscript{93} Mode selection

\textsuperscript{88} See Mitchell and Heap, “SoundGrasp,” 467.
\textsuperscript{89} Ibid.
\textsuperscript{90} “State control gestures switch the system between different modes which enable the performer to activate different types of audio control processes. This forms a one-to-many mapping between gestures and audio control where a single gesture can be mapped to multiple audio processes through different modes. In establishing the control mapping, audio control gestures, which directly affect the produced sound, use metaphor to increase transparency. In contrast, state control gestures, producing no audible effect, were chosen for performer usability.” Ibid.
\textsuperscript{91} Ibid., 468.
\textsuperscript{92} Mitchell et al., 3.
\textsuperscript{93} Ibid. Here is a description of each mode: “In voice mode, the vocal microphone signal could be recorded or overdubbed into a two channel looper. This mode was controlled using a simple grasping gesture where record was enabled on the identification of an open hand posture and disabled at all other times, an idea described
is accessed via a particular gesture and is accompanied with a specific color displayed via LED units mounted on the back of the gloves, adjacent to the metacarpal bones of the thumbs. A wireless headset microphone was incorporated to allow Heap the ability to incorporate her voice with greater ease into the Mi.Mu system. Furthermore, the Gloves Team wired a Kinect module into the central set up to allow Heap to “map the stage…[to have] different areas of the stage telling…Ableton where [she is on stage, as] different sets of instruments [and effects] come into play.” This allowed Heap the ability to engage both the environment and the audience as she moved in different areas of the stage to trigger different effects; a good example of this is a reverb effect that becomes larger and more spacious as Heap moves farther away from the audience while raising her arms, thereby giving more of a sense of space, and comes down to a “dry” state (no effect) when she reaches the point mapped closest to the audience while lowering her arms.

previously…In wrist mode, the audio input received from the left and right wrist microphones can be recorded into a separate stereo looper. This enables the performer to play and record acoustic instruments where the record state was toggled when a rotational spike was detected around the axis of the right wrist. In effects mode, continuous control gestures with the right hand applied effects to the output mix of the looper and left hand gestures applied effects to the live vocal input. Reverberation and panning are controlled by the Euler angles $\Theta$ and $\Psi$. Furthermore, filtering was applied using the mean average of the finger flexion sensors for each hand. The wrist flick, as described in the wrist mode section, toggled the recording of automation for each of the effects. The synthesiser [sic] mode used a combined control mechanism in which segmented orientation of the $\Theta$ Euler angle selected the current note and the posture identification of an open hand was used to trigger note playback on a soft-ware synthesiser. Similarly, in drum mode, sounds were triggered with the identification of peaks in the raw inertial sensor data, with the selection of the drum sound controlled by inspecting the rotation matrix. In both modes recording was toggled with the formation of a fist with the right hand.”

94 “Mode selection was performed only when the left hand was open and the right hand formed a fist. This gesture was chosen because it is simple to perform and unlikely to occur incidentally. Each mode was ascribed a colour [sic] which was displayed on the left and right hand LED modules to provide feedback.”

95 See Mitchell et al. 3.


97 “It was really interesting to write a song in 3-D space…to think of it in movement, in proximity to the audience, how I might want to change the effect of the song…” Heap, “The Gloves Demo and Q&A,” February 11, 2013. At the Wired 2012 conference Heap described it as such: “‘The way we program the gestures is the same as playing an instrument in 3D space. As I walk around the stage you can see that I’m walking into a different set of effects. My
The earliest public performances by Heap with the Mi.Mu gloves were built around a semi-improvised tune which utilized voice, “air drums,” and acoustic instruments. Eventually Heap composed the song “Me the Machine” with the Mi.Mu gloves both as a means of demonstration and to include on her 2014 album *Sparks*. The song, which debuted as part of a live Internet broadcast on Earth Day (April 22) 2012, was described by Heap as a narrative of “what it must be like for a machine to want to be human.”

Nattinger, Wirtz, and Heap continue to tweak their respective technologies as they continue to improve in both their abilities to use their controllers and as computers and sensor components advance. While Nattinger, Wirtz, and Heap are all able-bodied, it has been realized that these types of controllers, and others like them, can help people of differing abilities.

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both physical and cognitive, compose and perform music. This is where we will now turn our attention.

**Case Study: Extending Physical Gesture – Differently-Able Human**

While the lyrics of “Me the Machine” examine a machine “contemplating” becoming human, more and more we are witnessing technology helping people of varying abilities regain, or at least adapting, elements of their humanity. One entity promoting this idea is the Australian electronic music collective Tralala Blip. The collective, also known as “TLLB,” was begun by musician Randolf Reimann in 2007 “to provide a fertile environment in which intellectually and physically handicapped people would have access to new technologies that would enable more creative possibilities for self-expression.”

Within the first year the ensemble numbered around sixteen participants and ranged in age from teenagers to people in their late fifties. In 2009 Tralala Blip began the transition from a workshop series to a full-fledged band and eventually boiled down to a five-person line-up. Within a year of forming

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104 The current line-up is (with the year they joined): Randolf Reimann (2008), Mathew Daymond (2008), Lydian Dunbar (2010), Zac Mifsud (2011), and Phoebe Rose (2013). Prescott, “In My Natural Way: Tralala Blip Interviewed.” Of the current line-up, Daymond, Dunbar, and Mifsud are less-abled; Reimann and Rose are fully-able. Reimann also acts as the artistic director.
Tralala Blip played their first show, opening for Australian electronic musician Muttboy.\textsuperscript{105} Over the course of the next few years Tralala Blip recorded and released a couple singles and extended play (EP) recordings and performed as far away as Krakow, Poland.\textsuperscript{106}

Tralala Blip is described as “having a differently-abled line-up.”\textsuperscript{107} From the inception of the group Reimann integrated technology as a means to make music an interactive endeavor for Tralala Blip participants:

At the time, music programs [in the resident facilities] usually meant a singalong situation with a facilitator strumming their guitar while others sung along or banged a tambourine. When I witnessed this, I just got angry. It seemed lazy, patronising and was obviously boring for the people who were participating. I had a lot of gadgets at home from years of making electronic music and [I] knew a little about singing…So I started taking the bits along to a disability service in Lismore and encouraged people to start composing their own original songs.\textsuperscript{108}

While Reimann admits that being a differently-abled band can make Tralala Blip’s relationship with controllers and electronic instruments a bit complicated, he takes solace in the idea that many of the instruments they use, which includes an array of static controllers and touch pad/surface devices, “[weren’t] designed as a conventional instrument anyway…[and] they inspire different approaches to composition.”\textsuperscript{109}

\textsuperscript{105} Ibid. Muttboy is the leader of Sound Crucible, a “collaborative, multi-disciplinary, electronic sound art group” based in the state of Victoria, Australia. SoundCloud, “Sound Crucible,” https://soundcloud.com/soundcrucible, accessed February 27, 2015.

\textsuperscript{106} Prescott, “In My Natural Way: Tralala Blip Interviewed.”

\textsuperscript{107} Ibid.

\textsuperscript{108} Ibid.

\textsuperscript{109} Instruments include: “sine wave synth, white noise machine, audio cubes and vocals,” a Yamaha Tenori-On, a Korg Kaossillator, a Korg Kaoss Pad, an Apple iPad, and a Frostwave SpaceBeam, and Ableton Live. Tralala Blip, “Artists/Musicians,” Tralala Blip, http://www.tralalablip.com/artistsmusicians/, accessed February 27, 2015. Members of Tralala Blip have also been known to use a Korg MS-20 modular synthesizer, a Novation Launchpad, and various small synthesizers. Prescott, “In My Natural Way: Tralala Blip Interviewed.” “Learning a popular-musical instrument, like the guitar, is an experience often accompanied by very informal learning processes. However, outside of the classical repertoire or formal instruction, there simply is no required or specified way to learn an instrument.” Joseph R. Keebler, Travis J. Wilshire, Dustin C. Smith, Stephen M. Fiore, and Jeffrey S. Bedwell, “Shifting the paradigm of music instruction: implications of embodiment stemming from an augmented reality guitar learning system,” \textit{Frontiers in Psychology} 5, Article 471, May, 27 2014, 1. doi: 10.3389/fpsyg.2014.00471.
The music produced by Tralala Blip is described as by many “experimental;” Reimann sees their sound as technology amplifying and multiplying their unique personalities:

[As] much as we all love pop music, experimentation and improvisation have always been a prominent component to our operation. We have long found kindred spirits in the more experimental scenes, especially in Brisbane. People into more conventional pop music are unaware of our existence, and usually have a very narrow view of what pop music is and are very exclusive. [We] love our friends who dwell in the more sonically inclusive realms of music.\(^{110}\)

While Tralala Blip works primarily in the world of experimental electronic music, British conductor and composer Charles Hazlewood has been approaching the case for differently-able musicians in the realm of orchestral music. Hazlewood first became aware of the plight of differently-able musicians after his fourth child was diagnosed with cerebral palsy.\(^{111}\) After this diagnosis, Hazlewood realized there were very few differently-able musicians playing in any of the major orchestras or instrumental groups he saw around the world.\(^{112}\) He said, “As soon as I started looking, I encountered amazing musicians of all sorts – and the founder members of the Paraorchestra began to appear.”\(^{113}\)

Hazlewood made a formal introduction of the British Paraorchestra when he gave a talk at the 2011 TEDGlobal conference.\(^{114}\) Later that year the first four members of the British

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\(^{110}\) Prescott, “In My Natural Way: Tralala Blip Interviewed.”

\(^{111}\) “The orchestra’s story is a personal one. I am lucky enough to have four wonderful children, the youngest of whom has cerebral palsy. Being a musician, it came naturally to me to sing with my children when they were small and mess about on the piano, guitar or wooden spoons. Five years ago, around the time my daughter was diagnosed at the age of 18 months, I began to notice how music affected her. Though she often seemed floppy and weak, she would be upright, engaged and energetic when music was being made.” Charles Hazlewood, “One from the heart: Charles Hazlewood’s Paraorchestra,” The Guardian, June 27, 2012, http://www.theguardian.com/music/2012/jun/27/charles-hazlewood-british-paraorchestra, accessed February 28, 2015.

\(^{112}\) “With these new eyes, I took a fresh look around my professional world. It suddenly became glaringly odd that there were virtually no disabled musicians in any of the orchestras or groups I played with anywhere in the world. Where was the talent with disability?” Ibid.

\(^{113}\) Ibid. Some members have received public accolades: left-handed pianist Nicholas McCarthy is a graduate of the Royal College of Music; wind instrumentalist Clarence Adoo was awarded the MBE (Master of the British Empire) by Queen Elizabeth II for his contributions to music.

Paraorchestra performed an improvisation on “Greensleeves” to a standing ovation at TEDxBrussels.\textsuperscript{115} In 2012 the full seventeen-member British Paraorchestra took to the world stage when they performed with the British rock band Coldplay at the closing ceremonies of the 2012 Summer Paralympics in London.\textsuperscript{116} The British Paraorchestra has also been the subject of a British documentary, provided theme music for a Paralympic television show, collaborated with the Kaos Signing Choir and some well-known British Paralympians to record a version of the Cyndi Lauper hit song “True Colors” for the United Nations and the International Day of Persons with Disabilities, and even garnered the attention of Queen Elizabeth II.\textsuperscript{117}

While a variety of traditional, historic instruments are played by the musicians of the Paraorchestra, a few members rely exclusively on electronic instruments and technology to aid in the composition and performance of music.\textsuperscript{118} Clarence Adoo was among the leading trumpet players in the United Kingdom until he was injured in an automobile accident in 1995, rendering him a quadriplegic.\textsuperscript{119} Within a decade Adoo was performing again with the aid of a computer-based system built around head-mounted, breath-controlled MIDI device called Head Space.\textsuperscript{120} Adoo is a founding member of the Paraorchestra and occasionally conducts for the group.\textsuperscript{121} One of Adoo's fellow members in the Paraorchestra is electronic musician Lyn Levett. Levett, who has cerebral palsy, is a known composer who works in several musical avenues, from live

\textsuperscript{118} Instruments include piano, violin, soprano saxophone, sitar, tabla, and archlute.
\textsuperscript{120} Ibid.
\textsuperscript{121} Hazlewood, “One from the heart: Charles Hazlewood's Paraorchestra.”
performances to film scores. Levett uses a MacBook Pro computer running the software Logic Pro for composing and Ableton Live and an Apple iPad for performing. Levett has an iPad mounted to her wheelchair via a special bracket/holder that allows her to trigger sounds and loops by touching the screen with her nose.

Hazlewood has stated that the Paraorchestra is not to be a project characterized by "warm fuzzies," but rather a stage for "making the very highest levels of music to change people's perspectives." Hazlewood is quick to quash negative opinions of Paraorchestra and other ensembles like it:

I am not interested in creating a ghetto for disabled performers, but using this opportunity [performing with Coldplay at the 2012 Summer Paralympics] to lift them up, enable them to take their rightful place.” And that is side-by-side with non-disabled musicians, on equal terms.

Adoo and Levett share Hazlewood's passion and sense of advocacy. When asked about the Paraorchestra's performance with Coldplay, Adoo said, “That's what's exciting us most...the global audience and the opportunity to shift attitudes and expectations that it provides.” Levett is very outspoken about both her music and the Paraorchestra:

I have tried for 20 years to get into the music business...but I don't blame my disability. This is a hard business to get into for anyone. You just have to push and push and push. I have been in other ensembles where the importance was in the taking part. That isn't enough for me. I love music and I want to create brilliant music...
...We have been given a level playing field to be professional.\textsuperscript{129} Technology can help differently-able musicians adapt to their circumstances, whether they are like Levett, who was born with a severe case of cerebral palsy, or like Adoo, whose condition came later as the result of an accident. But what about someone who is preparing for the future when they become less-able than they are presently? Kris Halpin is such a person.

Halpin, a musician and recording studio owner/engineer, is one of fifteen collaborators who financially invested in Imogen Heap's Mi.Mu gloves project to obtain a custom-made pair of the gloves. The collaborators joined Heap at her country home in England for an intensive weekend workshop on getting started with their gloves. For Halpin acquiring a pair of “Mi.Mu gloves means more to him than a way to create new instrumental ideas -- but a way to maintain and hone the skills he has already developed.”\textsuperscript{130} Halpin, too, has cerebral palsy; but his is progressive. While currently high-functioning, Halpin is preparing for the time when his abilities will be severely limited. Halpin is very candid about his coming to terms with his condition:

[I've] struggled to make records; my hands just don't let me play like I used to. Then [the Mi.Mu gloves] come along...and I think, 'wow, this might just be the answer.' As my abilities change it might be irrelevant -- the gloves might just take that problem away.\textsuperscript{131}

Halpin has been documenting his life and musical process on his YouTube channel \textit{Dancing About Architecture}.\textsuperscript{132} Even in the midst of his situation, Halpin remains optimistic: “I can't fit my hand round the piano...but I could fit the gloves around the disability.”\textsuperscript{133}

\textsuperscript{131} Ibid.
\textsuperscript{133} Lanxon, “Imogen Heap Opens Home for 'Musical Glove' Hack Weekend.”
Halpin has been working with Drake Music, a charitable organization “that aims to make
music accessible for disabled people and children,” in developing his work with the Mi.Mu
gloves. Gawain Hewitt, a research and development manager for Drake Music, expresses a
mix of concern and hope over the new developments: “I've got a big concern about the level of
thought and effort [currently] going into new musical technologies...If you compare the potential
and the actual technology being developed everywhere, it's an exciting time.” Despite this
excitement Hewitt notes that there is a gap between where the technology is and where it needs
to be. But Hewitt says he is hopeful that Heap, Halpin, and Drake Music will “help fill, in part,
with the research and learning garnered by their collaboration with the [Mi.Mu] project.”

Case Study: Extending the Human Voice

Most of what has been discussed thus far has primarily addressed gesture or physical
movement; but what about the human voice? As the voice is the original instrument it makes
sense that musicians would eventually look to technology to extend the capabilities of it. The
final case study of this section will focus on two musicians who use technology to extend the
abilities of their respective voices.

Tim Shaw's musical career began in childhood as a violinist; he was introduced to
electronic music in his early teens and began composing in various electronic genres shortly

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134 Ibid. “Drake Music breaks down disabling barriers to music through innovative approaches to teaching, learning and making music. Our focus is on nurturing creativity through exploring music and technology in imaginative ways. We put quality music-making at the heart of everything we do, connecting disabled and non-disabled people locally, nationally and internationally. Through our diverse offer, DM continues to explore different ways of working at the intersection of music, disability, art & technology and break new ground artistically and in terms of participatory practice.” Drake Music, “About Us,” www.drakemusic.org/about-us, accessed February 28, 2015.
136 “But compared to what's developed for people with special needs there’s a chasm.” Ibid.
137 Ibid.
thereafter. After pursuing graduate studies in electroacoustic composition, Shaw, now known better by his pseudonym “Tim Exile,” began to take his music in a more progressive direction. Originally working in the drum 'n' bass and IDM (intelligent dance music) genres, Exile went from standard DJing to controllerism.

As a controllerist Exile moved away from using preexisting loops and toward improvisation based on live sampling, via a microphone, from himself and audience members. The samples are held in a custom-made recording environment built in a software program called Reaktor. From Reaktor the samples are available for Exile to manipulate via a custom-built hardware setup. This hardware setup, which Exile dubbed “The Flow Machine,” features a panoply of buttons, faders, rotary encoders, and drum pads, along with both a MIDI keyboard and a computer keyboard, that allow Exile to stretch, warp, add any number of effects, and re-sample loops.

Exile has evangelized the world with his improvisational music-making; he has played clubs, given TED Talks (including at the Large Hadron Collider in Cern, Switzerland), toured as part of fellow Brit Imogen Heap's live band, live-sampled the Heritage Orchestra, and performed live improvisations from audio samples sent in by fans from around the world (including myself) in real-time.

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139 Reaktor was developed by software company Native Instruments.
140 Exile, who has also developed two software plug-ins for Native Instruments, outlines his setup in the video: Native Instruments, “Tim Exile Shows his Reaktor-Based Live Performance Setup,” *YouTube*, September 16, 2009, https://m.youtube.com/watch?v=9r38r3Blgw, accessed October 27, 2014. Among the instruments Exile’s rig contains a looper, a small set of drum samples, a “keymasher” (which uses the computer keyboard and focuses on real-time scratching and reordering of the sample), “The Finger” (which is similar to the keymasher, but leans toward “more extreme transitions”), fader FX (which harnesses traditional audio effects like reverberation, delay, flanger, etc.), and “The Mouth” (a voice synthesizer which can harmonize most any sound, including drums). All of this is setup via the highly-customizable software Reaktor. Ibid.
141 To date Exile has delivered at least five TED Talks: TEDx Talks, “Performance -- the LHC remix | Tim Exile | TEDxCERN,” *YouTube*, October 27, 2014, https://www.youtube.com/watch?v=d8w6q4JCRjA; TEDx Talks, “ExNihilo performance: Tim Exile at TEDxBrussels,” *YouTube*, November 3, 2013,
While Exile went from technology to the voice, Darren Foreman started with the voice, eventually finding technology. Like Exile, Foreman, better known by his stage name “Beardyman,” started with more traditional music, even composing a piece for his primary school orchestra. In his childhood Beardyman began imitating the vocalizations of comedian Michael Winslow; later on Beardyman took up beatboxing and began listening to drum and bass music. A two-time champion beatboxer in the UK, Beardyman began incorporating a Korg Kaoss Pad 3, an effect and sampling device with an X-Y touchscreen, after watching musician MC Xander perform. Beardyman's performance technology eventually included several effects units and samplers, including guitar pedals.

In 2012 Beardyman switched from his bank of samplers and effect units to a collaborative, proprietary software-based live-looping setup. The setup, christened “The Beardytron 5000 mkII,” was built by DMG Audio and features iPads running a number of programs and control displays, a MIDI keyboard, footswitches, and drum pads. The impetus behind The Beardytron 5000 mkII was Beardyman's frustration with the limitations of his voice.

I was constantly trying to extend my repertoire of noises to be the very maximum it could be...I know that there are some noises I'll never be able to make because I'm hemmed in by my physical body...There's things you can't do and these limitations on the human voice have always really annoyed me.

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143 Ibid.
144 Ibid. These can be seen on any number of Beardyman's videos on YouTube.
According to Beardyman, The Beardytron 5000 mkII is “a real-time music production machine...[which enables me] to, using nothing but my voice, create music, in real-time, as I hear it in my head, unimpeded by any physical restrictions...”147 Beardyman is quick to point out that The Beardytron 5000 mkII has no pre-recorded audio samples in it; it only has sounds when he begins to vocalize, beatbox, and sing into it.148 Vocalizations can be effected or processed as they enter into The Beardytron 5000 mkII; additionally, Beardyman can control the recorded sounds via various controllers, including sampling his voice to sound like a rock organ and playing it on a MIDI keyboard.149

Even though he has produced some amazing covers of other artists' music with The Beardytron 5000 mkII (including Pink Floyd), Beardyman passionately states, “I haven't made this machine so I that can emulate things that exist; I’ve made it so I can make any noise I can imagine.”150 Much like Imogen Heap's Mi.Mu gloves, Beardyman is hopeful that a consumer version of The Beardytron 5000 mkII can be put into production in the near future so other musicians can begin to perform “some things that are in [their minds].”151

Through these case studies I have shown the variety of research and development that has been done, and is presently being done, in the area of developing technology for extending ability in music composition and performance. From here this section will enter into a brief discussion of technical matters and skills to be taken into consideration with our topic of technology and music composition and performance.

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147 Ibid.
148 Ibid.
149 Ibid. Beardyman also has some of his live performances archived at www.beardyman.co.uk.
150 TED, “Beardyman: The Polyphonic Me.”
151 Ibid.
Technical Matters and Skills

While music is indeed an art not all aspects of music-making can be couched in emotion and subjectivity. There are technical aspects to music composition and performance; this is especially true when electronics and technology are added to the mix. This subsection will address the topic of technical matters, especially where the analysis of the music composed and produced as a result of the means and methods presented in the aforementioned case studies. Additionally, I will discuss skill(s) required for this kind of music production and performance.

In all of the case studies there is some kind of computer-based software being utilized. Despite the variety of software employed in the case studies all of them are used to record, effect, manipulate, and/or trigger audio.¹⁵² The two main ways audio/sound have been utilized in these cases are prerecorded audio files and what will be call “ex nihilo audio.”¹⁵³

Prerecorded audio normally takes two forms: samples/loops (typically live instruments recorded via a microphone or direct injection box) or MIDI (which could be any number of sounds or instruments).¹⁵⁴ This prerecorded audio can be triggered (typical of drum loops and sound effects) or played in real-time (like finger drumming or Imogen Heap's Mi.Mu instruments). This type of audio is usually launched in predetermined sequences and groups to form full pieces of music.¹⁵⁵

¹⁵² The software varies from in-house/proprietary to commercially-available software, like Ableton Live, Max/MSP, Serato DJ, Traktor, and Reaktor.
¹⁵³ “Ex nihilo” is a Latin phrase which means “from or out of nothing.” Merriam-Webster Dictionary, “ex nihilo,” i.word.com/idictionary/ex%20nihilo, accessed March 1, 2015. It is usually associated with Christian theology and the Creation account from the biblical book of Genesis. Tim Exile also gave a TED Talk titled “Ex Nihilo.”
¹⁵⁵ Despite the predetermined form of the loops and samples, they can be performed the same way every time or improvised with or upon, like jazz. “The impression that repeated performances of the same piece by the same artist differ in musically significant ways is widespread and perhaps contributes to the continuing popularity of live performance. Is the impression correct, and if so, are the differences due to random variation or to some-thing more systematic that is governed by musical intuition? On the one hand, musical performance is subject to the same kind of random variability as any other psychological process. Perhaps performers and audiences alike simply ignore or
Ex nihilo audio can come from a human voice or instrument. Ex nihilo audio does not exist in a prerecorded form; it is produced when the musician vocalizes or plays an instrument, and the musician records the audio into their system of choice. This type of audio performance is exemplified by Nattinger and the VAMP, Heap and the Mi.Mu gloves, Exile and the Flow Machine, and Beardyman and The Beardytron 5000 mkII; all four audio devices have the capabilities to sample and effect audio in some way, shape, or form.

When it comes to the topic of skills there can be a lot of disagreement as to what constitutes “skills”: some people would argue for traditional academic quantifiers, others would argue that skill can be obtained independent of traditional methods. I would like to propose two skill sets for our consideration: programming and performance.

Programming can take at least two forms: computer programming (basic programming, like MIDI mapping; programming languages, like C++) or sample/MIDI programming. Many musicians who utilize performative technology participate in the programming of their technology, whether they are the programmers (such as Elena Nattinger, Tim Exile, or CutterJ the Absurdist) or they collaborate with a programmer to accomplish their goal (such as Imogen Heap or Beardyman).

Performance with technology does not equate perfection of performance. Like most any other instrument, performative technology requires one to study and practice their craft. The human factor in a performance opens up the performance to vulnerability, to error. Robert Keller suggests that human performers can actually improve the quality of electronic music-making. When performing “Me the Machine” for the Wired UK 2012 conference Imogen Heap inadvertently hits two unintended notes with the bass synthesizer mapped to her left hand; she quickly and subtly changed the notes to the intended notes. Even though the notes Heap hit could be analyzed as suspended notes, they were not the notes intended.

Based on the material presented in this section it can be noted there exists more than one type of technology available for composition/performance purposes. This technology can be

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157 Sergi Jordà says the problem standing in the way of this concept is the attitude toward the conception and invention of new instruments: “New standards may not be essential for the creation of new music; perhaps even the concept of a musical instrument is just an old romantic burden that would be better left aside, but somehow it seems that some unrestrained potential is being eschewed in this lawless anything-goes territory. New digital instruments conceived holistically and not as a conglomerate of several interchangeable components are scarce; even worse, in most cases they are only performed by their creators. This situation complicates any progression in the field, both from the design and from the performance perspective. It is not only that electronic music controllers evolve so rapidly that it is rare for a musician to work long enough with one to develop virtuosic technique; it is that every new incarnation seems to come out of the blue. “A growing number of researchers/composers/performers work with gestural controllers but to my astonishment I hardly see a consistent development of systematic thought on the interpretation of gesture into music, and the notion of musical feed-back into gesture.” Jordà,100.

158 “Technological advances in computers have also made computers quite useful to composers. Computers are sometimes needed for the replication of super complex music because humans are incapable of producing the degree of accuracy required. While this is true, Kramer writes, ‘Sequencers, on the other hand, produce coldly regular rhythms, far more precise than any human can perform. The result can be lifeless.’ The dilemma between computers and humans is simple. Human performers are not rhythmically perfect but they can add elements of life to music. Computer performances tend to sound more mechanical and forced. The composer is left with a choice between a rhythmically perfect performance but void of emotion, or a performance filled with emotion but far from computer perfect.” Robert Keller, “Mapping the Soundscape: Rhythm and Formal Structure in Electronic Dance Music,” 69-70. Tobias van Veen comes at this from a different point of view: “...the spectre of laptop music has largely been overblown. Yet the ghosts in the glitch machine—or the glitches in the ghost machine—haunt every laptop performance: a movement of the human to the posthuman, a cyborgian connection between performer and circuitry, even a shift in the nature of performance ‘as such’...” van Veen, “Laptops & Loops: The Advent of New Forms of Experimentation and the Question of Technology in Experimental Music and Performance,” 6-7.


160 If one compares the Wired UK 2012 performance with the final album version, one can hear the intended harmonization on the final album version of “Me the Machine” and the accidentals in the Wired UK 2012 performance. “Artists are able to reliably reproduce the same nuances of interpretation in repeated performances and normally do so, once a new piece has been prepared, giving essentially the same performance on more than one occasion.” Chaffin et al., “It is Different Each Time I Play: Variability in Highly Prepared Musical Performance.”
adjusted or co-opted as needed or desired. Furthermore, multiple avenues (gesture, voice, etc.) can be assisted via technology and the technical necessities and skills required can be as varied as the performers/musicians themselves.

The next chapter will look at the evaluation and assessment of computer-based composition and performance.\(^{161}\)

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\(^{161}\) We must have experience playing and performing on an instrument before we can classify and assess it. As the charismatic Christian author Agnes Sanford famously wrote, “…experience comes before theology.” Agnes Sanford, *Sealed Orders* (Alachua, FL: Bridge-Logos, 1972). 313.
CHAPTER IV
EVALUATION AND ASSESSMENT

The previous chapter looked at the ability of technology to extend human capabilities in musical composition and performance. This chapter will address issues of evaluating and assessing music composed and performed with the aforementioned technologies; specifically, this section will suggest potential issues with defining an electronic composition, touch on skills for composition and performance, present thoughts on assessment and evaluation (from a primarily academic standpoint), and postulate on musical literacy.

Defining “Composition”

The question as to what defines a composition is a point of contention among people in the field of music.© Composition is a complex, multifaceted construct.© Three categories are suggested for defining a composition: musical cohesion/coherence, complexity, and how the resulting piece of music is viewed by its creator.

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© Indeed, the very act of defining of music can be a difficult venture. Horacio Vaggione offers a thought, along with a quote from Jacques Bouveresse on the matter: “…it can be argued here that the very idea of ‘music itself’ encounters a major difficulty: nobody can say what music is, other than by means of a normative proposition, because ‘music itself’ is in fact a non-demonstrable thing, and its practice is neither arbitrary nor based on physical or metaphysical foundations: ‘It is not because we know, in one manner or another (and without being able to say how), what music is that we also speak of atonal or concrete music as music. We use the word “music” according to certain rules, and these are neither very precise nor based on the ”nature of things”, even if they cannot be considered as arbitrary.’” Horacio Vaggione, “Some Ontological Remarks about Music Composition Processes,” Computer Music Journal 25, no. 1, “Aesthetics in Computer Music (Spring 2001), 55. http://www.jstor.org/stable/3681635.

© “Music composition processes can be envisioned as complex systems involving a plurality of operating levels. Abstractions of musical ideas are manifested in myriad ways and degrees, one of which is of course their suitability for implementation as algorithms, enabling musicians to explore possibilities that would otherwise lie out of reach.” Ibid., 54. Luigi Russolo, famed early twentieth-century Futurist and painter, said, “In order to excite and stir our sensibility, music has been developing toward the most complicated polyphony and toward the greatest variety of instrumental timbres and colors.” Luigi Russolo, “The Art of Noises: Futurist Manifesto,” Audio Culture: Readings in Modern Music, Christoph Cox and Daniel Warner, eds. (New York: Continuum International, 2004), 11.
Musical Cohesion/Coherence

The eighteenth-century French writer and composer Jean-Benjamin de Laborde, writing in his *Abrégé d’un Traité de Composition*, said this about composition:

Then it boils down to two things: to set certain rules in order to organize the sounds, one after the other, so that a pleasant melody results from them, and to provide the means to accompany this melody with a good harmony. That is to say, to have several different melodic lines heard at the same time, without this mixture having anything unpleasant [about it].\(^{164}\)

If this definition were to be our model then there are copious amounts of music that would be considered “compositions” and yet there would also be a considerable amount of music that would not be designated compositions, in particular where Leborde’s definition says a composition should not have “anything unpleasant [about it].”

Aurelio de la Vega writes that there are two main considerations when delineating electronic music composition:

(1) accepting the honesty of the electronic music composer, his artistic ability, his technical skill and the validity of his creation as an organized artistic experience, is this type of artistic creation music at all? and, (2) given that the product is accepted as music of a new type or order, is not such music “inhuman”?\(^{165}\)

He follows this with a brief comparison of the division between the stereotypically subjective nature of nineteenth-century music and the attempted objectivity of early twentieth-century

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\(^{164}\) Donald Craig Filar, *Jean-Benjamin de Laborde’s "Abrégé d’un Traité de Composition:"
*The Merger of Musica Speculativa and Musica Pratica with an Emerging Musica Historica* (PhD diss., Florida State University, 2005), 249. Preceding this summary, Laborde says, “What we call composition consists of only two things. The first is to line up and arrange several sounds, either similar or different, one after the other, in such a way that this series of sounds will have nothing unpleasant about it and may make pleasure for the ear; this is what the Ancients called melody and what we name song. The second consists of having two or several sounds heard together in such a way that this mixture will be pleasant. That is to say, it is to devise several different melodic lines which will be able to go together in such a way that the mixture or collection of different sounds of which they are composed will contain nothing that shocks the ear. This is what we call harmony, and what would only be worthy of the name composition. A dual use has prevailed, however. We hear this word [composition] used equally for melody and harmony, thus, to set up a pleasant series of sounds that produce a beautiful song when they are put together from other sounds to create a harmonic whole. All of this is composition.” Ibid., 248-9.

composers. This objectivity, de la Vega says, is “epitomized in Stravinsky's description of it as ‘a form of speculation in terms of sound and time’.” For de la Vega recognition and/or appreciation of twentieth-century music is more important than a comprehension of its forms and sounds. This view of appreciation over comprehension is not new to the realm of “new music;” composers from Debussy to Stockhausen have had to defend their music against the onslaught of purists.

Musical Complexity

The discussion of complexity in music is not exclusive to electronic music; many pieces and works over the centuries have been labeled “complex” by listeners and critics alike. But does a heightened degree of complexity equal a “good” composition? In an assessment rubric for the live-coding music software Sonic Pi, Pam Burnard and Louis Major describe complex as “detailed, elegant.” Arnold Whittall, in responding to a study on complex music, said,

166 “The ever-present popular concept of music as a direct, open, emotional expression and as a subjective form of communication from the composer, is, of course still that of the nineteenth century, when composers themselves spoke of music in those terms: e.g. ‘from the heart to the heart’ (Beethoven), ‘tone as the direct expression of feeling’ (Wagner), ‘emotional sensitivity’ (Berlioz), ‘the portrayal of soul states’ (Mahler), and ‘not needing the frame of pedantic forms’ (Busoni).” Ibid.
167 Ibid.
168 “An acceptance of this more characteristic twentieth-century view of the art of musical composition will of course immediately bring the layman closer to an understanding of, and sympathetic response to, electronic music, even if the forms, sounds and approaches it uses will still be of a foreign nature to him.” Ibid.
169 Stockhausen participated in a “musical exchange” with a group of electronic musicians dubbed the “Technocrats” (Richard D. James/Aphex Twin, Richie Hawtin/Plastikman, Robin Rimbaud/Scanner, and Daniel Pemberton). Stockhausen was given a piece from each of the Technocrats, he listened to them, critiqued them, and recommended one of his pieces to each of the Technocrats for their musical development. The Technocrats each listened to a Stockhausen piece, gave critique to Stockhausen, and then recommended one of their works for Stockhausen's musical development. While there was some appreciation shown most of the participants did react rather defensively of their music. This is documented in “Stockhausen vs. the 'Technocrats,'” Audio Culture: Readings in Modern Music, Cox and Warner, eds., 381-5.
170 Any number of electronic and electroacoustic compositions comes to mind, including Stockhausen's Gesang der Jünglinge and Varèse's Poème électronique, as well as “traditional” works, such as Stravinsky's Rite of Spring and Schoenberg's Erwartung.
I added that ‘the principal challenge for complex music is to create material as memorable and a formal context and treatment as rich and refined, as is possible (if rarely attained nowadays) with motives’.  

Taking this idea a step further, two rubrics were compared for the assessment of musical compositions: one for elementary school-aged children and one for university students. The general criteria for the elementary-aged rubric include “aesthetic appeal, creativity, and craftsmanship;” the rubric for university students considers “orchestration, presentation, compositional technique, aesthetics/creativity, literacy, and musical form.” Neither rubric uses the term “complex” to assess compositions; instead they focus on how well musical ideas are being communicated and developed and if the composer shows their awareness or understanding of certain elements or aesthetics of a musical form or genre.

using Sonic Pi, both compositions and live coded performances. In this section, we identify several approaches to assessment developed by Pam Burnard and Louis Major (Faculty of Education – University of Cambridge). These encourage practitioners (teachers/artists/technologists) and pupils to work together to develop assessment practices that take the form of joint evaluations.” Sonic Pi, “Resources,” http://www.sonicpiliveandcoding.com/, accessed March 16, 2015.

172 Arnold Whittall, James Dillon, “Review: Riverrun,” The Musical Times 134, no. 1805 (July 1993), 387. Roger Marsh, commenting on Whittall’s comment, says this, “Clearly a champion of the broad aesthetic of the 'new complexity' composers (Femeyhough, Dillon, Barrett, etc.), these remarks reveal a certain ambivalence which requires explanation. For while the exhortation to take the next mighty step has a bravely positive ring, it is nevertheless an implicit acknowledgement that 'complex' music has not yet achieved a very high degree of sophistication within its own language. The material, according to Whittall, is unmemorable and its treatment and formal distribution are neither rich nor refined by comparison with other (motivic) music. Leaving aside the question of what constitutes a 'motive', and whether or not 'complex' composers use them, it has to be said that Whittall's challenge is hopelessly unrealistic. If the challenge were to be met, 'complex' music would no longer be 'complex.'” Roger Marsh, “Heroic Motives: Roger Marsh Considers the Relation between Sign and Sound in 'Complex' Music,” The Musical Times 135, no. 1812 (Feb. 1994), 83.

173 While the term “elementary school” is not mentioned in the article the age range is implied when the author states, “...an assignment might invite students to ‘compose a piece of music that describes your favorite stuffed animal, using whatever sounds and notes you want.’” Maud Hickey, “Assessment Rubrics for Music Composition,” Music Educators Journal 85, no. 4 (Jan. 1999), 27. The university rubric was devised by Dr. Aleksander Sternfeld-Dunn and Dr. Ryan Hare, Washington State University, Spring 2010. A copy was given to me by Dr. Sternfeld-Dunn.

174 Hickey, 29.

175 Sternfeld-Dunn and Hare, 1-2.

176 See Appendix C for the rubrics.
Based on these ideas perhaps we should not assess musical complexity based merely on its level of difficulty; perhaps we should, as Burnard and Major suggested, look at the beauty and elegance of a piece, whether the piece be more intricate or more simplistic.\footnote{\textsuperscript{177} Although the ideas of beauty and elegance are rather subjective one can find both in a tone row piece or a Chopin nocturne.}

**A Composition in the Eyes (or Ears) of its Composer**

We have heard that beauty is in the eye of the beholder, but what about a composition in the eyes, or ears, of its composer? How do composers classify their works? This was the subject of a paper by Sandra Stauffer in 1994. Her paper involved a two-year, collaborative case study with electronic music pioneer Morton Subotnick and his then prototype composition software. Subotnick designed the program, later known as Making Music, as a “non-notational and intuitive, meaning that children would be able to compose without having to master music performance skills or read music or verbal instructions.”\footnote{\textsuperscript{178} Sandra L. Stauffer, “Composing with Computers; Meg Makes Music,” *Bulletin of the Council for Research in Music Education*, no. 150 (Fall 2001), 2. http://www.jstor.org/stable/40319096. Accessed August 31, 2014. A brief summary of the study is as follows: “The goals established for the first year of the study included observing children as they worked with versions of Subotnick's composition program, testing the software, and refining research procedures and questions for subsequent study of children's creative thinking and composition processes. At the beginning of the school year, a letter asking for volunteers to participate in an after-school computer music project was sent to the parents of all children who attended a local public elementary school. Volunteers were accepted on a first-come, first-served basis. Twenty-one children ranging in age from six to eleven years old participated in the project during the first year of study. Participants attended thirty-minute sessions once a week, with no more than three children participating during any time slot. Sessions continued through- out the academic year… After the conclusion of the first year, I reviewed and summarized data in preparation for the next phase of the study. Based on the data and our experiences, I revised procedures and developed the following questions to guide the second year of the study: How do children get started with their compositions? What does the process of composing look like among children? Do any patterns of composing develop over time? What evidence is there that student composers are thinking in sound?...The following fall, Subotnick concluded testing and I continued the study of children as composers. Parents of children who had participated in the first year of the project were contacted, and eleven participants continued in the study for the second year. If children or parents inquired about including siblings or friends, we accepted them. We also accepted one additional student who volunteered independently. Sixteen children participated in the second year of the study. Subotnick's software, now completed and published under the title *Making Music*, was the primary composition program used by participants in second year of the project.” Ibid., 2-4.} Subotnick did this by using the
computer screen and mouse as to represent the typology of a well-known children’s activity: finger painting.\textsuperscript{179}

Stauffer and Subotnick used three of John Sloboda’s criteria for determining creativity in music in their case study:

(1) examination of a composer's manuscripts, sketches, and completed works;
(2) examination of what composers say about their own compositional processes;
(3) observation of composers during the composition process.\textsuperscript{180}

Of these three criteria it is the second one (“examination of what composers say about their own compositional processes”) which concerns us at this time.

A considerable portion of Stauffer’s study focuses on one specific child, a young girl named Meg. According to Stauffer, Meg was selected because of [her] place in the center of the age range of all participants, the completeness of the case record, and because the data provided 'opportunity to learn' - a 'primary criterion' for selecting cases and for sampling data within them when constructing the report.

Stauffer documents Meg’s journey in four sections: “Meg as Composer,” “The Composition Process” (in three stages), “Thinking in Sound,” and “Implications.”\textsuperscript{181}

Meg developed a total of twenty-seven pieces of music. In “Ending: Concluding a Composition” (the third stage of “The Composition Process” section), Stauffer remarks, “…listening to and revising the end of the composition only or listening to the whole and making minor adjustments to the background of a piece usually signaled the conclusion of Meg's work.

\textsuperscript{179} “[Subotnick] described the program using the metaphor of finger painting in sound.” Ibid. “When a child plays with crayons or finger paints we don’t say, ‘Wait – before you experiment creatively, we’re going to give you drawing lessons.’ Yet, if a child has an idea for a piece of music they will have to bang at a piano or hit a drum; they will not be able to write the music at the level of finger painting. So we say, ‘Let’s give you piano lessons.’ I created Making Music to allow children to experience what it’s like to create music at the level of finger painting.” Transcribed from: Morton Subotnick, “Making Music: Home Edition,” Morton Subotnick’s Making Music, http://creatingmusic.com/demo/making_music_h.html?ref=m, accessed March 16, 2015.
\textsuperscript{180} Stauffer, 3. “We examined works participants created, talked with them about their works, and watched them as they composed.” Ibid.
\textsuperscript{181} Ibid., 5-19.
on a composition.” Ultimately, Stauffer notes, “The term ‘composition’ refers only to pieces Meg chose to call ‘composition’ and save in the ‘Composition Book’ file.”

Vaggione says, “What a composer wants comes from the ‘singularity’ of his or her musical project – from the composer’s manner of performing a critical act with relationships.” The evidence would suggest that ultimately it is the composer who christens their compositions as such. The genre or subgenre could be historically mandated (e.g. concerto, drum ‘n’ bass, etc.) however the differentiation of a full-fledged composition versus a ‘sketch’ or a ‘working idea’ would ultimately lay with the composer.

Skills

While the playing of a traditional instrument, such as a guitar or piano, carries with it a historical skill set and pedagogy, the playing of electronic music instruments and controllers spans a wide range, from the aforementioned historical skill set and pedagogy to a bespoke/case-by-case model. Not only have piano keyboard-based synthesizers have been popular electronic

182 Ibid., 13.
183 Ibid., 6. Hickey suggests, “Composition should be an ongoing activity in the music classroom, providing opportunities for students to experiment freely with musical sound in order to discover how to manipulate and organize it. Students should be encouraged to compose, edit, revise, and ‘doodle’ music as often as possible, keeping their ‘sketches’ as well as final compositions in personal ‘portfolios’ such as those visual artists use to hold their work.” Hickey, 26.
184 Vaggione, 60. “There is no musical process without representational systems at work – a plurality of representational systems, depending at which level or time scale we are operating. Algorithmic representations cover a substantial part of this plurality and are certainly pertinent, as they can match at least some of the assumptions underlying a given music production system, especially when including the condition of interaction, revealing its many simultaneous levels of articulation as well as its direct anchoring in perception. This leads us to valorize what is perhaps the most important issue for an ontology of music: the fact that situations organized around the production of music would not be pertinent if they were devoid of implications touching directly on questions of action and perception.” Ibid., 60-1.
185 Examples of bespoke electronic music controllers would include Nattinger’s VAMP, Heap’s Mi.Mu gloves, Exile’s Flow Machine, and Beardyman’s Beardytron 5000 mkII. Sergi Jordà, speaking on gestural controllers, notes, “Acoustic instruments consist of an excitation source that can oscillate in different ways under the control of the performer(s), and a resonating system that couples the vibrations of the oscillator to the surrounding air. Where in most non-keyboard acoustic instruments, the separation between the control interface and the sound generating subsystems is fuzzy and unclear, digital musical instruments can always be easily divided into a gestural controller (or input device) that takes the control information from the performer(s), and a sound generator that plays the role
music instruments for a number of years (as mentioned in Section II, “Extending Cognitive Ability”) but guitar-, drum-, and wind instrument-based synthesizers/electronic instruments and controllers have enjoyed a range of popularity since the late 1970’s. The governing logic behind these four instrument-based typologies (piano, guitar, drum, wind) is to use something of the excitation source. The controller component can typically be a simple computer mouse, a computer keyboard, a MIDI keyboard or a MIDI fader box, but with the use of sensors and appropriate analogue to digital convertors, any control signal coming from the outside (i.e. the performer, but also the audience or environment – as in the case of interactive installations) can be converted into control messages understandable by the digital system. Changes in motion, pressure, velocity, light, gravity, skin conductivity or muscle tension, almost anything, can now become a ‘music controller’.” Jordà, 96-7. “Where we typically think of an instrument as singular, within live electronic music, it is perhaps best to think of the individual components (eg turntables and drum machines) as the musical objects of the live rig as instrument. Percussionists are a close acoustic parallel to the modular musical rig of electronic performers. While there are percussion players who use a single percussive instrument for their performances, others will have a rig of component elements to use at various points throughout a set. The electronic performer inherits such a configuration from keyboardists, who typically have a rig of keyboards, each with different sounds, to be used throughout a set. Availing themselves of a palette of sounds allows keyboardists to break out of the limitations of timbre and verge toward the realm of multi-instrumentalists. For electronic performers, these limitations in timbre only exist by choice in the way the individual artists configure their rigs. From the perspective of users of traditional instruments, a multi-instrumentalist is one who goes beyond the standard of single instrument musicianship, representing a musician well versed at performing on a number of different instruments, usually of different categories. In the context of electronic performance, the definition of instrument is so changed that it is more practical to think not of multi-instrumentalists but multi-timbralists. The multi-timbralist can be understood as the standard in electronic performance. This is not to say there are not single instrument electronic performers, however it is practical to think about the live electronic musician’s instrument not as a singular musical object, but rather a group of musical objects (timbres) organized into the live rig. Because these rigs can be comprised of a nearly infinite number of musical objects, the electronic performer has the opportunity to craft a live rig that is uniquely their own. The choices they make in the configuration of their rig will define not just the sound of their performance, but the degrees of variability they can control.” Primus Luta, “Live Electronic Performance: Theory And Practice,” Sounding Out!, December 9, 2013, http://soundstudiesblog.com/2013/12/09/live-electronic-performance-theory-and-practice/, accessed March 17, 2015. Chris Brown adds, “Considering the intuitive facility that acoustic musicians develop through years of practicing physical gestures that create sounds on their instruments, what strategies should electronic musicians can take in designing their instruments for live performance?” Chris Brown, “Music 252 Seminar in Electronic Music Performance Spring 2015 Syllabus,” Mills College, 2.

Jordà reinforces this: “…not only keyboards, but virtually all traditional instruments (such as saxophones, trumpets, guitars, violins, drums xylophones or accordions) have been reconceived as MIDI controllers.” Ibid., 97. Kickstarter reports the Expressiv MIDI Guitar was successfully funded November 25, 2014 (https://www.kickstarter.com/projects/733246303/expressiv-midi-guitar-real-midi-real-guitar-real-c); online music retailer Musician’s Friend stocks fifty-four different electronic drum sets as of this writing (http://www.musiciansfriend.com/electronic-drum-sets?pageName=category-page&N=500311&Nao=0&recsPerPage=20&v=g&profileCountryCode=US&profileCurrencyCode=USD); and digital audio company Akai Professional continues to make the flagship wind controller, the EWI (Electronic Wind Instrument, http://www.akaipro.com/product/ewiusb). All websites accessed March 16, 2015.
familiar (fingerings, chords, embouchure, breath controller, etc.) to gain access to something foreign (i.e. synthesized sounds).

In the early days of computer-based composition and performance composer-musicians used room-sized computers littered with knobs, dials, switches, and levers to create their compositions. These gargantuan machines could contain a series of oscillators, tape machines, and filters. In these situations musical skill could be defined by the ability to turn a knob or flip a switch at a predetermined time or how well a punched card was authored or magnetic tape was spliced.

The difficulty in codifying a set of skills and pedagogy for electronic music instruments and controllers is the diversity and sheer number of options that exist and are currently under development. Sergi Jordà, based off of research by Marcelo M. Wanderley, gives us three categories of controllers: “instrument-like controllers,” “extended controllers,” and “alternative controllers.”

Instrument-like controllers refer to the kind mentioned at the beginning of this “Skills” sub-section; extended controllers “includes traditional instruments…which with the add-on of extra sensors afford additional playing nuances or techniques and thus supplementary

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187 “Music controllers can preserve traditional playing modes, permitting us to blow, strike, pluck, rub or bow our ‘computers’…With the flexibility offered by MIDI, any controller can certainly be combined with any sound- and music-producing device.” Jordà, 99. While Jordà preceding encouragement, he also offers this caveat: “Still, each choice is critical…Any input device can become a good or a bad choice depending on the context…Just as the automotive engineer chooses a steering wheel over left/right incrementing buttons, ‘we should not hand a musician a butterfly net when a pitchfork is required’…The challenge remains how to integrate and transform this apparatus into coherently designed, meaningful musical experiences with emotional depth.” Ibid.


190 Jordà, 97.
sound or music control possibilities.” Examples of extended controllers would include Livid’s Guitar Wing (mentioned in Section II) and Machover’s Hyperinstruments. Jordà’s third category is the one which is particularly of interest to this thesis.

Jordà notes that the first two types of controller categories are based on historical typologies. The stumbling block, according to Jordà, is that the majority of these “commercially available controllers, mainly modified versions of traditional instruments, have remained mostly imitative and conservative.” As a result, he says, “[Traditional] performance

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191 Ibid.
192 Jordà points out: “Although several extended controllers have been constructed to measure (e.g. for virtuosi such as Yo-Yo Ma or Wynton Marsalis) none of them is being played on a regular basis; none of them has managed to ‘dethrone’ their original instrumental role model.” Ibid.
193 “The two aforementioned categories profit from known playing techniques and thus may address a potentially higher number of instrumentalists.” Ibid. “Throughout most of the history of electronic music, the interaction end of instrument design could be classed loosely as a branch of ergonomics. Over the last 15 years, electronic instruments became digital, and within the next decade or so, their functions will probably be totally absorbed into what general purpose computers will become. Thus, for all practical purposes, musical interface research has merged with the broader field of human-computer interface. This merger has two basic frontiers; at one end, there are interfaces for virtuoso performers, who practice and become adept at the details of manipulating subtle nuances of sound from a particular instrument. At the other end, the power of the computer can be exploited to map basic gesture into complex sound generation, allowing even non musicians to conduct, initiate and to some extent control a dense musical stream. While the former efforts will push the application of noninvasive, precision sensing technologies in very demanding real-time user interfaces, the latter relies more on pattern recognition, algorithmic composition, and artificial intelligence.” Joseph Paradiso, “Electronic Music Interfaces,” Joseph A. Paradiso, 1998, http://web.media.mit.edu/~joep/SpectrumWeb/SpectrumX.html, accessed March 17, 2015.
194 Jordà, 97. Paradiso offers, “The desire for musical expression runs deeply across human cultures; although styles vary considerably, music is often thought of as a universal language. It is tempting to surmise that one of the earliest applications of human toolmaking, after hunting, shelter, defense, and general survival, was probably to create expressive sound, developing into what we know and love as music. As toolmaking evolved into technology over the last centuries, inventors and musicians have been driven to apply new concepts and ideas into improving musical instruments or creating entirely new means of controlling and generating musical sounds. The classic acoustic instruments, such as the strings, horns, woodwinds, and percussion of the modern orchestra (and sitars, kotos etc. of the non-western world) have been with us for centuries, thus have settled into what many think of being a near-optimal design, only slowly yielding to gradual change and improvements. For hundreds of years, the detailed construction of prized acoustic instruments, especially in the string family, has remained a mysterious art, and only recently have their structural, acoustic, and material properties been understood in enough detail for new contenders to emerge…Electronic music, in contrast, has no such legacy. The field has only existed for under a century, giving electronic instruments far less time to mature. Even more significantly, technology is developing so quickly that new sound synthesis methods and capabilities rapidly displace those of only a few years before. The design of appropriate interfaces is therefore in a continual state of revolution, always driven by new methods of sound generation that enable (and occasionally require) expression and control over new degrees of freedom.” Paradiso, http://web.media.mit.edu/~joep/SpectrumWeb/SpectrumX.html, accessed March 17, 2015.
techniques may not constitute the best strategy to confront the new music-making paradigms…”

As mentioned previously, the difficulty in constructing a codified skill set and pedagogy is the variety of “alternative controllers,” to use Jordà’s term. Joseph Paradiso, in his article “Electronic Music Interfaces,” lists these forms of controllers: “keyboard, percussion interfaces, batons, guitar, strings, wind, voice, noncontact gesture sensing, wearables.” Each of these categories, plus any subset of them, would necessitate different requirements. Just because the process of developing pedagogical materials for specific alternative controllers is potentially difficult does not mean musicians and educators should not try, particularly if the goal is to maintain or increase the use of a specific alternative controller.

If one were to loosely define the skills needed to compose and perform using an alternative controller, a person would need a good working knowledge of which ever software program they have chosen to use (i.e. Ableton Live) and select a controller to use for a significant length of time, as to learn the capabilities and nuances of the controller.

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195 Ibid., 97-8.
196 “When it comes to the third category, the jumble of alternative controllers not easily includable in any previous grouping, it is difficult to provide a taxonomy that facilitates a quick overview.” Ibid., 98.
198 For example, Nattinger’s VAMP and Heap’s Mi.Mu gloves are both wearables, however VAMP is a one-glove system, while Mi.Mu is a two-glove system; as a result the skill set and pedagogy would differ between the two systems.
199 Consider Lev Termen’s work on the theremin. Many people over the last several decades have championed the instrument, performing with them around the world, transcribing and composing music for the theremin, and developing pedagogy. For more on this see, Theremin World, http://www.thereminworld.com/, accessed March 17, 2015.
200 “As pointed out by Joel Ryan, improvers, leading researcher in the NIME [New Interfaces for Musical Expression] field and technical director of the Dutch laboratory STEIM, ‘a horizontal slider, a rotary knob, a sensor that measures the pressure under one finger, an accelerometer which can tilt and respond to rapid movements, a sonar or an infrared system that can detect the distance between two points, each have their idiosyncratic properties.’” Jordà, 99. When you combine several of these items into one device, like an alternative controller, then you have layers of idiosyncratic properties that will respond and react to each other in an exponential number of ways. Musician and writer Primus Luta says similar things about programs like Ableton Live: “Designed with the intent of taking the DAW to the stage, Ableton Live allows artists to have an interface that facilitates the translation of electronic concepts from the studio to the stage. There are a world of things that are possible just by learning the Live basics, but there’s also a rabbit hole of advanced functions all the way to the modular Max for Live
Evaluation and Assessment

During the research for all the topics preceding this subsection there has been a growing awareness of people discussing assessment and evaluation of music produced with computers, electronics, and controllers, particularly from an academic standpoint. Many academic institutions that have some form of an electronic music program or degree usually have some form of an electronic music composition course in their curriculum. Additionally, many of them have some sort of electronic ensemble; some will even have courses geared toward individual performance. Based on this, academic evaluation and assessment seems to fall into two categories: 1) composition and 2) performance.

Evaluating/Assessing Composition

The reason for discussing composition in this chapter is due to the fact that there exists very little in the form of oeuvres for electronic music performance, particularly with controllers.

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201 The topics of evaluation and assessment of electronic music have been at the forefront of my academic thoughts and interests for a number of months as of this writing. Not only has it been part of my thoughts and interests for this thesis, it has also been a topic of discussion among the members of the music department of Central Christian College of Kansas, where I presently serve as Professor of Music History and Music Technology. We have been wrestling with assessment and evaluation of electronic music since the Spring 2012 semester, when we submitted a proposal for a course in Electronic Music Production (which was subsequently approved and first taught by myself during the Winter 2013 term). After teaching that course for two consecutive Winter terms, I proposed the development of an Applied Lessons course for Electronic Music, specifically for composition and performance within Ableton Live. MU-AP 207 Applied Lessons: Electronic Music has been a pilot course for the SP14, FA14, and SP15 semesters.

Many early electronic instrument builders would play or attempt to play pre-existing music to prove the merit of their instruments. While this may work for more standardized electronic instruments like the theremin, for people using software and MIDI controllers this becomes a more difficult concept. There is no sheet music for Ableton Live; one cannot purchase a broadside of “Me the Machine” by Imogen Heap scored for Mi.Mu gloves at my local music store to perform at home or for a chamber music concert. Most of this is owed to the above-mentioned personalized approach to combing software and MIDI controllers. Because of this multi-faceted approach we must have a rubric or rubrics that are broad enough to allow flexibility in compositional approach, yet defined enough as to allow some sense of academic rigor.

To at least achieve a rough framework for a compositional rubric the rubrics by Hickey and Sternfeld-Dunn & Hare mentioned earlier in this section will be utilized; additionally a third rubric, in the form of program goals and a syllabus from Chris Brown at Mills College for his course “Seminar in Electronic Music Performance,” will be introduced.

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203 See the “Theremin Repertoire” page (http://www.thereminworld.com/Theremin-Repertoire) on Theremin World’s website for examples of this.

204 Often times when a customized MIDI controller is harnessed (i.e. Nattinger’s VAMP, Heap’s Mi.Mu gloves, Exile’s Flow Machine, and Beardyman’s Beardytron 5000 mkII) there is often a customized software, or a customization made to a previously existing software, that goes hand-in-hand with it. When I teach Electronic Music Production at Central Christian College the students and I use Ableton Live for composing and performing. When I introduce them to the software I show them how I and a few other composers/controllerist arrange and customize the setup to achieve the workflow we desire. “In the sleeve notes of their 1989 CD, John Bischoff and Tim Perkins note that ‘for us, composing a piece of music is like building a new instrument, an instrument whose behaviour makes up the performance. We act at once as performer, composer, and instrument builder, in some ways working more like sculptors than traditional musicians’.” Jordà, 94-5.

205 A Graduate-level course for the Master of Fine Arts in Electronic Music & Recording Media, Mills College, “MUS 252 Seminar in Electronic Music Performance,” http://www.mills.edu/academics/graduate/mus/courses/course_description.php?courseid=mus252, Mills College, accessed March 17, 2015. “MUS 252 Program Goals: To have a developed understanding of cultural, political, social, and intellectual issues in diverse contemporary and historical musical & sound art practices. (Introduced, Practiced - Assess and critique musical examples of contemporary electronic music performance on aesthetic as well as technical grounds. Examine and discuss issues of technological use in the arts and the socio-political implications and ramifications of such use.); To have distinctive creative ideas and the ability to realize them successfully on a professional level. (Practiced, Mastered - Compose short electronic works in response to class project criteria incorporating sound diffusion, MIDI control, electro-acoustic sources, network interaction, and real-time audio
words in the rubrics to those used in Bloom’s Taxonomy was used to facilitate the examination of the three rubrics; a chart containing Bloom’s Taxonomy (1956, Bloom), Bloom’s Revised Taxonomy (2001, Anderson & Krathwohl), and Bloom’s Digital Taxonomy (2008, Churches) to gain the widest perspective on the three rubrics was utilized.\(^{206}\) The breakdown of the three rubrics is as follows:\(^{207}\)

**TABLE 1**

**COMPARISON OF THREE MUSIC COMPOSITION RUBRICS VIA BLOOM’S TAXONOMY**

<table>
<thead>
<tr>
<th>Knowledge/Remembering</th>
<th>Comprehension/Understanding</th>
<th>Application/Applying</th>
<th>Analysis/Analyzing</th>
<th>Synthesis/Evaluating</th>
<th>Evaluation/Creating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDH, B</td>
<td>H, SDH, B</td>
<td>H, SDH, B</td>
<td>H, SDH, B</td>
<td>SDH, B</td>
<td>SDH, B</td>
</tr>
</tbody>
</table>

H = Hickey; SDH = Sternfeld-Dunn & Hare; B = Brown

All three rubrics deal with concepts of Comprehension/Understanding, Application/Applying, and Analysis/Analyzing. This shows that mid-level Bloom’s taxonomic ideas (classifying, expressing, applying, demonstrating, implementing, comparing, structuring, experimenting, mashing) are considered essential to assessing compositions across all ages and analysis. Produce and perform class projects in class and in formal concert at the end of the semester.; To be able to critically analyze & clearly identify strengths and weaknesses in her/his own work, & the work of others. (Practiced, Mastered - Explain methods employed in class projects and discuss their musical attributes. Develop listening skills and critique other student's work in class in a seminar format.); To be able to productively collaborate with others in professional contexts relating to her/his area of expertise. (Introduced, Practiced, Mastered - Build collaborative performances using unique interconnection capabilities of electronic technologies. Investigate new musical properties made possible by real-time group composition and performance.); To demonstrate a technical mastery of her/his instrument or discipline, and a comprehensive knowledge of its styles and repertoire, past and present. (Practiced, Mastered - Construct hardware and software instruments and refine them through musical performance practice. Categorize and compare historical and contemporary uses of electronic technology for sonic art and musical performance.). Ibid.


\(^{207}\) The first word is utilized by the 1956 Bloom’s; the second word is utilized by both the 2001 Revised Bloom’s and the 2008 Digital Bloom’s. Ibid.
Interestingly, the rubrics utilized in higher education (Sternfeld-Dunn & Hare, Brown) deal with the entire range of taxonomic levels. This recognizes the need to meet people on all levels and abilities. What is additionally noteworthy is the upper-level taxonomic ideas dealt with in the higher education rubrics: Synthesis/Evaluating and Evaluation/Creating. This shows that upper-level taxonomic ideas (arranging, composing, constructing, experimenting, critiquing, assessing, supporting, designing, inventing, programming, mixing, remixing) are considered essential to assessing compositions by more experienced composers and those with potentially higher-level abilities.

What was previously mentioned only in passing is that the rubric by Hickey that has been used thus far is for “assessing general criteria in a composition assignment.” In the article from which this rubric was obtained Hickey documents four assignment-specific rubrics that, when combined with the “assessing general criteria,” can constitute the whole rubric for a particular composition. Brown also utilizes an assignment-specific rubric for his course. This bipartite approach (a general rubric combined with an assignment-specific rubric) is one potential solution.

A companion solution would be to see what ideas or concepts all three rubrics hold as necessary. All three rubrics mention aesthetics as playing a key role in compositional assessment; the higher education rubrics tie aesthetics to an awareness of the idioms of “contemporary

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208 Again, the Hickey rubric is for elementary/primary-age children, the Sternfeld-Dunn and Hare rubric is for university students; the Brown rubric is for graduate university students.
209 Hickey, 29.
210 These assignments include: “Assessment rubric for composition using dotted-eighth and sixteenth notes,” “Assessment rubric for a composition in rondo form,” “Assessment rubric for a melody with well-defined parameters,” and “Assessment rubric for a melody with two musical ideas.” Ibid., 30-32, 33.
electronic music.” Creativity is also listed as an essential in all three rubrics, whether as a stand-alone idea or combined with another idea. A third component in the three rubrics is some mention of “musical form” or “craftsmanship.” These three components, aesthetics (historical or otherwise), creativity, and musical form/craftsmanship, could form the criteria for a general assessment rubric.

Based on this discussion I propose a two-part approach to assessing composition. The first part is a general assessment rubric, comprised of aesthetics (historical or otherwise), creativity, and musical form/craftsmanship; the second part would be an assignment-specific rubric, written to reflect the specific goals determined by the assessing instructor. The advantage of a two-fold rubric is the ability to maintain a consistent base from which to operate

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213 “Includes very original, unusual, or imaginative musical ideas. Explores and varies at least two musical elements.” Hickey, 29. “The composer’s scores show an abundance of creative ideas and the composer demonstrates an astute awareness of the aesthetics of contemporary music.” Sternfeld-Dunn and Hare, 2. “To have distinctive creative ideas and the ability to realize them successfully on a professional level.” Brown, http://www.mills.edu/academics/graduate/mus/courses/course_description.php?courseid=mus252, accessed March 17, 2015.

214 “Presents at least one complete musical idea. Has a coherent and organized form with a clear beginning, middle, and end. Uses musical elements to organize musical ideas or the form.” Hickey, 29. “Musical language demonstrates a high degree of craft, consistency, and organization…A sophisticated knowledge of the processes that comprise form in music at basic and advanced levels is well conceived and consistently demonstrated. Demonstrates expertise beyond basic forms and can extend them in new directions.” Sternfeld-Dunn and Hare, 1-2. “To have distinctive creative ideas and the ability to realize them successfully on a professional level…Build collaborative performances using unique interconnection capabilities of electronic technologies.” Brown, http://www.mills.edu/academics/graduate/mus/courses/course_description.php?courseid=mus252, accessed March 17, 2015.

(first part) and the flexibility to tailor the assignment to suit the genre/type of composition
(second part). An example rubric for a forty-five point assignment could look like this:

TABLE 2
GENERAL ASSESSMENT RUBRIC

<table>
<thead>
<tr>
<th></th>
<th>5 pts.</th>
<th>4 pts.</th>
<th>3 pts.</th>
<th>1 pt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submitted on time</td>
<td>Turned in before class on the due date</td>
<td></td>
<td>Turned in after class on the due date</td>
<td>Turned in any day after the due date</td>
</tr>
<tr>
<td><strong>Aesthetics</strong></td>
<td>Pieces note an abundance of creative ideas and the composer demonstrates an astute awareness of electronic music. Knowledge and craft are consistently reformulated in to new musical ideas.</td>
<td>Some degree of naïveté towards salient issues of electronic music aesthetics or a base amount of derivative musical thinking.</td>
<td>Some basic illiteracy or lack of curiosity regarding aesthetics.</td>
<td>Real creativity is minimal. An awareness or curiosity of issues in electronic music aesthetics is absent.</td>
</tr>
<tr>
<td><strong>Creativity</strong></td>
<td>Includes very original, unusual, or imaginative musical ideas. Explores at least two musical ideas.</td>
<td>Involves some original aspect(s) or manipulation(s) of musical idea(s). Explores at one musical idea.</td>
<td>Musical ideas are more often clichéd than not. There is minimal variety or exploration of musical elements (range, melody, timbre, dynamics, rhythm, melody).</td>
<td>Musical idea is familiar or cliché. No variety or exploration of musical elements (range, melody, timbre, dynamics, rhythm, melody).</td>
</tr>
<tr>
<td><strong>Musical Form/ Craftsmanship</strong></td>
<td>Demonstrates an expertise in advanced and basic musical forms. Ability to extend musical forms in new directions exists.</td>
<td>Understanding of basic formal processes in music is clear but usually realized in an especially sophisticated way.</td>
<td>Use of basic forms is demonstrated but of inconsistent quality.</td>
<td>Struggles to successfully make use of even the most basic small forms in music.</td>
</tr>
</tbody>
</table>

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216 The “Submitted on time” and “Length” portions come from the rubrics for Central Christian College of Kansas Music Department, MU-MS 371 Electronic Music Production, Central Christian College of Kansas, 2014.
217 Sternfeld-Dunn and Hare, 1. I have tweaked the language to reflect electronic music.
218 Hickey, 29.
219 Sternfeld-Dunn and Hare, 1.
220 Ibid.
TABLE 2 (continued)

<table>
<thead>
<tr>
<th>Literacy²²¹</th>
<th>The composer demonstrates a wide and very thorough understanding and knowledge of music history and repertoire across multiple genres and musical eras. History and repertoire of a variety of 20th and 21st century musical genres are known thoroughly.</th>
<th>The composer demonstrates a wide understanding and knowledge of music history and repertoire across multiple genres and musical eras, but with some minor gaps.</th>
<th>The composer’s knowledge of music history and repertoire is limited to only a few eras or genres.</th>
<th>Basic ignorance or excessively narrow understanding of music history and repertoire, particularly regarding the 20th and 21st centuries.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>3-6 minutes</td>
<td>____</td>
<td>____</td>
<td>&gt;3 or 10+ min.</td>
</tr>
</tbody>
</table>

TABLE 3

ASSIGNMENT-SPECIFIC RUBRIC: DOWNTEMPO/AMBIENT/NOISE/GLITCH/IDM²²²

<table>
<thead>
<tr>
<th>5 pts.</th>
<th>4 pts.</th>
<th>3 pts.</th>
<th>1 pt.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fulfills project requirements</strong></td>
<td>3 scenes, 5-6 audio clips per scene</td>
<td>3 scenes, 3-4 audio clips per scene</td>
<td>2 scenes or 3-4 audio clips per scene</td>
</tr>
<tr>
<td><strong>Demonstrates understanding of genre/subgenre (tempo, form, instrumentation)</strong></td>
<td>Tempo, instrumentation, and form all contribute to the subgenre</td>
<td>____</td>
<td>One of the following does not contribute to the genre: tempo, instrumentation, form</td>
</tr>
<tr>
<td><strong>Software and Mixing Proficiency</strong></td>
<td>“Properly quantized” and mix is balanced</td>
<td>Quantization is slightly off unintentionally or one element of the mix is not balanced</td>
<td>Quantization is noticeably off or more than one element of the mix is not balanced</td>
</tr>
</tbody>
</table>

Evaluating/Assessing Performance

Like composition, performance can be very subjective; a quick YouTube search will yield thousands of performances of various songs.²²³ When we move from the realm of “traditional”

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²²¹ Ibid., 2.
²²² Based on an assignment from Central Christian College of Kansas Music Department, MU-MS 371 Electronic Music Production, Central Christian College of Kansas, 2014.
²²³
(i.e. classical) music performance to electronic music performance this can become even more subjective, particularly as many musicians, composers, and, especially, audience members may be unfamiliar with what goes into composing and performing electronic music. A strategy to assessing the performance of electronic, computer-based music should be multi-pronged, utilizing education and historical awareness as a basis.

When many people today hear the term “electronic music” their thoughts are likely to go towards the pounding kick drums, lumbering beats, and robotic roars of electronic dance music (EDM) or the ethereal soundscapes and oscillations of old science fiction movies. There is a wide, vast space between these musical poles, yet not every audience member who walks into a performance of electronic music knows or understands this. Furthermore, the audiences may

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224 “The use of electronic music instruments in live performance is a complex topic within our culture where recorded media are the dominant means by which people experience music.” Brown, 1. “Actually, most computer music performers still seem shyly reluctant to consider the computer as a regular musical instrument, but nonetheless, the computer is finally reaching the point of feeling as much at home on stage as a saxophone or an electric guitar.” Jordà, 89. “With electronic music however, particularly with laptop performances, audiences know that the instrument (laptop) is capable of playing music without human aid other than telling it to play. The ‘checking their email’ sentiment is a challenge to the notion that what one is seeing in a live electronic performance is indeed an ‘actual performance.’” Luta, “Toward a Practical Language for Live Electronic Performance,” Sounding Out!, April 29, 2013, http://soundstudiesblog.com/2013/04/29/toward-a-practical-language-for-live-electronic-performance/, accessed March 17, 2015.

225 “At the time of this writing [2013], for example, Wikipedia lists over 200 genres of electronic dance music. Under the heading ‘Psychedelic trance/Goa trance’ (one of the subgenres of Trance), styles include Dark psytrance, Full on, Psyprog, Psybient, and many others.” Joseph Auner, Music in the Twentieth and Twenty-First Centuries (New York: W.W. Norton & Company, Inc., 2013), 2. The quintessential example of the old science fiction movie sound is Louis and Bebe Barron’s soundtrack for the classic Forbidden Planet.

226 The following is an excerpt from a pre-concert address by Jacques Barzun from 1961; it could easily be read before concerts of electronic music today: “Your presence here, at a concert of electronic music, is a compliment to the composers, as well to the Universities that sponsor their work; and while I extend to you a welcome on behalf of the Universities I also wish to convey the composers’ hope that you will be as gratified by hearing their works as they are by your willingness to listen. No doubt your expectations are mixed. You are ready to be surprised, to have your curiosity satisfied, and possibly even to experience snatches of enjoyment as you would at an ordinary concert. If that is your state of mind I am fairly sure you will not be disappointed. But it may be that you are here in a mood of combined trepidation and resistance: this, after all, is the Age of Anxiety…Or you may be bent on proving that electronic music is not music – doing this by the most painful test of endurance – or else you may be feeling caught because you have been brought by a friend and friendship is dearer to you than prudence. If for these or any other reasons you are ill at ease, allow me to suggest a very few considerations which should make your more serene,
be oblivious to the types of performance practices that have been traditionally used in electronic music. Chris Brown states it this way:

The values ingrained by our experiences of recorded music and sound are inseparable from the desire for an authenticity that we associate with live musical experiences. And still we thirst for experiences where musical communication and decision-making happens in the moment – the experience of now. Performance is about presence, and staying present in a world saturated by recordings requires designing our compositions and our instruments to clarify our experience of time while still embracing the multiplicity of frames that confuse it.\textsuperscript{227}

With this in mind two categories of electronic music performance are suggested: 1) realized/realization and 2) live electronic performance.\textsuperscript{228}

Realized electronic music performance is usually associated with early \textit{musique concrète} and synthesizer music. Some of the compositions were so complex that they might be nearly impossible to perform as intended; thus, the only real way to achieve the composer’s aural vision for the piece was to record the piece to tape in a studio and play it back via a set of loudspeakers (the “realization”) for an audience.\textsuperscript{229} This raises the question, “What is the difference between listening to a recording of this on my home stereo and listening to it on a set of speakers in a concert hall?” The answer lies in the composer/performer’s intent. There is a vast amount of pop, rock, and electronic music that can, or will, only be heard via a stereo recording.\textsuperscript{230}

\footnotesize

\textsuperscript{227} Brown, 1.
\textsuperscript{229} Composers associated with this practice include Pierre Boulez, John Cage, Pierre Schaeffer, Karlheinz Stockhausen, Edgard Varèse, Iannis Xenakis; compositions associated with this practice would include \textit{Poème électronique} (Varèse), \textit{Gesang der Jünglinge} (Stockhausen), \textit{Williams Mix} (Cage), and \textit{Diamorphoses} (Xenakis).
\textsuperscript{230} Brown supports this idea: “To have distinctive creative ideas and the ability to realize them successfully on a professional level.” Brown, http://www.mills.edu/academics/graduate/mus/courses/course_description.php?courseid=mus252, accessed March 17, 2015.
But what if the composer/performer intended the work for a multi-channel, surround-sound performance? In this case the answer to the previously-posed question is, “The composer/performer intends to place you in the environment of the piece so that you experience the piece in an immersive way, not just as sound coming from in front of you.” It is the difference between watching a movie about outer space on a television in your living room versus watching the same movie in an IMAX movie theatre with 7.1 surround sound.

While realization performances may fuel the “pressing play” controversy that has troubled electronic music for decades, realization is, in some cases, the only option a composer has in order to present their music to the public. With that in mind I will move from solely realized electronic music to live electronic performance.

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231 This point of view can be seen through written accounts about Poème électronique (Varèse) and Gesang der Jünglinge (Stockhausen).

232 The “pressing play” controversy is the idea that laptop/live electronic performers, especially DJs and producers, only hit “play” on a track or set, and then hide behind a shroud of lights, visualizations, pyrotechnics, and on-stage antics. EDM artist/producer Joel Zimmerman, a.k.a. Deadmau5, set off major ripples in the EDM scene after he made statements both in his blog (Joel Zimmerman/Deadmau5, “we all hit play,” united we fail, http://deadmau5.tumblr.com/post/25690507284/we-all-hit-play) and a cover story in Rolling Stone magazine (Josh Eells, “The Rise of Deadmau5,” Rolling Stone, July 5, 2012, 48.) about how all EDM artists and DJs just hit play on a song or set: “From the crowd, it's hard to tell exactly what a dance musician is doing onstage. Almost all of them use prerecorded tracks; sometimes it seems like they're getting paid to wave their arms and occasionally adjust their headphones. ‘If I wanted, I could play a….wav file and just stand there and fist-pump all night, and no one would [care].’ Zimmerman says. In fact, he says, a lot of people do just that. ‘David Guetta has two iPods and a mixer and he just plays tracks – like, “Here's one with Akon, check it out!” Even Skrillex [a friend of Zimmerman's] isn't doing anything too technical. He has a laptop and a MIDI recorder, and he's just playing his [set]. People are, thank God, smartening up about who does what – but there's still button-pushers getting paid half a million. And not to say I'm not a button-pusher. I'm just pushing a lot more buttons.” Eells, “The Rise of Deadmau5,” 48. Luta approaches Zimmerman’s from a more tame perspective: “Unfortunately, quite often it is impossible to know exactly what range of tools are being utilized within a laptop strictly by looking at an artist on stage. This is what leads to probably the biggest misnomer about the performing laptop musician. As common as the musical object may look on the stage, housed inside of it can be the most unique and intricate configurations music (yes all of music) has ever seen. The reductionist thought that laptop performers aren’t ‘doing anything but checking email’ is directly tied to the acousmatic nature of the objects as instruments. We can hear the sounds, but determining the sources and understanding the processes required to produce them is often shrouded in mystery. Technology has arrived at the point where what one performs live can precisely replicate what one hears in recorded form, making it easy to leap to the conclusion that all laptop musicians do is press play.” Luta, “Live Electronic Performance: Theory And Practice,” Sounding Out!, December 9, 2013, http://soundstudiesblog.com/2013/12/09/live-electronic-performance-theory-and-practice/, accessed March 17, 2015.
Primus Luta, in the second article of a three-part series of articles designed to “develop a ‘usable aesthetic language’ to describe live electronic performance,” lists “four basic distinctions for live electronic performance”:

1) The electro/mechanical manipulation of fixed sonic performances
2) The physical manipulation of electronic instruments
3) The mechanized manipulation of electronic instruments
4) A hybrid of physical and mechanized manipulation of electronic instruments.

In the third article Luta urges his reader, “To put live electronic performances into the proper musical context, one must determine what type of performance is being observed.” The idea of educating audiences, even with an intentional pre-concert lecture, may be one of the best options live electronic music performers have in getting audiences to understand and appreciate their music; moreover, it can be useful in assessing live electronic performance in academic settings.

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234 Luta, “Live Electronic Performance: Theory And Practice,” *Sounding Out!*, December 9, 2013, http://soundstudiesblog.com/2013/12/09/live-electronic-performance-theory-and-practice/, accessed March 17, 2015. Luta continues, “For example, an artist who performs a set using solely vinyl with nothing but two turntables and a manual crossfading mixer, falls in the first distinction between live electronic music performances. Technically, the turntables and manual crossfading mixer are machines, but they are being controlled manually rather than performing on their own as machines. If the artist includes a drum machine in the set, however, it becomes a hybrid (the fourth distinction), depending on whether the drum machine is being triggered by the performer (physical manipulation) or playing sequences (machine manipulation) or both. Furthermore, if the drum machine triggers samples, it becomes machine manipulation (third distinction) of fixed pre-recorded sounds (first distinction) If the drum machine is used to playback sequences while the artist performs a turntablism routine, the turntable becomes the performance instrument while the drum machine holds as a fixed source. All of these relationships can be realized by a single performer over the course of a single performance, making the whole set of the hybrid variety. While in practice the hybrid set is perhaps the most common, it’s important to understand the other three distinctions as each of them comes with their own set of limitations which define their potential variability.” Ibid.

The issue Luta brings to the forefront is the “performance’s variability”: can a live electronic music performer improvise within their set, akin to a jazz musician? With this idea Luta basically says there are two parts of a live electronic performance: 1) the performer in front of an audience and 2) the ability of the performer to have control over, in some way, shape, or form, at will or whim, the music issuing from their instrument. While Luta admits this performative framework can be tricky to sort out, it is still the factor that can bring electronic music onto the same playing field as rock, jazz, and even classical music.

Based on the information presented above it would appear the ideas of realized/realization and live electronic performance each require a different assessment. Realized/realization could use the abovementioned assessment rubrics for electronic music composition. One thing that could be added to the rubric is how the realized piece is presented; it could be presented with a multi-channel speaker system or with visualizations and lights, à la

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236 Luta, “Live Electronic Performance: Theory And Practice,” *Sounding Out!*, December 9, 2013, http://soundstudiesblog.com/2013/12/09/live-electronic-performance-theory-and-practice/, accessed March 17, 2015. “Critical listening to a live performance includes identifying when these shifts happen and how they change the variability of the set. Through the combination their individual limitations can be overcome increasing the overall variability of the performance. One can see a performer playing the drum machine with pads and correlate that physicality of it with the sound produced and then see them shift to playing the turntable and know that the drum machine has shifted to a machine performance. In this example the visual cues would be clear indicators, but if one is familiar with the distinctions the shifts can be noticed just from the audio.” Ibid. This is actually the way Luta begins the first article of this series: “Amongst friends I’ve been known to say, ‘electronic music is the new jazz.’ They are friends, so they smile, scoff at the notion and then indulge me in the Socratic exercise I am begging for. They usually win. The onus after all is on me to prove electronic music worthy of such an accolade. I definitely hold my own; often getting them to acknowledge that there is potential, but it usually takes a die hard electronic fan to accept my claim. Admittedly the weakest link in my argument has been live performance. I can talk about redefinitions of structure, freedom of forms and timbral infinity for days, but measuring a laptop performance up to a Miles Davis set (even one of the ones where his back remained to the crowd) is a seemingly impossible hurdle.” Luta, “Toward a Practical Language for Live Electronic Performance,” *Sounding Out!*, April 29, 2013, http://soundstudiesblog.com/2013/04/29/toward-a-practical-language-for-live-electronic-performance/, accessed March 17, 2015.

237 “Essential to all categories of live electronic music performance, however, is the performance’s variability, without which music—and its concomitant listening practices—transforms from a ‘live’ event to a fixed musical object. The trick to any analysis of such performance however, is to remember that, while these distinctions are easy to maintain in theory, in performance they quickly blur one into the other, and often the intensity and pleasure of live electronic music performance comes from their complex combinations.” Luta, “Live Electronic Performance: Theory And Practice,” *Sounding Out!*, December 9, 2013, http://soundstudiesblog.com/2013/12/09/live-electronic-performance-theory-and-practice/, accessed March 17, 2015.
Poème électronique by Edgard Varèse. A professor could easily add a line to their rubric to look something like this (shaded in grey):\textsuperscript{238}

The live performance rubric would be the harder one. In developing a rubric for a pilot course in Applied Lessons with the instrument being “Electronic Music,” the Music Department of Central Christian College of Kansas utilized the following for the performance/recital portion:\textsuperscript{239}

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|}
\hline
& 5 pts. & 4 pts. & 3 pts. & 1 pt. \\
\hline
\textbf{Fulfills project requirements} & 3 scenes, 5-6 clips per scene, screenshot & 3 scenes, 3-4 clips per scene, or no screenshot & 2 scenes or 3-4 clips per scene or no screenshot & 2 scenes and less than 3 clips per scene and no screenshot \\
\hline
\textbf{Demonstrates understanding of genre/subgenre (tempo, form, instrumentation)} & Tempo, instrumentation, and form all contribute to the subgenre & One of the following does not contribute to the genre: tempo, instrumentation, form & More than one of the following does not contribute to the genre: tempo, instrumentation, form & \\
\hline
\textbf{Ableton and Mixing Proficiency} & “Properly quantized” and mix is balanced & Quantization is slightly off unintentionally or one element of the mix is not balanced & Quantization is noticeably off or more than one element of the mix is not balanced & Quantization is significantly off and more than one element of the mix is not balanced \\
\hline
\textbf{Presentation} & Piece is presented in a creative, historically-informed manner with obvious thought given to aesthetics. & Piece is presented in an above-average manner with thought given to aesthetics & Piece is presented in an average manner, one that shows some thought given to aesthetics & Piece is presented in a below-average manner, one that shows little to no thought given to aesthetics \\
\hline
\end{tabular}
\end{table}

\textsuperscript{238} Based on an assignment from Central Christian College of Kansas Music Department, MU-MS 371 Electronic Music Production, Central Christian College of Kansas, 2014.

\textsuperscript{239} Taken from Central Christian College of Kansas Music Department, MU-AP 107, 207, 407 Applied Lessons – Electronic Music, Central Christian College of Kansas, 2014.
<table>
<thead>
<tr>
<th>Recital/Concert Evaluation Form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student:</strong></td>
</tr>
<tr>
<td><strong>Semester:</strong></td>
</tr>
<tr>
<td><strong>Date:</strong></td>
</tr>
<tr>
<td>Choice of material suitable for performer? _______/10</td>
</tr>
<tr>
<td>Material well-prepared? _______/10</td>
</tr>
<tr>
<td>Technique? _______/10</td>
</tr>
<tr>
<td>Control, balance, rhythm? _______/10</td>
</tr>
<tr>
<td>Musicality - interpretation, phrasing, dynamics? _______/10</td>
</tr>
<tr>
<td>Communication with other participants? _______/10</td>
</tr>
<tr>
<td>Communication with the audience? _______/10</td>
</tr>
<tr>
<td>Performance successful? _______/10</td>
</tr>
<tr>
<td>Professionalism and timeliness? _______/10</td>
</tr>
<tr>
<td><strong>Student evaluation completion</strong> _______/10</td>
</tr>
<tr>
<td>Rank by</td>
</tr>
<tr>
<td>0= none</td>
</tr>
<tr>
<td>1-5 = failed attempt</td>
</tr>
<tr>
<td>6 = below average</td>
</tr>
<tr>
<td>7 = average 8 = very good</td>
</tr>
<tr>
<td>10= outstanding</td>
</tr>
</tbody>
</table>
TABLE 5 (continued)

<table>
<thead>
<tr>
<th>Student Recital/Concert Personal Evaluation Form</th>
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<td>Student: ___________________________</td>
</tr>
<tr>
<td>Date: ___________________</td>
</tr>
<tr>
<td>Please comment on the following:</td>
</tr>
<tr>
<td>Preparation:</td>
</tr>
<tr>
<td>Control, Balance, and Rhythm:</td>
</tr>
<tr>
<td>Musical Interpretation:</td>
</tr>
<tr>
<td>Performance Success:</td>
</tr>
</tbody>
</table>

While this is a department-wide performance rubric, it gives a starting point for the development of an instrument-specific performance rubric. Brown utilizes the following rubric for his “Seminar in Electronic Music Performance” course at Mills College:

> To demonstrate a technical mastery of her/his instrument or discipline, and a comprehensive knowledge of its styles and repertoire, past and present. (Practiced, Mastered): Construct hardware and software instruments and refine them through musical performance practice. Categorize and compare historical and contemporary uses of electronic technology for sonic art and musical performance.\(^{240}\)

Clearly there is the potential for a wide range of possibilities when it comes to the construction of rubrics for electronic music performance. I would derive mine from the rubric put forth by the Music Department of Central Christian College of Kansas because they are seeking to put electronic music performance on the same level as historic performance practices.

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After much discussion of composition the next phase of our journey is to give space to a discussion of musical literacy and its place in technology’s influence on music composition and performance.

Musical Literacy

When introducing people to the performance of rock, jazz, and classical music it is important that they be introduced to the oeuvres specific to the genres. The same can be said for electronic music. To return to the composition rubrics discussed above, both of the higher education composition rubrics have a history/literacy component to them.\(^{241}\) This is why in many books on electronic and computer music have chapters on the development and history of the music, often contain some kind of discography or suggested listening, and/or may contain CDs of music.\(^{242}\)

This idea of a musical literacy can be a linguistic idea as well as knowledge of key works. It is necessary to have a shared literacy of electronic music; to speak and fashion a common language would behoove the electronic music idiom as it would place it on a footing akin to traditional music composition and performance. The problem comes in agreeing upon what that

\(^{241}\) “The composer’s scores show an abundance of creative ideas and the composer demonstrates an astute awareness of the aesthetics of contemporary music…The composer demonstrates a wide and very thorough understanding and knowledge of music history and repertoire across multiple genres and musical eras. History and repertoire of a variety of 20\(^{th}\) and 21\(^{st}\) century musical genres are known thoroughly.” Sternfeld-Dunn and Hare, 2. “To have a developed understanding of cultural, political, social, and intellectual issues in diverse contemporary and historical musical & sound art practices. (Assess and critique musical examples of contemporary electronic music performance on aesthetic as well as technical grounds. Examine and discuss issues of technological use in the arts and the socio-political implications and ramifications of such use.)…To demonstrate a technical mastery of her/his instrument or discipline, and a comprehensive knowledge of its styles and repertoire, past and present… Categorize and compare historical and contemporary uses of electronic technology for sonic art and musical performance.” Brown, http://www.mills.edu/academics/graduate/mus/courses/course_description.php?courseid=mus252, accessed March 17, 2015.

literacy should entail or include; which works and pieces are necessary to achieve a certain degree of electronic music literacy? The brief answer is the language may still be developing and we may still be too close chronologically to many of these electronic works to achieve definitive musicological lists such as we have for the Baroque, Classical, and Romantic eras. There are many works of electronic music from the past ninety years that will probably become the electrified equivalents to Desprez’s motets, Gabrieli’s concerti, J.S. Bach’s cantatas, Mozart’s operas, and Chopin’s nocturnes. Accomplishing this would require performers, educators, and musicologists to examine what has been done and used in the past and set a typology. It could be rather fluid until at such time it seems to be settling (not unlike gelatin).

A “canon” of compositions, again, would give gravitas to electronic music. It seems the more “historic” pieces might be easier to agree upon as a set canon, however there would need to be some agreed upon parameters to help a group filter the works to a set number or at least to a set of historical guidelines/parameters (e.g. historic epochs, etc.). A few record labels and music historians have tried to offer some form of introductory set of pieces, most notably the record labels Chrome Dreams, who have released two double-disc albums under the titles *Forbidden Planets: Music From The Pioneers Of Electronic Sound* and *Forbidden Planets 2: More Music From The Pioneers Of Electronic Sound* (both of which focus on the historic or pioneering works of electronic music, e.g. the Barrons, Varèse, Stockhausen, Xenakis), and Sub Rosa, whose seven-volume *Anthology of Noise & Electronic Music* series covers from 1921-2012 and is set in an a-chronological manner.

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243 As a place to start for “historic” electronic music I would recommend the double-disc album *Forbidden Planets: Music From The Pioneers Of Electronic Sound* (Chrome Dreams, 2009).

Two likely issues present themselves in creating a canon of electronic music. First is the divide between “formal” or “academic” electronic music (e.g. *musique concrète*, tape music, electroacoustic) and popular electronic music (i.e. EDM). A divide has existed for centuries between formal music and popular music; this can be most clearly seen in western cultures of the 20th century with the advents of jazz and rock ‘n’ roll. That being said, popular music studies have become an academically accepted discipline within the field of musicology, so the gap may be smaller than imagined. Again, it will take performers, educators, and musicologists weighing and deliberating on the elements and merits of both academic and popular electronic music.

The second issue is the splintering of popular electronic music. It seems more subgenres of popular electronic music have developed in its first forty years than almost any other genre in music history. In my experience musicians working in popular electronic music seem to fall into one of three categories: 1) Copy: they pattern their music after their favorite musicians(s),

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246 American universities offering graduate degrees with popular music studies (sometimes as a subset of ethnomusicological studies) as an emphasis include UNC-Chapel Hill, Columbia University, Mills College, and UCLA.

thereby continuing the tradition of a subgenre; 2) Create: they want to create their own new, unique sound or subgenre, thereby developing any number of sub- or sub-subgenres; or 3) “Care Less”: they compose the music they like and enjoy, regardless of who it may sound like or what the influences are, thereby caring more about artistic expression than classifications or pigeonholing. An academic solution to this issue would have to include musicologists and performers, professors and fans compiling an adequate list of main subgenres, composers, etc.; even that might require a little more time for the collective consciousness to marinate with the music in order to come to an informed decision.

The splintering effect could be tamed somewhat by placing popular electronic music subgenres under a few choice meta-subgenre headings. Possible terms could include EDM, electronica, and synthpop. EDM would include the more “dancing” or “club-style” music; this could include house, techno, trance, progressive, American dubstep, dance pop, and drum ‘n’ bass. Electronica has been defined as “electronic dance music that is geared for listening instead of strictly for dancing.” This definition opens a fairly wide door to a number of subgenres; these could include ambient, downtempo, chillwave, and trip-hop. Synthpop would encompass genres like disco, new wave, synthpop, and other genres that prominently feature synthesizers.

Figure 1 shows an oversimplified way to categorize all electronic music:

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249 Much of the electronic music I listen to would fit in the “electronica” category because trying to fit them neatly into a category often proves difficult. Spotify has a couple playlists (“Heady Beats | Smooth Electronic,” “ESM | Electronic Study Music,” “Indie Electronica”) that I follow which feature several of my favorite electronica musicians.
250 Fabian Holt addresses the idea of genre division in his book *Genre in Popular Music*. He lists nine potential genres of American popular music: “Blues, Jazz, Country music, Rock, Soul./R&B, Salsa, Heavy metal, Dance, and Hip-hop.” Fabian Holt, *Genre in Popular Music* (Chicago: The University of Chicago Press, 2007), 15-6. Holt goes on to state, “Such a list can only be tentative. It serves a rudimentary purpose and should not limit the agenda for our thinking about genre….To understand the complex work of genre we need more than a systematic account of individual dimensions. We need explanations of fundamental connections and moments in the trajectory of a genre. The nine genres on my list above have evolved differently, but they have all gone through two basic processes: They have been *founded* (and *categorized*) in what I call ‘center collectives,’ and they have changed through *further*
While this takes a very broad view of electronic music it could continue to move conversation toward both musically literacy and a canon of electronic music forward.

This type of music should be included in the tomes of musicology and music history. The trials and difficulty of assessing and evaluating electronic music is what makes it beautiful and wonderful: its diversity. As presented in this section there are people (myself included) who are attempting not a pigeonhole classification of this music but rather who are attempting to give banks to the river of electronic music.\textsuperscript{251} Scholars, teachers, and performers will have to come to some consensus on the base elements of assessment and evaluation of this music in order for it to properly sit alongside music of previous centuries; then Karlheinz Stockhausen, Frankie Verderosa cautioned, “The term ‘Electronica’ is a term of convenience for label executives and record-store chains, and ultimately does not provide listeners with a true picture of the many individual styles found in most urban centers. Getting past the term ‘Electronica’ and learning the details of specific styles is your first important step in understanding Techno music and DJ culture.” Verderosa, 28.

\textit{negotiations.} It is reasonable to distinguish between formative and subsequent stages in a genre’s history.” Ibid., 16, 20.
Knuckles, Imogen Heap, and Flying Lotus can sit next to Monteverdi, Corelli, Beethoven, and Debussy.

This section can be boiled down to a few salient points. First, by defining what constitutes a “composition” electronically-composed/-performed music can sit alongside music of other eras. Second, the skills required to compose and perform electronic music can vary widely based on the performer/composer and the means (e.g. software, controllers) utilized by the performer/composer. Third, a taxonomic approach can assist in the development of rubrics for electronically-composed/-performed music in order to compensate for the inherent variability. Finally, a corpus of electronically-composed/-performed music for literacy would give it gravitas; however this requires consensus from a host of people, including musicologists, composers, performers, fans, etc. Furthermore, the multitude of subgenres could be a detriment to this cause.

This chapter has addressed issues of evaluating and assessing electronically-composed and -performed music, considered potential issues with defining an electronic composition, discussed skills for composition and performance, examined assessment and evaluation, and briefly reflected on the issue of electronic music literacy. The final chapter will present conclusions based on the ideas and research presented in Sections II, III, and IV.
CHAPTER V

CONCLUSION

In this chapter I discuss and synthesize findings from Chapters II-IV, focusing potential directions for the role of technology in composition and pedagogy. This is accomplished by following the progression of ideas from section to section: cognition (in this case, thinking about an action) leads to gesture (doing the action) which leads to evaluation (reflecting on the action and contemplating ways to refine said action and make it better).

Extending Cognition in Music

Chapter II, “Extending Cognitive Ability,” showed how technology can enable people to compose and perform music by compensating for gaps in musical knowledge or cognitive ability. A two-part case study illustrated this process, featuring the software program Hyperscore and Tod Machover and Adam Boulanger’s work with Dan Ellsey utilizing Hyperscore as a both a composition and performance tool. Hyperscore proved to be a powerful, GUI-based composition tool, which could be harnessed by amateurs and professionals alike for compositional output. Machover and Boulanger proved that Hyperscore could be harnessed in conjunction with a Hyperinstrument (in Ellsey’s case a head-mounted, infrared light). The tailoring of Hyperscore and the Hyperinstrument made it possible for Ellsey to express musically beyond his cognitive level, whether that be a musical knowledge or cognitive ability, or even motor-skills cognition;
Ellsey had never taken a course in music theory or orchestration, yet he was able to compose some very intricate and beautiful music with Hyperscore and his Hyperinstrument.²⁵²

Especially helpful in this section was David Rothenberg’s three extensions of thought, the “assistive technologies for cognition (ATC)” by Gillespie et al., and the concept put forth by Saloman et al. that common items, like a handheld calculator, are artificial intelligences.²⁵³ These ideas put the theory of extending cognition into simplified terms and concepts, ones that could be grasped with a fair amount of ease by the general public.

My conclusion is technology can extend and/or compensate for cognition. More concrete evidence and quantitative research needs to be done in order to satisfy the rigors of academia. Examples of further research could include analyzing those with cognitive disabilities, analyzing those with no cognitive disabilities and no formal background in composition. Even a deeper qualitative study would be beneficial in anchoring this conclusion.

Extending Gesture and Physical Ability in Music

Chapter III, “Gesture and Extending Physical Ability,” sought to illustrate how technology can enhance gesture and physical ability in music composition and performance. The section discussed musical gesture, offered four case studies, and considered technical matters and postulated about required skills.

The portion on discussing musical gesture cited Halmrast et al. and their suggestion that the typology of musical gesture changes when the instruments in question move from traditional

²⁵² On a personal note, I played the TED Talk video of Ellsey performing for a colleague of mine, who is very well versed in music. After the performance was over, he said, with a look of wonder in his eyes, that he heard shades of Aaron Copland and Leonard Bernstein in Ellsey’s composition; he found Ellsey’s piece to be rather moving.

²⁵³ Rothenberg’s “tools of abstraction” is a good fit for Hyperscore and other software programs like it: “‘tools of abstraction’, which are instruments that extend cognitive dexterity by extending abstract thought and language functions. These technologies include devices such as computers and calculators, but also ‘immaterial’ technologies such as natural languages, numerical systems, and formal languages such as those of mathematics, symbolic logic, and computer programming.” Brey, 5.
instruments to electronic or computer-based instruments. The change in typology comes, primarily, from the fact that the performative gestures of a traditional, acoustic instrument include a level of excitation, that of a string, membrane, resonator, etc., whereas Halmrast et al. note that in electronic and computer-based instruments the performative gestures are “what we would call a control gesture: it does not by itself transfer energy from our body to any instrument of sound-production, nor can such a gesture modify any feature of the sound apart from its volume.” The conclusion drawn from this is electronic or computer-based instruments requires a different typology than traditional instruments; the typology is still fluid and taking shape, however people such as Halmrast et al., Mark Butler, and Primus Luta are taking steps to solidify that shape.

In order to demonstrate the extension of gesture via technology, I offered four case studies based on the development of hardware technology, examples of Rothenberg’s artifacts. The highlighted devices, which have been produced since 2005, fell into the following categories: movable controller, extending physical gestures–fully-able human, extending physical gestures–differently-able human, and extending the human voice. The technology ranged from adapting pre-existing technology (the Midi Fighter 3D) to bespoke systems (Mi.Mu Gloves). After reading several articles and watching several videos, both of those mentioned in this paper and several that were not mentioned in this paper, the conclusion is that technology has the ability to extend physical ability via whatever gestures any particular human can make. Although there has been quite a bit of both quantitative and qualitative research done on this subject, this thesis has hopefully drawn attention to some individuals, groups, and devices that may not be receiving much notoriety beyond their immediate circle.

254 Halmrast et al., 208. I further noted that Halmrast et al. typological shift by stating there is one thing that electronic and computer-based instruments have as distinct and positive in their typology: mapping.
The device that acted as a primary impetus behind this thesis was Imogen Heap’s Mi.Mu Gloves. Watching Heap work with the gloves was exciting and showed one facet of the realm of possibilities the Mi.Mu Gloves could open; the article about Kris Halpin and his desire to use the Mi.Mu Gloves to help counteract the effects of progressive cerebral palsy on his body opens another door. Similar to Boulanger’s query about if technology can be adjusted or co-opted to suit users, Halpin was looking for technology that could adapt or be adapted as his motor skills diminished. This is one of the new thoughts mentioned at the beginning of this section: I did not expect to become involved in disability studies, nor did I expect that I would potentially want to be involved with the discussion of music, technology, and disability, yet Ellsey, Hazlewood and the British Paraorchestra, Tralala Blip and Halpin in presented in this thesis. The future of these people and those who will follow in their collective footsteps is exciting territory.

The subsection on “Technical Matters and Skills” put forth two types of audio production: prerecorded audio files and what was labeled “ex nihilo audio.” The prerecorded audio includes audio files, normally called “loops,” and MIDI (either of which could be triggered or played in real-time); ex nihilo audio infers that the instruments have nothing preloaded or sampled (e.g. The Flow Machine and the Beardytron 5000 mkII). Both of these constitute a legitimate performance as they require a certain level of composition and performance, regardless if the composition has happened before the performance or if it is improvised.

Additionally, I proposed two distinct skill sets: programming and performance. Programming can take at least two forms: computer programming (basic programming, like MIDI mapping; programming languages, like C++) or sample/MIDI programming. It was indicated that many musicians who utilize performative technology participate in the programming of their technology, whether they are the programmers (such as Elena Nattinger,
Tim Exile, or CutterJ the Absurdist) or they collaborate with a programmer to accomplish their goal (such as Imogen Heap or Beardyman). With reference to performance with technology it was noted that harnessing technology in performance does not equate perfection in performance; an example of a performance mishap, Heap inadvertently hitting two unintended notes at the Wired UK 2012 conference, was given. A “both/and” rather than an “either/or” approach to both the technical matters and skills discussions is recommended. One is not inherently better than the other; each has their technical and artistic merits; some people will appreciate the timbre of a carefully crafted synthesizer arpeggio that can only be fashioned in the recording studio and then deployed as a loop, others will appreciate the live twisting and sonic puréeing of ex nihilo audio.

No definitive conclusion was reached concerning technical matters and skills. It could be argued that fully educated and trained composition is the only way, yet the argument could be made that ignorance is bliss. Perhaps this, as a pedagogical and creative goal, is sufficient.

**Evaluation and Assessment**

Initially, Chapter IV, “Evaluation and Assessment,” seemed as though it would be the shortest of the three main body sections (Chapters II, III, and IV). Imagine my surprise when it looked as if Chapter IV were going to overtake the case study-laden Chapter III. Chapter IV sought to address issues of evaluating and assessing music composed and performed with the technologies similar to those mentioned in Chapter III. The goal was to deal with potential issues of defining an electronic composition, touch on skills for composition and performance, present thoughts on assessment and evaluation (from a primarily academic standpoint), and suggest solutions for musical literacy.
I examined three components of composition: musical cohesion/coherence, complexity, and how the resulting piece of music is viewed by its creator. On the topic of musical cohesion/coherence it was found that most of the commentary points toward the subjective nature of music, especially de la Vega’s comparison of the division between the stereotypically subjective nature of nineteenth-century music and the attempted objectivity of early twentieth-century composers. De la Vega would prefer we give recognition to and/or appreciation of twentieth-century music rather than try to comprehend its forms and sounds. Additionally, an allusion was made to a “musical exchange” between Stockhausen and four electronica/EDM composers in which both parties gave a piece of music to the other as a good piece of music and gave critique/advice on the other’s music.

When it came to the topic of musical complexity the question was if “complex” equaled “good.” Two rubrics for the assessment of musical compositions were compared: one for elementary school-aged children and one for university students. The general criteria for the elementary-aged rubric include “aesthetic appeal, creativity, and craftsmanship;” the rubric for university students considers “orchestration, presentation, compositional technique, aesthetics/creativity, literacy, and musical form.” Neither rubric used the term complex to assess compositions; instead they focused on how clearly musical ideas are communicated and developed and if the composer demonstrates their awareness or understanding of certain

255 “The ever-present popular concept of music as a direct, open, emotional expression and as a subjective form of communication from the composer, is, of course still that of the nineteenth century, when composers themselves spoke of music in those terms: e.g. ‘from the heart to the heart’ (Beethoven), ‘tone as the direct expression of feeling’ (Wagner), ‘emotional sensitivity’ (Berlioz), ‘the portrayal of soul states’ (Mahler), and ‘not needing the frame of pedantic forms’ (Busoni).” de la Vega, 5.
256 “An acceptance of this more characteristic twentieth-century view of the art of musical composition will of course immediately bring the layman closer to an understanding of, and sympathetic response to, electronic music, even if the forms, sounds and approaches it uses will still be of a foreign nature to him.” Ibid.
257 Richard D. James/Aphex Twin, Richie Hawtin/Plastikman, Robin Rimbaud/Scanner, and Daniel Pemberton. Again, this is documented in “Stockhausen vs. the Technocrats,” Audio Culture: Readings in Modern Music, Cox and Warner, eds., 381-5.
258 Hickey, 29. Sternfeld-Dunn and Hare, 1-2.
elements or aesthetics of a musical form or genre. Further study could flesh this out; however, the evidence suggests that, from an academic standpoint, compositions that demonstrate an application of creativity and aesthetic appeal with craftsmanship and awareness of musical form are preferred to works that demonstrate complexity for complexity’s sake. As mentioned previously Burnard and Major recommend looking at the beauty and elegance of a piece, whether the piece be more intricate or more simplistic.

How a composition is viewed by its composer seems rather subjective from the outset. In the case study presented in “Meg Makes Music,” while the author, Stauffer, observed, “…listening to and revising the end of the composition only or listening to the whole and making minor adjustments to the background of a piece usually signaled the conclusion of Meg’s work on a composition,” in the end, she acknowledges, “The term ‘composition’ refers only to pieces Meg chose to call ‘composition’ and save in the ‘Composition Book’ file.” It is proposed that while a historically-defined genre or subgenre (e.g. concerto, drum ‘n’ bass, etc.) might have a bearing on how a piece of music is labeled, the final say on distinguishing a full-fledged composition versus a “sketch” or “draft” would ultimately rest in the composer’s purview.

In the subsection on skills the conclusion came quickly. The difficulty of constructing a codified skill set and pedagogy is the variety of controllers; each type of controller would necessitate different requirements. It should be stated that just because the process of developing pedagogical materials might be difficult does not mean it should not be attempted,

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259 Stauffer, 13, 6. Hickey suggests, “Composition should be an ongoing activity in the music classroom, providing opportunities for students to experiment freely with musical sound in order to discover how to manipulate and organize it. Students should be encouraged to compose, edit, revise, and ‘doodle’ music as often as possible, keeping their ‘sketches’ as well as final compositions in personal ‘portfolios’ such as those visual artists use to hold their work.” Hickey, 26.

260 “When it comes to the third category, the jumble of alternative controllers not easily includable in any previous grouping, it is difficult to provide a taxonomy that facilitates a quick overview.” Jorda, 98. The examples given previously were Nattinger’s V AMP and Heap’s Mi.Mu gloves. Both are wearables, however V AMP is a one-glove system, while Mi.Mu is a two-glove system; as a result the skill set and pedagogy would differ between the two systems.
particularly if the goal is to maintain or increase the use or validity of a specific controller. Additionally, if the skills needed to compose and perform using a various controllers were loosely defined a person would need a good working knowledge of which ever software program they have chosen to use (i.e. Ableton Live) and select a controller to use for a significant length of time, as to learn the capabilities and nuances of the controller.

When it came to a praxis-based approach to assessment and evaluation three rubrics were compared: the two previous composition rubrics (Hickey, Sternfeld-Dunn and Hare) with one from a graduate-level electronic music performance course (Brown). Bloom’s Taxonomy was applied to the three rubrics to find areas of similarity. All three rubrics had components of aesthetics (historical or otherwise), creativity, and musical form/craftsmanship. Based on this a two-part rubric solution was suggested for academically assessing compositions: the first part would be a general assessment rubric, focusing on the three components mentioned above; the second part would be an assignment-specific rubric, focusing on goals for the particular piece (e.g. a musique concrète piece, an ambient piece). While this may not be an end-all solution it is one that is workable and one I will look to implement when teaching electronic music courses in the future.

Chapter IV concluded by considering electronic music literacy and a canon of electronic music. It was proposed that we are far enough into the musical epoch to set down rudimentary literacy guidelines for electronic music, such as terminology, a timeline/history of the development of electronic music, key composers, key compositions, turning points, major events, and the like. At the same time we may be too close to what has happened in the past 15-20 years to cut lines of demarcation; this ties back to the idea of the splintering of popular electronic music.
I also proposed the concept of developing a canon of electronic music, focusing on key composers and compositions that have endured the test of even this short time (less than sixty-five years for most compositions), especially those that have maintained their popularity or noteworthiness beyond the lifetime of their composer. The difficulty will lay in academics and lay people, experts and neophytes coming to a consensus for the basic corpus of electronic music, particularly in the case of popular electronic music.

Closing Remarks

In closing, three thoughts have been with me throughout this thesis. First is an idea I wrote about in a paper for the Music of the 20th Century course at Wichita State University, and alluded to earlier in this thesis: that there are two poles in electronic music – formal/academic and EDM – but there exists a vast land between them that we have yet to fully explore. There is so much room to experiment, play, explore, discover, etc. that we should be brave, push out into it, and see/hear what becomes of it.

Second is a line from the song “State of the Art” by the Australian musician Gotye. The song focuses on the home electronic organ culture that was popular in the 1950’s and 1960’s; the lyrics, and the accompanying music video, describe how a family becomes obsessed with the organ and the organ takes over their lives. A particularly thought-provoking verse section says, “Enjoy the state of the art / The Magic Swing Piano really is astounding / Now we can't tell them apart / But these amazing simulations end up sounding even better than the real thing.”

Technology keeps advancing and there are times, whether in audio or visual arts, that distinguishing reality from synthetic sounds can be difficult. Perhaps the lesson to be learned is

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the music can be beautiful, of high quality, expertly rendered, etc., regardless of the sound source (e.g. acoustic vs. electronic).

The final thought comes from American composer/musician Dan Deacon. Deacon’s music is known for its variety of electronic sounds, use of acoustic instruments (including an orchestra), and sonic impact. When he was interviewed by NPR about his 2012 album *America* Deacon was asked, “What do you say to people who are dismissive of electronic music? Do you ever feel that kind of criticism?” Deacon responded

I don’t really feel the criticism, but I think I just feel like it’s insane that people still call electronic music, electronic music. It’s just - it’s like calling music guitar music, or vocal music or something. And I don’t know. It just doesn’t make any sense. Like, you know, and people talk about how it’s permeating the mainstream, but it’s been in the mainstream forever, forever. But I feel like it’d be kind of like, people saying: I can’t believe they’re allowing trombones in the church…That’s sort of like the mentality that I feel when people are like: Electronic music. Do you think it’s going to last? Do you think - so...

Perhaps we will continue to call it electronic music; maybe we will get enough distance within this century where genre, not means of sound generation, will dominate. Whichever way music goes in the future I will certainly be there—participating, composing, watching, listening—and, as I have striven/strived to do in this thesis, drawing attention to the vast possibilities that do and can exist when humanity converges its musical creativity with technology.

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263 Ibid.
264 During the writing of this paper I was introduced to the band Too Many Zooz, a three-piece band consisting of trumpet, baritone saxophone, and a drummer/percussionist that plays house and drum ‘n’ bass music. For more see http://toomanyzooz.com/.
BIBLIOGRAPHY


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Sternfeld-Dunn, Aleksander and Ryan Hare. “Composition Assessment Rubric.” Washington State University, Spring 2010.


Wirtz, Aaron. In discussion with the author. February 6, 2015.


APPENDICES
APPENDIX A: GLOSSARY

Ableton Live – A composition and performance software. Live has two modes: “Session (performance)” and “Arrangement (composition).”

ATC – “Assistive Technology for Cognition” – A device that extends or enhances a person’s ability to think. This can be as simple as a calculator or as advanced as a computer program.
Controller – A device used to play, trigger, and manipulate audio and MIDI files. The can come in a variety of styles. A popular model is some kind of grid-based controller, such as the Akai APC40.

(Akai Professional APC40)

Controllerism – A form of musical performance in which the musician uses a MIDI controller to activate or manipulate audio clips and sounds.

Controllerist – The name of a musician who primarily performs music using MIDI controllers.

Electronica – A catch-all term for popular electronic music. The term is often used for “non-club” electronic music.

Loop – A short section of prerecorded audio often used in electronic music. Loops can be drums, synthesizers, leads, vocals, etc.


Sample – A loop taken from a pre-existing recording. Early hip-hop music was built on samples, primarily drum breaks from gospel and funk recordings.

VST – Acronym for “Virtual Studio Technology.” A VST may take the form of audio effects or instruments. They are also known as “plugins.”
APPENDIX B: THESIS QUESTIONNAIRE – CONSENT FORM

Ryan Mackey – Thesis Questionnaire – Consent Form

**Purpose:** You are invited to participate in a study of the implications of technology on the composition and performance of music. I hope to learn how technology can help extend human ability to compose and perform music, and how we can assess and evaluate music made with the aid of technology.

**Participant Selection:** You were selected as a possible participant in this study because of your unique integration of technology in the process of the composition and/or performance of music. I was made aware of your approach to technology either through first-hand observation or an article about you and your music production. The intended population for this survey and resulting thesis is composers, musicians (both professional and amateur), and educators. Approximately 2 participants will be invited to join this study.

**Explanation of Procedures:** If you decide to participate, you will be asked to answer a brief questionnaire; it will take between 20-60 minutes to answer (depending on the length of your answers). This questionnaire will inquire as to your use of technology in music, as well as your thoughts on current and future use of technology in music. Here are two sample questions:

1. What do you see as the benefits, if any, of technology in music? What do you see as the drawbacks, if any, of technology in music?

2. How do you assess a good composition, particularly where compositions are made utilizing technology?

**Discomfort/Risks:** There are no anticipated risks associated with participating in this study. There is a requirement of time to answer the questionnaire. If you feel uncomfortable with a question, you may skip it.

**Benefits:** The benefits of this thesis will be an increased awareness of the use of technology in music and its potential benefits. Additionally, the thesis will suggest means of academic assessment and evaluation for such music.

**Confidentiality:** Every effort will be made to keep your study-related information confidential. However, in order to make sure the study is done properly and safely there may be circumstances where this information must be released. By completing this survey, you are giving the research team permission to share information about you with the following groups:
Office for Human Research Protections or other federal, state, or international regulatory agencies;
The Wichita State University Institutional Review Board;

The researchers will not publish the results of the study in a public journal.

**Refusal/Withdrawal:** Participation in this study is entirely voluntary. Your decision whether or not to participate will not affect your future relations with Wichita State University and/or the investigators of this thesis. If you agree to participate in this study, you are free to withdraw from the study at any time without penalty.

**Contact:** If you have any questions about this research, you can contact me at: Ryan Mackey, (620) 755-1105, rdmackey@wichita.edu or Dr. Elaine Bernstorff, (316) 978-6953, elaine.bernstorf@wichita.edu. If you have questions pertaining to your rights as a research subject, or about research-related injury, you can contact the Office of Research and Technology Transfer at Wichita State University, 1845 Fairmount Street, Wichita, KS 67260-0007, telephone (316) 978-3285.

You are under no obligation to participate in this study. Completing and returning this survey indicates that:

- You have read (or someone has read to you) the information provided above,
- You are aware that this is a research study,
- You have had the opportunity to ask questions and have had them answered to your satisfaction, and
- You have voluntarily decided to participate.

You will be sent a copy of this consent form for your records.

Your Name (print or type) _______________________________

Your Signature _______________________________ Date _____________
Hickey: "Rubric for assessing general criteria in a composition assignment"\textsuperscript{265}

<table>
<thead>
<tr>
<th>Components</th>
<th>Needs Work</th>
<th>Quality Line</th>
<th>Terrific!</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aesthetic Appeal</strong></td>
<td>Does not present an effective general impression. Musical ideas do not hold the listener's interest.</td>
<td>Includes at least one interesting musical idea. Yet, the overall impression is not effective.</td>
<td>Includes some interesting musical ideas. The general impression is pleasant and moderately effective.</td>
</tr>
<tr>
<td><strong>Creativity</strong></td>
<td>Musical idea is familiar or a cliché. No variety or exploration of musical elements (range, timbre, dynamics, tempo, rhythm, melody).</td>
<td>Musical idea is neither familiar nor a cliché. However, there is no development, variety, or exploration of musical elements.</td>
<td>Involves some original aspect(s) or manipulation(s) of musical idea(s). Explores and varies at least one musical element.</td>
</tr>
<tr>
<td><strong>Craftsmanship</strong></td>
<td>Gives no sense of a completed musical idea. Exhibits no clear beginning, middle, or end section. Form appears random rather than organized. Musical elements (range, dynamics, timbre, tempo, texture, rhythm, melody) do not connect well or are not used to organize musical ideas or the form.</td>
<td>Presents one complete musical idea. However, composition lacks overall completeness. Fails to use musical elements to organize musical ideas or form.</td>
<td>Ending feels final. Uses at least one musical element to organize the musical ideas and overall form.</td>
</tr>
</tbody>
</table>

\textsuperscript{265} Hickey, 29.
Hickey: “Assessment rubric for composition using dotted-eighth and sixteenth notes”

<table>
<thead>
<tr>
<th>Components</th>
<th>Needs Work</th>
<th>Contains one or two dotted-eighth and sixteenth note rhythms</th>
<th>Contains three dotted-eighth and sixteenth note rhythms</th>
<th>Contains four or more dotted-eighth and sixteenth note rhythms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes at least four dotted-eighth and sixteenth note rhythms</td>
<td>Contains no dotted-eighth and sixteenth note rhythms.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Includes dynamic markings and is eight measures long</td>
<td>Contains no dynamic markings and is less than eight measures long.</td>
<td>Is at least eight measures long or uses dynamic markings.</td>
<td>Is at least eight measures long and uses dynamic markings.</td>
<td>Is at least eight measures long and uses dynamic markings effectively for expression.</td>
</tr>
<tr>
<td>Melody</td>
<td>Does not feel complete or coherent.</td>
<td>Seems complete and coherent but lacks imagination.</td>
<td>Seems complete and coherent and contains some imaginative aspects.</td>
<td>Is convincingly complete, coherent, and imaginative.</td>
</tr>
</tbody>
</table>

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266 Ibid., 30.
Hickey: “Assessment rubric for a composition in rondo form”\textsuperscript{267}

<table>
<thead>
<tr>
<th>Components</th>
<th>Needs Work</th>
<th>Has a clear two-measure theme and one other theme but is not in rondo form</th>
<th>Is in rondo form but with only two other themes—ABACA.</th>
<th>Is clearly in rondo form, with three other themes—ABACADA.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rondo form</td>
<td></td>
<td>Has no formal structure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suits the instrument (if applicable)</td>
<td></td>
<td>Is outside the practical range of the instrument and is beyond the technical grasp of players of this level.</td>
<td>Is within the practical range of the instrument but has too many difficult passages for players of this level.</td>
<td>Falls within the proper range of the instrument and is playable by performers at this level of proficiency.</td>
</tr>
<tr>
<td>Melody</td>
<td></td>
<td>Does not feel complete or coherent.</td>
<td>Seems complete but lacks imagination.</td>
<td>Feels musically complete and contains some imaginative aspects.</td>
</tr>
<tr>
<td>Rhythm</td>
<td></td>
<td>Is erratic. It does not make musical sense for the piece overall.</td>
<td>Is stable but does not have any variety or does not make musical sense for the piece as a whole.</td>
<td>Makes musical sense for the overall form of the composition.</td>
</tr>
</tbody>
</table>

\textsuperscript{267} Ibid., 31.
Hickey: “Assessment rubric for a melody with well-defined parameters”\textsuperscript{268}

<table>
<thead>
<tr>
<th>Components</th>
<th>Needs Work</th>
<th>Work</th>
<th>Excellent</th>
<th>Terrific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begins on \textit{do} and ends on \textit{ti-do}</td>
<td>Does not begin or end with the correct notes (\textit{do}, \textit{ti}-\textit{do}).</td>
<td>Begins or ends with the correct notes but does not do both.</td>
<td>Begins and ends with \textit{do} but does not include \textit{ti}.</td>
<td>Begins and ends with the correct notes as specified by the assignment.</td>
</tr>
<tr>
<td>Uses only notes from chord tones on template</td>
<td>Less than 50% of the remaining notes match the corresponding chord tones.</td>
<td>Between 50% and 75% of the remaining notes match the corresponding chord tones.</td>
<td>Between 75% and 90% of the remaining notes match the corresponding chord tones.</td>
<td>All other notes match the corresponding chord tones.</td>
</tr>
<tr>
<td>Suits the instrument (if applicable)</td>
<td>Is outside the practical range of the instrument and is beyond the technical grasp of players of this level.</td>
<td>Is within the practical range of the instrument but includes too many difficult passages for players of this level.</td>
<td>Is within the practical range of the instrument and has only one or two passages that are technically awkward for players of this level.</td>
<td>The composition falls within the proper range of the instrument and is playable by performers at this level of proficiency.</td>
</tr>
</tbody>
</table>

\textsuperscript{268} Ibid., 32.
Hickey: “Assessment rubric for a melody with two musical ideas”

<table>
<thead>
<tr>
<th>Components</th>
<th>Needs Work</th>
<th>Terrific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has at least two complete musical ideas that complement each other</td>
<td>Has no apparent complete musical ideas.</td>
<td>Has at least two complete musical ideas that complement each other within the structure of the song. However, the transitions between musical ideas are not smooth.</td>
</tr>
<tr>
<td>Suits the instrument (if applicable)</td>
<td>Is outside the practical range of the instrument and is beyond the technical grasp of players of this level player.</td>
<td>Falls within the proper range of the instrument and is playable by performers of this level of proficiency.</td>
</tr>
<tr>
<td>Melody</td>
<td>Does not feel complete or coherent.</td>
<td>Feels musically complete and some imaginative aspects.</td>
</tr>
<tr>
<td>Rhythm</td>
<td>Is erratic. Does not make musical sense for the piece overall.</td>
<td>Makes musical sense for the overall form of the composition.</td>
</tr>
<tr>
<td>Aesthetic Appeal</td>
<td>Does not present an effective general impression. Musical ideas do not hold the listener's interest.</td>
<td>Makes strong general impression and has great appeal. Would be enjoyed by many listeners. Keeps the listener interested.</td>
</tr>
</tbody>
</table>

269 Ibid., 33.
<table>
<thead>
<tr>
<th>Composition Rubric</th>
<th>Superior 6</th>
<th>Excellent 5</th>
<th>Above Average 4</th>
<th>Average 3</th>
<th>Fair 2</th>
<th>Poor 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orchestration</strong></td>
<td>Demonstrates an advanced understanding and creativity in idiometrically writing for and combining instruments, voices, or electronics. Mature knowledge of fundamental and extended techniques.</td>
<td>Demonstrates an advanced understanding but is lacking the final mature creativity in writing for and combining instruments, voices, or electronics. Largely complete knowledge of fundamental and extended techniques, but some elements missing.</td>
<td>Knowledge and creativity slightly unsophisticated in some manner regarding instruments, voices, or electronics. Knowledge of fundamental and extended techniques mostly but not entirely complete.</td>
<td>Basic but not sophisticated understanding of instruments, voices, or electronics. Fundamental knowledge is mostly there but understanding of extended techniques is lacking. Writing is not always idiomatic.</td>
<td>Fundamental knowledge of writing for and combining instruments, voices, or electronics exists but is essentially unsophisticated or unimaginative. Writing is often not especially idiomatic.</td>
<td>Knowledge of writing for and combining instruments, voices, or electronics is crude, non-idiomatic, and frequently includes errors.</td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td>Quality of notation and presentation of materials gives the impression of professionalism and an astute attention to detail.</td>
<td>Quality of notation and presentation of materials generally very good. Attention to detail is not perfect but what few errors or inconsistencies exist are easily corrected.</td>
<td>Attention to detail is generally good, but there are frequent minor errors or inconsistencies. There are no or very few large problems.</td>
<td>Attention to detail is generally good, but there are frequent minor errors or inconsistencies, and occasional large problems. Professionalism not obvious.</td>
<td>Numerous small and large errors or inconsistencies in presentation. Details are there, but not sufficient for a professional product.</td>
<td>Presentation is crude, messy, unsophisticated, or very inconsistent.</td>
</tr>
<tr>
<td><strong>Compositional Technique</strong></td>
<td>Musical language demonstrates a high degree of originality, consistency, and organization.</td>
<td>Musical language demonstrates a high degree of consistency, but is not as original, thoroughly organized, or polished.</td>
<td>Original musical craft is clear, but there are some minor inconsistencies or fundamental weaknesses in organization.</td>
<td>Musical language shows basic knowledge or craft, but is generally unpolished. Musical language is inconsistent, or the whole is not particularly well organized.</td>
<td>Basic organizational skills are lacking. Musical language is essentially inconsistent.</td>
<td>Crude, thoughtless, disorganized.</td>
</tr>
</tbody>
</table>

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Sternfeld-Dunn & Hare: “Composition Rubric”

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270 Sternfeld-Dunn & Hare, 1-2.
<table>
<thead>
<tr>
<th>Aesthetics/ Creativity</th>
<th>The composer’s scores show an abundance of creative ideas and the composer demonstrates an astute awareness of the aesthetics of contemporary music. Knowledge and craft are consistently reformulated into new musical ideas.</th>
<th>Some small degree of naïveté towards salient issues of contemporary music aesthetics or a very slight amount of derivate musical thinking exists.</th>
<th>Basic naïveté but with apparent interest and curiosity to learn more. Occasional, conspicuously derivate musical thinking.</th>
<th>Musical ideas are more often clichéd than not. Some basic ignorance or lack of curiosity regarding aesthetics.</th>
<th>Real creativity is minimal. An awareness or curiosity of issues in contemporary music aesthetics is absent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literacy</td>
<td>The composer demonstrates a wide and very thorough understanding and knowledge of music history and repertoire across multiple genres and musical eras. History and repertoire of a variety of 20th and 21st century musical genres are known thoroughly.</td>
<td>The composer demonstrates a wide understanding and knowledge of music history and repertoire across multiple genres and musical eras, but with some minor gaps.</td>
<td>The composer’s knowledge of music history and repertoire is limited to only a few eras or genres.</td>
<td>Basic ignorance or excessively narrow understanding of music history and repertoire, particularly regarding the 20th and 21st centuries.</td>
<td>Knowledge of music history and repertoire is essentially absent or extremely narrow (e.g. confined mainly to recent popular music.)</td>
</tr>
<tr>
<td>Musical form</td>
<td>A sophisticated knowledge of the processes that comprise form in music at basic and advanced levels is well conceived and consistently demonstrated. Demonstrates expertise beyond basic forms and can extend them in new directions.</td>
<td>Demonstrates an expertise in advanced and basic musical forms, but not always in the most sophisticated way. Ability to extend musical forms in new directions exists but is of inconsistent quality.</td>
<td>Understanding of basic formal processes in music is clear but not usually realized in an especially sophisticated way.</td>
<td>Use of basic forms is demonstrated but of inconsistent quality.</td>
<td>Struggles to successfully make use of even the most basic small forms in music.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No knowledge of musical form is apparent.</td>
</tr>
</tbody>
</table>
Brown: “Mills College MUS 252 Seminar in Electronic Music Performance”

- **Music Elec & Rec Media**
  - To have a developed understanding of cultural, political, social, and intellectual issues in diverse contemporary and historical musical & sound art practices. (Introduced, Practiced)
    - Assess and critique musical examples of contemporary electronic music performance on aesthetic as well as technical grounds.
    - Examine and discuss issues of technological use in the arts and the socio-political implications and ramifications of such use.
  - To have distinctive creative ideas and the ability to realize them successfully on a professional level. (Practiced, Mastered)
    - Compose short electronic works in response to class project criteria incorporating sound diffusion, MIDI control, electro-acoustic sources, network interaction, and real-time audio analysis.
    - Produce and perform class projects in class and in formal concert at the end of the semester.
  - To be able to critically analyze & clearly identify strengths and weaknesses in her/his own work, & the work of others. (Practiced, Mastered)
    - Explain methods employed in class projects and discuss their musical attributes.
    - Develop listening skills and critique other student’s work in class in a seminar format.
  - To be able to productively collaborate with others in professional contexts relating to her/his area of expertise. (Introduced, Practiced, Mastered)
    - Build collaborative performances using unique interconnection capabilities of electronic technologies.
    - Investigate new musical properties made possible by real-time group composition and performance.
  - To demonstrate a technical mastery of her/his instrument or discipline, and a comprehensive knowledge of its styles and repertoire, past and present. (Practiced, Mastered)
    - Construct hardware and software instruments and refine them through musical performance practice.
    - Categorize and compare historical and contemporary uses of electronic technology for sonic art and musical performance.

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