A PRACTICAL AND THEORETICAL FRAMEWORK FOR UNDERSTANDING CONTEMPORARY ANIMATED SCORING PRACTICES

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ABSTRACT

Animated Music Notation [AMN] describes any notational approach that is represented in real time as a necessarily dynamic set of notational symbols that rely on the functional relationships between these symbols to prescribe musical actions. An Animated Score is any score that contains AMN as a necessary component to its proper representation.

Before the emergence of contemporary animated scoring practices, the score existed primarily as a fixed, tangible object, with few exceptions to the contrary. With the inclusion of perceptible movement, including the real-time generation of notational information in some cases, the concept of the score as a static point of reference for one's personal interpretation is largely dismantled. In many cases, the performer's traditionally-held interpretive capacity is displaced, as this interpretive authority is transferred to the computational processes of the score. The performer's interpretive capacity is further limited by the representational directness demonstrated by AMN functionalities, and the limited temporal window within which these functionalities are perceptible. In short, an animated score will often indicate little more than what to do and when to do it, and provide the performer with little leeway to do otherwise.

This representational directness results in part from the distillation of notational information to what is often a small collection of graphic notational elements and their respective dynamic functionalities. Although these elements appear to emerge from the visual aesthetics of 20th century graphic notational practices, when combined with their dynamic functionalities they demonstrate a prescriptive specificity that reflect the prescriptive capacities of common practice notation [CPN]. However, the directness of AMN does not require one to understand an extensive symbol system like that of CPN in order to successfully engage; again, the performer is simply provided real-time instructions as to what to do and when to do it, and often on momentary, event by event basis. This directness, and the ephemerality of the score itself, require the notation to be immediately accessible to the performer. Thus, the animated score leads to a diminishment of the amateur-professional divide commonly associated with the Western musical tradition, specifically regarding the requirements that one gain a thorough understanding of CPN, including how to interpret these marks both technically and aesthetically.

Within the history of Western music notational practices, the dynamic qualities found in Contemporary Animated Scoring Practices demonstrate a significant departure from tradition, and this dissertation seeks to develop new understandings of these practices from two complementary angles. First, I develop a low-level terminology for analysis of the symbols and dynamic behaviors commonly found in animated scores produced over the past 15 years. This practical groundwork is complemented by a theoretical account comprising three key ideas: the capacity these notational practices have for specific prescription, their tendency to disrupt traditional interpretive models, and the potential for animated scores to enable a post-literate representational model. Examples drawn from my body of artistic work are interspersed throughout the dissertation in order to highlight the various qualities of this practical and theoretical framework, and to track how my compositional and notational processes and intentions have progressed. In closing, I suggest areas for technological and artistic expansion, and propose a speculative codification of the field in its present state of development.

1. Introduction

1.1 Overview

For centuries, the literate tradition of Western art music has been preserved through the written score. The notational marks contained within the score represent a detailed specification of how the performer might audibly instantiate the composer’s intentions. While the physicality of these scores render them vulnerable to loss or deterioration, when adequately preserved, the fixed nature of these notational marks in the context of the established symbol system of common practice notation [CPN] enables generations of composers, scholars, and performers to access the composer’s intentions with a high degree of specificity. However, it is also this very fixedness that maintains the traditional dynamic between the composer, the score, and the performer. The score, penned by the composer, is the document from which the performer develops her personalized musical interpretation of the marks contained within. She is able to reference the score as a fixed record of the composer’s prior act of composing; it is “out-of-time” in this sense. Her “real time” interpretative realization unlocks the sonic potentials of the score, injecting the composer’s original intentions with her own musical inclinations, while influenced by the general musical climate of the day in matters of interpretative precision. However, this “real time” is still tethered to the static, fixed form of the traditional score, effectively maintaining the traditional composer-score-performer dynamic.

With the introduction of graphic scoring practices in the mid-20th century, new concepts about the role of the score, and what notation could and should be, provided alternatives to the established, prescriptive formality of CPN. In short, graphic scores often diminish the more authoritative tendencies of CPN by reducing prescriptive specificity in favor of suggestive or open representational models, enabling a variety of improvisatory and open concepts that are difficult to represent with CPN. Still, these notational experiments were, with few exceptions, static and fixed to the page.

In the late 20th and early 21st centuries, composers began exploring new ways to represent musical notation beyond the fixedness of traditional scores, whether presented on paper, or more recently, computer screen. Using a variety of commercial and open source software and programming languages, the score was reconceived to become a dynamic medium, enabling new possibilities for notational representation. This dissertation argues that the most significant of these possibilities is the emergence of Animated Music Notation [AMN], in which the use of graphic symbol systems and perceptible, real-time notational movement demonstrates a clear notational, compositional, and ontological break with the fixed representational methods of traditional scoring practices.

This thesis presents both a practical and theoretical framework to understand Animated Music Notation and, more broadly, Contemporary Animated Scoring Practices in the early 21st century. Interest in these practices has intensified in recent years, through articles appearing in scholarly journals and conference proceedings, the emergence of performance and research groups dedicated to contemporary animated scoring practices, a steady rise in creative output, and the creation of online repositories dedicated to these new types of scores. The research conducted for this dissertation coincides with this rise in activity, and by combining scholarly reflection on the current state of the art with the creative submission and analysis of my own compositional work involving AMN, the practical and theoretical framework submitted serves as a foundation for understanding the current state of contemporary animated scoring practices. This framework will be will be defined by three key ideas.

The first idea claims that AMN has the potential to combine both notational prescriptiveness with an openness of compositional structure and notational design that follows from the graphic notation of the 20th century. In the mid-20th century, graphical approaches to notation were designed to dissolve the prescriptive requirements of CPN, incorporate improvisation, open the work's formal structure, and redirect creative agency away from the composer and score to the performer. In general, graphic scores represented compositional intentions that *required* an enhancement of the performer's traditional interpretive capacity. Contemporary animated scoring practices demonstrate a reclaiming of the prescriptive specificity of CPN, while accentuating the openness and accessibility enabled by graphic notational practices, and following closely in their visual characteristics. The prescriptive and visual characteristics of these scores will be emphasized by the identification and extension of low and high-level AMN and Animated Score terminologies respectively.

The second idea, which concerns the time-bound nature of animated scores in conjunction with the prescriptive qualities of AMN, demonstrates a displacement of interpretive power away from the player, and toward the computational processes, notational functionalities and control structures of the score. Unlike traditional notions of interpretation, in which the fixed score can be referenced by the performer prior to performance, the animated score is often ephemeral, with performer access limited to the duration of the work as it is being rehearsed or performed. The functionality of the score is largely contained by the computational processes that create or *dynamize* the score, and the notational functionality is often decisive and controlling, further displacing the possibility for performer interaction on an interpretive level.

The third idea concerns the potential in animated scores to broaden participation in music making beyond traditionally trained common practice literacy, which results from the symbolic and functional distillations found in these scores, and the control structures that are necessary to their real-time legibility. This distillation is most often represented by the visualization of contact and intersection, functional relationships that simply instruct the performer what to do, and when to do it. The simplicity and clarity of these functionalities enable the realization of a wide range of complex musical concepts without requiring a comparable level of musical literacy and expertise. To this end, it will be shown that AMN is generally manifested as a post-literate notational approach. By enabling participation by a wide range of performer abilities through the aforementioned symbolic and functional distillation, while preserving specific prescription within a rigid control structure, these scores demonstrate a blurring of the line between the amateur and the professional.

I have been deeply involved in animated scoring practices for the past six years, and during that time I have composed over 50 works utilizing AMN, the majority of which were composed during my time at Rensselaer. Through my efforts as a composer, researcher, and as the creator of the website animatednotation.com [ANDC], I have had the opportunity to develop a strong working relationship with these practices, and an extensive knowledge of how the field of practice has developed during this time. I have also had the opportunity to present my work in concerts, lectures and workshops internationally, and have developed close scholarly and personal relationships with many of the key composers and researchers in this field. Coupled with my background in traditional musical pedagogy, and a decade of professional experience beyond the academy, I am well-positioned to explore this field from within the context of academic musical scholarship.

1.2 Objectives

As mentioned in the previous section, a body of recent scholarship about contemporary animated scoring practices serves as the foundation for this scholarly examination. A general terminology of score functionalities that is applicable to a large cross-section of animated scores has been established.[1] The practical issues of real-time animated scoring practices have been considered at length,[2,3] including expressions of these work's artistic merit and theoretical foundation,[4,5,6] the potential for networking and interaction,[7,8,9,10] and the volume and the variety of documented animated scores and their instantiation in performance demonstrate a significant practical baseline.

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[1] Cat Hope and Lindsay Vickery, "Screen Scores: New Media Music Manuscripts," ECU Publications (2011): 226, accessed February 18, 2016, url: http://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1420&context=ecuworks2011.
[2] Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," *Computer Music Journal* 32:3 (2008): 30.
[3] Lindsay Vickery, "The Limitations of Representing Sound and Notation on Screen," *Organised Sound* 19:3 (2014): 226.
[4] Gerhard E. Winkler, "The Realtime-Score. A Missing-Link in Computer-Music Performance" (paper presented at First Sound and Music Computing Conference, SMC '04, Paris, France, 2004), 5.
[5] Guðmundur Steinn Gunnarsson, "An Approach to Rhythm" (MA thesis, Mills College, 2007).
[6] Justin Wen-Lo Yang, "Sometimes I Feel the Space Between People (Voices) in Terms of Tempos – A Work for Percussion Duo with Computer Animated Notational Interface" (DMA diss., Stanford University, 2008).
[7] Georg Hajdu, Kai Niggemann, Ádám Siska and Andrea Szigetvári, "Notation in the Context of Quintet.net Projects," *Contemporary Music Review* 29:1 (2010): 39-53.
[8] Georg Hajdu, "Quintet.net – A Quintet on the Internet" (paper presented at the International Computer Music Conference, Singapore, September 29 – October 4, 2003).
[9] "monochrome," matralab, accessed February 18, 2016, http://matralab.hexagram.ca/projects/monochrom/.
[10] G. Douglas Barrett, Michael Winter and Harris Wulfson, "Automatic Notation Generators" (paper presented at the 7th International Conference on New Interfaces for Musical Expression, New York, New York, June 6-10, 2007).

However, at this point it appears that a large-scale practical and theoretical framework for understanding contemporary animated scoring practices in general has not been established. It is my objective with this dissertation to develop this framework in order to better understand contemporary animated scoring practices, built upon the three ideas described in the previous section, framed by a meta-narrative of musico-technological developments, and demonstrated by examples of these scoring practices. Additionally, the terminological distinctions currently used to describe a large cross-section of contemporary animated score functionalities will be extended through the identification of several alternative score functionalities. While this terminology concerns the high-level, dynamic functionalities of the score, at this point little has been written about the low-level, atomic symbols and functionalities that populate AMN. Based on an analysis of my own work and the works of other composers, I will posit new terminological distinctions of the low-level symbols and functionalities found in AMN.

During the course of this paper I will highlight many of my creative works in order to demonstrate specific compositional and notational intentions and functionalities respectively. In chapter 5 I provide an analysis of six of these works: *Study no. 10*, *Study no. 30*, *Study no. 40.3 [pulseven]*, *Study no. 0*, *Study no. 44 [Lecture1]*, and *Study no. 50*. These analyses demonstrate how the objectives of this paper have been manifested in my creative practice, highlight the particular compositional and notational directions my work has maintained during the research and writing process, and provide the foundation for a discussion of what directions my work might take in the future.

I will conclude this paper with a brief, speculative discussion on what I am calling the *First Wave* of Contemporary Animated Scoring Practices. Based on the three ideas developed throughout this paper, and supported by the low and high-level AMN and Animated Score terminologies, the *First Wave* will be described as a concentrated and contemporary manifestation of these practices.

1.3 Scope of Study and Research Methodology

In order to develop an understanding of contemporary animated scoring practices, I began by amassing a large collection score documentation. Due to the digital nature of these notational practices, a large portion of this work was done online by searching through video repositories, contacting composers and examining their websites, and the development of an online platform to organize my findings, and to attract attention to my research concerns. Many of these works were discovered in scholarly writings that reference these composers and their works, including a much smaller number through concert, conference, and festival attendance. While I cast the umbrella quite wide in this search, I only included works that clearly demonstrated the real-time, dynamic functionalities associated with contemporary animated scoring practices, and focused primarily on those scores that did not incorporate CPN. These works formed the practical basis for my extensions to the existing high-level animated score functionality terminology, and the development of the low-level terminology to describe the symbolic and functional aspects of AMN.

Although the creative works cited in this paper represent composers from around the world, my historical, theoretical and practical investigations are principally framed in the context of the Western music tradition and Western notational practices. This limitation allowed me to utilize my prior knowledge and experience with Western music and Western notational practices, including CPN and graphic notation, and provided a relevant framing for contemporary animated scoring practices. Specifically, the prescriptive qualities of CPN in combination with the visual and formal characteristics of graphic notation in particular provide a robust foundation on which to build a practical and theoretical understanding of contemporary animated scoring practices.

1.4 Overview

This dissertation is divided into 5 chapters. In chapter 1, I provide an introduction to the primary components of this paper, including an explanation of my research objectives, scope of study, and research methodology.

In chapter 2, I develop a meta-narrative of historical notational and compositional technological and creative development in the Western music tradition, with a focus on the 20th century. This chapter also includes a literature review that outlines the theoretical framework mentioned previously, in order to further develop the three essential ideas.

In chapter 3, I extend the theoretical framework covered in chapter 2 through a secondary literature review that focuses specifically on recent high and low-level Animated Score and AMN functionalities respectively, in order to develop the practical aspects of this framework. In this chapter I propose suggestions for the extension of these high-level functionalities and terminologies, and propose a suite of terminological definitions to understand the low-level symbols and functionalities found in AMN. I also use this chapter to highlight the diversity of terms used to describe contemporary animated scores, and offer my reasoning for its clarification.

In chapter 4, I examine six compositions created since 2012, including *Study nos. 10*, *30*, *40.3*, *0* and *50*. Each composition was selected for its distinct notational approach, and for how these approaches are designed to represent each compositional intention respectively. These three compositions suffice to document the evolution of my creative process over the past 4 years, will serve as practical examples of the high and low-level terminologies discussed in chapter 3, and as a demonstration of how the three essential ideas of contemporary animated scoring practices are manifested in my work.

In chapter 5 I discuss the results of my research, and the evolution of my creative practice. The strengths and limitations of my research and practice are also identified, concluding with speculations on the directions that both the field of animated scoring at large, and my creative practice, may take in the future. In closing, I suggest that the framework established throughout this paper, and the practices that demonstrate it, encompass a body of work of that can be referred to as the First Wave of contemporary animated scoring practices. Following a brief discussion of what defines this first wave in particular, I will speculate on what the next wave of animated scoring practices might look like.

2. A Conceptual Framework for Understanding Contemporary Animated Scoring Practices

2.1 Introduction

Over the last 15 years, a relatively small group of composers have been developing and implementing a new form of music notation, colloquially referred to as Animated Music Notation [AMN], or simply Animated Notation. Using digital visualization software and coding languages, these composers incorporate movement as a fundamental component of the functionality of what are appropriately called Animated Scores. An animated score contains one or more notations that feature real-time dynamic characteristics, and while these characteristics vary considerably in their appearance, functionality and intentions, a score is only considered to be an animated score if movement is an essential quality. A dynamic characteristic is essential only when its absence renders the score illegible to the degree intended by the composer. In other words, movement is not an essential quality if the notations embedded within the score are legible to the degree intended by the composer prior to some dynamic activation. An additional feature of these scores is that their symbol systems build upon the general design characteristics found in graphic scoring practices. Thus, even though some animated scores are built upon the symbols and functionalities found in common practice notation, the term "Animated Music Notation" is largely constrained to those notational practices that break away from these more traditional representations.

Because movement (and the perception of movement) is time-based, animated scores are uniquely time-dependent, especially when considered in the context of traditionally-fixed methods of Western notational practices. To this end, the time-dependent nature of animated scores enables the representation of time, in particular, in ways distinct from common practice notation (CPN). The representation of time with CPN is based on the relationships between symbolically-coded temporal events, and it is because of this that CPN can function in a fixed form. With the exception of the first event, even if that event is a rest, all subsequent events form a relational stack, in which the temporal location of each event is determined by what precedes it. The performer locates these events by determining the duration of adjacent events, and advancing linearly through the stack. Because each event is represented by a symbol that indicates a specific duration, and common practice normally dictates that events advance in a linear manner, it is unnecessary to reinforce temporal location with literal movement; the performer's eye effectively *moves* through the score. Thus, the traditionally-notated score already contains those qualities essential to its legible representation, and to introduce dynamic behaviors into such a score would be redundant.[11]

AMN, on the other hand, facilitates the representation of absolute temporality *directly* by circumventing the relational symbol system of CPN; by introducing motion, the stack is decoded on a momentary basis. This momentary ordering is still linear, as each notated event will follow what precedes it, but the distinction with CPN is that the temporal location of an event need not *notationally* reference what came before. Using AMN to represent the temporal location of sonic events in absolute time enables compositional concepts that may have seemed improbable or impossible with CPN, and can represent certain musical processes with a degree of specificity not realistically attainable with CPN.

Equally significant is the unique accessibility of AMN. Unlike CPN, AMN does not require the performer to understand the entirety of CPN. Rather, the performer develops an understanding for a (often small) symbol set, and an understanding of how to interpret the dynamic interactions between these symbols: "the process of rehearsing shifts from 'studying notes' to get to know, 'how the system works."[12] These interactions, or *indications*, form the functional foundation for AMN. *Indication* describes the perceptible, momentary or sustained dynamic relationship between two symbols. The two primary modes of indication are contact and intersection, although other less common methods are in use.

Although it wasn't until the late-20th/early-21st century that animated scoring practices began to reach a critical mass of sorts, the concept of a dynamic score has its roots in the mechanical technologies of the mid-to-late 19th century, and in film and entertainment (Max Fleischer's Screen Scores and later Karaoke) from the early to mid 20th century, as well as popular music and games in the late-20th and early 21st century

[11] Contrarily, there are plenty examples in which the use of CPN is far from redundant, including the work of Georg Hajdu, Nick Didkovsky and Harris Wulfson in particular.
[12] Gerhard E. Winkler, "The Realtime-Score. A Missing-Link in Computer-Music Performance."

(rhythm games). Now, with access to low cost, open-source visualization software and hardware, reproducible applications, easily-distributable video, and the global connectivity of the internet, composers have readily available tools to produce and disseminate animated scores that would previously have been improbable or impossible to create and transmit mechanically or otherwise. Still, despite its largely digital manifestation, another genealogy of the animated score follows from the lineage established by the fixed, analog representational approaches in CPN and graphic notation. Specifically, the role of the score as a prescription of musical activities is largely maintained. The compositional intentions enabled by animated scores also follow in the progressive lineage of Western compositional practice, and in particular, AMN practices follow the tendency toward the dissolution of time as a pulsed entity. Pulsed, in this context, describes music in which rhythmic relationships can be perceived by the listener as outlining the primary structural aspects of a given meter (e.g. clearly defined downbeats, regular instantiations of the primary beat division [2, 3 and 4 primarily], fixed rhythmic relationships between players in ensembles, etc.). Contemporary animated scoring practices also extend the compositional openness that emerged in mid-century, while still preserving the identity of the work. As Umberto Eco remarked as early as 1959 concerning the "work in movement", "in the Einsteinian universe, in the 'work of movement' we may well deny that there is a single prescribed point of view. But this does not mean complete chaos in its internal relations."[13] The unique approach to openness found in animated score functionality is most readily demonstrated by the transfer of creative agency away from the performer to the real-time computational processes that ultimately determine the solidification of these possibilities into prescriptive notation. For unlike open scores that are fixed to the page, the performer is not necessarily able to influence the score, yet the score maintains its openness until the moment of its generation or unfolding.[14]

AMN has now emerged as a significant notational practice, especially in Reykjavik, Iceland and Perth, Australia, while also including significant practices based

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[13] Umberto Eco, *The Open Work*, trans. Anna Cancogni (Cambridge, MA: Harvard University Press, 1989), 19.

[14] This is primarily applicable to Generative Animated Scores, although the transfer of interpretive agency is often apparent in the unique control structures found throughout these works.

in Europe, the United Kingdom, and the USA. Scholarly writings have found a foothold in established academic journals and conferences, and online repositories, including Páll Ivan Pálsson's animatednotation.blogspot.com and my research website animatednotation.com, have begun to consolidate and map the field. More recently, AMN has been exploited for its pedagogical potential,[15,16] and has found its way into popular culture.[17,18] However, despite its recent establishment, contemporary animated scoring practices remain a decidedly experimental field of practice, represented by a variety of notational approaches that are as diverse as the composers creating and implementing them. Still, this diversity across the field does not preclude a set of fundamental practical and theoretical ideas that can be generalized across the field of practice. In the following sections I will develop the foundation of musicological, notational, historical, and ontological thought that will support these claims.

2.2 Prescription vs Descriptive Notation

In "Prescriptive and Descriptive Music Writing," musicologist Charles Seeger tackles the musicological distinction between the musical score and its realization. Seeger notes that the score is "prescriptive and subjective",[19] and contains a set of explicit instructions as to what actions the performer must take in her decoding of the notation, while leaving an instructional gap into which she inserts her own unique interpretation. It is this gap that enables, if not requires, the performer to discover her own aesthetic relationship to the score, and is a hallmark of the Western music tradition. This interpretive flexibility is an essential component of the traditional score-performer dynamic, as CPN cannot adequately represent the atomic minutiae of musical performance. To this end, Seeger

[15] "Dabbledoo Music," Dabbledoo Music, accessed February 16, 2016, http://www.dabbledoomusic.com/about.html.
[16] "Testing the ipads music notation system at Sussex University," Vimeo video, posted by Ed Hughes, January 12, 2016, accessed February 16, 2016, https://vimeo.com/151517296.
[17] "Björk: Biophilia App," iTunes Store, accessed February 16, 2016, https://itunes.apple.com/us/app/bjork-biophilia/id434122935?mt=8.
[18] The animation of fixed, traditionally notated sheet music has become an interesting micro-scene on YouTube. Furthermore, the use of music in video games (Guitar Hero and Dance Dance Revolution in particular) continues to be a mainstay in popular culture.
[19] Charles Seeger, *Studies in Musicology: 1935-1975* (Berkeley, CA: University of California Press, 1977), 169.

describes this relationship between notation and its sonic instantiation as more than just marks on the page:

> It does not tell us much about the connection of the structures. It does not tell us as much about how music sounds as how to make it sound. Yet no one can make it sound as the writer of the notation intended unless in addition to a knowledge of the tradition of writing he has also a knowledge of the oral (or, better, aural) tradition associated with it – that is, a tradition learned by the ear of the student, partly from his elders in general but especially from the precepts of his teachers. For to this aural tradition is customarily left most of the knowledge of 'what happens between the notes,' between the links in the chain and the comparatively stable levels in the stream.[20]

When approaching her interpretation of the score from an analytical standpoint, the particular nuances of her performance can no longer be directly matched to the notation.[21] However, according to Seeger her performance can be objectively *described* based on what the listener, be it human or machine, hears, and that these nuances can be more accurately "graphed".[22] For as Seeger notes, the interpretive expectation of CPN extend beyond the capacity of its representational power:

> Our notation [is] par excellence, a matter of norms determined by the vast aggregate of practice and codified by generations of workers. The graph, however, shows individual performance. Each graph, whether of the exceptional performer of the merest tyro, is unique.[23]

This interpretive uniqueness breathes life into the score, contextualizing it with every new generation of performers, and facilitating its longevity by what has become the established symbolic and functional formalities of CPN.

Not unlike Seeger's formalist approach to the score-performer dynamic, in *Languages of Art*, Nelson Goodman analyzes the low-level or atomic symbols and relations that enable the prescriptive, yet still subjective capacities of CPN. In general, the score, which is populated by these symbols, must provide the information necessary for an "authoritative identification of a work from performance to performance",[24] which for

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[20] Ibid., 170.
[21] Ibid., 170.
[22] Ibid., 169-171.
[23] Ibid., 179.
[24] Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols* (New York: The Bobbs-Merrill Company, Inc., 1968), 128.

Goodman is enabled by the representational clarity and prescriptive specificity of CPN. The representational legibility and specificity enabled by CPN is due in part to its relatively low resolution (which also leads to the subjectivity of CPN). Resolution here describes the smallest unit of time, frequency, or other parameter that can be legibly represented by, and realized from, a particular notational approach; A high resolution notational approach to pitch or rhythm would provide access to smaller divisions of the frequency spectrum or time than a low resolution approach respectively. For instance, in order to determine that an 'A4' is an 'A4' and not a 'B4,' the representation of these adjacent pitches on the standard 5-line staff must be vertically displaced to the degree that one cannot be mistaken for the other, a relationship Goodman describes as "finitely differentiated, or articulate."[25] However, in order to represent a pitch that falls between 'A4' and 'A-Sharp4,' a higher-resolution staff, a suite of compound symbols, or some other articulate solution is necessary. A variety of notational systems that explicitly tackle the representation of alternative tuning systems, for example, have been successfully developed and implemented, although these systems represent only the fringes of CPN. The pervasive well-temperament of the dodecaphonic scale, the general inflexibility of instrument design, and music education grounded in the theory and practice of the Western tradition exert significant pressures on the continued use of CPN, and perpetuate CPN as the foundation upon which Western music persists. In short, while this finite, low-resolution differentiation enables one to distinguish between adjacent pitches, or to determine the duration of events, it introduces limitations on what can be specifically prescribed.

Similar to how pitch is represented in relation to the staff, the symbolic representation of duration with CPN is in reference to tempo and meter, but taken singularly, is not dependent on any other duration. However, the temporal location of each event is relative to the combined duration of the events that precede it. For example, in one measure in common time, the starting point for each quarter note is contingent on the start and end times of the preceding quarter note(s). If the duration of each event is not clearly defined, or one cannot parse these durations due to their high-resolution or

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[25] Ibid., 135.

complexity, it may not be possible to locate the starting point of an event. In order to finitely differentiate the temporal qualities of each symbol, the duration of that symbol must be determinable by referencing higher-level structures (tempo and meter in particular) or larger durations (for instance, a tuplet will always be in reference to the duration that contains it). However, it is still the case that the prescriptive specificity and extensibility of CPN can theoretically enable the representation of any pitch and time combination, as symbols can be compounded, modified, replaced, redefined and invented to represent the composer's intentions to the finest degree of specificity.[26] But it is also these limitations that enable communication between performers and composers, preserve interpretive necessity, and secure the legibility of their compositional intentions, contemporaneously and historically.

While pitch may be a factor in certain types of Animated Scores, the representation of time is often a distinguishing factor. Unlike most CPN scores, animated scores are generally structured around elapsed clock time (minutes, seconds, milliseconds) or cycle time (frames per second), and can symbolically represent or *indicate* the absolute temporal location of an event to a resolution near or equal to its frame rate.[27] For instance, at 60fps, an event that occurs six seconds into the start of the score will fall on the 360th frame.[28] This example could be easily represented by both AMN and CPN: at a tempo of 60 beats per minute, the score would read 5 quarter note rests followed by the event. However, if the event must occur on the 361st frame, the relative structures of CPN requires that the 360th frame, and all prior frames, be accounted for. This could be represented by attaching a tie from the 5th quarter note to a note value equal to 1/60th of the quarter note, or by inserting a rest of the same value (the symbol for a duration of 1/60th of a quarter note might be represented by the first 32nd note in a 15-tuplet nested within the duration of a 16th note). Contrarily, because the absolute nature of AMN does not need to reference preceding events, but simply indicates the moment the event is supposed to occur *at* the moment it is supposed to occur, an animated score might indicate this event with the perceptible contact between two dynamic symbols. This moment of contact would be

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[26] Ibid., 141.

[27] Regardless of frame rate, the score's notational indications must still be readily perceptible to the performer.

[28] In this case the first frame is numbered "0".

preceded by some action that gives the performer adequate time to prepare (the duration of this action being relative to the event itself, i.e. the dynamic symbol travelling toward the static symbol), but not necessarily in any structural relation to any previous events.

In this example, the temporal location of an event can be specifically prescribed by both CPN and AMN, but with the addition of several similarly-minute temporal divisions introduced in succession, the CPN score will quickly produce a high level of complexity and performance difficulty. Thus, the representational capacity of AMN to prescribe the absolute temporal position of an event introduces compositional possibilities that, while certainly possible to represent with CPN, may be considered improbable or impossible due to its representational complexity and performance difficulty. In other words, the representation of certain rhythmic concepts may simply be unrealistic in the context of CPN.[29]

Thus, Animated Scores, like scores represented by CPN, are prescriptive, and rely on the "finite differentiation" of symbols (and their dynamic functionalities) to represent the composer's intention with a high degree of specificity. The primary distinction is how time, in particular, is represented by AMN, and the methods by which the specificity of the notated events are transferrable to the performer. Furthermore, the Animated Score will often *not* require the performer to inject his own interpretation. Rather, in order to realize a successful aural instantiation of the score, he must submit to the specific prescription represented by the score. The interpretive *gap* is diminished by both the highly-prescriptive, finitely differentiated symbols, and the limited temporal window within which they only momentarily appear.

2.3 Historical Lineage: From Orality to the Post-Literate

The current state of CPN as a set of prescriptive, finitely differentiated symbols and functionalities, did not emerge out of thin air. In the *Oxford History of Western Music*, Richard Taruskin outlines a historical narrative of notational development that identifies three primary modes of music representation: orality or pre-literate, literate, and post-literate.

[29] Clearly, practicality is a factor. Given the right circumstances (time, exceptional performers, patience), even the most challengingly dense scores can be, and are, performed well.

Before the emergence of Roman church chant, music was transmitted orally, and preserved in the memories of teachers and students.[30] In the 9th century, the Church, driven by a desire to export their influence succinctly and deliberately, required a more effective approach to the dissemination of chant, one that favored the eye over the ear.[31] But even though the neumes that populated these "scores" had the capacity to represent the musical intention in written form, "a melody still had to be taught to the performers through oral tradition."[32] It wasn't until the end of the 10th century that an adequate alternative to oral transmission began to emerge, enabled by innovations to diastematic notation, including the introduction of horizontal lines to improve the prescriptive specificity of pitch relationships.[33]

In particular, Guido D'Arrezzo's notational innovations in the early 11th century decisively signaled the transition away from an oral, pre-literate mode of representation: "For the first time in the West, the pitches of a melody could be transmitted without the aid of oral tradition."[34] Still, without a method for representing rhythm, "orality and music notation continued in complementary roles",[35] and it wasn't until the development of polyphonic music in the late-12th century that engravers "demanded a more specific type of rhythmic notation to clearly delineate between contrapuntal parts."[36] In the 13th century, Franco of Cologne developed a method of rhythmic notation that "gave notes individual values instead of values based on context",[37] which began to free note durations from their textual basis, while in the 14th century, the minim and notations for note-groupings further improved rhythmic prescription.[38] As Strayer notes, although the capacity for prescriptive specificity was still a far cry from its eventual codification centuries later, notation had reached a point in which a piece of music could exist both on paper and in performance:

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[30] Richard Taruskin, *The Oxford History of Western Music: Volume 5: The Late Twentieth Century* (Oxford: Oxford University Press, 2005), 2.
[31] Hope R. Strayer, "From Neumes to Notes: The Evolution of Music Notation," *Musical Offerings* 4:1 (2013): 3, accessed February 16, 2016, doi: http://dx.doi.org/10.15385/jmo.2013.4.1.1.
[32] Ibid., 3.
[33] Ibid., 4.
[34] Ibid., 5.
[35] Ibid., 5.
[36] Ibid., 6.
[37] Ibid., 8.
[38] Ibid., 8-9.

> Since an exact notation for both pitch and rhythm resulted from these two periods, oral tradition was no longer necessary to teach a song. Now the representation of music on paper allowed for the exact oral replication and recreation of music.[39]

The notational practices of the Ars Nova period mark the emerging dominance of a musically literate culture, and as Lloyd Ultan notes in Strayer's text, "the notational forms evolved here [14th century], 'provided the foundation for the developments that were to produce the notation still in use in the twentieth century'."[40] With an increasingly precise method for musical representation, previously unknown or unattainable musical concepts could now be notated. Richard Taruskin bases this in part on the newly-*visual* aspects of musical representation:

> The development of musical literacy also made possible all kinds of new ideas about music. Music became visual as well as aural. It could occupy space as well as time. All of this had a decisive impact on the styles and forms music would later assume. It would be hard for us to imagine a greater watershed in musical development.[41]

While the notational developments that occurred between the 10th and 14th centuries effectively laid the foundation for the codification of CPN by the 18th century, these developments were not based entirely on musical considerations alone. During the Baroque period, motivated by music publishers' commercial interests, "the expected or intended mobility of musical repertoires within and across notational boundaries" required "the presence of a reasonably standardized body of instrumentalists wherever his music might be performed."[42] The standardization of representation and realization methods made the dissemination of music for large forces increasingly practical, and to this end, the establishment of the Western orchestra developed in tandem with the standardization of notation, "supported by … changes in instrument design and manufacture, newly emerging systems of musical training (for example, the conservatoires in Naples and Venice in the seventeenth century), and even the development of standard tunings and

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[39] Ibid., 10.
[40] Ibid., 9.
[41] Taruskin, *The Oxford History of Western Music: Volume 5: The Late Twentieth Century*, 1.
[42] Tim Carter and Erik Levi, "The History of the Orchestra," in *The Cambridge Companion to the Orchestra*, ed. Colin Lawson (Cambridge, UK: Cambridge University Press, 2003), 1.

temperaments."[43] By embracing the constraints of the emerging notational standard and instrumental codification, composers and performers were not only free to pursue their respective professional paths separate from one another, but to explore their own unique *identity* within their field of practice. Following this, and like the newly-found distinction between visual notation and its audible realization, the relationship between the composer and performer became an increasingly palpable power dynamic.

However, a significant rupture in notational practices occurred with the emergence of graphic notational practices in the mid-20th century that questioned the established composer-score-performer dynamic, and the notational codification that maintained it. Dissatisfied with the representational constraints of CPN, and the creative distance engendered by the established score-performer dynamic, composers began to explore the compositional potentials that might be accessible with alternative, graphic approaches to music representation. These graphic scores are labelled as such for their visual and functional idiosyncrasies, but also represent a departure from the codified functionality of CPN. Many graphic scores rejected the prescriptive specificity enabled by CPN by implementing notational methods that were less specific in their prescription, and often singular (i.e. non-transferrable). As the visual relationship with CPN became increasingly stretched, so too did the expectations that the performer develops an understanding of the score's idiosyncrasies, and thus, discover a personalized realization of the score that was distinct from the (relatively narrow) interpretive expectations of CPN. In short, by deconstructing notational prescription, and loosening the expectation that the audible content of a performance must demonstrate some perceptible reference to the score, the composer transfers new levels of creative agency to the performer in order to discover new musical concepts.[44] The performer is not indebted to the faithful decoding of a prescriptive representation, but is instead required to explore his or her own interpretive directions within the context of the "notational conventions used in it and the performance practices that are assumed without being explicitly indicated."[45] The representational constraints necessary to the established functionality of CPN, which are reinforced by

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[43] Ibid., 6.
[44] Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols*, 128.
[45] Stephen Davies, *Musical Works and Performances: A Philosophical Exploration* (New York: Oxford University Press, 2001), 103.

historically and culturally defined instrument design, tuning, and others, can be subverted by altering the representation model to reflect an increasingly indeterminate relationship between score and performer.

Still, even the most extravagant notational experiments did not completely break the established composer-performer dynamic, and by the end of the 20th century, graphic notation was well established as part of the literate tradition, albeit a literacy of interpretation and context,[46] with no standardized representational form.[47] To clarify, even though graphic notation may require an alternative, performer-influenced interpretation far beyond that of the established protocols of CPN, the performer still references the composer's fixed score for direction, even when she must discover or invent her own unique directives to follow.

However, it was not only experimentation with new notational forms that signaled a rupture in traditional musical practices. This dynamic begins to dissolve through musical practices that did not require a score and/or performer, including improvisation and the incorporation of mechanical, electronic, and eventually, digital instruments and devices for compositional, performance, and notational practices. David Dunn notes that "throughout the second decade of the 20th century there was an unprecedented amount of experimental music activity much of which involved discourse about the necessity for new instrumental resources capable of realizing the emerging theories which rejected traditional compositional processes."[48] A significant number of experimental electronic instruments were developed in the early decades of the 20th century, but it was the "widespread commercial manufacturing and distribution of magnetic tape recorders [that] became a reality by 1950" that sparked "a new period of rapid innovation."[49] The capacity that magnetic tape had to "both store and manipulate sound events"[50] redefined the role of

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[46] Ibid., 103.
[47] While numerous texts have approached the consolidation of 20th century graphic and textual scoring practices, including John Cage's *Notations* (1969), Theresa Sauer's *Notations 21* (2008), Pauline Oliveros' *Anthology of Text Scores* (2013), Erhard Karkoschka's *Notation in New Music* (1972), and Cornelius Cardew's *Scratch Music* (1974), there is no established common practice that formally binds these approaches together.
[48] David Dunn, "A History of Electronic Music Pioneers," essay for the exhibition Eigenwelt der Apparatewelt: Pioneers of Electronic Art (Linz, Austria: Ars Electronica, 1992), 5-6.
[49] Ibid., 10.
[50] Ibid., 10.

the composer by fusing the conceptualization and realization of the musical intention without requiring any notational representation. Dunn notes that this transition accelerates in the 1980s with the introduction of the new digital musical landscape:

> One of the most important shifts to occur in the 1980's was the progressive move toward the abandonment of analog electronics in favor of digital systems which could potentially recapitulate and summarize the prior history of electronic music in standardized forms. By the mid-1980's the industrial onslaught of highly redundant MIDI interfaceable digital synthesizers, processors, and samplers even began to displace the commercial merchandizing of traditional acoustic orchestral and band instruments. By 1990, the presence of these commercial technologies had become a ubiquitous cultural presence that largely defined the nature of the music being produced.[51]

Returning to Taruskin, "what the digital revolution of the 1980s presaged above all was liberation from the literate tradition … and its probable eventual demise."[52] Empowered by digital technologies, composers were no longer required to represent their ideas on paper, as performers were increasingly less integral to their realization. Like these technologies, the dynamic functionalities of AMN do not require CPN to represent the composer's intentions. Following this, while Taruskin's post-literate describes a dissolution of notational practices in general, what AMN demonstrates is a notational practice that preserves the prescriptive powers of CPN, but does so beyond its stratified symbol system. Thus, AMN demonstrates a post-literate notational approach that is a contextual alternative to CPN, while still maintaining the importance of notational literacy of a new sort toward the faithful representation and realization of the composer's intentions.

2.4 Ontologies of the Musical Object

2.4.1 Goehr's Work-Concept

As the roles of composer and performer became increasingly stratified, and notational and instrumental practices codified, a significant shift in the very ontology of the score itself began to occur. In *The Imaginary Museum of Musical Works*, philosopher Lydia Goehr

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[51] Ibid., 45.
[52] Taruskin, *The Oxford History of Western Music: Volume 5: The Late Twentieth Century*, 480.

explores the ontology of the musical object toward the development of what she calls the work-concept.[53] Goehr notes that the work-concept is regulative, and contains "structuring mechanisms that sanction particular thoughts, actions, and rules as being appropriate."[54] This does not explicitly reference the notational or performative methods by which a work reaches fruition only (through score, direct realization [improvisation or fixed media]), but that the work is also regulated by its position within the Western tradition. In short, there is an expectation that the performer adequately realize what is represented by the score, and what is adequate is regulated by the musical context and notational framework that a score is contained by.

Goehr tracks the appearance of the work-concept to approximately 1800, and asserts that this coincides with the crystallization of the literate tradition, and the emergent, regulative capacity of the work: "…prior to 1800, the work-concept existed implicitly within musical practice; second, prior to 1800, the work-concept did not regulate practice."[55] From a notational standpoint, the prescription enabled by CPN embeds the particulars of performance practice by more explicitly specifying the intentions of the composer. But with the emergence of the work-concept as a regulative concept, and the solidification of the literate musical culture, Goehr asks "to what degree and at what cost have musicians been constrained by this commitment, or has it worked to every musician's advantage?"[56]

For instance, while the open, graphic or generative score indicates a rupture in standard notational practices, does it also signal a break in the regulative capacity of the work-concept? Citing John Cage's *4'33"*, Goehr notes that "whatever changes have come about in our material understanding of musical sound, the formal constraints of the work-concept have ironically been maintained."[57] Despite the openness of the *First Tacet Edition 4'33"*, in which Cage disregards convention in the score's representation and context, it is still regulated by the work-concept in an authorial sense, and still contains

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[53] Lydia Goehr, *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music* (New York: Oxford University Press, 2007), 7.
[54] Ibid., 104.
[55] Ibid., 114.
[56] Ibid., 285.
[57] Ibid., 264.

instructions for an appropriate performance. Even though an appropriate performance of *4'33"* requires the performer to disengage from the conventional notion of musical performance, this disengagement is only possible by the absence of convention: one is aware it is missing, and so, it maintains its presence.

Even when the score begins to challenge the work-concept by transferring creative agency through less-prescriptive or open notational approaches, and it becomes difficult to match a performance with its score,[58] the regulative capacities of the work-concept are still maintained. This is no different in respect to contemporary animated scoring practices, for despite the displacement of creative agency away from the performer (and sometimes composer) toward the computational processes embedded in the score, the controlling nature of AMN, and the (often) visibility of the score for both the performers and the audience intensifies this regulative quality.

In fact, the visibility of the score introduces a new dynamic in which the audience is privy to a multi-modal understanding of a composition, namely, by redirecting the eyes away from only the performer to a shared experience with the score, in which the audience can see a real time visual correspondence to the sounds they are hearing. Coupled with the ephemeral nature of animated scores, the animated score demonstrates a unique manifestation of the work that is simultaneously identifiable as the score in its aural and visual correspondence in performance while being available only during performance. The work becomes the code, or the application, designed by the composer to generate instances of the score, and the performance cannot be referred back to a particular instance of the score because that instance would ostensibly no longer exist (with the obvious exception of video documentation). Each performance is singular, as improvisation is by definition, while still deliberately prescriptive in the conventional sense of the word. Still, the composer maintains her role as composer while delegating prescriptive authority to the autonomous functionality of the score, most specifically in generative works, but this alone does not guarantee that the audible content of any given realization will produce a perceptible reflection of the score.

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[58] Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols*, 128.

This shift in the composer-score-performer dynamic, in tandem with the relationship between the controlling score and the controlled performer, is a perceptible intensification of the regulative capacity of the work-concept. For even though creative agency is shifted from both the composer and performer to the autonomous functionality of the score, the prescriptive and controlling qualities of AMN strongly impel the performer to strictly maintain the traditional score-performer dynamic, as the score provides little interpretive leeway.

2.4.2 Davies' Ontological Continuum

These aspects of contemporary animated scoring practices often result in a high-degree of perceptible correspondence between the notation and its audible realization, although the specific degree to which the identity of a work can be adequately matched to both its representation and realization varies based on the prescriptive specificity of the notation. Stephen Davies' ontological continuum is a framework within which the relationship between score representation and realization can be adequately mapped: "…works for performance range along a continuum, with some very thin and others nearly as thick as the performances that instance them."[59] The relative thickness of a work can be determined by considering the relationship between the composer's notational representation of her intentions, and how closely the audible instantiation of this representation matches. If it is the composer's objective to thoroughly prescribe the total minutiae of her compositional intention, the score would be considered quite thick, whereas "works that are for performance in all their parts, that do not contain indeterminacies, and that are conveyed by orthodox musical notations, fall around the continuum's middle."[60] Works in this area of the continuum would reflect the more traditional role of the performer as not simply an instrumental technician, but also as an aesthetic collaborator. A thin work, then, is one that transfers a level of creative agency to the performer far beyond the traditional expectations of interpretive agency. However, this does not necessarily mean that the performer is free to do as she pleases, for her performance is still regulated by the particular musical context

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[59] Stephen Davies, *Musical Works and Performances: A Philosophical Exploration*, 29.
[60] Ibid., 29.

from which the work emerges.[61,62] Thus, the performer playing a thin score is regulated by their understanding of the work's context in addition to the composer's intention, and how her intentions are reflected in the notation: "The player can perform the work on the basis of a score only in the light of a clear understanding of the appropriate notational conventions and of the performance practices assumed by its composer."[63] But while the performer playing a thicker score is constrained in their interpretation by prescriptive specificity, "performances are always thicker than the works they are of."[64] Like Seeger's explanation of the graph, the idiosyncratic, audible minutiae of a performance will contain sounds not specifically prescribed by the score, be it a slightly detuned pitch, an overzealous use of rubato, or any other slight departure from the score. In short, any performance will contain more audible information than the score could realistically and legibly represent.

Like any other notational approach, animated scores vary considerably in their relative thickness. At the thin end of the continuum are scores that do not provide a prescriptive symbol system, but suggest some form of musical response by framing dynamic, gestural movements as impetus for a corresponding sonic reaction. Slightly thicker works that feature suggestive notational abstractions of CPN do not generally offer much prescriptive information, but rather, exploit the symbolic and functional characteristics of CPN. Even when displaced from their linear, fixed context, they still retain a reflection of the symbolic implications of the notational context from which they were appropriated (for example, an eighth note is generally considered to be shorter than a quarter note regardless of context). The symbolic implications that are retained can be exploited by the composer to suggest a musical response without prescribing its details in full.

The thick end of the continuum is populated by scores that prescribe the musical intentions of the work with a high degree of specificity, and often represent these intentions in a deliberately controlling manner. The functionality of these scores varies considerably, but generally indicates temporal location by the contact and intersection of

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[61] Lydia Goehr, *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music*, 7.
[62] Stephen Davies, *Musical Works and Performances: A Philosophical Exploration*, 103.
[63] Ibid., 21.
[64] Ibid., 3.

dynamic symbols. The specificity with which these indications prescribe a particular action is the primary consideration in determining an animated score's ontological thickness.

Davies' theory appears to problematize the relationship between the score and the performer when viewed in the context of animated scores. Davies notes that if the score is correctly interpreted by a performer to "a suitable degree of matching between the performance and the work's contents," and clearly references the score and the composer's intentions, then that performance is "of a work."[65] However, if a particular instance of the score is not available before or beyond its realization, not only can it not be matched to the score, it cannot even reference it (again, video recording notwithstanding). Yet, the potential for score-performance matching is also amplified when the score is made visible to the audience during performance; the audience can literally follow along in real-time, and often without the need for traditional musical literacy. Then again, even a suggestive or "thin" score may elicit a suitable degree of matching in situations where specific matching is not necessarily intended, as the audience may perceive correspondences between the image and the audible content that are not necessarily indicated by the score. If the audience perceives correspondences between the performer's actions and suggestive notations, can these correspondences also be considered matches, or simply a multi-modal chance correspondence? In a sense, both are true, in that even a chance-correspondence can be considered a match if the score veers toward thinness, as the score itself was not designed to produce a specific set of sonic events.

When matching performances to thick animated scores, the audio-visual relationship is abundantly clear, as the visible, dynamic functionalities of the score generally maintain a direct, 1:1 correspondence with the audible content. In general, the first wave of contemporary animated scoring practices demonstrates this direct correspondence explicitly, and more often than not, can be positioned toward the thick end of Davies' continuum.

[65] Ibid., 5.

2.5 Challenges and Extensions to Common Practice Notation

2.5.1 20th Century Notational Ruptures

From the visual perspective, ontologically thin and thick animated scores directly relate to the graphic notation of the mid-20th century, and similarly, are emblematic of the shift away from the dominant notational paradigm, while introducing unique modifications to the traditional composer-score-performer dynamic.[66] Earle Brown's *December 1952* is often considered to be exemplary of this period of graphic notational experimentation. Featuring a single sheet of paper, populated by a set of black rectangles, Brown explicitly disregards the symbol system and functionality of CPN, "eschewing the standards of conventional sheet music in favor of a symbolic language all its own."[67] The performance instructions are similarly non-conventional, illuminating Brown's desire to diminish the constraints imposed by Western convention in favor of the "improvisatory impulse."[68] In order to accomplish this, standard notions of notational representation are drastically thinned, reducing prescriptive detail in the score while increasing the performer's interpretive responsibilities.[69] Brown considered the notational approach in *December 1952* as a method "to bring performers into realizing that they can make interesting sonic conditions,"[70] which he accomplished by eliminating prescriptive specificity, thereby creating a vacuum designed to be filled by the performer's intentions.

But even though idiosyncratic notations, including *December 1952*, appear not to be regulated by the same "structuring mechanisms that sanction particular thoughts, actions, and rules as being appropriate", mechanisms maintained by the prescriptive specificity of CPN, the performer is still regulated by her responsibility to the composer's intentions, and how these intentions are represented in the score.[71] Still, the appropriate realization of a very thin score may not be determinable by simply analyzing how closely a particular realization references the score.[72] Earle Brown, recalling a recording of

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[66] Christoph Cox, "Every Sound You Can Imagine," catalog essay for Every Sound You Can Imagine exhibition at the Contemporary Arts Museum Houston (Houston, TX: 2008): 7-8.
[67] Ibid., 5.
[68] Ibid., 7.
[69] Stephen Davies, *Musical Works and Performances: A Philosophical Exploration*, 103.
[70] Amy C. Beal, "An Interview with Earle Brown," *Contemporary Music Review* 26:3 (2007): 356.
[71] Goehr, *The Imaginary Museum of Musical Works*, 104.
[72] Davies, *Musical Works and Performances*, 2001.

December 1952 made by Gordon Mumma: "He sent me a tape, and one of the interesting things that strikes me is that if he hadn't written on the box December 1952, I wouldn't have known what it was! That piece is completely anonymous…"[73] If Brown's reminiscence is any indication, then it seems unlikely that a performance of *December 1952* will be easily matched to the score, but by not being able to identify a direct correspondence between representation and realization, is Brown's compositional intention fulfilled? In this case, it is difficult to determine without access to the performers' interpretive decisions, or the degree to which a faithful interpretation can be audibly gleaned from a particular performance: "Because thin works leave more than thick ones to the discretion of the performer, this should be reflected in the audience's evaluation of the composer's and the player's contributions to the resulting performance."[74]

Thus, in this case the transfer of creative agency to the performer focuses the regulative aspects of the work-concept less on what the notation literally represents, and more on the particular musical context within which the score emerged: "The player can perform the work on the basis of a score only in the light of a clear understanding of the appropriate notational conventions and of the performance practices assumed by its composer."[75] The "mark" is maintained, despite one's inability to determine with any specificity how well a realization of the score *matches* these marks.

While Earle Brown's *December 1952* is emblematic of graphic notation in general, graphic scores created since the 1950s illustrate a wide range of idiosyncratic notational approaches and diverse compositional intentions. Published in 1969, only one year after Nelson Goodman's *Languages of Art*, John Cage's compilation *Notations*, "shows the many directions in which music notation is now going",[76] and more recently, Theresa Sauer's *Notations21* illustrates the continued interest in these particular (yet not codified) methods of graphic notational representation.[77]

A comparable rupture to CPN are the text scores of Pauline Oliveros. In the foreword to *Anthology of Text Scores*, Brian Pertl writes: "Pauline Oliveros is a virtuoso

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[73] Amy C. Beal, "An Interview with Earle Brown," 355.
[74] Davies, *Musical Works and Performances*, 3.
[75] Ibid., 21.
[76] John Cage, *Notations* (New York: Something Else Press, 1969): preface.
[77] Theresa Sauer, *Notations 21* (New York: Mark Batty Publisher, 2008).

at getting to the heart of the matter."[78] While to "get to the heart of the matter" relates thematically to the title of the piece from which it is drawn, and is descriptive of the particularly inquisitive and intimate connection with the performance space, it also speaks to the directness by which Oliveros accesses particular musical activities with only a few lines of carefully written prose.

Like the exploration of new musical forms that required new approaches to graphic representation, the role that Oliveros' Deep Listening practice plays on both the apprehension and execution of the musical idea required an alternative representation. For Oliveros "the process of freeing myself from traditional notation,"[79] takes the form of a text that can be transmitted by the spoken word and/or demonstration, within the context of a holistic listening practice. By distilling the constitutive properties[80] of the work to a series of text instructions, the performative expectations of the work can be easily transmitted to performers. Furthermore, by breaking from the convention of the visual, symbolic score, performers are free to refocus their attentions toward the listening requirements necessary to an adequate treatment of Oliveros' compositional intentions. The text scores of Oliveros embody the intimate processes of pre-literate musical culture, demonstrating a process-based, contextually-post-literate representational model that is comparable to the communicative efficiency demonstrated by AMN. From the formal perspective, these notational approaches demonstrate a unique *opening* of what are often closed structures when represented by CPN.

2.5.2 Openness

An open work, as described by Umberto Eco, is a work designed in such a way that "considerable autonomy [is] left to the individual performer in the way he chooses to play the work."[81] Eco outlines several methods by which a field of possibilities is presented to the performer in such a way that its inherent openness is constrained to the degree that each realization of the score will not be derailed from its underlying concept,

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[78] Pauline Oliveros, *Anthology of Text Scores*, ed. Samuel Golter and Lawton Hall (Kingston, NY: Deep Listening Publications, 2013): i.
[79] Ibid., v.
[80] Davies, *Musical Works and Performances*, 20.
[81] Umberto Eco, *The Open Work*, 1.

and will not dissolve into “an amorphous invitation to indiscriminate participation.”[82] To this end, the degree of openness of a work is variable, regulated by the composer’s intention and the limitations placed on performer interaction by how the score is represented. When the score does not provide a linear structure upon which the performer builds her interpretation, but rather a field of possible musical directions, each realization only represents one possible instantiation of the meta-form inscribed by the score, in which the perception of form may occur despite the composer’s best intentions to subvert it.[83] The generative animated score retains the openness of Eco’s open work, but regulates its eventualities *prior* to performer interaction. To this end, the generative animated score is open only at, or until, the moment at which the notational representation is generated. Thus, the score’s generative processes are extremely thin in that they do not represent the compositional intention in such a way that the performer could realistically interpret them, but the simultaneous representation of these processes are far more thick, prescribing a high-level of rigorously-controlled, temporal detail, and subsequently, leaves little room for performer interpretation.

2.5.3 Extended Contemporary Conventional Practices

While graphic, text, and animated scoring signal a break from CPN, the increasingly detailed specificity of CPN by Brian Ferneyhough, as well as other New Complexity composers, illustrates the perpetuation and continued expansion of the literate tradition. Ferneyhough notes that his methods represent the logical extension of CPN into increasingly higher resolutions, and while still linear and based on symbolic relativity, his notational style has the capacity to represent virtually any musical quality, and does so toward maintaining the identity of the work as specifically as possible:

> In previous ages it was never performances which survived, but scores, notated music. If all the information necessary to a correct interpretation is not contained in a score, it is practically impossible to reconstruct original intentions with any degree of certainty. Only tradition can provide some sort of tenuous continuity in this respect.[84]

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[82] Ibid., 19.
[83] Ibid., 220.
[84] Brian Ferneyhough and James Boros, “Shattering the Vessels of Received Wisdom,” *Perspectives of New Music* 28:2 (1990): 14.

Ferneyhough's scores epitomize the thick end of Davies' continuum, and exemplify the extreme degree to which the audible content of a perfect performance might be matched to the score. However, as the standardly-notated score becomes increasingly complex, those players who are capable of realizing the score decrease; in other words, this representational specificity and complexity widens the distance between the professional and the amateur musician. The absolute temporality represented by AMN in the form of dynamic, perceptible indications, demonstrates one aspect whereby the amateur-professional divide appears to be narrowed. Furthermore, the distilled symbol system of AMN does not require the same deep symbolic knowledge necessary to an understanding of CPN, removing the "gateway" associated with traditional musical literacy.

2.6 The Dissolution of the Amateur-Professional Construct

2.6.1 Attali's Theory of Composing

While performance difficulties of a Ferneyhough score maintain, if not make more extreme, the distinction between the amateur and the professional, this distinction has implications beyond the intrigue of extreme notational specificity. For Erik Ulman, the highly-specific score may become "an intimidation mechanism," one that "can signify richness and multivalency" but "also conceal their absence."[85] Perhaps more cynically, Kyle Gann notes that "a plethora of expression markings has been regarded as a sign of professionalism in a composer."[86] Ulman and Gann's criticisms suggest that the notational over-specification of intention may effect more than just the preservation of the composer's "original intentions with any degree of certainty."[87] When access (be it tangible or educational) is controlled, as is the case with ultra-specific notational endeavors, the flow of the musical object (conceptually and tangibly) only moves toward consumption by those with the necessary knowledge as to how to consume it (or in this context, how to decode the score). In some cases, the unique symbol systems and dynamic

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[85] Erik Ulman, "Some Thoughts on the New Complexity," *Perspectives of New Music* 32:1 (1994): 204.
[86] "The Case Against Over-notation: A Defense and a Diatribe," Kyle Gann, accessed February 16, 2016, http://www.kylegann.com/notation.html.
[87] Brian Ferneyhough and James Boros, "Shattering the Vessels of Received Wisdom," 14.

functionalities of animated scores may level the playing field, enabling access by both performers and audience members to engage, and in some cases interact, with a musical performance regardless of their musical understanding or ability. As previously mentioned, the visibility of the animated score in performance, in combination with the (often) clearly perceptible correspondence between the notation and its realization, enables audience engagement on a level far beyond the traditional representation of the score. When all parties can simultaneously engage in the process of reading the score, the possibility for identifying correspondences between the score and its realization is heightened, regardless of training.

In *Noise*, Jacques Attali describes a methodology of new musical thought and practice that has the capacity to reclaim music from its role as a privileged commodity.[88] Attali's "Composing" describes the reclamation of communicative power, and the rejection of music as a sign for some other entity, "professionalism" for instance, in favor of "doing solely for the sake of doing,"[89] and the "pleasure in being instead of having."[90] In the context of the distinction between the coded nature of CPN, and the (necessarily) instantly decodable qualities of AMN, the commodity is both the score, and the value placed on understanding its functionality. There is no privilege associated with the performance of a score that is designed to facilitate access by performers of any ability, and thus, its adoption by performers is not likely to generate accolades of the professional sort (for better or worse).

Thus, the animated score, which demonstrates a post-literate notational representation that, due in part to its visibility (performer *and* audience), clarity, and legibility, thwarts the mystery of performance represented by the traditional performer-audience structure, and effectively diminishes the power structure implicit between the professional and the amateur by democratizing participation. In this context, "composing" can be reframed within Taruskin's post-literacy as a notational approach designed to enable participation across a wide range of abilities; and it is the availability of visualization technologies (open source software and programming languages, digital

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[88] Jacques Attali, *Noise*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1985), 7.
[89] Ibid., 134.
[90] Ibid., 134.

projection) that enable the creation of these notational approaches without relying on the symbolic expectations of CPN. As Attali notes, "Every code of music is rooted in the ideologies and technologies of its age, and at the same produces them".[91] Contemporary animated scoring practices are a reflection of these technologies, and similarly, demonstrates a comparable ideology of access, while maintaining traditional notions of the work, and the score as a prescriptive entity.

2.7 Temporality and Duration

2.7.1 Linearity and Time

The real-time qualities of the animated score demonstrate a unique sense of musical time that is not only apparent in its visual unfolding, but in the compositional and performance possibilities enabled by the score's momentary qualities. In "New Temporalities in Music", Jonathan D. Kramer examines the various ontologies of musical time. Within the tonal system, time is distinctly linear, "always in motion toward tonic resolution",[92] while "nondirected linear music moves by a variety of means and with varying degrees of localized stability at cadences, yet it avoids the implication that certain pitches can become totally stable."[93] Still, nondirection is not directionless, nor lacking in a stable foundation. Rather, the largely singular, hierarchical position of the tonic is dispersed across a series of potential points of interest, but are not clearly related. When these points of interest appear to serve a particular functional purpose, but are perceptibly displaced, the piece exists in multiple time.[94] Like linear music and nondirected linear music, one's perception of multiple time is dependent on one's understanding of the underlying musical code, in order to "comprehend the function of a musical gesture even when it occurs in the 'wrong' part of a composition."[95] In all three cases, one's perception of the passage of musical time is contingent on the hierarchical relationship between a series of events in a specifically-coded Western context. "'Moment time,' after Stockhausen's formulation of moment form", describes a music in which the ordering and qualities of the musical content are not

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[91] Ibid., 19.
[92] Jonathan D. Kramer, "New Temporalities in Music," *Critical Inquiry* 7:3 (1981): 539.
[93] Ibid., 542.
[94] Ibid., 545.
[95] Ibid., 545.

causal.[96] Each moment does not have a functional relationship to those adjacent to it, nor to the composition as a whole: "a work in moment time does not really begin; rather, it simply starts."[97] But even with the dissolution of beginnings and endings, internal form is still perceptible, for rather than basing compositional form on hierarchical direction, "the self-containment of moments allows the listener to process them as individual entities", each a formal contributor despite is lack of any global relativity.[98] Finally, Kramer describes vertical time as "a single present stretched out into an enormous duration, a potentially infinite 'now' that nonetheless feels like an instant."[99]

While the compositional intentions of animated scores are as varied as their respective notational approaches, most animated scores represent musical ideas far removed from any tonal basis. And so, although an animated score can be designed to proceed linearly, the musical content does not necessarily lead toward a sense of development or resolution in the traditional sense. Rather, the animated score is often designed to create a sense of vertical time, enabled by its real-time, generative functionality, and the constrained temporal window within which performers access their performative instructions. Furthermore, this functionality enables the creation of compositional ideas that exploit the extension of musical moments beyond the constraints of an otherwise linear structure. In fact, a sense of musical linearity is more difficult to produce with AMN than CPN, due in large part to its ephemeral, time-bound nature, and the challenges of representing complex melodic and harmonic phrasing. Recalling Attali, "Every code of music is rooted in the ideologies and technologies of its age, and at the same produces them",[100] and the animated score often reflects contemporary notions of displacement and non-linear, random access. As media theorist Lev Manovich puts it:

> After the novel, and subsequently cinema privileged narrative as the key form of cultural expression of the modern age, the computer age introduces its correlate – database. Many new media objects do not tell stories; they don't have beginning or end; in fact, they don't have any development, thematically, formally or otherwise which would organize their elements

[96] Ibid., 546.
[97] Ibid., 547.
[98] Ibid., 549.
[99] Ibid., 549.
[100] Ibid., 19.

> into a sequence. Instead, they are collections of individual items, where every item has the same significance as any other.[101]

Generative animated scores explicitly mirror this claim in that the notation emerges from a collection of possibilities contained by the score generator. These possibilities are not linked prior to their selection, and in their representation are only linked by their arbitrary succession. Thus, the representational limitations of the animated score, especially in the context of the extensibility and linearity of CPN, may lead one toward a particularly discontinuous, if not vertical, compositional ideology.

2.7.2 Being and Becoming

In "Sonic Philosophy," philosopher Christoph Cox critiques how the "ordinary ontology privileges the sense of sight and touch", disregarding the more ephemeral nature of music, and specifically, sound.[102] By reframing sound not as "static objects but as temporal events," Cox's sonic philosophy distinguishes itself from ontological projects requiring tangible matter as necessary to establishing its being.[103] Similarly, in "From Music to Sound: Being as Time in the Sonic Arts," Cox suggests that the "shift from 'music' to 'sound' marks an ontological shift from being to becoming, and a temporal shift from time (le temps) to duration (la duree)."[104] Music, as defined by Cox, "constitutes a domain of beings, time-objects that spatialize sound and that mark a pulsed time", and sound as "not being in time but being as time."[105] Framed by Bergson's distinction between quantified time and "time as a qualitative process," and Nietzsche's rejection of being in favor of "ceaseless becoming and change", Cox positions Cage's *4'33"*and *0'00"* as demonstrative of the possibility for emergent behaviors that, in their becoming, occupy a space unadorned by musical expectation.[106] In the score for *0'00"*, the amplified, "disciplined action" describes an indeterminate physical process of which the sonic result

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[101] Lev Manovich, "Database as a Symbolic Form," *Convergence: The International Journal of Research into new Media Technologies* 5 (1999): 80.
[102] Christoph Cox, "Sonic Philosophy," *Artpulse* 16:4 (2013).
[103] Ibid.
[104] Christoph Cox, "From Music to Sound: Being as Time in the Sonic Arts," Sonambiente Berlin 2006: Klang Kunst Sound Art (2006): 214-23.
[105] Ibid.
[106] Ibid.

is an intentional byproduct,[107] but not representative of a fixed musical object. The audible content of a performance of *0'00"* results from one referencing the score, and executing its requirements, but this audible content is ultimately not contained by the score in any specific, referential way: "Sound […] affirms an ontology of flux (in) which objects are merely temporary concretions of fluid processes." Following this, it seems possible that if "…sounds are not punctual or static objects but temporal, durational flows",[108] notational representation itself need not be tethered by its traditionally-fixed and linear nature.

The animated score, like Cox's assessment of sound as "being as time", is similarly ephemeral, manifesting as a musical score only through its own real time becoming. Thus, where being may describe the fixed score, the implementation of a real time process as a necessarily dynamic notational becoming suggests a uniquely time-bound ontological distinction from traditionally-fixed methods of representation. Of course, to describe AMN as a process of notational becoming in line with Cox's sound and music distinction is not to suggest that the realization of an animated score is somehow distinct from music. Rather, it is to affirm that this method of representation is necessarily time based, and like sound, exists only as a "temporal event."

2.8 Summary

Animated Music Notation [AMN] describes a post-literate, graphic notational approach that is (often) specifically prescriptive, and will always utilize explicit movement in its representation. Unlike CPN, the marks contained within AMN are not indicative of a centuries-long process of development and refinement, do not directly correspond to instrumental and tuning codification, and do not often require performer interpretation in the realization of a work. In many cases, the notational functionalities found in animated scores simply indicate what to do, and when to do it, simplifying the rehearsal and performance process, and democratizing access across a wide range of performance abilities and experience. With this apparent dissolution of the amateur-performer distinction, the composer can turn to more exploratory uses for AMN, exploiting the absolute temporality and *becoming* qualities of these notations toward the development of

[107] Ibid.
[108] Christoph Cox, "Sonic Philosophy," *Artpulse* 16:4 (2013).

persistent (non)structures, and the use of AMN as a visual or *sculptural* component in the presentation of the work. It is this theoretical foundation, covered in chapter 2, that forms the basis for the three essential ideas upon which the framework for understanding contemporary animated scoring practices is built.

In chapter 3 I will also examine a selection of historical antecedents that predate the emergence of contemporary animated scoring practices, framed largely by technological developments in the entertainment sector. This narrative is followed by a survey and analysis of current animated scoring practices that will be positioned within the context of both the aforementioned historical antecedents, as an extension of standard and graphic notational practices, and as a demonstration of the three essential ideas. Lastly, I will propose several extensions to the existing terminology of animated score functionalities, and introduce a suite of *atomic* terminologies to describe the low-level symbols and functionalities that form the foundation for Animated Music Notational practices.

3. Field Mapping

"We have eyes as well as ears, and it is our business while we are alive to use them."[109]

3.1 Introduction

Animated Music Notation [AMN] describes a contemporary notational practice that has its practical and theoretical basis in three ideas. The first is that scores incorporating AMN (which will be referred to as Animated Scores) are capable of preserving the prescriptive function of notation. By using two primary methods of *indication*, contact and intersection, AMN enables an ontologically thick representation of those musical qualities essential to the fundamental characteristics of the composer's intention, to use the terminology of Davies introduced in the previous chapter.[110] These prescriptive characteristics, which are traditionally represented in fixed form by Common Practice Notation [CPN], permit AMN to specify a consistent compositional identity, despite the animated score's ephemeral, and in some cases, generative qualities. But unlike CPN, which is fixed on the page, the digital, computer-based nature of AMN makes possible an elasticity in the representation of the composition's fundamental characteristics, while introducing a unique control structure. Coupled with an often limited symbol system that favors notational marks that follow more directly from graphic notation than CPN, AMN occupies a unique position in the field of notational practices, in which the prescriptive qualities of CPN are merged with the visual and conceptual intentions of graphic notation in a necessarily dynamic environment.

The second idea is toward the displacement of a work's variability from the traditional notion of the performer as interpreter to the computational properties of the score as an autonomous, ephemeral, and time-bound entity (while remaining prescriptive, as noted above). Traditionally, the score provides the foundation upon which the performer develops a unique and personal interpretation, framed by what Davies refers to as the "constitutive features" of the work:[111] "It is in her manner of going beyond the work's detail to the concrete repleteness of sounded music that the musician reveals her

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[109] John Cage, *Silence* (Middletown, CT: Wesleyan University Press, 1973), 12.
[110] Stephen Davies, *Musical Works and Performances*, 3.
[111] Ibid, 47.

interpretation of the work."[112] Furthermore, it is not simply that the performer is necessary to the sonic instantiation of the score, but that this step in the process of bringing about a musical performance is embedded in the very concept of the work as a fixed entity that is distinct from its otherwise ephemeral realization.[113] This step generally occurs prior to performance, a temporal distinction facilitated by the fixed nature of CPN. With an animated score, this temporal distinction is minimized, or removed completely; the performer, while likely familiar with the notational approach, can only engage with the score as it is produced (or as it unfolds). But while this particular engagement with the score, aptly described by Jason Freeman as "extreme sight-reading"[114], demonstrates an intriguing performance practice, the controlling qualities of AMN and the potential variability enabled by the real-time generation of a prescriptive, animated score all but removes the possibility for performer interpretation in the traditional sense. The performer is consumed with the expectations of a score that is only momentarily available and rigid in its prescription, and without the ability to reference the score in any other time domain before or beyond the present moment, the performer may feel "powerless or like a victim of the 'system'."[115] The performer must sacrifice personal inclination in order to accurately realize each action at the moment it is indicated. Thus, this interpretive displacement is not simply a *byproduct* of the animated score's dynamism and ephemerality, but a displacement that is necessary to a successful realization of the score.

The third idea is a fusion of the first two, and points toward a broadening of participation in music performance beyond the skills normally possessed by those trained in the traditional Western musical context, which generally includes an in-depth knowledge of CPN. By representing prescriptive notation in an accessible, distilled format, and displacing performer interpretation by relocating the locus of creative agency from human expression to a time-bound computational process, it becomes possible, and necessary, to represent complex compositional ideas with an economy of means and notational clarity. Richard Taruskin has described the potential for a post-literate music,

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[112] Ibid, 3.
[113] Lydia Goehr, *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music*, 228.
[114] Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation," 25-41.
[115] Gerhard E. Winkler, "The Real-Time-Score: Nucleus and Fluid Opus," *Contemporary Music Review* 29:1 (2010): 99.

enabled by digital technologies, that follows in "the traditions of classical music without ever using notation."[116] AMN extends the idea of musical post-literacy by enabling the realization of the composer's intentions without requiring literate virtuosity in the traditional sense. This is accomplished in part by substituting simple, real-time dynamic motion for the static, relational symbol system of CPN; perceptible movement replaces the movement of the eye. These dynamic functionalities, in combination with a distilled symbol system, simplify the realization process by clearly indicating what the performer is supposed to do, and when he is supposed to do it. Thus, AMN represents a kind of *notational* post-literacy that enables a wide range of participation while not relying on performer interpretation (and the technical, historical, and aesthetic knowledge it requires), and still preserving the prescriptive qualities of CPN. Jacques Attali notes that "learned music is restricted to a concert-going elite. It is no longer distributable among the middle bourgeoisie, since the instruments and techniques it uses makes it impossible for amateurs to communicate or perform it."[117] While one's technical facility with an instrument may still constrain one's ability to adequately realize certain animated scores, by diminishing or removing the notational and interpretational barriers associated with "learned music", the distinction between the amateur and the professional becomes effectively blurred. Composer Arthur Clay illustrates this in his composition *China Gates*, in which he used a "system that was simple, easy for anyone to use", and although it would be "different each time it was performed",[118] the work still retained its identity, a sentiment that is generally applicable to a wide range of contemporary animated notational practices.

The task of this chapter is to map the field of contemporary animated scoring practices in the 21st century, framed by the three ideas outlined above, and the theoretical framework covered in chapter 2. This mapping begins with a narrative of technological and notational antecedents, from the late 19th century through the 20th century. Next, I propose a clarification to the terminological stratification found in the contemporary animated scoring discourse. Once this historical and general terminology has been established, I embark on a survey of existing terminological distinctions regarding score

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116 Richard Taruskin, *The Oxford History of Western Music: Volume 5: The Late Twentieth Century*, 509.
117 Jacques Attali, *Noise*, 120.
118 Arthur Clay, "You Can Play It Too: The Virtuoso Audience," *Contemporary Music Review* 29:1 (2010): 66.

functionality, followed by a proposal for their extension. This chapter will conclude with a collection of terms designed to describe the low-level or "atomic" symbols and functionalities commonly found in AMN.

3.2 Technological Antecedents to Contemporary Animated Scoring Practices

3.2.1 Mechanical Patents

While the majority of contemporary animated scores rely on digital computer technologies for their creation and representation, numerous antecedents can be found in a variety of contexts reaching as far back as the 19th century. For instance, from the late-19th century into the 20th century, a variety of mechanical devices were invented, and subsequently patented, that demonstrate in a pre-computational format several elements of the three tendencies outlined in the previous section. The three patents examined for this section represent only a small cross-section of these technologies, and are meant to provide no more than a generalization of their functionalities and the relevance of their respective intentions.

The "Key Indicator for Musical Instruments" (see Figure 1), patented August 17, 1886 by E. P. Carpenter and M. S. Wright, was a mechanical device designed to indicate the moments at which a particular pitch or set of pitches is to be played, and released, on a keyboard instrument.[119] The Indicator facilitated these indications with a mechanism that automatically traverses a roll of paper containing a series of rectangular marks, the index sheet, vertically between two spools. The Indicator was designed to attach directly above the keys of the keyboard, with the vertical tracks of the index sheet horizontally aligned to correspond to the keys below. The index sheet is then mechanically drawn past the attack bar, a thin metal bar that indicates the attack and release points for each mark. Thus, the pitch of each event is clearly indicated by the mark's horizontal position on the index sheet, and its attack and release are indicated by the mark's point of vertical intersection with the attack bar. Here we see an early example of how the prescriptive qualities of CPN can be preserved within a dynamic, alternative notational system without

[119] Edwin P. Carpenter and Morris S. Wright. 1886. Key-Indicator for Musical Instruments. U.S. Patent 000347686, filed April 10, 1884, and issued August 17, 1886.

requiring any knowledge of CPN. The player physically mirrors what he sees on the index sheet, and ostensibly, can accurately realize the score with little prior musical or notational experience. These indications are represented in real-time, and are only perceptible due to the dynamic functionality of the Indicator. This reflects the second essential idea, in that the player's ability to reference the score is constrained to a small temporal window, and largely focused on the moment that the marks contained within the index sheet pass the attack bar. Thus, the performer is unable to develop a personal interpretation of the score, as the dynamic qualities of the Indicator require that the bulk of his attention stay focused on the attack window. Lastly, the correspondent relationship between the marks on the index sheet and the piano keys, in conjunction with the perceptible indication enabled by the dynamic functionality of the Indicator, clearly represent the musical characteristics of each event without requiring the player to have prior knowledge of CPN or the Western music tradition in general. The indicator appears to democratize participation by circumventing the notational gateway of CPN through the clear, dynamic representation of what the performer is to do, and when he is to do it.

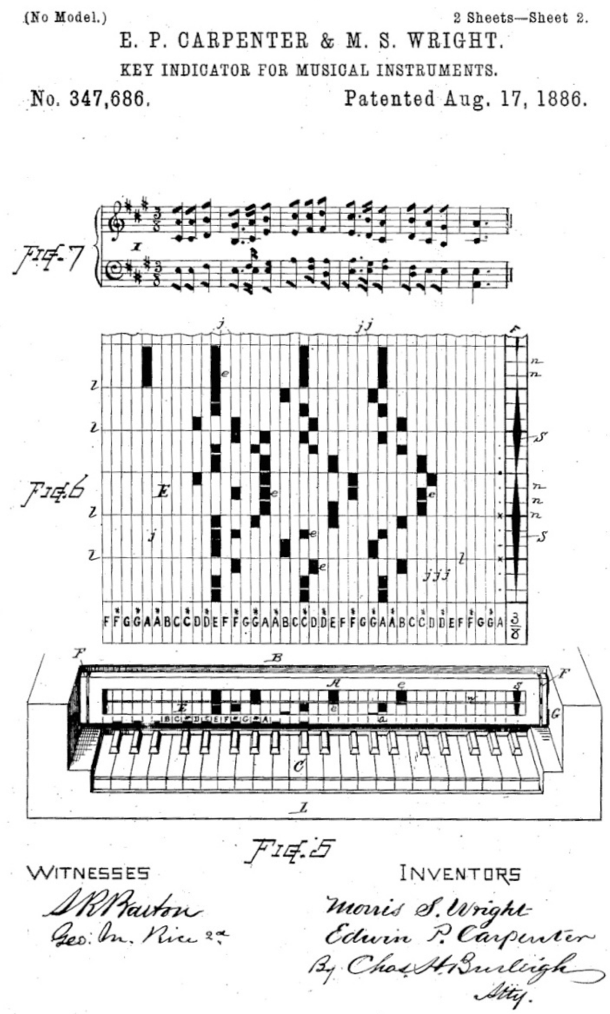

Figure 1: Key Indicator for Musical Instruments

Not surprisingly, Carpenter and Wright's justification for the Indicator hints at the possibilities a post-literate notational representation may have in enabling amateur performance:

> The eye, readily catching the color of the spots […] instantly perceives which key or keys to depress in order to give the respective notes of the music without the usual mental calculation which a beginner has to exercise […] enabling the young player to more quickly attain a knowledge and handling of the manual-keys.[120]

[120] Ibid, 2.

Like Carpenter and Wright's Indicator, R. D. Bergey's "Music Timing Apparatus" (MTA) (see Figure 2) from 1949 also emphasizes the pedagogical possibilities that a dynamic notational representation may have by providing the "means for expediting the musical education of students and produce more accurate and a higher quality of playing for the scholar", and "to eliminate all confusing symbols and lines from a musical composition in order to simplify the reading of a traveling strip bearing the various notes and other symbols." [121] Bergey's MTA was capable of displaying a variety of notational forms, including CPN, but also notes "in combination with signals of different colors … to indicate when each note should be played and the moment the playing should stop and the periods of rest." [122] Unlike the Indicator, which was designed to represent keyboard music only, the MTA could adequately represent a wider range of notational marks, but the use of motion to create perceptible temporal indications is still maintained, and similarly, is necessary to a legible representation of these marks. With the exception of a traveling strip populated with CPN, the necessarily dynamic qualities of the MTA demonstrate the second essential idea. Like the Indicator, the player must fixate on the point of attack in order to produce an adequate sonic instantiation of these indications, effectively limiting one's interpretive possibilities as the performer must execute each event in direct temporal correspondence with the functionality of the device. The presence of the 3rd tendency is more difficult to assess. While Bergey maintains that alternatives or embellishments to CPN are possible, it is unclear if the marks would still require the grand staff that is present in the patent's diagram, and if so, would necessitate some knowledge of CPN. However, the dynamic indication of each event's temporal qualities still circumvents the rhythmic symbol system designations found in CPN, at the very least suggesting a post-literate, democratizing approach to the representation of rhythm.

[121] R. D. Bergey. 1949. Music Timing Apparatus. U.S. Patent 002483570, filed April 24, 1945, and issued October 4, 1949.
[122] Ibid.

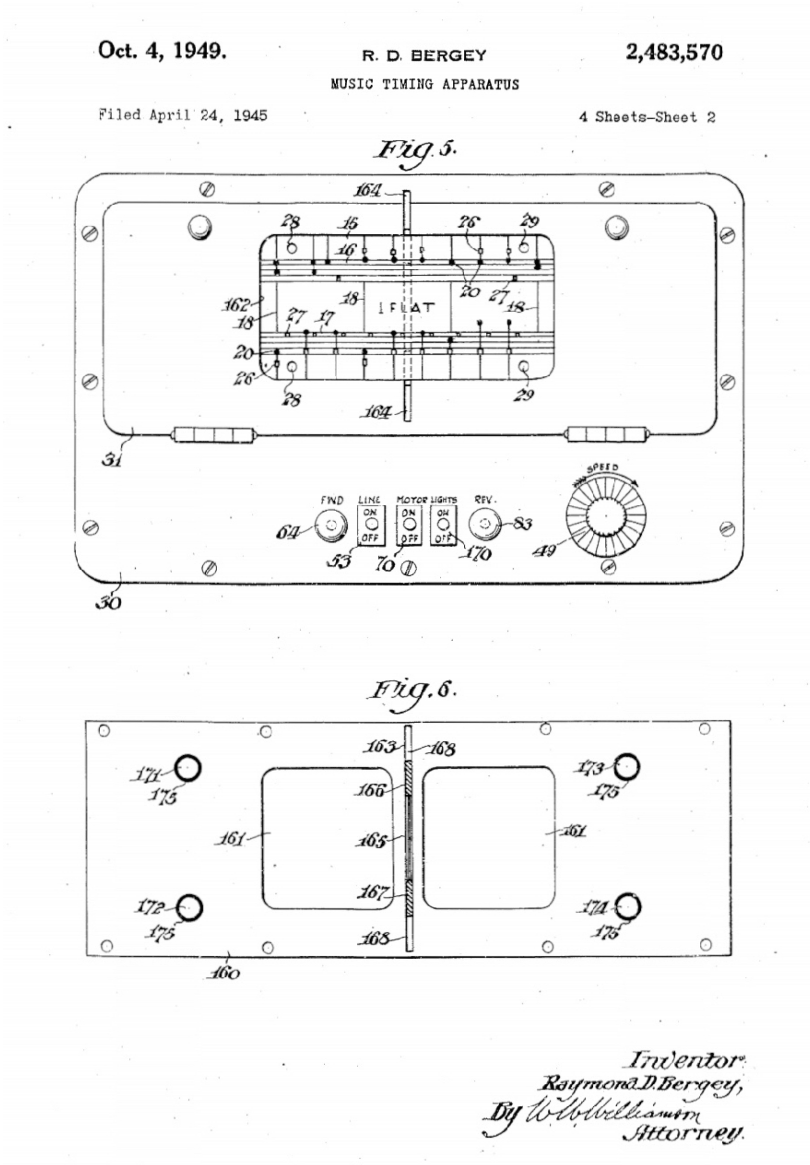

Figure 2: Music Timing Apparatus

The final patent example, John McTammany's "Mechanical Indicator for Musicians" (1890) (see Figure 3), is unique in that unlike most indicators developed during this time, McTammany's is designed for wind instruments.[123] While the dynamic scrolling functionality of the previous devices is maintained to represent the temporal qualities of each mark, pitch indications are replaced by "indents, spots, or perforations arranged in rows or groups and severally denoting the valves to be pressed or finger-holes to be

[123] John McTammany. 1890. Mechanical Indicator for Musicians. U.S. Patent 000422964, filed June 14, 1889, and issued March 11, 1890.

opened." [124] McTammany's system, like Carpenter and Wright's, circumvents the notation-decoding process by clearly representing the physical actions the performer must take in order to produce the intended sonic result. Thus, McTammany's dynamic tablature notational scheme enables wind instrument performers to engage with the musical score without prior knowledge of CPN, while still maintaining its prescriptive qualities. The dynamic representation of time also limits the performer's interaction with the score to a narrow temporal window, diminishing the potential for prior reference and interpretation.

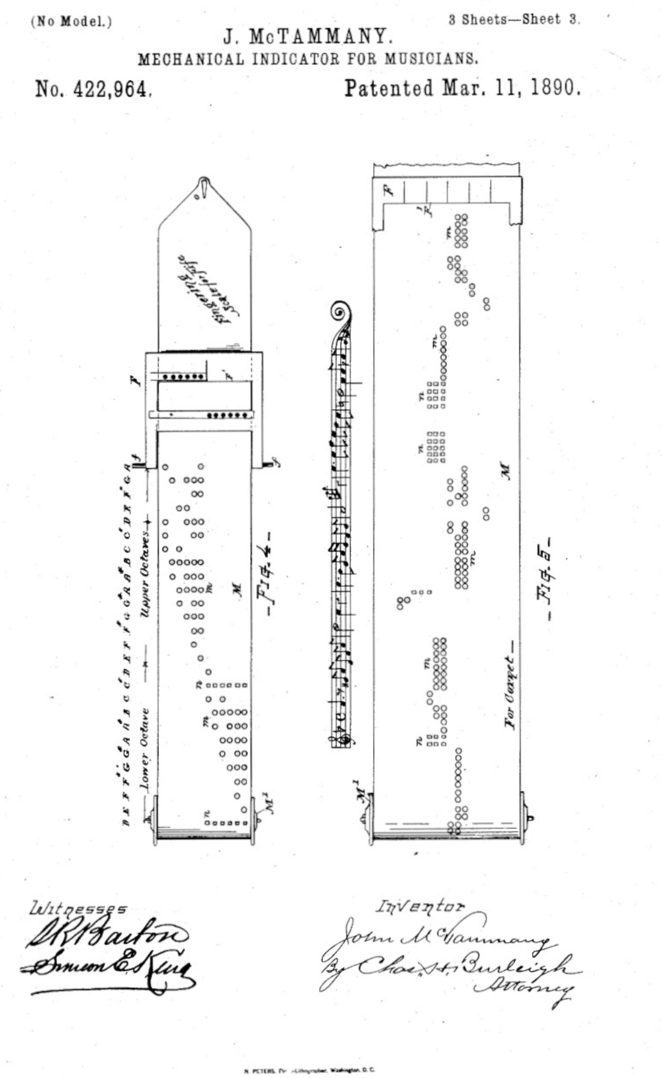

Figure 3: Mechanical Indicator for Musicians

[124] Ibid.

These devices demonstrate the three essential ideas found in contemporary animated scoring practices in several ways. First, by indicating the temporal qualities of each musical event through the employment of a particular functionality that maps the intersection of a dynamic mark with a fixed reference point, each device specifically prescribes the temporal boundaries of each event without requiring any literacy with CPN.

Second, whereas the player can reference the entirety of a fixed score out of time, the dynamic functionalities of each device limit accessibility by displaying each passing moment of the score in real time as it is meant to be played. Without access to the score in its entirety, and the expectation that each indication be met with a corresponding, temporally-linked performed action, the player is unable to impart her interpretation in the traditional sense. Rather, each device specifically prescribes what to do and when to do it on a momentary basis.

And third, each device is designed to facilitate an ease of interaction by providing an alternative notational approach that is enhanced by its dynamic functionalities. With the Indicator, this is accomplished by distilling the notational information to a series of marks that horizontally correspond to the layout of the keyboard, and the temporal position of these marks by framing their dynamic, vertical position in reference to a fixed point of articulation. McTammany's Mechanical Indicator for Musicians demonstrates an alternative notational distillation by representing pitch in tablature form, while maintaining the dynamic scrolling functionality to represent rhythm. While Bergey's device incorporates, or has the potential to incorporate CPN, each device still relies on its dynamic qualities to distill the otherwise relative temporality of notated rhythm found in CPN to a proportional layout that prescribes the temporality of each event with a simple indication. In general, the combination of a distilled symbol system in a dynamic context that represents musical actions by the intersection of notational marks with a fixed point of articulation enables the player to realize the score without having prior knowledge of CPN; the player must simply understand the functionality of the system, and physically respond in correspondence with the device. Thus, these representational methods demonstrate post-literate approaches to the notation of music by circumventing the significant task of developing fluency in CPN, while still maintaining CPN's prescriptive specificity.

3.2.2 Max Fleischer and the "Famous Bouncing Ball"

While these patents demonstrate dynamic notational functionalities geared toward music pedagogy, similarly functional inventions were emerging in the entertainment sector. In the early 1920s, film showings would often feature a sing-along, which included song lyrics projected on the screen and accompaniment provided by a keyboardist. However, due to inadequate synchronization between the accompanist and the projectionist (who swapped slides), "audiences would [also] frequently get out of synch with the lyrics."[125] Max Fleischer, an accomplished and well-known animator, responded with the development of the bouncing ball, "a white ball that bounced from word to word" in time with the music.[126] Fleischer's well-known method has a simplicity to it that borders on comical: as the ball bounced from word to word, the audience would sing each word as the ball made contact. However, with this simple innovation, Fleischer developed an animated notational method that not only improved the synchronization of large groups of mainly untrained singers, but demonstrated a screen-based approach to temporal indication that was ostensibly extensible to any event type. Of course, Fleischer's bouncing ball could only represent the moment of attack for each word; other musical qualities, including pitch in particular, were left unnotated, the assumption being that the melody and affectation of the song were already well-known to the audience.

With Fleischer's bouncing ball we again see a desire to specifically prescribe the temporal aspects of the composition without requiring prior notational knowledge, and like the aforementioned mechanical devices, this is accomplished by representing the point of articulation for each word with an indication that results from the dynamic interaction of two or more marks (in this case, the moment the bouncing ball makes contact with a word). Furthermore, the ball's movements are synchronized to the backing track, which unfolds at the speed dictated by the projector, reducing the potential for temporal deviation (assuming audience members attempt to match their singing to the screen). So while one may endeavor to invent and execute their own harmonies and flourishes, the specific prescription of the attack point for each word demonstrates Fleischer's intentions to

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[125] Richard Fleischer, *Out of the Inkwell: Max Fleischer and the Animation Revolution* (Kentucky: The University Press of Kentucky, 2005), 36.
[126] Ibid., 37.

transmit an unwavering series of temporal indications to the audience, leaving little room for interpretive exploration (at least rhythmically). Fleischer's invention also demonstrates a notational method by which the audience members are not required to have any understanding of CPN or otherwise, but must simply understand the functionality of the bouncing ball, and respond accordingly to the indications produced by this functionality. Still, this example, while indicative of a post-literate, necessarily dynamic notational approach, relies heavily on the performers' previous knowledge of the song they are attempting to sing, not unlike Fleischer's apparent heir: Karaoke.

3.2.3 The Karaoke Machine

Karaoke is one of the most ubiquitous antecedents to contemporary animated scoring practices found in the 20th century. Like Fleischer's bouncing ball, the Karaoke score represents the lyrics in tandem with a dynamic indication of their temporal location, synchronized to the previously-recorded instrumental track. While the specific methods of temporal indication vary, words are generally *highlighted* in temporal correspondence with the instrumental track.

This dynamic indication represents a notational method by which singers of any ability can easily identify moments of attack and release, including the duration of, and location within, sustained words and affected, phonemic elongations (e.g. OOOOOOOOHHHH). Karaoke also introduces an interesting shift in the social aspect of music-making. The Karaoke *score*, as it were, is often visible to the singer as well as the audience. While the social aspects of Karaoke events (weddings, bars, bachelor parties) are far beyond that of a traditional concert setting, watching the singer sing synchronously with the visible score is a significant departure from tradition. The score is not shrouded in mystery; audience members can clearly assess the degree to which the aural-visual correspondence between the singer and the score is maintained (i.e. how well are they doing).

Following this, even though little to no notational information is represented beyond rhythm, the Karaoke score is still quite thick in Davies' terms. This is due to the familiarity the singer likely has prior to her performance, and in combination with the audience's likely knowledge of the song's melodic contours and affectations, there is bound to be some expectation that the singer adheres to both the score's rhythmic indications, and the musical qualities of the original. In short, a performance that deviates from the original is both audibly *and* visually identifiable, demonstrating a uniquely-public displacement of the performer's interpretative powers.

Lastly, Karaoke enables performers of diverse musical backgrounds to easily execute the score without prior knowledge of notation, CPN or otherwise. As long as the singer has prior knowledge of the song, the Karaoke score enables synchronization by clearly indicating the temporal location of each word in correspondence with the backing track.

3.2.4 Guitar Hero

In the 1980s and 90s, a unique approach to video game design emerged in which music, and in particular the rhythmic aspects of music, was exploited as an essential component in gameplay. These aptly-named Rhythm Games were notational in that the on-screen prescription denoted player actions designed to directly correspond to the music the player was hearing. The methods by which performer actions were prescribed varied, but shared a common foundation built upon the traditional score-performer dynamic; namely, the performer physically responds to the on-screen or *scored* prescription. Musician-turned-videogame designer Masaya Matsuura, in his consideration of musical outlets beyond traditional forms of music dissemination, ultimately designed *PaRappa the Rapper*, "a game where players had to repeat lines rapped by a selection of colourful characters by pressing buttons on the controller in time with the rhythm of the music."[127] In the late-1990s, videogame company Konami released *Beatmania* (1997), "which gave players a DJ turntable and mixer and challenged them to play in time to various techno tunes",[128] followed by *Dance Dance Revolution* and *Karaoke Revolution*, featuring choreographic and vocal prescription respectively. In 2005, video game developer Harmonix released *Guitar Hero*,[129] which went on to become one of the most popular rhythm games ever produced, due in part to its extensive list of popular guitar-based songs, and the ease by

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[127] Tristan Donovan, *Replay: The History of Video Games* (Lewes: Yellow Ant, 2010), 537, iBook edition.
[128] Ibid., 544.
[129] Ibid., 548.

which non-musicians could engage with the game. In an article on the "simulational fidelity" of *Guitar Hero*, Dominic Arsenault notes that "the game promises to tap into common fantasies of rock superstars playing in front of large audiences more than it guarantees raw simulational fidelity in the act of guitar playing."[130] Citing the arbitrariness of controller design ("the controller only has five buttons, while a guitar has at least four times as many frets" for example[131]), the controller, and the ways in which one interacts with it, are not meant to emulate the physical complexities required to play a real guitar. Rather, the controller is designed to facilitate a high-level of interactive correspondence with little to no knowledge of how a real guitar actually functions.

The notational aspects of *Guitar Hero* are similarly abstracted. The representation of musical events is distilled to a color-coded symbol system that corresponds directly to the button layout on the controller. Five vertical lanes extend across the screen, each one terminating at an ellipse near the bottom of the screen that is color-coded in correspondence with the buttons on the controller's fret board.

During the course of a song, streams of color-coded cursors vertically traverse the screen, following the lane with the correspondingly-colored ellipse. At the moment each of these cursors makes contact with the ellipse at the bottom of the lane, the player is instructed to press the correspondingly-colored button on the controller's fret board while simultaneously "strumming" with their other hand. If the player executes these actions within a pre-defined margin of error, the sound that corresponds to that particular moment in the song will be activated (the correct pitch for example), while an incorrect action will result in an error sound. This system effectively links "the physical gestures of live musical performance with the reproduction of recorded songs", and like Fleischer's screen songs and Karaoke, does not facilitate the realization of a new compositional entity.[132] Yet, we still see the capacity that a dynamic notational functionality has to specifically prescribe the actions that are expected of the player. In the case of *Guitar Hero*, these notational functionalities, in correspondence with the player's actions, can also be *tracked*, for the

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[130] Dominic Arsenault, "Guitar Hero: 'Not Like Playing Guitar at All?'," accessed February 11, 2016, url: http://journals.sfu.ca/loading/index.php/loading/article/view/32/29.
[131] Ibid.
[132] Kiri Miller, *Playing Along: Digital Games, YouTube, and Virtual Performance* (Oxford: Oxford University Press, Inc., 2012), 85-6.

goal in *Guitar Hero* is not simply the synthetic realization of a guitar solo, but, like most video games, is the acquisition of points. Points are awarded for accuracy, and a perfect score can only be achieved when the player plays exactly what is prescribed by the score. This temporally-linked, 1:1 relationship between the on-screen prescription and its execution by the performer renders the score uniquely thick, and the distillation of both the on-screen prescription and the controller are designed to facilitate and encourage this relationship.[133] This point-based framework does not simply diminish the player's interpretive powers, but removes them entirely, for as the performer shows more personality in her performance, her accuracy (i.e. the expectations of the game) will diminish.

Because the *Guitar Hero* controller did not emerge in the same context as the instruments of the Western orchestra, it is not embedded in the same notational tradition that maintains any historical codification. Thus, the on-screen prescription in *Guitar Hero* is post-literate not only for its uniquely-accessible design and functionality, but because it is specifically designed for use with a musical instrument that is not contained by the Western tradition, democratizing musical participation by enabling a quasi-musical experience for anyone, regardless of their ability. Harmonix CEO Alex Rigopulos identifies this aspect of *Guitar Hero* as a key promotional item:

> Everyone is born with an innate urge to make music. It's one of the most profoundly joyful things in life. Yet the challenges are such that few people really get that far. We thought that was a significant problem, and we set about exploring new ways to solve it. Our mission was to show non musicians how it feels when you finally get to the other side. And hopefully, to inspire them to start making music the old-fashioned way.[134]

3.2.5 Section Conclusion

The previous section briefly surveyed antecedents to contemporary animated scoring practices, beginning with mechanical devices patented in the late 19th century, through Max Fleischer's bouncing ball, Karaoke, and ultimately, *Guitar Hero*. In each case, the essential ideas found in contemporary animated scoring practices were identified: the use of dynamic indications to specifically prescribe performer actions without relying on CPN,

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[133] Stephen Davies, *Musical Works and Performances*, 29.
[134] Kiri Miller, *Playing Along: Digital Games, YouTube, and Virtual Performance*, 101.

the displacement of the performer's interpretative powers through dynamic control structures, and the use of post-literate notational approaches in order to democratize participation and enable interaction across a range of musical backgrounds. These devices were also designed to represent pre-existing compositions, but in the following sections, the discussion turns to the use of movement to enable the representation and realization of new and innovative compositional intentions.

3.3 Antecedents in New Music

3.3.1 Introduction

This section contains a brief survey of works composed in the 20th century that feature dynamic notational approaches designed to enable the representation of new compositional intentions.

3.3.2 Earle Brown

Earle Brown's experimentation with formal structure led him to develop a variety of unique notational methods that encouraged formal malleability (*Available Forms*), extended interpretive freedom (*December 1952*), and interactivity (*Calder Piece*). While these three works are often cited in the contemporary animated scoring discourse, *Calder Piece* (1966) is of particular relevance. Based on the Alexander Calder mobile *Chef d'orchestre*, *Calder Piece* requires that *Chef d'orchestre* be present in conjunction with the fixed, paper score. In a television interview for Bravo Magazine in 1981, Brown describes the interactive process by which the mobile becomes a necessarily dynamic element of the score:

> There were certain areas in the composition where the musicians go to the mobile, play on it, which activates it, and in the activation of it, they go back to their positions while it is still revolving, and they sort of visualize the mobile as they glance at it, and then visualize that mobile superimposed over the music that I wrote.[135]

[135] Earle Brown, interview by Bravo Magazine, 1981, accessed February 16, 2016, url: http://www.tate.org.uk/context-comment/video/performing-sculpture-earle-browns-calder-piece-tateshots.

The performers are then instructed to “visualize (imagine) a configuration of the ‘petals’ as being superimposed over the field of pitch figurations […] and play the figurations that the ‘petals’ would cover at that instant, in any order you wish.”[136]

Jason Freeman describes *Calder Piece* as an “open form [that] jumps off the printed page into the real world: The physical traversal of the performance space by the mobile drives the visual traversal of the score by wandering eyes.”[137] The structure of the piece is thus determined in large part by the (semi)-autonomous movements of the sculpture, and these movements are an essential component to the correct representation of Brown’s compositional intention, displacing the performer’s control over the score to some degree by transferring agency to the mobile’s dynamic properties. However, unlike the examples outlines in the previous section, *Calder Piece* represents an *indirect* correspondence between the dynamic element (*Chef d’orchestre*) and its notational functionality: there is not an explicit representation of dynamic indication. One does not explicitly perceive contact or intersection between dynamic and fixed symbols. Rather, it is one’s perception of how the physically-displaced sculpture appears in conjunction with the paper score. Still, the significance of *Calder Piece* as an antecedent to contemporary animated notational practices cannot be understated: the incorporation of a dynamic entity (*Chef d’orchestre*) as a necessary component of the score clearly predates the necessarily dynamic qualities of contemporary animated scoring practices, and prior to the emergence of this field, is one of the few, and earliest examples of its kind.

3.3.3 John Cage

In “Experimental Music: Doctrine”, John Cage references Brown’s interest in alternative methods for the representation of time: “You insist on their [players in an orchestra] being together? Then use, as Earle Brown suggests, a moving picture of the score, visible to all, a static vertical line as coordinator, past which the notations move.”[138] But while their notational approaches and compositional intentions were quite distinct, Cage shared

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[136] “Calder Piece,” Earle Brown Music Foundation, accessed February 16, 2016, http://www.earle-brown.org/works/view/33.
[137] Jason Freeman, “Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance,” 27.
[138] John Cage, *Silence: 50th Anniversary Edition* (Middletown, CT: Wesleyan University Press, 2011), 15.

Brown's interests in alternative representations of time and form, influenced in part by his work with magnetic tape:

> Since so many inches of tape equal so many seconds of time, it has become more and more usual that notation is in space rather than in symbols of quarter, half, and sixteenth notes and so on. Thus where on a page a note appears will correspond to when in a time it is to occur. A stop watch is used to facilitate a performance; and a rhythm results which is a far cry from horse's hoofs and other regular beats.[139]

These two comments form an interesting dichotomy: while Cage appears to distance himself from what sounds like Brown's precursor to contemporary scrolling scores,[140] he at the same time supports the rhythmic specificity enabled by the proportional functionality of magnetic tape. While magnetic tape is itself non-notational, at least to a human performer, its prescriptive specificity, as it were, is functionally identical to the methods by which many devices discussed in chapter 3.1 operate. In fact, Cat Hope and Lindsay Vickery have noted the functional relationship between magnetic tape and contemporary scrolling score practice: "The 'score-reader' operates in a paradigm not unlike the play-head on a tape recorder: lines can be read at a certain speed they sound right, they can be fast forwarded or reversed, stopped and started at any time, but all parts move together."[141]

In addition to the retroactive reference to Cage's work with magnetic tape, and its functional relevance to contemporary animated scoring practices, there are additional approaches to score presentation and generation that demonstrate particularly salient qualities that predate certain fundamental characteristics of contemporary animated scoring practices. Cage's *Concert for Piano and Orchestra* (1957/58) features a uniquely visual, dynamic suggestion for the representation of non-pulsed clock-time in the performance instructions:

> The notation of each part uses a system wherein space is relative to time. The amount of time is determined by the musician and then altered during performance, by the conductor, whose role is to act as a chronometer on

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[139] John Cage, *Silence*, 11.
[140] Cat Hope and Lindsay Vickery, "Visualising the Score: Screening Scores in Realtime Performance" (paper presented at IM 7: Diegetic Life Forms II, Murdoch University, Western Australia, September 3-5, 2010).
[141] Ibid.

the podium whose arms simulate the movement of the hands of a clock.[142]

While this dynamic element is not necessary (local clock sources could suffice), it demonstrates an effective use of dynamic functionality to mark time beyond the pulsed directives that are indicative of the conductor's traditional role.

In Cage's *Variations* the performer is responsible for both the generation and realization of the score. The score generation process and its subsequent representation do not demonstrate any dynamic qualities, but the transfer of agency away from the composer in favor of chance-derived prescription, in tandem with the decrease in temporal distance between score creation and realization highlight two primary qualities found in many contemporary animated scores. First, that the composer transfers her creative agency to the computational process of the score generator (which is explicitly accomplished by the Decibel Ensemble's *The Complete John Cage Variations Project*).[143] Second, the temporal distance between the emergence, or unfolding, of the score and its realization in performance is diminished, although not quite to the degree demonstrated by the mechanical devices discussed in the previous section. In general, Cage's work often demonstrates the displacement of interpretation of both the performer's and composer's intentions in favor of autonomous systems (for even though Cage's chance operations were determined by his actions, his intentions were deliberately inconsequential as to the results of those actions).

3.3.4 Pauline Oliveros and Tony Martin: Circuitry

The score for Pauline Oliveros' and Tony Martin's *Circuitry for Percussion and Light* (1967) featured a grid of translucent material that could be illuminated by a series of dynamically-controlled light bulbs. Musical instructions were printed on each grid section, and when illuminated would indicate the quality of the sonic event, while another light indicated when to play that event (see figure 4). An interactive element that was based on the performer's realization of these instructions influenced the behavior of the grid: "Audio signals from the players were picked up by microphones and filtered. Those

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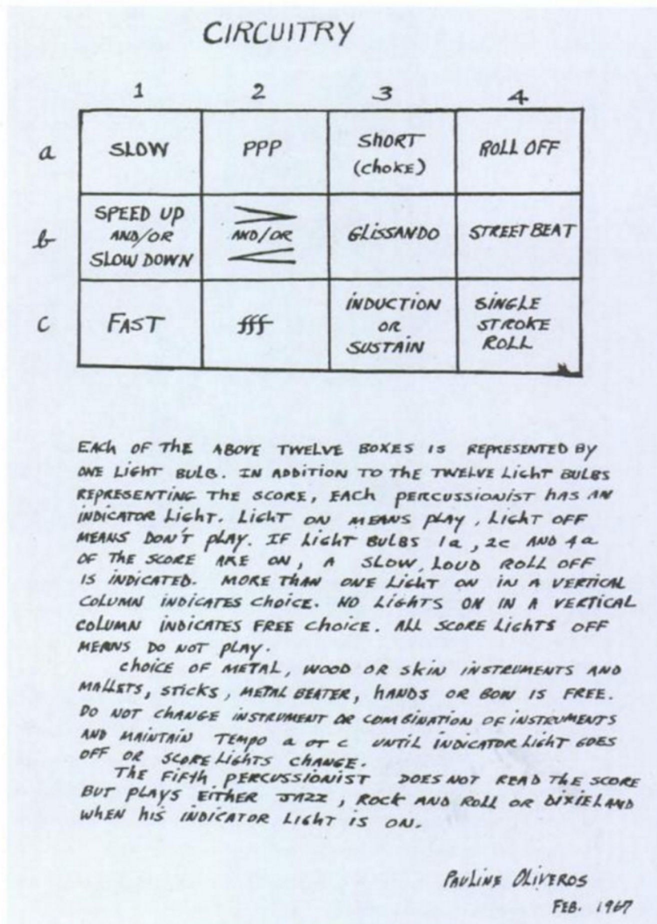
[142] "Concert for Piano and Orchestra," johncage.org, accessed February 16, 2016, http://johncage.org/pp/John-Cage-Work-Detail.cfm?work_ID=48.
[143] "The Complete John Cage Variations Project," decibelnewmusic.com, accessed April 27, 2016, http://www.decibelnewmusic.com/the-complete-john-cage-variations-project.html.

signals turned the lights on and off. Thus the players were engaged in a feedback situation where what they played changed the score indications and who was playing when."[144] The twelve grid segments had vast combinatorial potential, and because the triggering mechanism is based on the improvisational reactions of the performers, the representation and realization of events emerge simultaneously in real-time.



18 PAGE FROM SCORE FOR *CIRCUITRY*, BY PAULINE OLIVEROS.

Figure 4: *Circuitry* by Pauline Oliveros and Tony Martin (Performance Instructions Detail)

Here we see the dynamic functionalities embedded within the score of *Circuitry* as a component that is necessary to its accurate representation. While *Circuitry* does not contain the primary methods of indication found in contemporary animated scoring practices, including contact and intersection, nor is the score specifically prescriptive,

[144] David W. Bernstein, ed., *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-Garde* (Berkeley: University of California Press, 2008), 91.

performers are still temporally-bound by a non-linear, dynamic indicator light: "Light on means play, light off means don't play."[145] While the indicator light determines the temporal boundaries of each event, it is distinct from contact and intersection in that it is not preceded by any indication as to *when* it will turn on or off respectively. Rather, the indicator light is a temporal indicator that is momentary and sudden.

3.3.5 Robert Moran: Divertissement Number One

Robert Moran's *Divertissement Number One* (1967), also referred to as "The Popcorn Piece," demonstrates the framing of a dynamic process as a representation of the composer's intention. The instructions for the piece are straightforward, and require little preparation: The performers are instructed to wear "over-sized circus sunglasses with five lines representing the musical staff taped on the lenses. A lidless popcorn popper is placed in the center of the stage. As the popcorn flies, the musicians play what they see as the popcorn appears on the musical staves of their glasses."[146] Like *Calder Piece* and *Circuitry*, the popcorn popper's dynamization of popped corn is essential to the representation of Moran's compositional intention, and severely limits the duration between score generation and its realization. Like *Circuitry*, the score is designed to activate a series of improvisatory responses by the players, but although the score includes the traditional musical staff, it is not intended to be specifically prescriptive. Rather, the chaotic movement of the popcorn is exploited to produce a particular type of musical response with an economy of means: "Moran described the musical effect of the work as an ultra-complex 'Darmstadt piece' in that it would be nearly impossible to notate and impossible to duplicate in performance."[147] So while the score for *Divertissement* does not prescribe specific musical actions, it enables and encourages the realization of a particular musical complexity without requiring the performers to have gained the high level of musical literacy that would be necessary if notated with CPN.

[145] Ibid., 92.
[146] Lucas James Bernier, "The Percussion Music of Robert Moran" (DMA thesis, University of Iowa, 2012): 20.
[147] Ibid., 21.

3.3.6 Ramon Sender: Tropical Fish Opera

A performance of Ramon Sender's *Tropical Fish Opera* requires a large aquarium, several tropical fish, fish food, and a heater. Four singers or instrumentalists each position themselves at one side of the aquarium respectively. Two five-line staves are drawn on each side of the aquarium, and the X and Y, and Z location of each fish determines pitch (if within the area outlined by a staff) and dynamic respectively (see Figure 5). "A fish very close to your side of the tank should be played fortissimo, in the center mezzo-forte, etc."[148] Duration is determined by movement in general: a still fish represents a sustained tone, while an active fish represents one or more shorter tones. With these rules in place, Sender suggests two performance possibilities: The free version does not require the performers to predetermine a static pitch set, and "works well with musicians who are good at improvising but willing to respect the parameters of the piece."[149] The second requires performers to consult the I Ching to determine a particular pitch set, and if a vocalist is involved, the I Ching should be used to determine the vocalist's text. Sender's *Opera* exploits the dynamic activities of the fish by developing a notational framework within which the fish, like Moran's popcorn and Brown's mobile, prescribe a variety of musical responses, and their dynamic behaviors are necessary to the proper representation of Sender's intention.

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[148] Ramon Sender, *Tropical fish Opera*, 1962.
[149] Ibid.

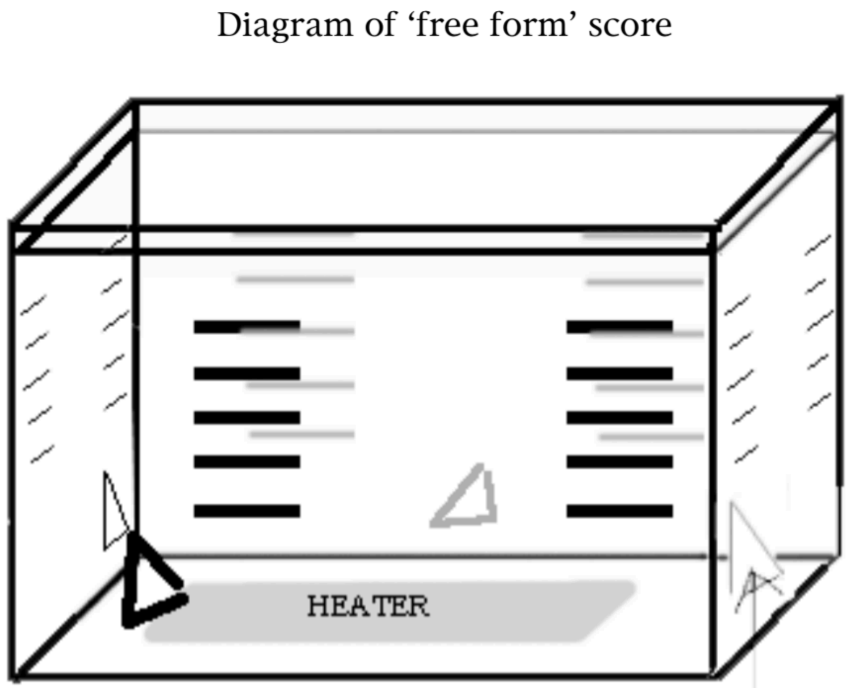

Figure 5: *Tropical Fish Opera* by Ramon Sender (Performance Instructions Detail) [150]

3.3.7 Randy Hostetler: Palm Quart and Floaters

A website devoted to the work of the late Randy Hostetler describes *Palm Quart* as "a score consisting of a video of Palm Trees videographed in Los Angeles by Francesca Talenti",[151] and links to a video of the performance that include the notes: "The score for this composition consists of a video of Los Angeles palm trees with detailed written instructions by Randy Hostetler as to how the string quartet is to 'play' the trees."[152] In a recent article on New Music box, author Steve Horowitz describes a recent performance of Hostetler's so-called "video string quartets":

> What the heck is a video string quartet you ask? Good question. In Randy's case, it is a piece of music where the images the musicians watch on screen creates the images the musicians hear. The players sit with their backs to

[150] Ibid.
[151] "Randy's Room," Livingroom Music, accessed February 16, 2016, http://www.livingroom.org/randys-room/.
[152] "Randy HOSTETLER & Francesca TALENTI," YouTube video, 10:01, posted by "ziggron," December 24, 2009, accessed February 16, 2016, https://www.youtube.com/watch?feature=player_embedded&v=VxHHagCa6Eg#!.

> the audience and watch the screen. In both cases, Randy included a couple of pages of instructions and that's it – that's the score.[153]

Horowitz also provides a brief, albeit vague description of how the players were to interpret the scores for *Palm Quart* and *Floaters*. For *Floaters*, each player's actions are prescribed by the behaviors of four dynamic icons, "triangle, square, circle, little Pac-Man guy […] and, as the icons enter and exit and whiz all over the screen, the music is created."[154] In *Palm Quart*, each player is assigned "a quadrant of the screen to 'read' as the palm trees pass by." While it is difficult to find additional information about these pieces, it is clear that the dynamic qualities of the video are essential to the work's representation, although like previous examples, these dynamic qualities are meant to activate an improvisational response, and do not prescribe specific actions. Hostetler's video scores, in particular, signal a shift toward the screen-based approaches found in contemporary animated scoring practices, and although Hostetler's works rely on the performer's improvisational reactions to what appears to be a relatively thin notational framework, *Palm Quart* and *Floaters* demonstrate the representational possibilities of dynamic, gestural actions found in the suggestive approaches to contemporary animated scoring practices that will be discussed in chapter 3.4.6.6.

3.3.8 Section Conclusion

The previous examples by Brown, Oliveros and Martin, Moran, Sender and Hostetler demonstrate antecedents to contemporary animated scoring practices by the incorporation of dynamic elements that are essential to the representation of the composer's intention. Furthermore, these scores displace the traditional interpretive model by restricting the performer's ability to reference the score prior to its unfolding in performance. Each of these works also demonstrates unique notational approaches that have been specifically designed to exploit these dynamic behaviors for the purpose of representing new compositional intentions. Lastly, each notational approach generally enables participation

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[153] Steve Horowitz, "Child of Amerika: A Musical Manifesto," NewMusicBox, accessed February 16, 2016, url: http://www.newmusicbox.org/articles/child-of-amerika-a-musical-manifesto/.
[154] Ibid.

by a wide variety of musical abilities by rejecting or abstracting CPN in favor of a post-literate, dynamic representation.

3.4 Contemporary Animated Scoring Practices

3.4.1 Introduction

The historical antecedents of contemporary animated scoring practices that were outlined in the previous two sections illustrate novel devices designed to enable the performance of preexisting music in the pedagogical and entertainment spheres respectively, and dynamic extensions to CPN and graphic notation toward the realization of new compositional intentions. Each example demonstrated one or more of the essential ideas that form the theoretical and practical basis for contemporary animated scoring practices. But while these precedents demonstrate these ideas in some form or another, they do so toward the representation of preexisting musical concepts (Patents, Fleischer, Karaoke, *Guitar Hero*), or, in those cases that endeavor to represent new compositional intentions (Oliveros and Martin, Moran, Sender, Hostetler), are generally thin in their representation. With the emergence of contemporary animated scoring practices, one sees a reclaiming of the prescriptive powers of CPN without relying on the symbol system *of* CPN, a tightening of the temporal window between score creation, representation, and realization, and a palpable increase in the controlling qualities of the notation.

3.4.2 Recent Foundations

Composer Gerhard E. Winkler's 2004 paper "The Realtime-Score. A Missing-Link in Computer-Music Performance"[155] is a reflection on his ten years of experimentation with real-time scoring. Winkler highlights several primary considerations in the creation of his real-time-scores that correspond to the essential ideas found in contemporary animated scoring practices. For instance, Winkler notes that because the score emerges in real time, it must be instantly legible. This requires a symbolic reduction or distillation to ensure that the symbols and instructions "can be seized with 'one glance' immediately during a performance",[156] that these symbols, or signs "have to be [notated] precisely enough to

[155] Gerhard E. Winkler, "The Realtime-Score. A Missing-Link in Computer-Music Performance."
[156] Ibid., 2.

avoid that the musicians shift into 'improvisation'", and that they are presented in a timely manner.[157] Here we see that Winkler has identified both the importance of a prescriptive notational system in an animated score, and that the time-bound qualities of these symbols must be considered in their design. This is in contrast to many of the notational intentions outlined in the previous section, in which the dynamic aspects of the score are used as a method for guiding improvisation, and so do not demand the kind of specificity Winkler requires.

For Winkler, some real-time-scores can be described as "dynamic systems" in which a "'nucleus' of relations" produces a "'set of potentialities.'"[158] As the score emerges in real time, and these potentialities are actualized as legible notation, their "behaviours" are contingent on relational structures developed by the composer, and must be dealt with by the performer as they emerge. While performer interaction may impact the notational content to some degree, in interactive scores for example, the timeliness of this emergence diminishes the performer's ability to interpret the score beyond what is immediately represented. By collapsing the generation and rendering processes of the score into the same temporal window as its realization, interpretive variation is largely determined by the computational processes of the score generator, which displaces the performer's traditional role as interpreter by simply removing the performer's ability to reference the score prior to the moment they are required to realize it.

In the decade following Winkler's text, numerous publications have bolstered contemporary animated scoring discourse. *Contemporary Music Review*, Vol. 29, Issue 1, "Virtual Scores and Real-Time Playing" contained articles about real-time score generation,[159,160,161] networked notation,[162] Harris Wulfson's *LiveScore*,[163] real-time

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[157] Ibid., 2.
[158] Ibid., 3.
[159] David Kim-Boyle, "Real-time Score Generation for Extensible Open Forms," *Contemporary Music Review* 29:1 (2010): 3-15.
[160] Johannes Kretz, "Extending the KLANGPILOT Score Language for Real-Time Notation," *Contemporary Music Review* 29:1 (2010): 29-37.
[161] Gerhard E. Winkler, "The Real-Time-Score: Nucleus and Fluid Opus," 89-100.
[162] Georg Hajdu, Kai Niggemann, Ádám Siska and Andrea Szigetvári, "Notation in the Context of Quintet.net Projects," 39-53.
[163] G. Douglas Barrett and Michael Winter, "LiveScore: Real-Time Notation in the Music of Harris Wulfson," *Contemporary Music Review* 29:1 (2010): 55-62.

computer-based improvisational scoring methods,[164] and tools for the creation of real-time scores.[165] *Leonardo Music Journal*, Vol. 21, 2011, "Beyond Notation: Communicating Music" contained several articles regarding real-time music notation software,[166] optical scores,[167] and live-coding as a real-time scoring practice.[168] In addition, several theses and dissertations have been written on relevant topics including real-time score generation,[169,170] and the notation of rhythm and performance based interactivity with animated notation.[171,172] In 2010, Páll Ivan Pálsson of S.L.Á.T.U.R. (samtök listrænt ágengra tónsmiða umhverfis Reykjavík [translated: Artistic Organization of Invasive Composers around Reykjavík]) began posting on "anything to do with animated notation, video notation, real-time notation" at animatednotation.blogspot.com,[173] which appears to be the first attempt at an online consolidation of contemporary animated scoring practices. Inspired by Pálsson's work, in 2012 I began making my research available at animatednotation.com [ANDC],[174] with a similar focus on the discovery and consolidation of animated score documentation and discourse on a publicly available platform.

In addition to the emergence of textual content, the production of animated scores has appeared to increase dramatically since Winkler's 2004 paper. This increase has been fueled in large part by the development of significant animated scoring practices by the Reykjavik-based composer's collective S.L.Á.T.U.R., Australia-based composers Cat Hope, Lindsay Vickery and David Kim-Boyle, and including the development of

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164 Nick Didkovsky, "Density Trajectory Studies: Organizing Improvised Sound," *Contemporary Music Review* 29:1 (2010): 75-80.
165 Jason Freeman and Andrew Colella, "Tools for Real-Time Music Notation," *Contemporary Music Review* 29:1 (2010): 101-113.
166 Jason Freeman, "Bringing Instrumental Musicians into Interactive Music Systems through Notation," *Leonardo Music Journal* 21 (2011): 15-16.
167 Catherine Pancake, "Optical Scores for Improvised Music," *Leonardo Music Journal* 21 (2011): 17-18.
168 Thor Magnusson, "Algorithms as Scores: Coding Live Music," *Leonardo Music Journal* 21 (2011): 19-23.
169 Kevin Baird, "No Clergy: A Piece for Flexible Small Ensemble Generated in Real Time Based on Audience Feedback" (PhD diss., The State University of New York at Buffalo, 2005).
170 Filipe Cunha Monteiro Lopes, "Õdaiko: Real Time Score Generator" (Masters thesis, The Royal Conservatoire, The Hague, 2009).
171 Guðmundur Steinn Gunnarsson, "An Approach to Rhythm."
172 Justin Wen-Lo Yang, "Sometimes I Feel the Space Between People (Voices) in Terms of Tempos – A Work for Percussion Duo with Computer Animated Notational Interface."
173 "Home," animatednotation.blogspot.com, accessed February 17, 2016, http://animatednotation.blogspot.com/.
174 "Composers," animatednotation.com, accessed February 17, 2016, http://animatednotation.com/composers.html.

foundational interactive frameworks by Jason Freeman, Georg Hajdu, Nick Didkovsky, Dominique Fober and Richard Hoadley.[175]

Based on the current discourse, in the following section I will identify recent terminological distinctions, posit extensions to the high-level terminology, and propose a set of low-level terms to describe AMN. In addition to the relevant textual discourse, this section is based primarily on screen-based animated scores produced since the turn of the century. Every effort was made to discover composers and works that utilize and implement animated scoring practices in preparation for this section. However, it should be noted that although this effort was made, it is still likely that some composers creating animated scores, and their scores, will have flown under the radar. In many cases, insufficient documentation rendered some scores questionable as to their relevance, and unfortunately could not be included.

3.4.3 Animated Score Practices: Terminology

In the preface to *Contemporary Music Review*, Vol. 29, No. 1, February 2010, editors Arthur Clay and Jason Freeman define real-time music notation as "any notation, either traditional or graphic, which is created or transformed during an actual musical performance."[176] Clay and Freeman go on to note that "the term has not been standardized, and various articles in this issue refer to real-time music notation using other terms, such as dynamic music notation, live scoring, virtual scoring, and reactive notation."[177] In fact, the range of alternative descriptions is quite extensive:

moving score[178]

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[175] This short list is by no means meant to dismiss the contributions made by the many composers throughout the world who have represented their works with animated scores. In fact, this sentiment can be applied to the paper in general. Because it is my intention to focus primarily on developing a theoretical and practical framework to understand contemporary animated scoring practices, it is simply not within the scope of this paper to also produce a list of each and every composer (and their works) that have been and/or are currently working within this field.
[176] Arthur Clay and Jason Freeman, "Preface: Virtual Scores and Real-Time Playing," *Contemporary Music Review* 29:1 (2010): 1.
[177] Ibid., 1.
[178] "Aarich Jespers - Moving Score for String Quartet." YouTube video, 4:41, posted by "Aarich Jespers," February 27, 2014, accessed February 16, 2016, https://www.youtube.com/watch?v=8K9O_I4sL-4.

graphic score[179]

video score[180]

visual score[181]

graphic dynamic learning[182]

animated score [183,184,185,186,187]

scrolling score[188,189]

graphical score[190]

graphical notation[191]

animated graphic score [192,193,194,195,196]

optical score[197]

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[179] "It's Not an Intervention." YouTube video, 3:31, posted by "Fupierre's channel," December 27, 2009, accessed February 16, 2016, https://www.youtube.com/watch?v=vaMU3EYStoY.
[180] "Ideomania," Vimeo video, 9:15, posted by "Alexander Ness," October 30, 2010, accessed February 16, 2016, https://vimeo.com/16355769.
[181] "Refurbishment," YouTube video, 10:30, posted by "Amenity Space," May 13, 2009, accessed February 16, 2016, https://www.youtube.com/watch?v=oW26rj-PrAQ.
[182] "Lighthouses III – Performed by Lucas Fels," YouTube video, 7:29, posted by "GraphicNotation," January 8, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=cZnMuAdEYN8.
[183] "vidatone 149 interpreted by Massimo Magee," YouTube video, 1:37, posted by "vidatone," April 12, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=jkkyvfhQvYk.
[184] "Animated Score #4: Galactic Underworld," Vimeo video, 4:24, posted by "Christopher Marianetti," December 28, 2010, accessed February 16, 2016, https://vimeo.com/18251944.
[185] "The Animated Score Project," small brain records, accessed February 17, 2016, http://www.smallbrainrecords.com/text/animatedscore.html.
[186] "clark nova," YouTube video, 1:33, posted by "Pedro Gómez-Egaña," April 2, 2006, accessed February 16, 2016, https://www.youtube.com/watch?v=SlVDPF_-s5k.
[187] "Music," Jesper Pedersen, accessed February 17, 2016, http://slatur.is/jesper/Music.html.
[188] Cat Hope and Lindsay Vickery, "Visualising the Score: Screening Scores in Realtime Performance."
[189] "Akousmetria: graphic revision," Vimeo video, 12:13, posted by "Alexander Ness," September 21, 2009, accessed February 16, 2016, https://vimeo.com/6684125.
[190] "ANTANAS JASENKA_NYC-001 (2008)," YouTube video, 9:50, posted by "exerpm," September 15, 2008, accessed February 16, 2016, https://www.youtube.com/watch?v=UqPoJcBRJtU.
[191] "SYN-Phon (Graphic notation)," Vimeo video, 10:56, posted by "candas sisman," September 12, 2013, accessed February 16, 2016, https://vimeo.com/74431122.
[192] "bitsmoke: movement HD," Vimeo video, 15:44, posted by "clf clf," March 4, 2008, accessed February 16, 2016, https://vimeo.com/754190.
[193] "Animated Graphic Score: 'Natural Politics 2.0'," YouTube video, posted by "Hasan Hujairi," September 16, 2013, accessed February 16, 2016, https://www.youtube.com/watch?v=JJwv3PCPdqI.
[194] "Leafcutter John Animated Graphic Score 1 played by York University Ensemble," YouTube video, 9:59, posted by "Leafcutter John," accessed February 16, 2016, https://www.youtube.com/watch?v=RYFQDhFGitg.
[195] "Animated Graphic Scores for Quartet," Vimeo video, 5:04, posted by "luze duze," December 24, 2008, accessed February 16, 2016, https://vimeo.com/2625318.
[196] "Preludium: An Animated Graphic Score," Vimeo video, 7:52, posted by "Michael James Olson," May 21, 2010, accessed February 16, 2016, https://vimeo.com/11926071.
[197] Catherine Pancake, "Optical Scores for Improvised Music," 17-18.

graphic score in action/dynamically shifting score/computer generated graphic score[198]

real-time score[199,200,201,202]

anigraphical[203]

realtime notation system[204]

real-time graphical score[205]

video score[206,207,208,209]

real-time notation[210,211]

animated notation[212, 213,214,215,216,217,218]

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198 "Archive for the 'Graphic Notation' Category," MajorC blog – Christopher Chong, accessed February 17, 2016, https://majorc.wordpress.com/category/graphic-notation/.

199 "eScore 'player'," Vimeo video, 2:11, posted by "Chris McClelland," September 3, 2008, accessed February 16, 2016, https://vimeo.com/1658576.

200 "The Heart Chamber Orchestra," The Heart Chamber Orchestra, accessed February 17, 2016, http://heartchamberorchestra.org/wordpress/.

201 "Piano Extensions," YouTube video, 3:22, posted by "ikonoflight," February 7, 2008, accessed February 16, 2016, https://www.youtube.com/watch?v=VY58mbn7394.

202 Gerhard E. Winkler, "The Real-Time-Score: Nucleus and Fluid Opus," 89-100.

203 "The Anigraphical Etudes™, LLC," David Lieberman, accessed February 17, 2016, http://anigraphical.davidlieberman.com/.

204 "Edward Kelly – Gemnotes: A Realtime music notation system for Pure Data," Vimeo video, 37:53, posted by "PdCon11," February 8, 2012, accessed February 16, 2016, https://vimeo.com/36419881.

205 "Do Desenho e Do Som," Vimeo video, 13:39, posted by "Filipe Lopes," accessed February 16, 2016, https://vimeo.com/85774065.

206 "Dust Music," Jockel Liess, accessed February 17, 2016, http://www.jockelliess.org/dustmusic.htm.

207 "'Dedications' (2014) for voices, chamber ensemble, 8 speakers & video scores," YouTube video, 19:16, posted by "Josten Myburgh," November 17, 2014, https://www.youtube.com/watch?v=UmgL3G2tBuA.

208 "PRAM TAK MIR," Vimeo video, 6:00, posted by "Sander Saarmets," October 3, 2012, accessed February 16, 2016, https://vimeo.com/50685023.

209 "Marina Rosenfeld – WHITE LINES – excerpt – video score for improvisers," Vimeo video, 2:42, posted by "Marina Rosenfeld," August 6, 2011, accessed February 16, 2016, https://vimeo.com/27385858.

210 Johannes Kretz, "Extending the KLANGPILOT Score Language for Real-Time Notation," 29-37.

211 Joel Eaton and Eduardo Miranda, "Real-Time Notation using Brainwave Control" (paper presented at Sound and Music Computing Conference, Stockholm, Sweden, 2013).

212 "'Dedications' (2014) for voices, chamber ensemble, 8 speakers & video scores," YouTube video, 19:16, posted by "Josten Myburgh," November 17, 2014, accessed February 16, 2016, https://www.youtube.com/watch?v=UmgL3G2tBuA.

213 "Animated Notation," Vimeo video, 4:25, posted by "Taavi Aher," June 9, 2010, accessed February 16, 2016, https://vimeo.com/43743925.

214 "Music," Jesper Pedersen, accessed February 17, 2016, http://slatur.is/jesper/Music.html.

215 "Chamber music using animated notation," Þráinn Hjálmarsson, accessed February 17, 2016, http://thrainnhjalmarsson.info/.

216 "List of Works," Guðmundur Steinn Gunnarsson, accessed February 17, 2016, http://slatur.is/gudmundursteinn/.

217 "Sketch #16," Music for Shuffle, accessed February 17, 2016, http://musicforshuffle.com/2013/02/13/sketch-16/.

218 "Skítalt (animated score)," YouTube video, 5:17, posted by "Páll Ivan frá Eiðum," November 22, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=8z5OA5rJWXs.

active notation[219]

animated digital score[220]

timeline-driven score[221]

generative score[222]

real-time computer-generated scores[223,224]

live generated score[225]

real-time screen scores[226]

real-time music notation[227,228]

virtual scores[229]

experimental video notation[230]

anitation[231]

This listing demonstrates the variety of terms in current and recent usage. In many cases the specificity of a particular label that a composer uses to describe his or her work may provide a better understanding of the work than the more general animated score or animated music notation (or any other label for that matter). In others, the works these labels correspond to may not necessarily represent the essential ideas of contemporary animated scoring practices, or are only vaguely relevant. Yet, this introduces an important

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219 "Continuum with Blues," Nigel Morgan, accessed February 17, 2016, http://nigel-morgan.co.uk/modules.php?op=modload&name=News&file=article&sid=96&phpMyAdmin=331c915b564fa46283e262b6f65631ab.

220 "Hyperions," Paul Turowski, accessed February 17, 2016, http://paulturowski.com/.

221 "Semi-Conducted (Dress Rehearsal Recording)," Vimeo video, 10:24, posted by "Hunter McCurry," May 13, 2010, https://vimeo.com/11719006.

222 "Works," Rui Penha, accessed February 17, 2016, http://ruipenha.pt/works/.

223 "Alien Lands," matralab, accessed February 17, 2016, http://matralab.hexagram.ca/projects/alien-lands/.

224 "Infiltrationen – computerscore (Stefan Prins)," YouTube video, 5:46, posted by "Stefan Prins," March 13, 2010, accessed February 16, 2016, https://www.youtube.com/watch?v=99PIEeFjsA0.

225 "SOM – Self Organized Music - 1° Stings," YouTube video, 2:28, posted by "Manu Falleiros," August 10, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=V8is8JKV5WI.

226 David Kim-Boyle, "Visual Design of Real-Time Scores," *Organised Sound* 19:3 (2014): 286-294.

227 Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," *Computer Music Journal* 32:3 (2008): 25-41.

228 Jason Freeman and Andrew Colella, "Tools for Real-Time Music Notation," *Contemporary Music Review* 29:1 (2010): 101-113.

229 Arthur Clay and Jason Freeman, "Preface: Virtual Scores and Real-Time Playing," 1.

230 "KRUMLOV," YouTube video, 5:45, posted by "Páll Ivan frá Eiðum," March 14, 2010, accessed February 16, 2016, https://www.youtube.com/watch?feature=player_embedded&v=9bxTiB5siS0#!.

231 Guðmundur Steinn Gunnarsson, "An Approach to Rhythm."

question: Is this terminological discrepancy simply due to the emergent, uncodified state of contemporary animated scoring practices? And if so, is it possible to determine a high-level, generalized term that, like animated music notation *may* appear to do, adequately encompasses the wide variety of recent and current practices? While it is my belief that the list of labels printed above provides a range of adequate terms for discussing these scores, I also believe in the value of a broad, generalizable term that not only encompasses the field of practice at large, but one that can be qualified in order to develop a more consistent approach to the classification of future developments in contemporary animated scoring practices. In the next section I will posit my suggestions regarding this classificatory terminology, following and based upon those terminological distinctions that have made the most significant contributions toward establishing the terminological foundation of this field.

3.4.4 Animated Score Terminology: Clarifications

Returning again to Clay and Freeman's preface, the term real-time (a common descriptor in the animated score discourse) is defined as "the actual time during which a process or event occurs",[232] and unlike a fixed score, a real-time notation "is created or transformed during an actual musical performance."[233] This distinction clarifies the real-time associated with the act of composing, from a real-time that corresponds to the act of performing by temporally consolidating them to "create a single, merged sonic output."[234] Following this, any pre-performance processes undertaken by the performer (creating the performance score in Cage's *Variations II* for example) occur prior to the performer's *performance real-time*. The performance instructions for some open works, like Brown's *Novara* (1962), may appear to complicate this distinction: "The conductor may begin a performance with any event on any page and may proceed from any page to any other page at any time."[235] Here the score is transformed during performer-time, and would thus

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[232] "real time," Oxford Dictionaries, accessed February 17, 2016, http://www.oxforddictionaries.com/us/definition/american_english/real-time#real-time__5.
[233] Arthur Clay and Jason Freeman, "Preface: Virtual Scores and Real-Time Playing," 1.
[234] Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," 36.
[235] "Novara Performance Instructions," Edition Peters, accessed February 17, 2016, https://issuu.com/editionpeters/docs/earle_brown_novara?e=1372998/2169059.

fall under Clay and Freeman's definition, as would John Zorn's *Cobra* or Butch Morris' *Conduction* (the score as a series of real-time "signs and gestures" in which Morris could "eliminate notation altogether and arrive at a real-time encounter.")[236] In another paper, Arthur Clay describes real-time notation as "notation that is not fixed, but is generated on the spot, which, in some cases, may change via interactivity based on responses to gestural input by the performer, the audience, or both."[237] Still, the term appears to encompass too broad a field of scoring practices, and may be better utilized in distinguishing between the different forms of timeliness in these scores.

The term "virtual" references the screen-based nature of these works, an immediate limiting factor, while hinting at the unique ontological distinction between a fixed, physical score, and the flexible and ephemeral animated score.[238] However, this term presents two potential issues. The first is that the *virtuality* of a score may be applicable to any notation were it to be displayed on a computer screen, including the dynamization of what are otherwise fixed scores.[239] The second is the possible implication that a virtual score is somehow not quite a real score, with realness referring to the score's representational adequacy. Live scoring is in a sense even further removed, and suggestive of a human-led, "performed" scoring process, e.g. John Zorn or Butch Morris, or perhaps, a human-led, live-coded scoring process.[240] Video Score implies a particular presentation format and visualization method, so although real-time transformation is likely, it does not fully encompass the variety of scoring methods in current practice. Similarly, Cat Hope and Lindsay Vickery's term *ScreenScores* adequately describe the presentation model for a large percentage of contemporary animated scores, but is perhaps too embedded in the particular technological aspects of score presentation to serve as a generalizable descriptor for the field at large.

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[236] "Butch Morris," Vimeo video, 8:53, posted by "Butch Morris," 2014, accessed February 16, 2016, https://vimeo.com/91050770.
[237] Arthur Clay, "You Can Play It Too: The Virtuoso Audience," 72.
[238] Arthur Clay and Jason Freeman, "Preface: Virtual Scores and Real-Time Playing," 1.
[239] "virtual," definition no. 4, Oxford Dictionaries, accessed February 17, 2016, http://www.merriam-webster.com/dictionary/virtual.
[240] Thor Magnusson, "Algorithms as Scores: Coding Live Music," 19-23.

The label Dynamic score poses an interesting solution.[241] The word dynamic is defined as "(Of a process or system) characterized by constant change, activity, or progress", and regarding physics, "Of or relating to forces producing motion. Often contrasted with static."[242] The antonymic relationship between dynamic and static correspond well to the scores they describe, and have been used to great effect in the textual discourse.[243] However, these terms are best suited for descriptions of the processes within these scores, and as a broad distinction between scores that contain motion, and those that do not. The terms Moving Score and Active Score are sufficiently high-level terms, but may also be mistaken as descriptors of the score's musical content or affect. The term Kinetic Score has an interesting functional and historical relevance. The second definition for Kinetic reads "(Of a work of art) depending on movement for its effect."[244] In a presentation on notation by composer Richard Hoadley, he concludes with a slide containing a link to a Vimeo channel devoted to kinetic typography, which is the animation of written words in creative correspondence with their verbalization.[245] While the aural-visual correspondence demonstrated by kinetic typography, including the obvious association with movement in general, suggests that kinetic score may be a viable term, its historical art-world usage implies a structural and tactile quality, and like dynamic and static, may be of better use as a low-level descriptor or qualifier.

Two terms that have been used with some frequency in the written and practical discourse, and have been the de facto descriptors throughout this paper thus far, are Animated Score and Animated Music Notation (or simply Animated Notation). In order to posit a definition of the animated score, and animated music notation, I will first return to three previously mentioned definitions. Clay and Freeman's definition of real-time music notation is "any notation, either traditional or graphic, which is created or transformed during an actual musical performance."[246] Winkler considers a real-time-

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[241] David Kim-Boyle, "Real-Time Score Generation for Extensible Open Forms," 3.
[242] "dynamic," Oxford Dictionaries, accessed February 17, 2016, http://www.oxforddictionaries.com/us/definition/american_english/dynamic.
[243] David Kim-Boyle, "Real-Time Score Generation for Extensible Open Forms," 5-6.
[244] "kinetic," Oxford Dictionaries, accessed February 17, 2016, http://www.oxforddictionaries.com/us/definition/american_english/kinetic.
[245] "Notation as Art," Rhoadley.net, accessed February 16, 2016, http://rhoadley.net/presentations/notation-as-art-s.pdf.
[246] Arthur Clay and Jason Freeman, "Preface: Virtual Scores and Real-Time Playing," 1.

score to be “generated in realtime by the computer during a performance”, with the score “projected directly onto a computer screen which is placed in front of the musicians.”[247] Hope and Vickery, in their description of screen-scores, are also careful to highlight a potential misunderstanding: “Screen-scores are notated music compositions devised to be performed; and are not to be confused with visual representations of music or the musical interpretation of visual art.”[248]

In all cases the presentation of the score is the result of some real time, dynamic unfolding or generative process, in which the notational information is revealed to the performer during performance on a momentary basis. To this end, I believe it is important to again clarify that this dynamic process is a necessary component to these scores. Without this dynamic process, there is no “creation” or “transformation” from which to discern player actions. These dynamic processes must also be perceptible to the performer at the event level. For instance, it would not be sufficient to shuffle fully-composed pages of a score, as that would not dynamically alter the notation at the event or note level. Following Clay and Freeman, Hope and Vickery, Winkler, and the extensive list of specific descriptors mentioned above, I propose an updated definition for scores and notations that fall under this new paradigm:

Animated Music Notation [AMN] describes any notational approach that is represented in real time as a necessarily dynamic set of notational symbols that rely on the functional relationships between these symbols to prescribe musical actions. An Animated Score is any score that contains AMN as a necessary component to its proper representation.

As high-level terms, Animated Score and Animated Music Notation can effectively sustain a wide variety of notational design and functionalities. The following subchapters will examine the various animated notational functionality and design characteristics most commonly found in contemporary animated scoring practices.

[247] Gerhard E. Winkler, “The Realtime-Score. A Missing-Link in Computer-Music Performance.”
[248] Cat Hope and Lindsay Vickery, “Visualising the Score: Screening Scores in Realtime Performance.”

3.4.5 Animated Notation: High-Level Terminology

As noted previously, the terms Animated Score and Animated Music Notation signify a generalization of score and notational functionalities beyond the technologies used in their representation. The following subchapters will expand upon this definition with the extension of the existing high-level score functionality terminology. This extension will be based primarily on the foundational work of Cat Hope, Lindsay Vickery, and David Kim-Boyle, and will be expanded based on the terminological distinctions and practical examples demonstrated by a variety of composers engaged with contemporary animated scoring practices, including my own creative work with AMN.

3.4.5.1 Screen Scores

In "Screen Scores: New Media Music Manuscripts", Cat Hope and Lindsay Vickery propose a terminology of high-level animated or screen score functionalities. Hope and Vickery begin by considering "the relationship between these new screen-based approaches and the traditional notated score," including medium, composition, performer and score.[249] Hope and Vickery's diagram (see Figure 6) succinctly illustrates the distinctions between the screen-score and paper-score, and how each medium addresses a particular set of compositional, performative, and notational approaches.[250]

[249] Cat Hope and Lindsay Vickery, "Screen Scores: New Media Music Manuscripts," ECU Publications (2011): 226, accessed February 18, 2016, url: http://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1420&context=ecuworks2011.
[250] Ibid., 226.

MEDIUM	COMPOSITION	PERFORMER	SCORE
Screen-score	Generative	Immanent/ Interactive	real-time score
	Transformative		
	Permutative		
	Sequential	Interpretative	scrolling score
Paper-score	Permutative	Explorative	Mobile score
	Sequential	Interpretative	traditional score

Figure 6: Cat Hope and Lindsay Vickery's “Paradigms for the Presentation of Notation to Live Performers” [251]

The screen-score and paper-score (paper-score here referring to scores that may or may not be flexible, but do not contain any dynamic characteristics necessary to its proper representation) are the two representational mediums under consideration. Composition refers to the methods by which “the musical materials may be configured … sequentially, permutated, transformed or generated in real-time.”[252] While both screen-scores and paper-scores may contain permutative or sequential qualities, only the screen-score can be generative or transformative in real-time, according to Hope and Vickery. The Performer distinction considers how the performer approaches the score, ranging from the immanence and interactivity of a generative real-time score, to the interpretative and explorative capacity of both screen and paper-based scores. Hope and Vickery’s “Paradigms” chart illustrates several important distinctions, but the score functionality terminology will be of primary relevance in the following sections.

3.4.5.2 Scrolling Score

According to Hope and Vickery, a “scrolling score moves a continuous notational graphic from left to right, allowing performers to execute events as they strike a fixed ‘playhead’” [253] (Freeman and Colella refer to this as the continuous scrolling “view arrangement” [254]).

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[251] Ibid., 226.
[252] Ibid., 226.
[253] Ibid., 226.
[254] Jason Freeman and Andrew Colella, “Tools for Real-Time Music Notation,” 107.

In Hope's *Black Disciples* (2013) for three low voices and a.m. radio static (see figure 7), the "notational graphic", (which can viewed in its entirety here: http://www.cathope.com/uploads/1/7/7/0/17709781/blackdisciplescathope.pdf), contains all of the necessary information for performance except timings. In order to accurately realize the score, the notational graphic must be activated by the Decibel *ScorePlayer*,[255] or viewed as a movie file. In the performance instructions, Hope writes that "the score is proportional, that is, each line has a relationship to the other lines in terms of pitch and time. Important synchronisities are indicated with a vertical dotted line."[256] As the notational information intersects with the vertical attack line (the yellow vertical line in figure 7), the three players can stay in perfect temporal coordination, enabling the ensemble to correctly execute the complex, detuned layering that is emblematic of many of Hope's work with animated scores.

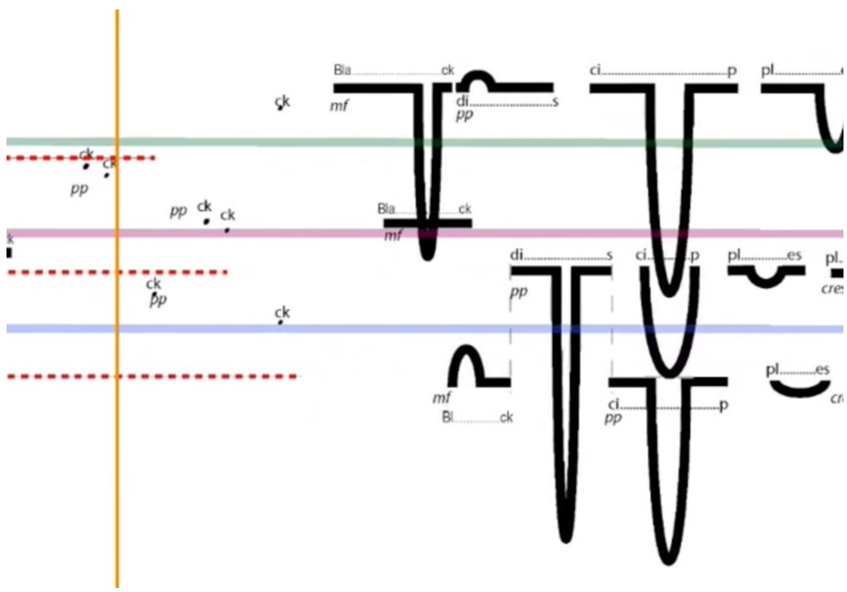

Figure 7: *Black Disciples* by Cat Hope (score detail)[257]

[255] "The Decibel ScorePlayer," Decibel New Music, accessed April 27, 2016, http://www.decibelnewmusic.com/decibel-scoreplayer.html.
[256] "Black Disciples," Cat Hope, accessed April 27, 2016, http://www.cathope.com/black-disciples-2013.html.
[257] "her pockets full of intertia," Vimeo video, posted by "cat hope," September 17, 2015, accessed February 16, 2016, https://vimeo.com/139554304.

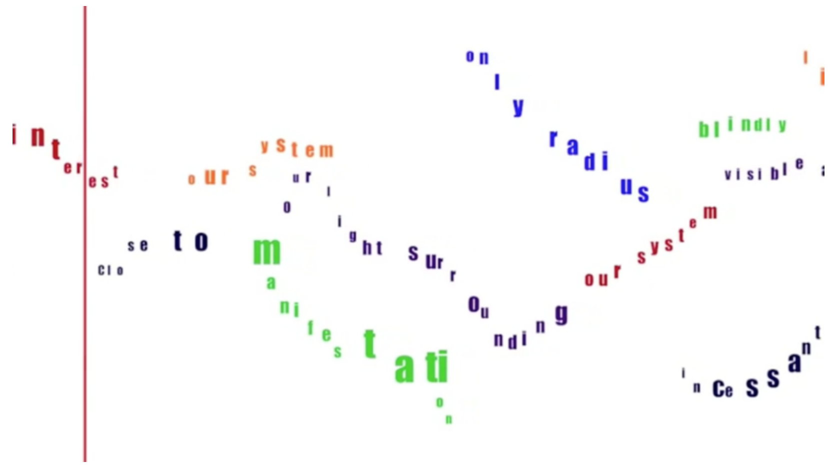

Figure 8: *Resonance Manifestations* by Lindsay Vickery (score detail) [258]

Lindsay Vickery's *Resonance Manifestations* for whispering choir is, like Hope's work, represented as a scrolling score to be presented as a movie file or with the *ScorePlayer* (see figure 8). In the performance notes, Vickery writes that "each of the six parts [are] indicated by a different colour. Relative pitch is indicated vertically and relative loudness by font size."[259] Like Hope's work, pitch indications are not distinctly specified, but determined through the interactions and relationships between voices. Still, the temporal basis for this and many of Vickery's works is clearly defined and deterministic. There is little to no leeway for temporal exploration; the movement of the notational graphic continues steadily, indicating the temporal qualities of each event with a high degree of specificity.

3.4.5.3 Swiping Playhead

The swiping playhead is the reverse functionality of the scrolling score, in that the notational information is more or less static, while the swiping playhead (or dynamic attack line) represents playing position by its relation to the underlying notation. Unlike the scrolling score, which may feature a large amount of notational information based on the horizontal length of the notational graphic, the swiping playhead functionality "limits the amount of graphical material that is visible to a single page or 'screen'."[260] Contact

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[258] "resonance manifestations [2013] for whispering choir," YouTube video, posted by "Lindsay vickery," April 7, 2013, accessed February 16, 2016, https://www.youtube.com/watch?v=i-6P3Ohjf5Q.
[259] "2013," Lindsay Vickery, accessed April 27, 2016, http://www.lindsayvickery.com/music-2013.html.
[260] Cat Hope and Lindsay Vickery, "Screen Scores: New Media Music Manuscripts," 227.

and/or intersection between the notational elements and the swiping playhead will generally indicate the attack and release points for each event.

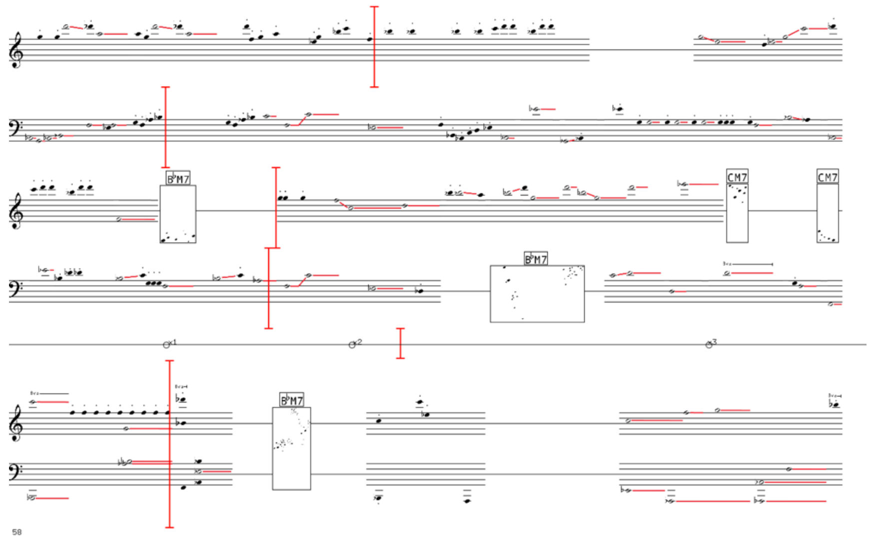

Figure 9: *Study no. 2* by Ryan Ross Smith (score detail) [261]

In my *Study no. 2* (see figure 9), each of the six staves features a swiping playhead designed to traverse the score at independently determined speeds. The attack and release points for each event, including any continuous parameter changes (detuning for example) are temporally indicated by the location of the swiping playhead in relation to the notated event. For staccato events, attacks can be considered as either the moment the playhead makes contact or intersects with the notational mark, so long as the performer is consistent as to which of these methods he utilizes. The location of the playhead within a sustained event (denoted by a red line extending beyond the initial pitched mark) indicates what part of the event the player should be instancing. For instance, in a detuning event (an angled red line), the player can clearly see at what point in the detuning process he should be by referencing the location of the playhead in relation to the height of the line on the staff.

3.4.5.4 Permutative Score

Similar in concept to the open form works of Earle Brown mentioned earlier, the "permutative score allows the presentation of materials to the performer in an indeterminate order."[262] As Hope and Vickery note, the permutative approach will likely

[261] *Study no. 2*, Ryan Ross Smith, 2011.
[262] Cat Hope and Lindsay Vickery, "Screen Scores: New Media Music Manuscripts," 227.

feature a swiping playhead to indicate event location. *Study no. 2* (see figure 9) is also indicative of this approach, as each notational line (or part) will immediately, and randomly, reorganize as the swiping playhead reaches the right side of the screen. There are no new notational fragments created in this process. Rather, a database containing a variety of notational fragments of various lengths are randomly selected and/or permutated in order to generate a persistent, malleable score with extensive combinatorial possibilities.

3.4.5.5 Transformative Score

Citing the malleability of Stockhausen's *Refrain* and Cage's *Cartridge Music* as antecedents, the "transformative score allows a fixed score to be altered in real-time."[263] This is not to be confused with the alteration of the "continuous notational graphic" featured in scrolling scores, but a change or modification to the notational information that is already present, in conjunction with the dynamic functionalities necessary to its representation. This approach is most apparent in the notational research conducted by Dominique Fober toward the development of *INscore*. *INscore*, which is described as "an environment for the design of interactive augmented music scores",[264] is an extensible, open source framework that enables a variety of real-time notational functionalities. While the various capabilities of *INscore* are certainly relevant to this dissertation, only the transformative aspects of it will be considered, primarily because of the rarity of transformative score functionalities in contemporary animated notational practices. What is important to note is the basic premise of the transformative score approach as it is found in contemporary animated scoring practices, which is a layering of notational information that is distinct from the layering found in other approaches. For instance, in the previous examples of the scrolling score, the two primary layers are the continuous notational graphic and the vertical attack line. In order for the notational graphic to appear to intersect with the vertical attack line, they must exist on two layers: static (attack line) and dynamic (notational graphic). In *Study no. 2* (figure 9), the layers include the permutative notational fragments (temporarily static) and the swiping playhead (dynamic). In fact, layering is a

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[263] Ibid., 227.
[264] "INSCORE," inscore.sourceforge.net, accessed April 26, 2016, http://inscore.sourceforge.net/.

necessary component to all contemporary animated scores in order to facilitate the dynamic relationships necessary to their functionality. The layering represented in transformative scores are distinct in that they do not denote the temporal specificity found in these other approaches, but rather, alter notational information in some other way. Nigel Morgan's *Le Jardin Pluvieux*, like *INScore*, is perhaps indicative of this approach. In a short preview of the work,[265] the fixed keyboard score is overlaid with a series of abstract images, designed to extend the performer's interaction with the work by encouraging an improvisatory response to these changes. The transformative score thus describes a method that is distinct from most animated notational functionalities in that the transformative layer does not necessarily indicate performer actions with the kind of specificity that the aforementioned functionalities do. In short, when a transformative score begins to specifically prescribe performer actions, it is likely that the functionalities present in the score are more indicative of some other notational functionality.

3.4.5.6 Generative Score

As the title suggests, the notational contents of a generative score are created in real time, during or immediately prior to their realization, and is not necessarily limited to any one method of indication. In other words, the generative score label describes a particular method by which the score is created, but doesn't necessarily describe its notational functionality.[266] With the exception of interactive scores that feature perceptible correspondences between the performer's and/or audience's actions and the score, it is not necessarily clear whether or not a particular score is generative, or is based on the dynamization of a fixed image or set of images. Rather, the distinction lies in the compositional potentials enabled by these generative methods: namely, persistent or ongoing notational production, and the openness enabled by this method of production.

[265] "Fifteen Images (Le Jardin Pluvieux)," nigel-morgan.co.uk, accessed April 26, 2016, http://nigel-morgan.co.uk/fifteen-images-score/preview.html.
[266] Cat Hope and Lindsay Vickery, "Screen Scores: New Media Music Manuscripts," 227.

3.4.5.7 Segmented, Rhizomatic, 3D and Animated Scores

In his article "The Limitations of Representing Sound and Notation on Screen", Lindsay Vickery introduces several terminological distinctions that extend beyond his earlier work with Cat Hope. Framed by an examination of the "limitations of human visual capabilities", Vickery's terminology includes the segmented score, scrolling score, rhizomatic score, 3D score, and animated score. "The segmented screen-score paradigm most closely approximates traditional printed notation in that continuous spans of music are segmented and presented sequentially."[267] Like the aforementioned permutative score, the notational components of a segmented screen-score are rendered prior to their dynamization in performance. "The horizontal, rhizomatic and 3D scrolling score paradigms each employ the technique of moving the score past the performer's notional fixation point", which is typical of contemporary animated scoring functionalities.[268] In general, these distinctions appear to be largely based on new approaches to the visual design of the score, and thus may feature a variety of functionalities likely covered by Hope and Vickery's original terminology.

3.4.6 Extensions to the Existing Functionality Terminology

3.4.6.1 Introduction

Hope and Vickery's analyses have provided a robust terminology that can be used to describe the majority of contemporary animated score functionalities, and in the following section I will propose several high-level animated score functionality terms that extend beyond their foundational work.

3.4.6.2 Atomic Scroller

The Atomic Scroller is an extension on Hope and Vickery's description of the scrolling score. As described earlier, in a scrolling score, a single, static image is traversed past a fixed attack line. Although this image likely contains a variety of notational symbols, these symbols are fixed in their relationship to one another. In an atomic scroller, each symbol is functionally independent of the others. One of the primary advantages of the atomic

[267] Lindsay Vickery, "The Limitations of Representing Sound and Notation on Screen," 218.
[268] Ibid., 219.

scroller functionality is that because each symbol is functionally independent, traversal rates can be locally defined, enabling the creation of complex rhythms in a generative context, for instance, as the materials for the score need not be created prior to their dynamization, but can emerge in real time from "a nucleus of relations."[269] The atomic scroller functionality also facilitates score generation at the atomic level, enabling score persistence and emergent behaviors that may be inaccessible to scores with pre-rendered collections of symbols in a fixed relationship to one another.

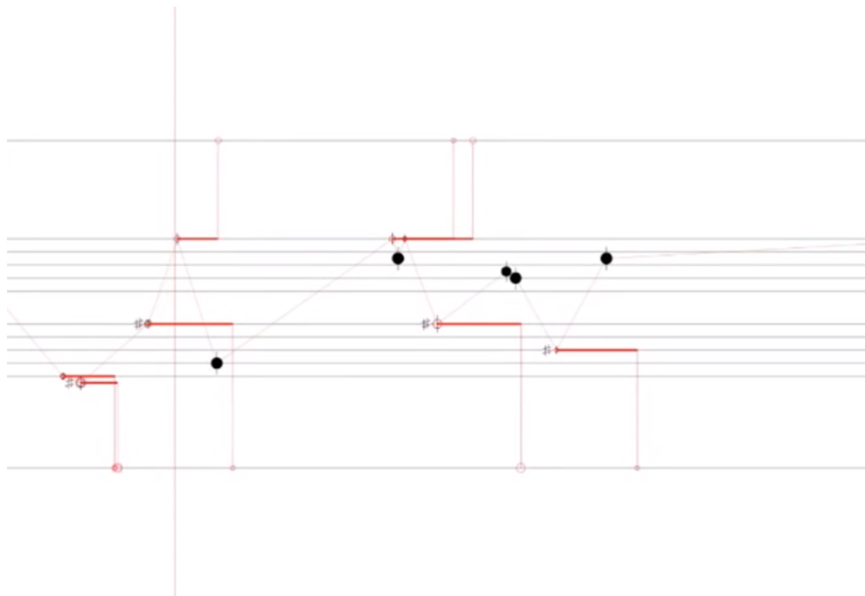

Figure 10: *Study no. 10* by Ryan Ross Smith (score detail) [270]

My composition *Study no. 10* (see figure 10 and chapter 4) is an example of a generative score in which each notational element (here represented by note heads) are autonomous instances of a programmed class (ac()). The characteristics of each note head are determined independently of the others, and this is most apparent in the speed by which each note head traverses the score. Note heads with higher speeds traverse the screen faster, appearing to overtake those note heads with slower speeds. While this introduces a challenging and necessarily-focused performance situation, what it also demonstrates is the decoupling of notational information from the "page", as it were, at the atomic level.

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[269] Gerhard E. Winkler, "The Realtime-Score. A Missing-Link in Computer-Music Performance."
[270] *Study no. 10*, Ryan Ross Smith, 2012.

3.4.6.3 Radial

Composer David Kim-Boyle describes his *Point Studies no. 4* (2013) as "five sets of concentric rings and rotating radials",[271] (see figure 11) and following this description, the term radial score can be used to describe any score that features attack lines and/or attack cursors rotating in clockwise or counter-clockwise motion to create contact and/or intersection between nodes, regions, and other symbols.

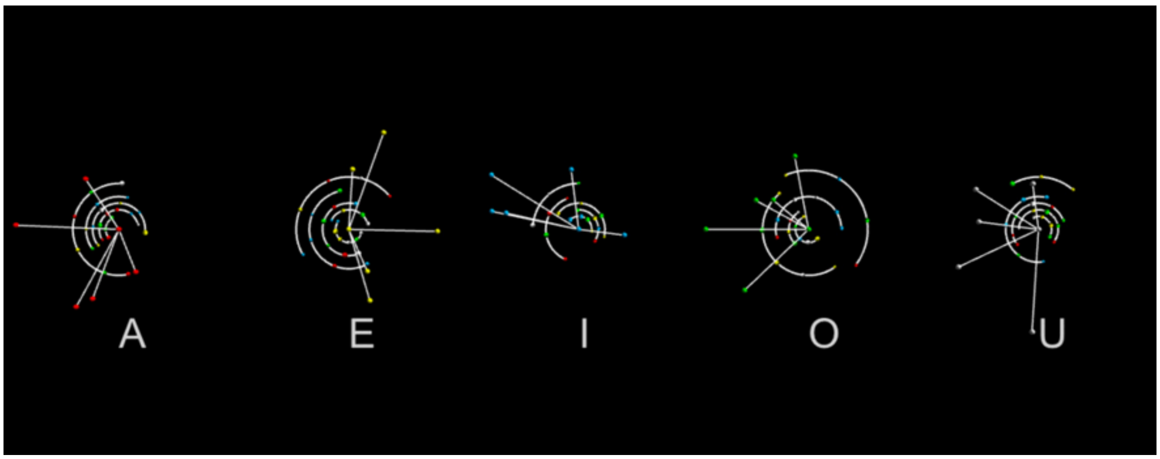

Figure 11: *Point Studies no. 4* by David Kim-Boyle (score detail)[272]

Like the functionality of a swiping playhead, radial notations are generally on-screen for the duration of a performance, as opposed to scrolling scores or atomic scrollers which tend to emerge from the right side of the screen, and disappear off the left side. In addition to Kim-Boyle's work, Jesper Pedersen incorporates flexible regions into the radial score for *Spooky Circle* to determine the timing and relative pitch of three theremin performers (see figure 12). Justin Wen-Lo Yang's *Webwork I* incorporates multiple radial attack lines in addition to static and rotating nodes and lines to prescribe a variety of performer actions (see figure 13). In my own work I have used radial notations to generate complex rhythmic relationships between players (*Study no. 11* & *Study no. 40.3* [see figure 14]), and to represent flexible timeframes within which one or more events are prescribed (*Study no. 16* & *Study no. 35*).

[271] "Point Studies no. 4," David Kim-Boyle, accessed February 18, 2016, http://www.davidkimboyle.net/point-studies-no-4-20141.html.
[272] Ibid.

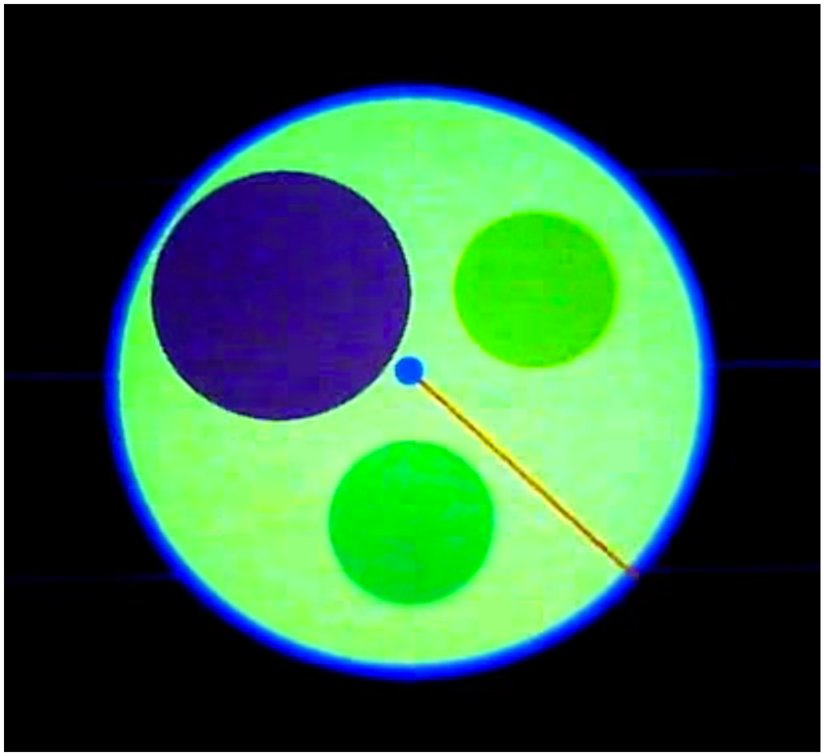

Figure 12: *Spooky Circle* by Jesper Pedersen (score detail) [273]

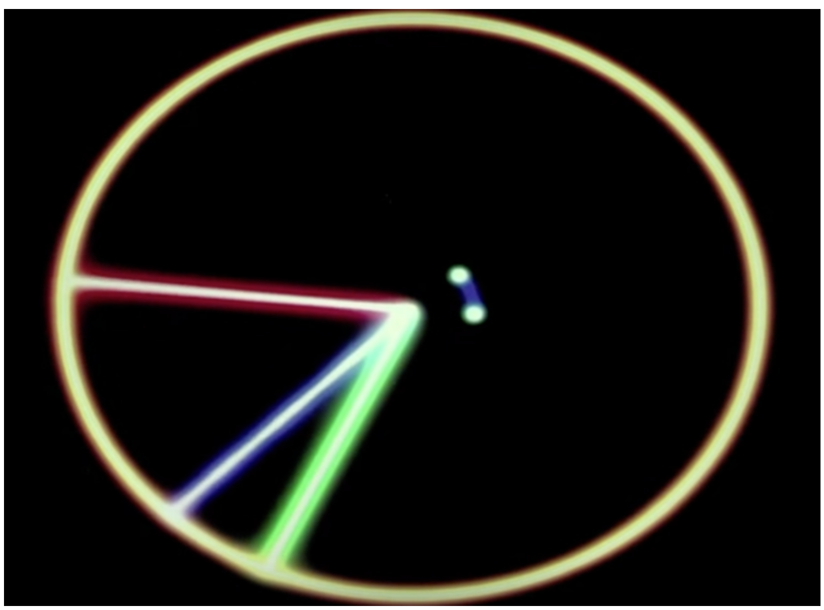

Figure 13: *Webwork I* by Justin Wen-Lo Yang (score detail) [274]

[273] "Jesper Pedersen – Spooky Circle," posted by "akiasgeirsson," October 28, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=NN5Z9c5lrac.
[274] "Webwork I by Justin Yang," posted by "Justin Yang," December 6, 2010, accessed February 16, 2016, https://www.youtube.com/watch?feature=player_embedded&v=O2F7M1Wh8n4.

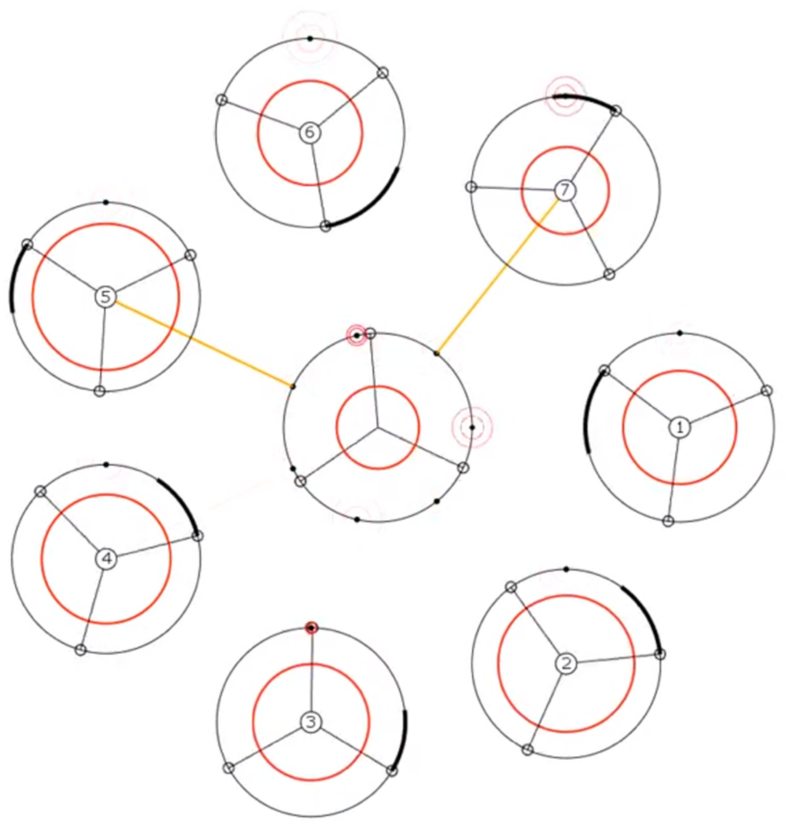

Figure 14*: Study no. 40.3 [pulseven]* by Ryan Ross Smith (score detail)[275]

3.4.6.4 Node Array

The score for David Kim-Boyle's *Music for 4* contains a "5x5 cell grid upon which patterns of black or white circles, each circle representing unique sonic events are placed."[276] (see figure 15). This notational representation can be referred to as a node array, which describes a structure containing two or more interconnected nodes organized in a line, grid or other arrangement. Like Kim-Boyle's *Music for 4*, each node within the array will generally correspond to a predefined musical event, and the temporal designations for each event can be indicated by the arrival of an attack cursor for instance. In some cases, the arrangement of the nodes within an array will reflect the functionality of the attack cursor. For instance, in cases where any node can follow any other node, the attack cursor must have unobstructed access in its movements between nodes, and in order

[275] *Study no. 40.3 [pulseven]*, Ryan Ross Smith.
[276] "Music for 4," David Kim-Boyle, accessed February 18, 2016, http://www.davidkimboyle.net/music-for-4-2011.html.

to preserve legibility, the attack cursor should not pass through one or more nodes as it moves toward its target node, as these nodes may be incorrectly identified as the target node. In my *Study no. 46*, 44 phonemes are stacked vertically down the center of the score, flanked on either side by a single static node. Each node array (the 44 stacked nodes on either side of the phoneme stack), in combination with the attack cursors, function as the aggregate for six vocalists, combining for a total of twelve vocalist aggregates (see figure 16). In order to distinguish between each player's respective attack cursor, each cursor is color-coded, and in order to avoid node-crossings during attack cursor traversals, each cursor travels in an arc between the active node and the target node. Upon reaching the target node, the singer vocalizes the corresponding phoneme, and the attack cursor immediately travels to any of the other 43 nodes. This functionality has since been used in *Study no. 48* to activate 15 performer-determined sounds, and in *Study no. 50* to determine which of the wooden planks the performer plays (see chapter 4).

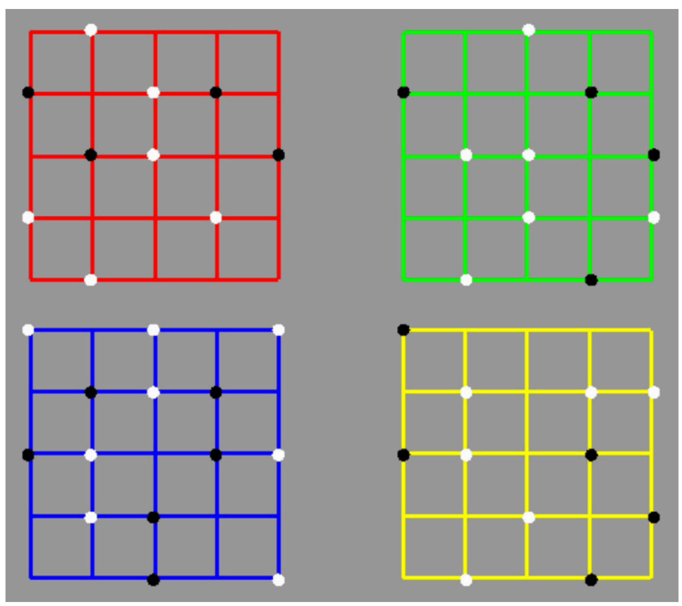

Figure 15: *Music for 4* by David Kim-Boyle (score detail)[277]

[277] "music for 4 (2011) for any four instruments," David Kim-Boyle, accessed March 1, 2016, http://www.davidkimboyle.net/music-for-4-2011.html.

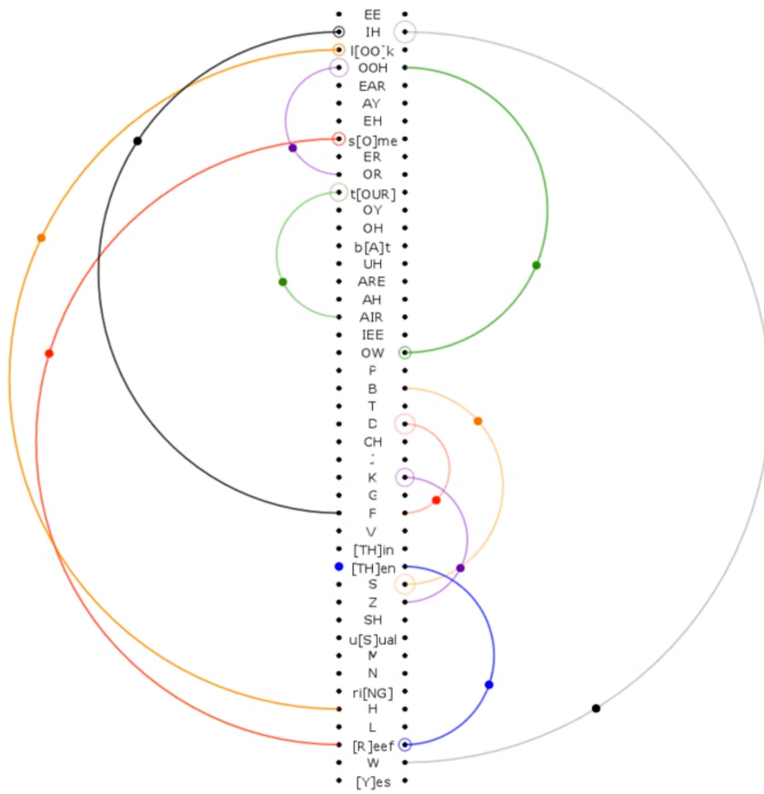

Figure 16: *Study no. 46* by Ryan Ross Smith (score detail)[278]

An earlier work, *Study no. 38 [Variations on Sol LeWitt's Variations of Incomplete Open Cubes]* is, as the title implies, based on the Sol LeWitt work *Variations of Incomplete Open Cubes* (1974). In LeWitt's diagram for the piece, each one of the 122 incomplete cubes is missing one or more edges, while the remaining edges are connected to one another. At the time (Spring, 2014), I had become increasingly interested in limiting my sonic palette, while exploring the combinatorial possibilities of iterative and generative systems. In LeWitt's drawing, the final image, 11/1, is the most complete of the cubes, missing only one edge, and clearly indicating seven points of intersection between the remaining edges. These seven points came to represent the seven performer-determined sounds in *Study no. 38*, and the resulting node array contains six nodes 60 degrees apart (as if represented on a circle), with a single node in the center. Each variation in *Study no. 38* was modelled after a corresponding image in LeWitt's drawing. For instance, in Variation 8, modelled after LeWitt's 4/5, four lines connect five nodes in a single

[278] *Study no. 46*, Ryan Ross Smith.

trajectory. Each node is activated by the arrival of an attack cursor, and the attack cursor can only travel to target nodes connected by a line to the active node (see Figure 17).

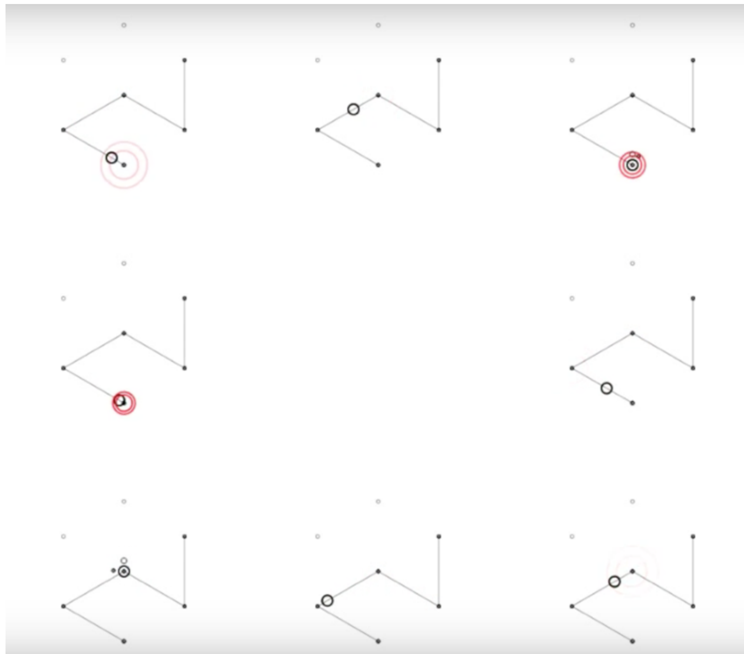

Figure 17: *Study no. 38 [Variation 8]* by Ryan Ross Smith (score detail)[279]

David Kim-Boyle's *Point Studies no. 3* for piano and computer (2013) features "a series of graphical nodes [are] stochastically distributed in a rectilinear grid and connected at vertical and horizontal points of alignment."[280] Each node array determines pitch by node color, duration by relative length of the horizontal lines, and are "periodically rotated … resulting in shifting harmonic delineations and pitch successions."[281] In this case, the node array does not utilize an attack cursor to determine each event, but rather, as an elegant method for the representation and modification of a limited sonic palette (see figure 18).

[279] *Study no. 38 [Variations on Sol LeWitt's Variations of Incomplete Open Cubes]*, Ryan Ross Smith, 2014.
[280] "Point Studies no. 3," David Kim-Boyle, accessed February 18, 2016, http://www.davidkimboyle.net/point-studies-no-3-2013.html.
[281] Ibid.

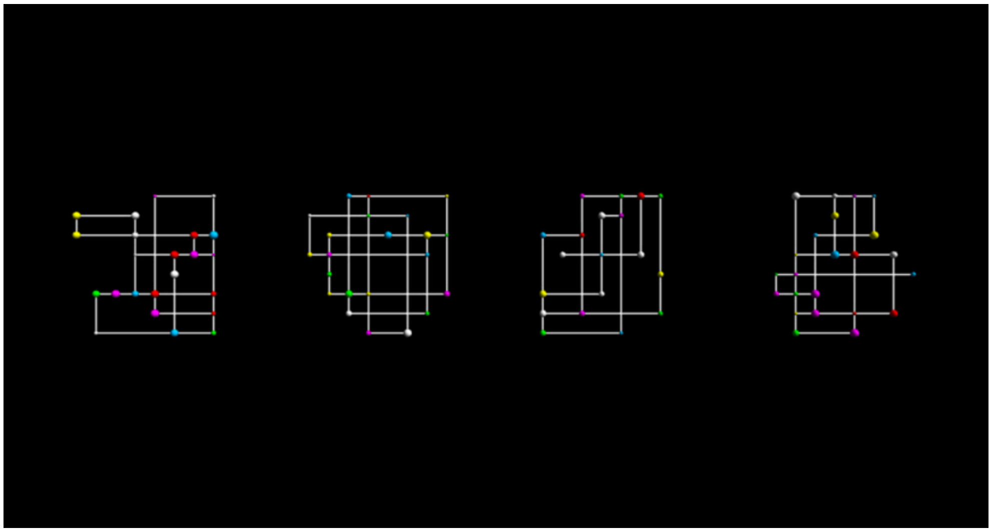

Figure 18: *Point Studies no. 3* by David Kim-Boyle (score detail) [282]

3.4.6.5 Action or Tablature

An action or tablature score is a visual representation of the physical process by which a particular sound is to be activated by the performer. In the score for my *Study no. 8 [15 Percussionists]* (2012) and *Study no. 22 [for 24]* (2013), the action of a mallet or stick striking an instrument is represented by an attack cursor descending on to, and making contact with a static node, and immediately reversing direction, effectively mirroring the physical process of striking an instrument (see figures 19 & 20). Lindsay Vickery has described *Study no. 8* as a tablature score, in which "The smooth pendulum movement of the mallet symbols in this work allows the performers to anticipate the point at which they will strike the small grey circles on each side of the figure representing the instrument."[283] In reference to *Study no. 8* and *Study no. 22*, David Kim-Boyle has described these notations as a mapping of "graphic typography to gesture."[284] The pendulous movement of the attack cursor can be simply mirrored as a gesture, or physical action, by the performer.

[282] Ibid.
[283] Lindsay Vickery, "The Limitations of Representing Sound and Notation on Screen," 220.
[284] David Kim-Boyle, "Visual Design of Real-Time Screen Scores," 293.

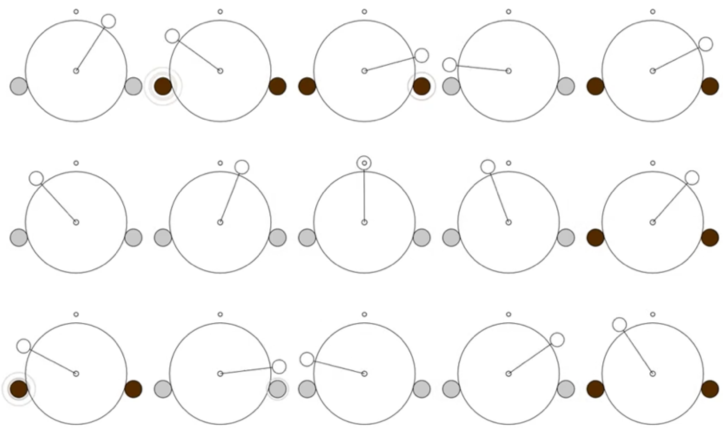

Figure 19: *Study no. 8 [15 Percussionists]* by Ryan Ross Smith (score detail) [285]

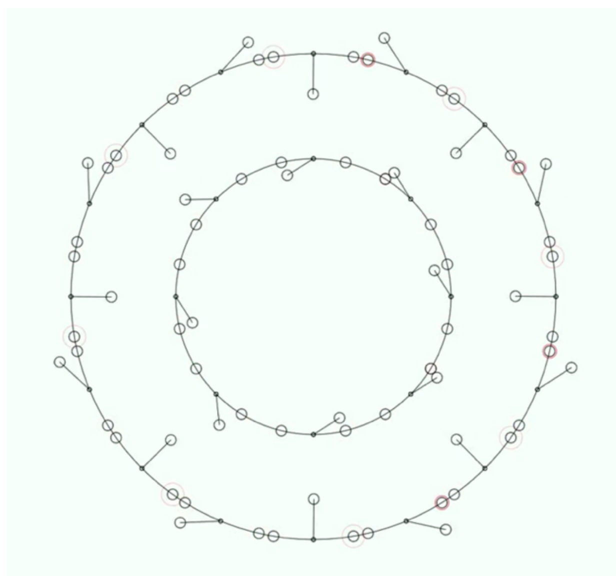

Figure 20: *Study no. 22 [for 24]* by Ryan Ross Smith (score detail) [286]

Action Score can be used to describe any score in which the physical actions of the performer are represented by the dynamic functionality of the score, including scores that indicate performer actions with a simple "on/off" functionality, but are less explicit in mirroring the specific actions of the performer. Many scores created by the composers associated with the Reykjavik-based S.L.Á.T.U.R. collective have exploited this approach to great effect. In Jesper Pedersen's *Bottleneck* (2011), each performer holds a piece of string with a plastic cup attached to it in each hand. The score, which contains a series of

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[285] *Study no. 8 [15 Percussionists]*, Ryan Ross Smith, 2012.
[286] *Study no. 22 [for 24]*, Ryan Ross Smith, 2013.

color-coded triangles, prescribes performer actions by tilting these triangles side to side, with sudden changes to their vertical position (see figure 21). These movements indicate that the performer is to shake the cups side to side and quickly lift them up before letting them fall to the floor respectively. Páll Ivan Pálsson's *Sáðrás* (2013), for toy piano, indicates each attack by the moment a small dynamic cursor makes contact with the interior of an orange cavity (see figure 22). Like Pedersen's *Bottleneck*, the action of each node falling, and subsequently making contact with the interior walls of the cavity clearly mimic the physical actions of the performer's finger descending to make contact with a key on the toy piano.

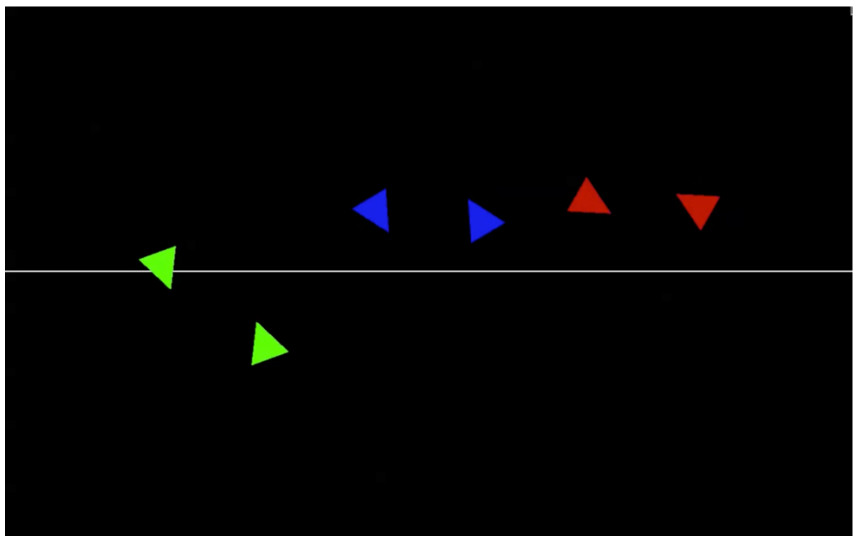

Figure 21: *Bottleneck* by Jesper Pedersen (score detail)[287]

[287] "Flöskuhnakki / Bottleneck (musical score)," YouTube video, posted by "Jesper Pedersen," December 16, 2011, accessed February 16, 2016, https://www.youtube.com/watch?v=li6rJJFflYM&feature=youtu.be.

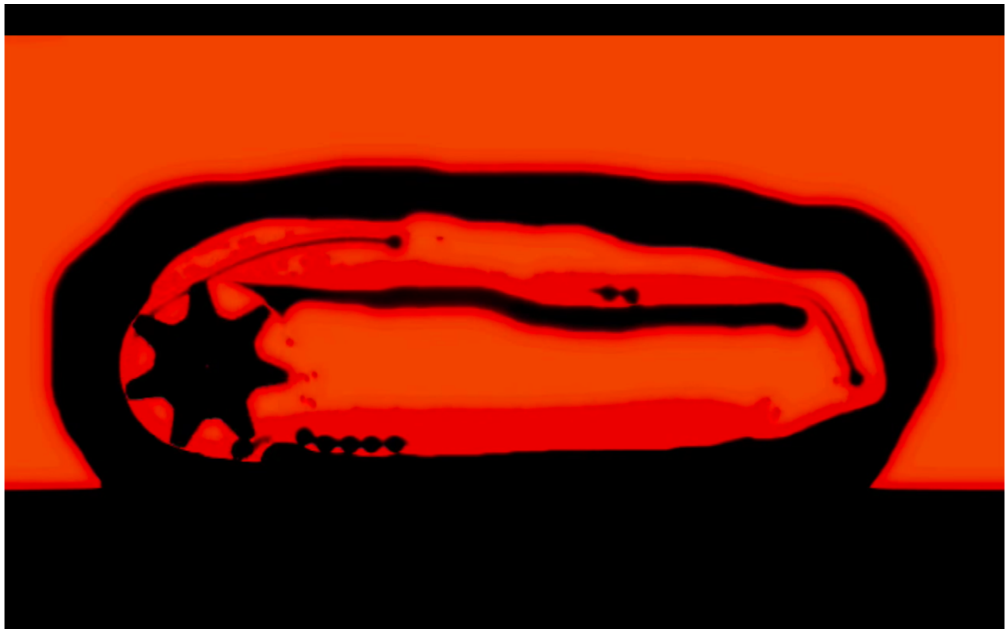

Figure 22: *Sáðrás* by Páll Ivan Pálsson (score detail)[288]

3.4.6.6 Suggestive Animated Scores

Suggestive Animated Scores may include functionalities found in the approaches previously discussed, but are generally not designed to prescribe specific actions. While these scores do not always incorporate the essential ideas outlined in chapter 3.1, they are included under the umbrella of animated scoring practices, due to their necessarily dynamic functionalities. Unlike the prescriptive specificity found in animated scores that implement contact and intersection, suggestive animated scores are designed to activate performers in an improvisatory manner. The suggestive aspect of these scores can be described as either suggestively referential or suggestively gestural.

A suggestively referential animated score borrows the symbolic content from established notational practices, CPN in particular, but displaces these symbols from their original functional context. Alexander Dupuis' *It's Not an Intervention* (see figure 23) and *Children of the Seventh Species: Reveal Yourselves*, Luke Harris' *For Oskar* and *4x4x4*, and Andre Vida's *Animated Scores 139-149* all contain CPN symbols dissociated from their functional context, and appropriated to simply reference the functionality of CPN

[288] "Sáðrás (performance)," YouTube video, posted by "Páll Ivan frá Eiðum," October 25, 2013, accessed February 16, 2016, https://www.youtube.com/watch?v=7A4z-iXVoiI&feature=c4-overview&list=UUj_87pxB8giza9f4I7AjxHQ.

(see figure 24). These symbols are then combined and animated in a variety of ways to elicit some musical response. Vida's accompanying text clarifies the intentions of his works:

> First you must choose how to approach the score. An antagonist, a mirror, an ignorant, or otherwise? If otherwise, do you hear the symbols as parts of a whole? Or do you hear the individual symbols? Would you like to isolate them and assign each a sonic identity? No?[289]

Vida's possible modes of interpretation invite the performer to determine not only the representational intentions of the score, but suggest a range of specificity:

> 2. Use the score as a suggestion for the motion of an external object in relation to your instrument. […] 4. Consider using the visual as a 1 to 1 map of the parameters of your sound, then consider superimposing your own sonic maps over the moving scores.[290]

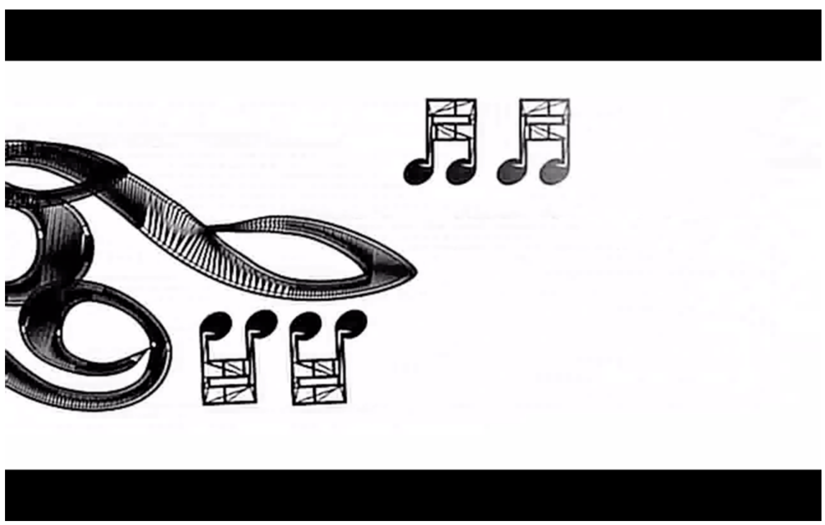

Figure 23: *It's Not an Intervention* by Alex Dupuis (score detail) [291]

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[289] "Animated Scores," Andre Vida, accessed October 15, 2013, http://www.vidatone.com/animatedscores.html.
[290] Ibid.
[291] "It's Not an Intervention," YouTube video, 3:31, posted by "Fupierre's channel," December 27, 2009, accessed February 16, 2016, https://www.youtube.com/watch?v=vaMU3EYStoY.

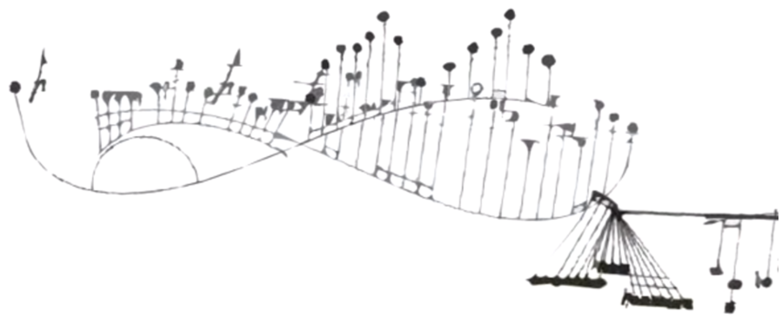

Figure 24: *Animated Score #149* by Andre Vida (score detail)[292]

The works of Dupuis, Harris and Vida represent a shift away from specific prescription generally associated with AMN toward suggestive improvisation, while still regulated by the symbolic baggage of CPN. The realization of these works, while improvisatory, will likely lead to a less-than-ambiguous relationship between representation and realization, although certainly thinner than an otherwise prescriptive animated score. In a sense, the sonic realization of these works in conjunction with the score is a recoupling of the notation with its original function, its suggestiveness specified by its realization, although not nearly to the prescriptive degree enabled by dynamic indication and a predefined symbol system.

Beyond scores that feature the animation of decontextualized abstracted notational symbols are animated scores that represent the musical idea without referencing preexisting notational symbols, relying entirely on the gestural qualities of the score. Casey Farina describes his *bitsmoke: movement* (1997) as "an experiment in the limits of graphic notation", and layers a variety of generative animations on top of performance footage of a dance quartet.[293] (see figure 25) Farina instructs each of the four performers to interpret "one quadrant of the animated score", and that "the only instructions for the

[292] "vidatone 149 interpreted by Massimo Magee," YouTube video, 1:37, posted by "vidatone," April 12, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=jkkyvfhQvYk#t=28.
[293] "bitsmoke: movement HD," Vimeo video, 15:44, posted by "clf clf," March 4, 2008, accessed February 16, 2016, https://vimeo.com/754190.

performers in addition to the animated graphic score are: White = Sound Black = Silence."[294]

Figure 25: *bitsmoke:movement* by Casey Farina (score detail)[295]

In Michael James Olson's *Preludium*, the score also contains four quadrants, each containing a series of evolving, abstract animations. Like Farina, Olson is interested in exploring "the limits of graphic notation", and supplies a similarly-themed set of instructions in which black represents silence, light images and dark images represent long and short sounds respectively, and pitch is based on the "gestural movement of the images."[296] While Olson provides slightly more instructional information, the scores for *Bitsmoke* and *Preludium* demonstrate the use of movement to activate a real time, gestural response without a prescriptive notation.

3.4.7 Interactive Animated Scores

Computer-based animated scores introduce the potential for real-time input beyond the embedded process(es) from which the score is generated. Jason Freeman, who has created

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294 Ibid.

295 "bitsmoke: movement HD," Vimeo video, 15:44, posted by "clf clf," March 4, 2008, accessed February 16, 2016, https://vimeo.com/754190.

296 "Preludium: An Animated Graphic Score," Vimeo video, 7:52, posted by "Michael James Olson," May 21, 2010, accessed February 16, 2016, https://vimeo.com/11926071.

several large-scale interactive animated scores, suggests that artist and composer's interest in developing intriguing methods of audience-performer connectivity "follow recent technological and aesthetic trends that have challenged active cultural consumers, helping to create the content we enjoy rather than serving as mere spectators."[297] Freeman's works often include audience interaction to influence the content and flow of a piece. In *Flock* (2007), "music notation, electronic sound, and video animation are all generated in real time based on the locations of musicians, dancers, and audience members as they move and interact with each other."[298] In *Glimmer* (2004), "each audience member is given a battery-operated light stick which he or she waves back and forth over the course of the piece," and this visual information is captured, analyzed, and used to activate each performer's notation "via multi-colored lights mounted on each player's stand."[299] The score application for Sandeep Bhagwati's *Monochrom* "listens to the musicians and re-configures itself to generate the pages during the concert", and in the final movement, the performers have a more direct, autonomous interaction with the score, deciding "for themselves when to turn to the next page … independently of each other."[300] In Harris Wulfson's *LiveScore*, elements of the score can be dynamically altered by audience members with a MIDI controller. Each rotary knob on the controller is configured to modify generalized parameters titled sparseness, pitchiness, stasis, and togetherness:[301] "The actual musical content was generated by a simple stochastic algorithm whose bounds were determined by the knob positions."[302] In Paul Turowski's *Hyperions*, "real-time performance decisions about pitch, timing and activity … influence a physics-based game world",[303] and in Arthur Clay's *China Gates* for distributed gong ensemble, GPS devices are used to determine each performer's physical distance from a predefined starting location, which modifies their respective notational representations. Using an LED array

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297 Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," 30.
298 "Flock," distributedmusic, accessed February 18, 2016, http://distributedmusic.gatech.edu/flock/.
299 "Jason Freeman: Glimmer (excerpt)," Vimeo video, 2:02, posted by "Jason Freeman," February 1, 2009, https://vimeo.com/3047748.
300 "monochrome," matralab, accessed February 18, 2016, http://matralab.hexagram.ca/projects/monochrom/.
301 G. Douglas Barrett, Michael Winter and Harris Wulfson, "Automatic Notation Generators."
302 Ibid.
303 "Hyperions," YouTube video, 6:44, posted by "Paul Turowski," November 21, 2014, accessed February 16, 2016, https://www.youtube.com/watch?v=ggq49UjScOg&feature=youtu.be.

fixed on the performer's wrist, the aptly-named "Wrist-Conductor" acts as the score, instructing performers when to play their respective gongs. As each player moves further away from the "SynchPoint," their tempo increases independent of the others.[304] In this case, performers interact with the score by changing their location, rather than the deliberate manipulation of an object, a midi controller for example, by performers or audience members. One of the more challenging interactive animated scores is Nick Didkovsky's *Zero Waste* for sight reading pianist and computer. The score begins by displaying "two measures of software-generated music in common music notation. Once [Kathleen] begins playing, the software begins to transcribe her performance into the score. The performer in turn, 'sight reads' this score."[305] Each mistake becomes part of the system, and is maintained until overwritten by a non-scored musical event. Georg Hajdu's *Quintet.net* enables the transmission and modification of real-time notation to physically-displaced performers. Hajdu's platform enables multiple streams of influence to the ensemble, the technology itself functioning as a framework for compositional experimentation, but not a fixed composition in and of itself.[306]

3.4.8 Animated Score Presentation

The majority of animated score presentation models can be generalized as either local or global. The local presentation model describes a performance situation where the score is only visible to the performers. This approach more closely approximates the traditional model, and is best evidenced by the Decibel ensemble's *ScorePlayer* app. The *ScorePlayer* app runs on an iPad, and in performances, the ensemble places their networked iPads on music stands. The global or cinema model describes the presentation of an animated score using one or more large-scale projections. This model enables viewing by both the performers and the audience, and often provides an opportunity for the audience to develop a better understanding of the compositional idea. As Freeman

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[304] Arthur Clay and Dennis Majoe, "The Wrist-Conductor" (paper presented at the 7th International Conference on New Interfaces for Musical Expression, New York, New York, June 6-10, 2007).
[305] "Zero Waste, for sight reading pianist and computer," YouTube video, 4:47, posted by "doctornerve," August 1, 2010, accessed February 16, 2016, https://www.youtube.com/watch?v=ityRapVd4kw&list=UU5_kF1cE2YwGCernIxLT6FA&index=60&feature=plpp_video.
[306] Georg Hajdu, "Quintet.net – A Quintet on the Internet" (paper presented at the International Computer Music Conference, Singapore, September 29 – October 4, 2003).

notes, "many composers display the notation generated by their systems not only to the musicians but also to the audience, so that the audience can better understand the relationship between the algorithm's direct output and the musicians' interpretation of that output."[307] For thinner, more suggestive works, while any apparent correspondence between the image (score) and the performers' sonic realization may be largely coincidental, whatever correspondences do occur may enhance the audience's understanding of the work.[308] Furthermore, the cinema model enables the representation of large-scale score formats in which audience members are the sole performers (Erin Vargas' *Al Encuentro del Silencio*, Jim Ryan's *Follow the Lederhosen* and Ryan Ross Smith's *Study no. 35*).

Within these general categories, animated score presentation in rehearsal and performance can take a variety of forms. Jason Freeman and Andrew Colella identify several presentation methods that have been employed in animated score presentation. The Direct-Display System describes a system in which the score is presented from a single device; a computer, for example. This display can then be networked to facilitate the spatialization of performers, or projected for the audience. The Screen-Sharing System describes a server-client relationship between the score generator/score playback device (server) and its visual representation on one or more separate devices (client(s)).[309] This server-client relationship is best represented by the Decibel *ScorePlayer* iPad App (see figure 26). Designed specifically for the representation of scrolling scores, "The Decibel ScorePlayer is an application that enables network-synchronised scrolling of proportional color music scores on multiple tablet computers."[310]

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[307] Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," 36.
[308] Ibid., 36.
[309] Jason Freeman and Andrew Colella, "Tools for Real-Time Music Notation," 101-113.
[310] "The Decibel ScorePlayer," Decibel New Music, accessed February 18, 2016, http://www.decibelnewmusic.com/decibel-scoreplayer.html.

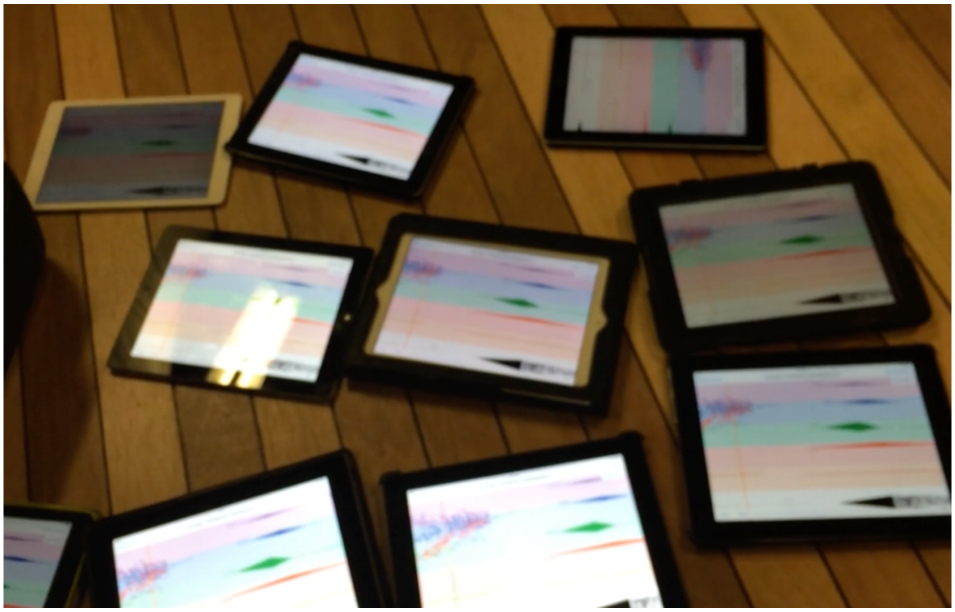

Figure 26: Decibel ScorePlayer[311]

The aforementioned notational system developed by Arthur Clay for *China Gates*, the Wrist-Conductor, demonstrates a unique approach to the local presentation model.[312] While the score is likely only visible to the performer, it is in a sense globalized by the performers roaming behaviors. Similarly, in Jason Freeman's *Flock*, "The computer software sends the real-time notation wirelessly to PocketPC PDA devices", allowing the performers the freedom to wander, while still maintaining prescriptive control.[313]

The animated score also introduces innovative performance situations that exploit the generative functionalities and presentation capabilities of a dynamic, digital system. According to Winkler, "[a] mixture of 'installation' (where one can enter, move around and go out at will) and 'concert-situation' […] seem to be the best environment for the presentation of this type of music."[314] When presented in an installation context, the dynamic, generative qualities of an animated score can be successfully exploited over an extended duration, in order to provide sufficient time for a range of compositional potentialities to be actualized, and for the audience members to develop an understanding

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[311] Ibid.
[312] Arthur Clay, "You Can Play It Too: The Virtuoso Audience," 63-73.
[313] Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," 33.
[314] Gerhard E. Winkler, "The Realtime-Score. A Missing-Link in Computer-Music Performance," 5.

of the system.[315] Following this, the use of projection mapping describes a presentation method in which the score is (in)directly mapped onto the instruments themselves, integrating representation and instrument in a sculptural way (see figure 27 and the discussion of *Study no. 30* in chapter 4).

Figure 27: *Laser Cat* by Jesper Pedersen (score detail)[316]

In the case of non-digital animated scores, methods for score presentation are varied, from the paper-based, human-operated scrolling scores of Andy Ingamells (*Dozen it make you sick?* and *Free as in beer* [see figure 28]) and Ryan Ross Smith's *Study no. 23.1* (a 'ScrollBox' built with receipt paper and a cigar box) to Charles Ross' real-time, handwritten notation in *Reading* and physical indication in *Sandbox*. The presentation model for each of these pieces is determined by the functionality and materials of the score itself, and unlike a video file or computer application, is not generally transferrable to other presentation models.

[315] Ibid., 5.
[316] "Laser Cat," YouTube video, 6:13, posted by "Jesper Pedersen," June 8, 2010, accessed February 16, 2016, https://www.youtube.com/watch?v=BIzF5zwELlE.

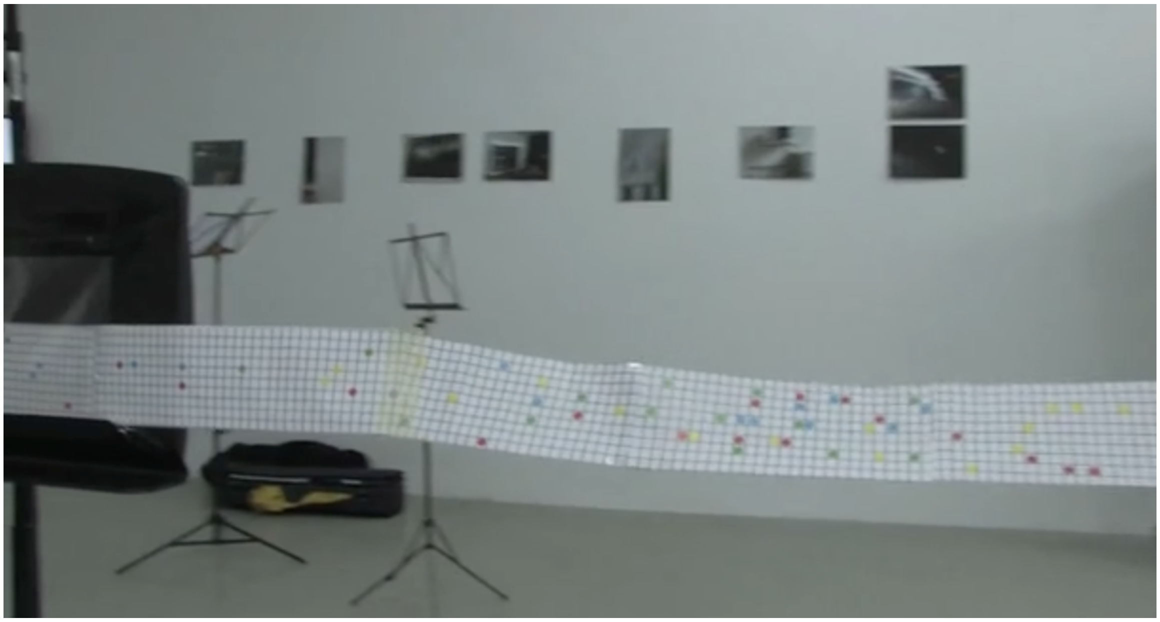

Figure 28: *Free as in Beer* by Andy Ingamells (score and performance detail)[317]

3.5 Animated Music Notation: Low-Level or Atomic Terminology

3.5.1 Introduction

The animated scoring discourse covers a wide range of relevant topics, from the distinction between a variety of high-level functionalities, to the various of methods for score presentation, but little has been published regarding the low-level or atomic notational components of AMN. In the following section I will propose a series of terminological distinctions designed to clarify the atomic elements commonly found in AMN. This terminology has been largely influenced by the works examined during my research, conversations with composers, and scholarly writings. I have also had the opportunity to refine this terminology in conversations with performers in the various concerts, workshops and lectures I have presented over the past several years, including in particular a paper written for Tenor 2015: First International Conference on Technologies for Music Notation and Representation [318] from which much of this material is sourced.

[317] "Free as in beer," Vimeo video, 1:25, posted by "Andy Ingamells," November 10, 2013, accessed February 16, 2016, https://vimeo.com/79038326.

[318] Ryan Ross Smith, "An Atomic Approach to Animated Music Notation" (paper presented at Tenor 2015: First International Conference on Technologies for Music Notation and Representation, Paris, France, May 28-30, 2015):40-48.

The atomic elements of AMN can generally be reduced to four increasingly complex entities: atomic symbols, compound symbols (visually and functionally integrated atomic symbols), structures and aggregates. It is important to note that the following terminological distinctions are not necessarily applicable to all animated notational approaches, and thus, are not essential toward determining distinctions between what is, and what is not, an animated score. Rather, the following terms refer to a significant cross-section of animated scoring practices that, like CPN, favor prescriptive specificity over directed suggestiveness in the manner by which these notational elements are utilized.

3.5.2 Atomic Symbols

> "In most symbol schemes, inscriptions may be combined in certain ways to make other inscriptions. An inscription is atomic if it contains no other inscription; otherwise it is compound."[319]

In the context of AMN, an atomic symbol is an irreducible static or dynamic symbol. A symbol is only irreducible when no aspect of its design can be removed without limiting its intended function. Atomic symbols may be of any shape or size, but are often cast as small geometric shapes (circles, squares, rectangles, and straight or curved lines). A static atomic symbol can be referred to as a node or attack line (or simply point of articulation) based on its shape and functionality. A node is generally represented by a static circle (although other non-line shapes can function as nodes). A static attack line is most often represented by a fixed horizontal or vertical line. Screen boundaries, the horizontal and vertical edges of the score display are not generally treated as static attack lines, but may serve the same functional purpose (see figure 29).

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[319] Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols*, 141.

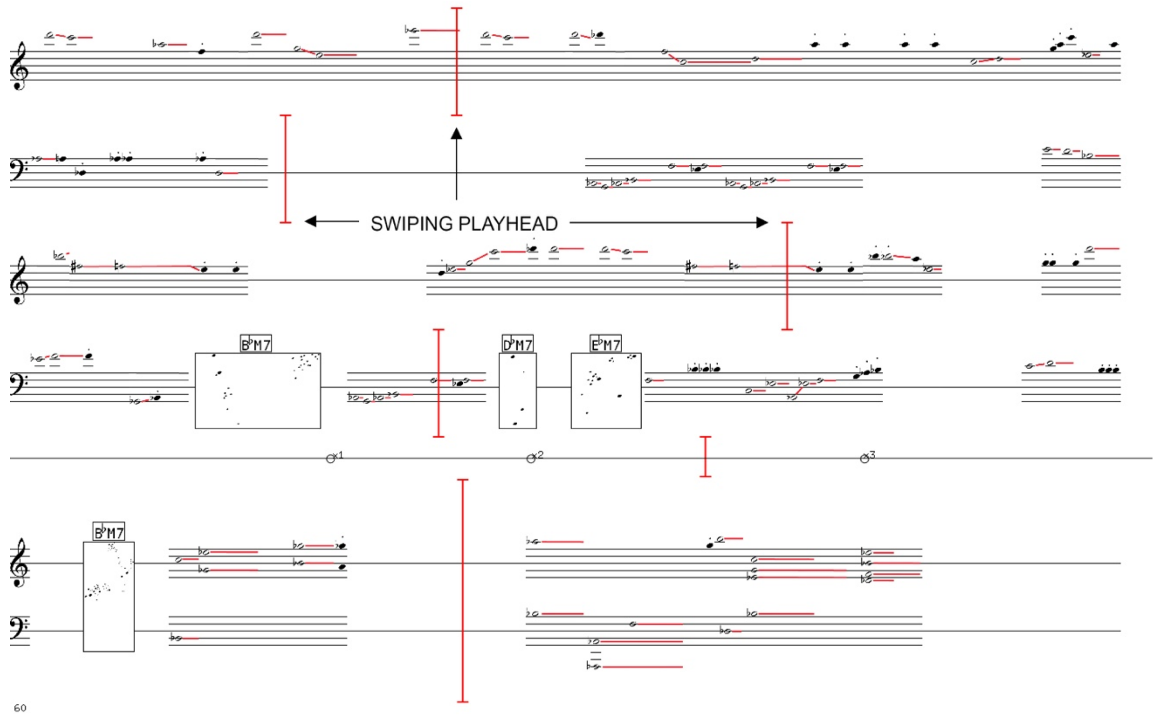

Figure 29*: Study no. 2* by Ryan Ross Smith (score detail) [320]

Dynamic, non-line atomic symbols will often have some functional relationship with a static node and/or static attack line. If the functional relationship between a dynamic non-line atomic symbol and another dynamic or static atomic symbol determines the onset of an event, the atomic symbol that indicates, or initiates some musical response by its dynamic behavior is called an attack cursor (see figure 30).

[320] *Study no. 2*, Ryan Ross Smith, 2011.

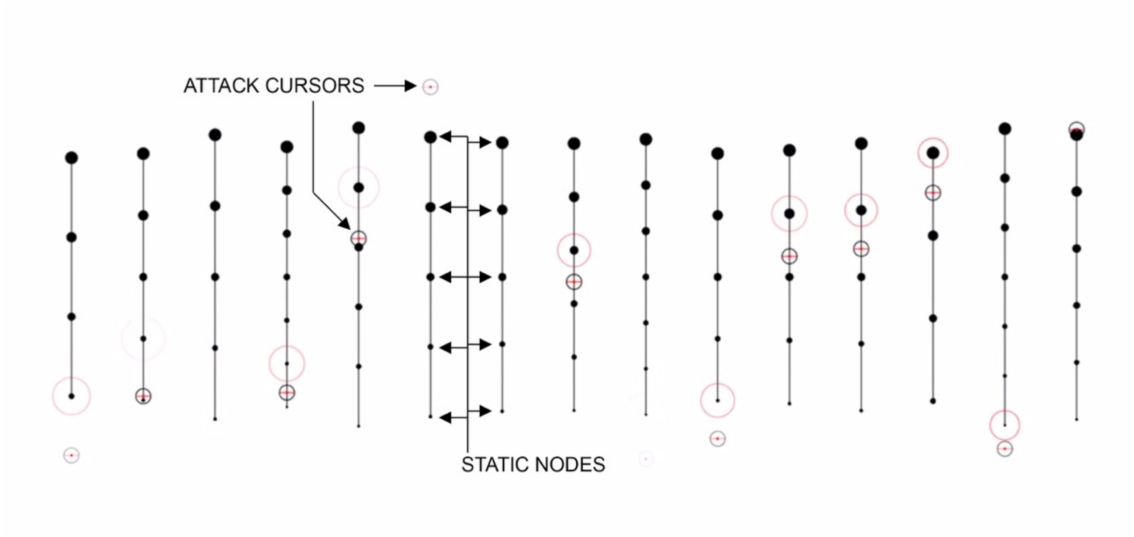

Figure 30: *Study no. 27* by Ryan Ross Smith (score detail)[321]

A dynamic line atomic symbol, or simply dynamic line, is often represented as a horizontal or vertical line moving along the X or Y axis respectively (although vertical traversal is less common). In both cases, the dynamic line can be referred to as a dynamic attack line, or swiping play head.[322] A dynamic attack line can also be configured as a radial.[323] A radial attack line, or simply attack radial, is generally fixed in place at one end, while the other end rotates in clockwise or counterclockwise motion (see figure 31).

[321] *Study no. 27*, Ryan Ross Smith.
[322] Ibid.
[323] "Point Studies no. 5," David Kim-Boyle, accessed February 18, 2016, http://www.davidkimboyle.net/point-studies-no-5-2014.html.

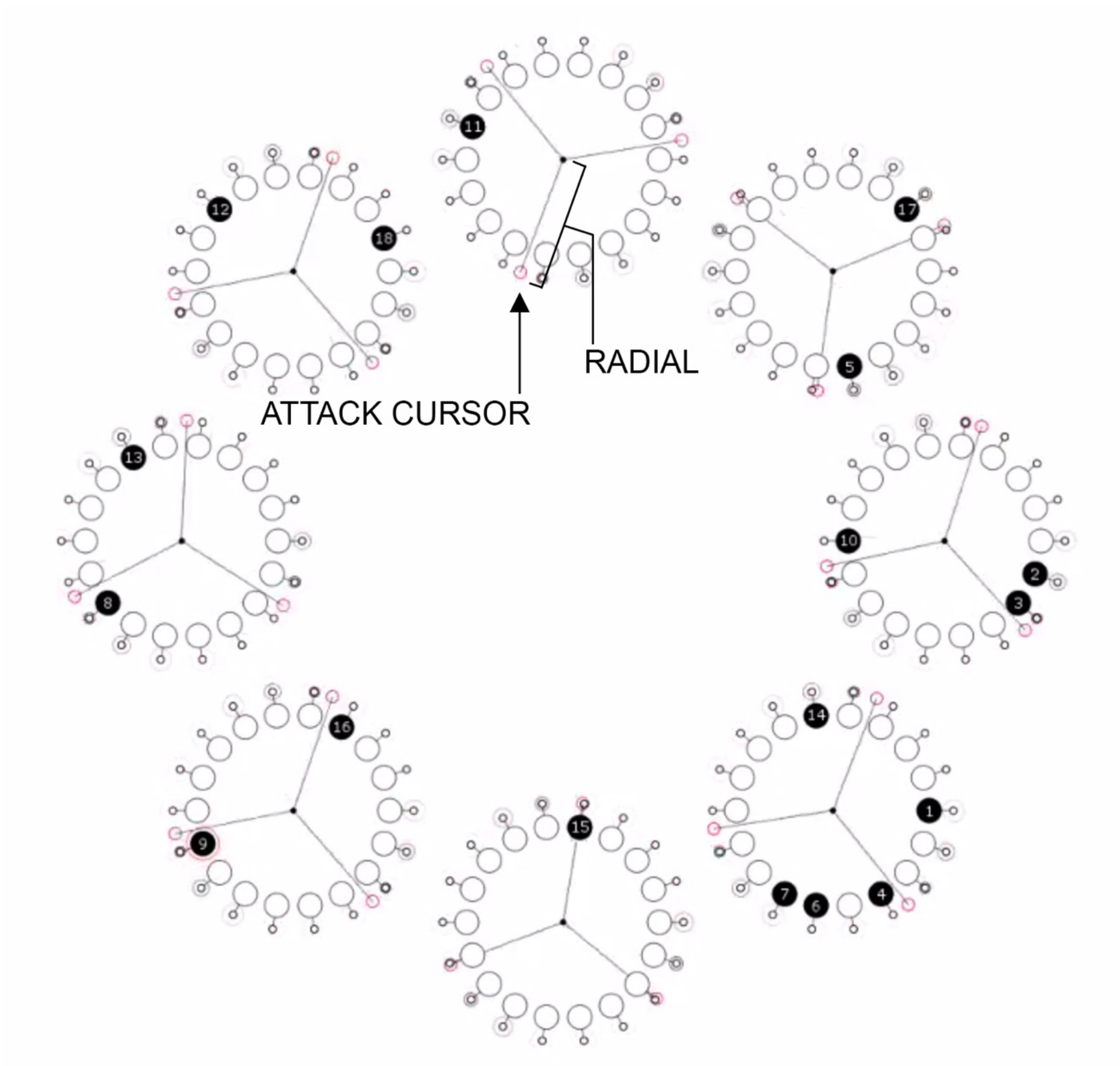

Figure 31: *Study no. 40.1 [pulseighteen]* by Ryan Ross Smith (score detail)[324]

While atomic symbols are generally cast as simple geometric shapes, an image can also function in much the same way, so long as it is similarly irreducible. These image symbols, which may take a variety of forms (frogs[325] and spaceships[326] for example (see figure 32 and 33)), generally correspond to a particular sonic event, based simply on their appearance in the score, or their interaction with other symbols.

[324] *Study no. 40.1 [pulseighteen]*, Ryan Ross Smith.
[325] "Skítkalt (animated score)," YouTube video, 5:17, posted by "Páll Ivan frá Eiðum," November 22, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=8z5OA5rJWXs.
[326] "Jesper Pedersen – Spooky Circle," YouTube video, 4:50, posted by "akiasgeirsson," October 28, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=NN5Z9c5lrac&feature=youtu.be.

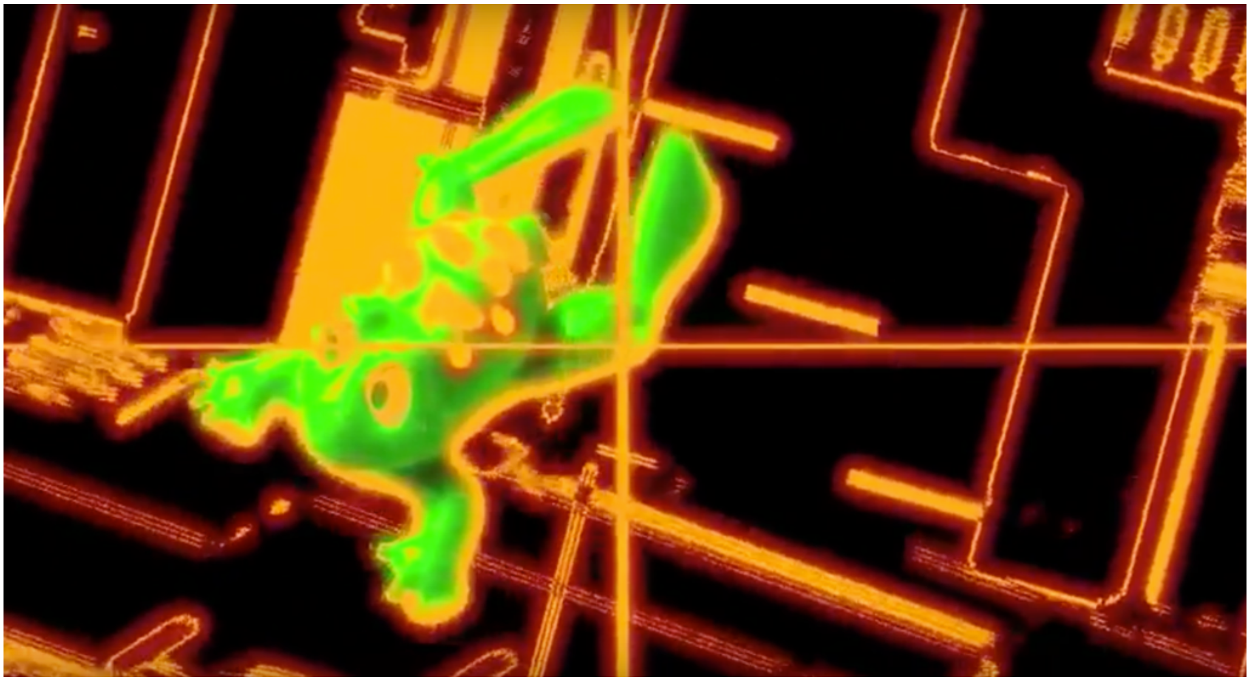

Figure 32: *Skítkalt* by Páll Ivan frá Eiðum (score detail)[327]

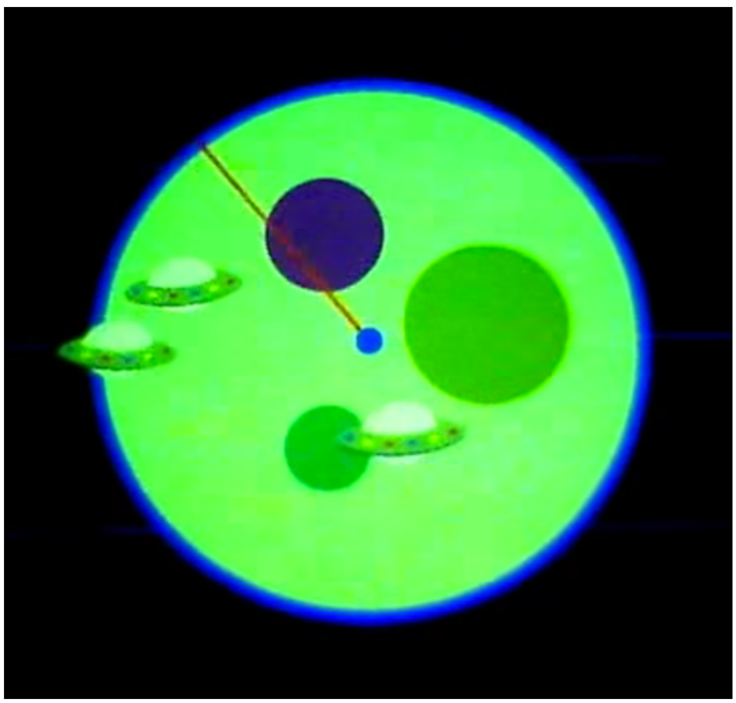

Figure 33: *Spooky Circle* by Jesper Pedersen (score detail)[328]

[327] "Skítkalt (animated score)," YouTube video, 5:17, posted by "Páll Ivan frá Eiðum," November 22, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=8z5OA5rJWXs.
[328] "Jesper Pedersen – Spooky Circle," YouTube video, 4:50, posted by "akiasgeirsson," October 28, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=NN5Z9c5lrac&feature=youtu.be.

3.5.3 Compound Symbols

Two or more atomic symbols can be combined in such a way that the secondary symbol enhances or embellishes the primary symbol, creating a compound symbol.[329] Compounding an atomic symbol may serve a variety of purposes, including improved legibility or modification to the initial appearance of the primary symbol in order to extend or clarify its functionality. In general, a compound symbol will be represented visually as a self-contained symbol (see figure 34).

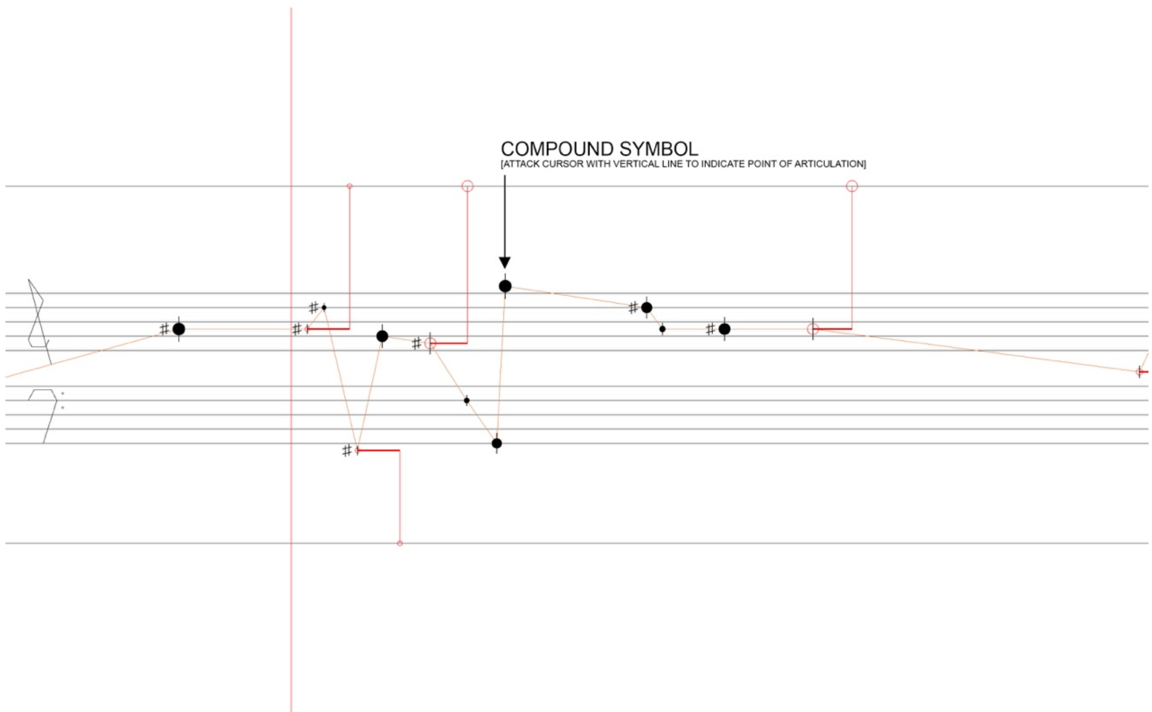

Figure 34: *Study no. 10* by Ryan Ross Smith (score detail)[330]

3.5.4 Region Symbols

A region describes an uncharacteristically large atomic symbol. Generally speaking, a region will be used for musical events that feature some change to its musical qualities over some duration, or to represent a sustained event (see figure 35).

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[329] Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols*, 141.
[330] *Study no. 10*, Ryan Ross Smith.

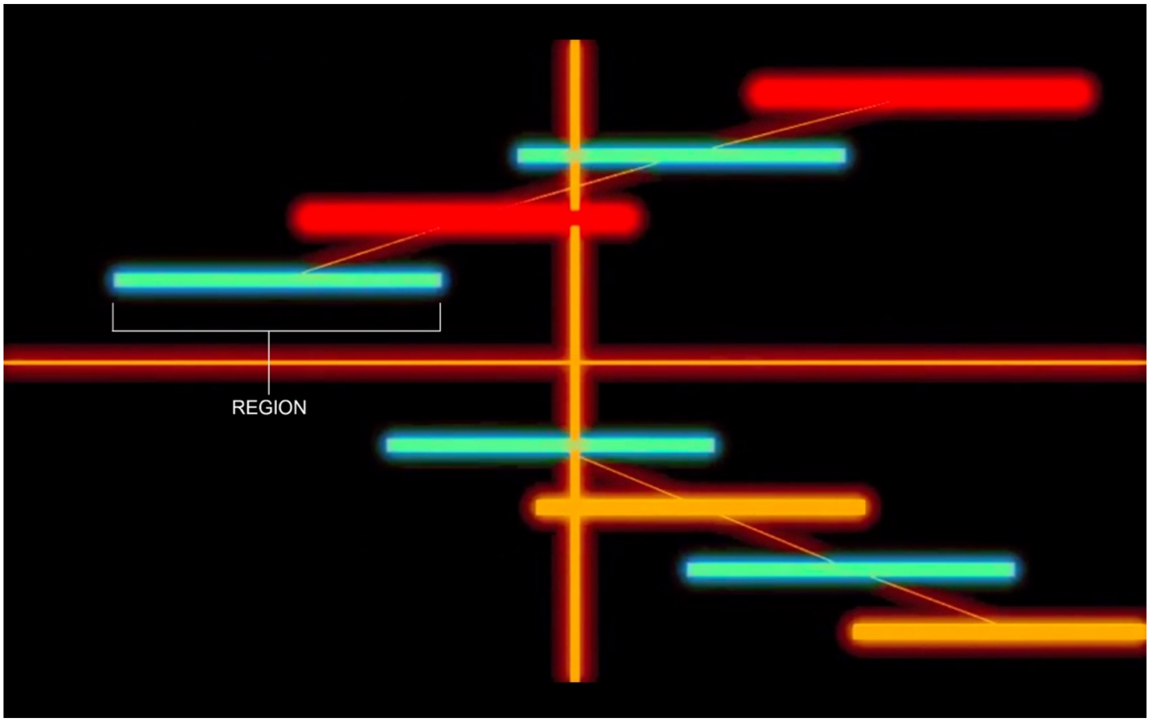

Figure 35: *Skítkalt* by Páll Ivan frá Eiðum (score detail)[331]

3.5.5 Structures

A structure describes two or more atomic and/or compound symbols that are linked in some functional relationship. A structure may contain static and dynamic symbols, in which the static elements of a dynamic structure are acted upon by the dynamic elements. At the lowest level, a single structure may contain the elements necessary to prescribe one or more musical events, and because an animated score is necessarily dynamic, every animated score will contain at least one structure (see figure 36).

[331] "Skitkalt (animated score)," YouTube video, 5:17, posted by "Pall Ivan fra Eidum," November 22, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=8z5OA5rJWXs.

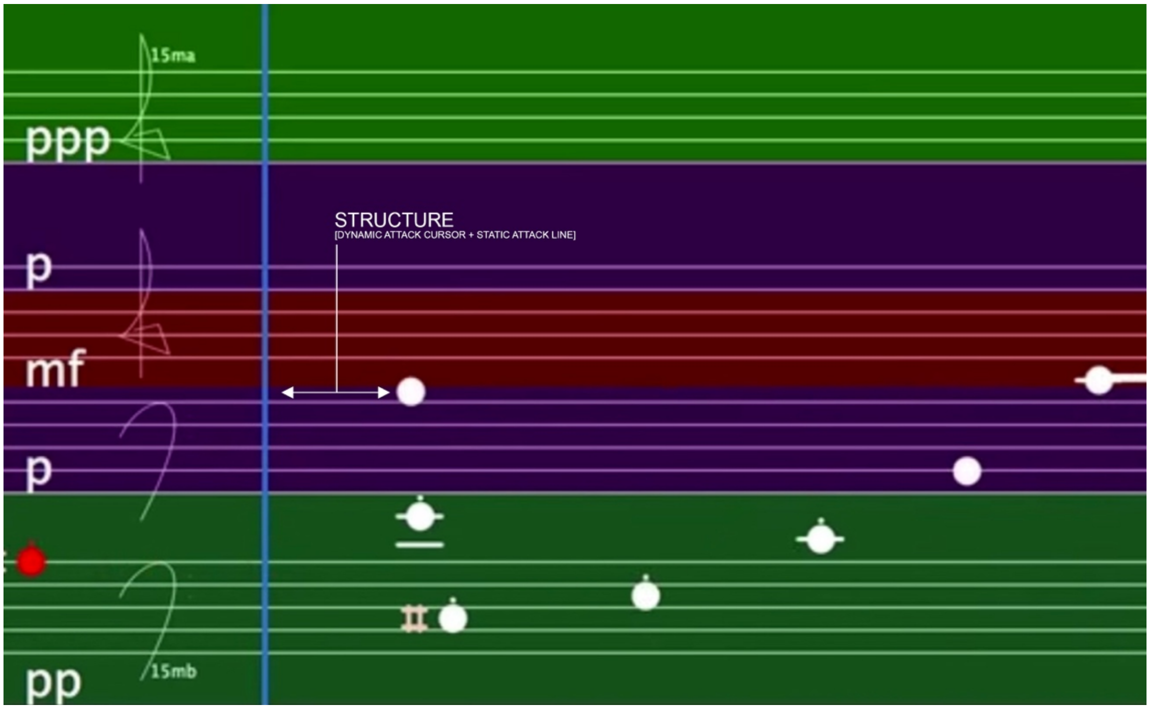

Figure 36: *Safmana* by Gudmundur Steinn Gunnarsson (score detail)[332]

3.5.6 Aggregate

An aggregate encompasses the total set of atomic and compound symbols, structures, and their respective dynamic qualities that correspond to a single player in an animated score. Aggregates may be visually displaced or integrated with other aggregates, and may be functionally autonomous or dependent on the functionality of other aggregates, or the global functionality of the score. Depending on the functionality of the score, performers may at times be instructed to shift aggregates, although this is not common. In its simplest form, an aggregate may be represented by a single structure (see figure 37 and 38).

332 "Gudmundur Steinn Gunnarsson – Safmana excerpt 1," YouTube video, 0:57, posted by "gudmundursteinn," August 4, 2015, accessed February 16, 2016, https://www.youtube.com/watch?v=CPgVrKMWVpo.

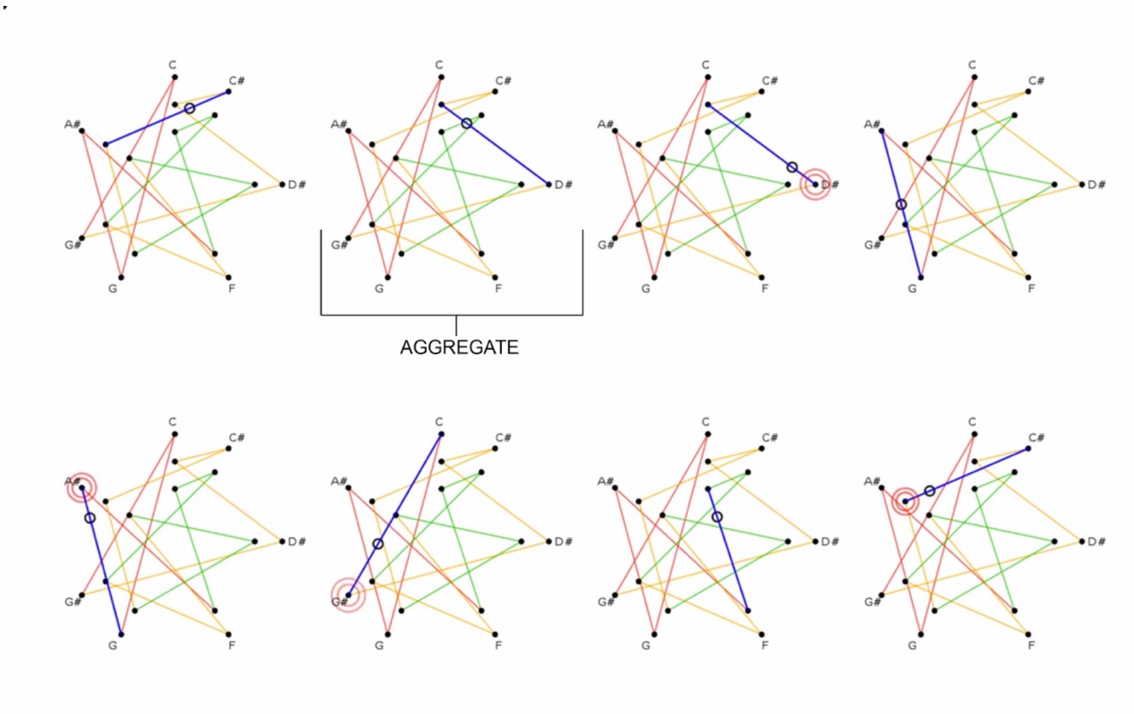

Figure 37: *Study no. 32* by Ryan Ross Smith (score detail)

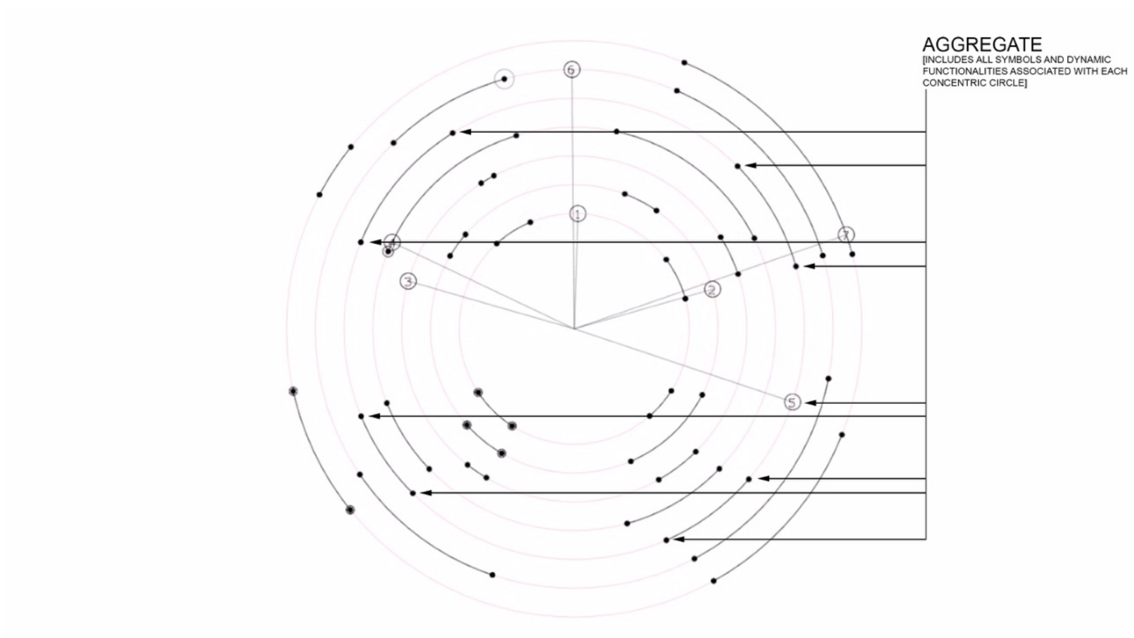

Figure 38: *Study no. 31* by Ryan Ross Smith (score detail)

3.5.7 Traversal Duration

Traversal duration describes the time it takes for an attack cursor or attack line to move from its starting point to the point of contact or intersection, and traversal offset refers to the distance an attack cursor or attack line travels over the course of the traversal duration. Cursor traversal must be perceptible in order that the performer can clearly gauge the arrival of an incoming cursor and prepare for the point of articulation, and traversal duration and cursor offset must be considered in conjunction toward this end. Lindsay Vickery has considered these issues in depth, suggesting that "at scroll rates greater than 3 cm per second the reader struggles to capture information".[333]

3.5.8 Indication: Contact and Intersection

Indication describes the dynamic functionalities that represent the temporal qualities of a sonic event, including attack, release, and for larger symbols, including regions, the player's current position within a sustained event, or a continuous parameter change to an event. The most common instantiations of indication include the sometimes-interchangeable contact and intersection, and to a lesser extent, convergence.

Contact is the "union or junction of surfaces",[334] with 'surfaces' referring to the delineated boundaries of any symbol.[335] In a 1986 *Scientific American* article, Anne Treisman writes "…boundaries are salient between elements that differ in simple properties such as color, brightness, and line orientation but not between elements that differ in how their properties are combined or arranged."[336] In the case of AMN, in order for two symbols to make perceptible contact, at least one must demonstrate dynamic qualities, and their respective visual representations must be well defined and differentiated. Contact is generally represented by the perceptible collision of two symbols, and this action often prescribes the onset of some musical event. One of the most common methods of contact occurs when a dynamic attack cursor makes contact with a static node or static attack line. In these cases, contact occurs at the moment the cursor's boundary collides with the node or play head's boundary, followed by the cursor reversing its previous trajectory, appearing to bounce off the node, or simply disappearing. (see figure 39 and 40)

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[333] Lindsay Vickery, "The Limitations of Representing Sound and Notation on Screen," 226.
[334] "contact," Merriam-Webster's Online Dictionary, accessed January 31, 2015, http://www.merriam-webster.com/dictionary/contact.
[335] J. Feldman, "What is a Visual Object?," *TRENDS in Cognitive Sciences* 7:6 (2003): 252.
[336] Anne Treisman, "Features and Objects in Visual Processing," *Scientific American* 255:5 (1986): 114-125.

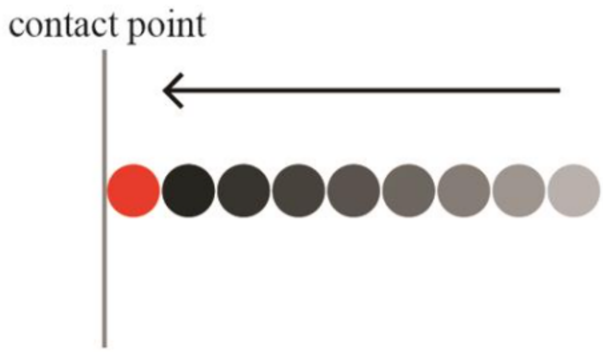

Figure 39: Contact (detail)

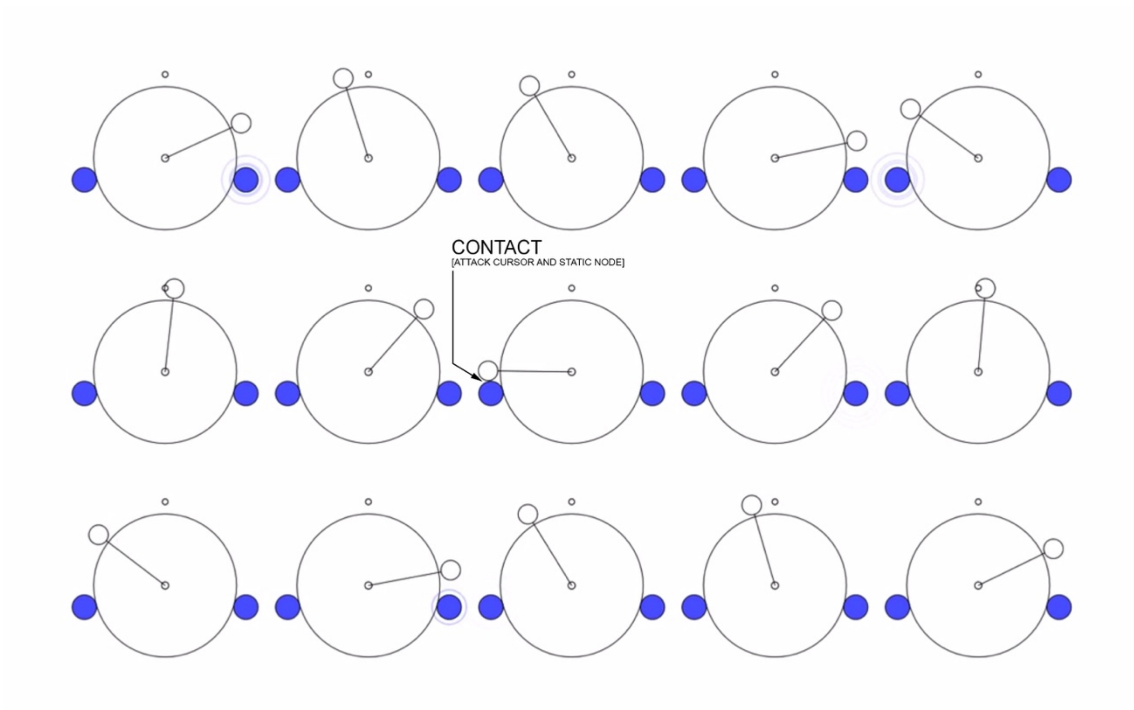

Figure 40: *Study no. 8 [15 Percussionists]* by Ryan Ross Smith (score detail)[337]

Intersection is generally represented by an attack cursor or region intersecting with a node or attack line. Unlike contact, intersection requires the cursor or region to penetrate the

[337] *Study no. 8 [15 Percussionists]*, Ryan Ross Smith, 2012.

node or attack line, and in general, the cursor will continue in the same trajectory following intersection. In some cases, a small, fast moving attack cursor or attack line will make it difficult to discern between the moment of contact and its subsequent intersection. In these situations, either term would be sufficient (see figure 41 and 42).

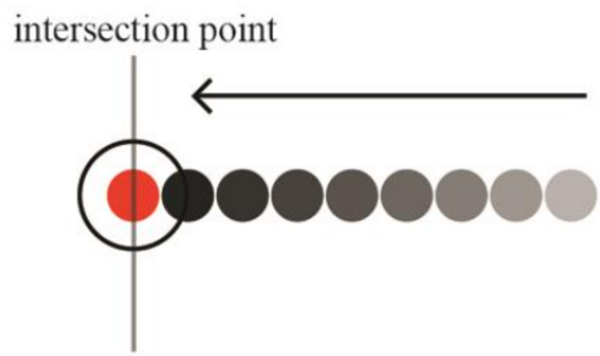

Figure 41: Attack Cursor intersecting static attack line (detail)

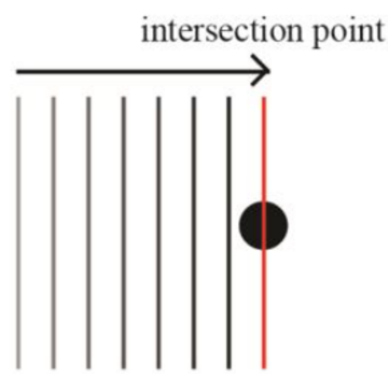

Figure 42: Dynamic attack line intersecting static node (detail)

Intersection is often utilized for sustained or continuously modified events, and regularly incorporates regions. For continuously modified events, the position at which the attack point (line or node) intersects with the region corresponds to the particular musical prescription of that moment. In many of Cat Hope's works, including *Cruel and Usual* (2011) for example, sustained tones are represented by regions in the form of straight and curved lines (see figure 43 and 44). The position of each region in relation to the fixed attack line determines the relative degree to which the current pitch should be detuned by indicating where in the region the player is currently located. Related to this functionality is the dynamic attack line, or “swiping play head”,[338] in which the point of articulation represented by the moment the attack line intersects with each node or region.

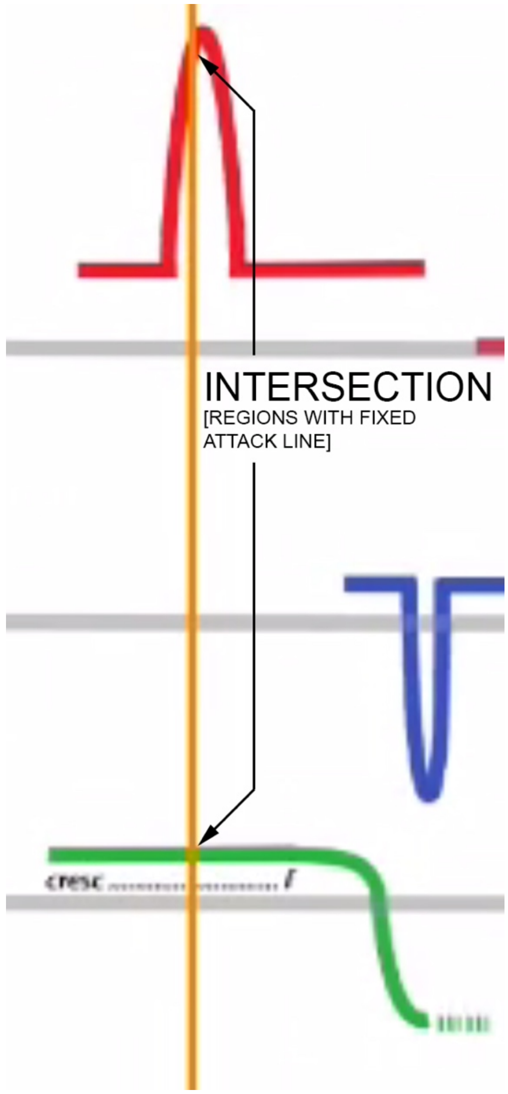

Figure 43: *Cruel and Usual* by Cat Hope (score detail) [339]

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[338] Cat Hope and Lindsay Vickery, “Screen Scores: New Media Music Manuscripts.”
[339] “Cruel And Usual,” Vimeo video, 8:26, posted by “cat hope,” April 6, 2014, accessed February 16, 2016, https://vimeo.com/91175555.

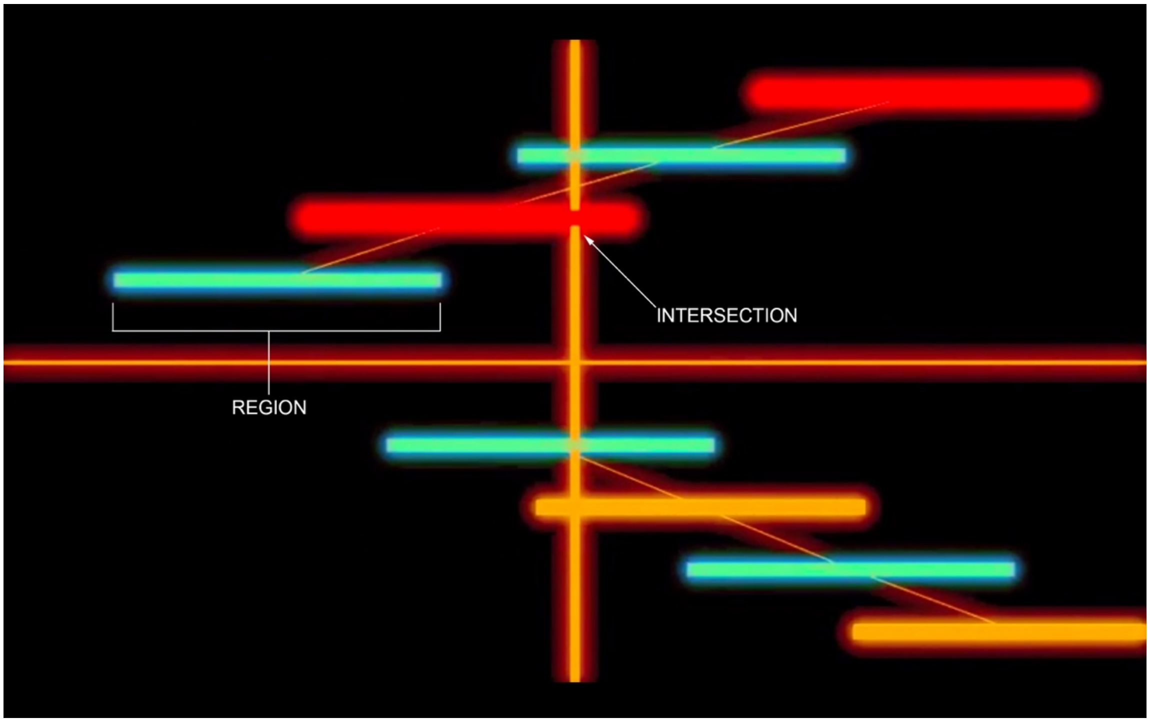

Figure 44: *Skítkalt* by Páll Ivan frá Eiðum (score detail)[340]

Convergence is a less common form of contact, but is a highly effective indication for an event's point of articulation. Convergence is indicated by a static or dynamic node encapsulated by a convergent ring of similar shape. Both symbols will share the same center, and the convergent ring will diminish in size until it makes contact with the outer boundary of the node (see figure 45 and 46).

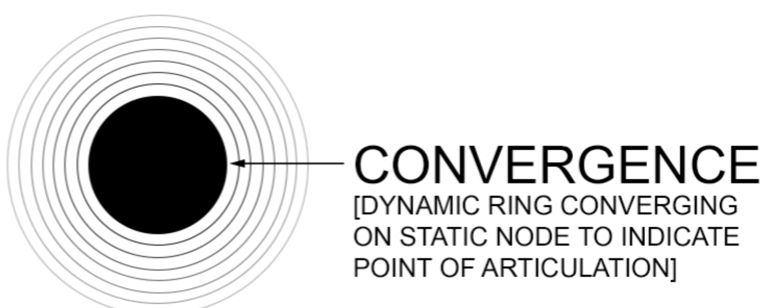

Figure 45: Convergence (detail)

340 "Skitkalt (animated score)," YouTube video, 5:17, posted by "Pall Ivan fra Eidum," November 22, 2012, accessed February 16, 2016, https://www.youtube.com/watch?v=8z5OA5rJWXs.

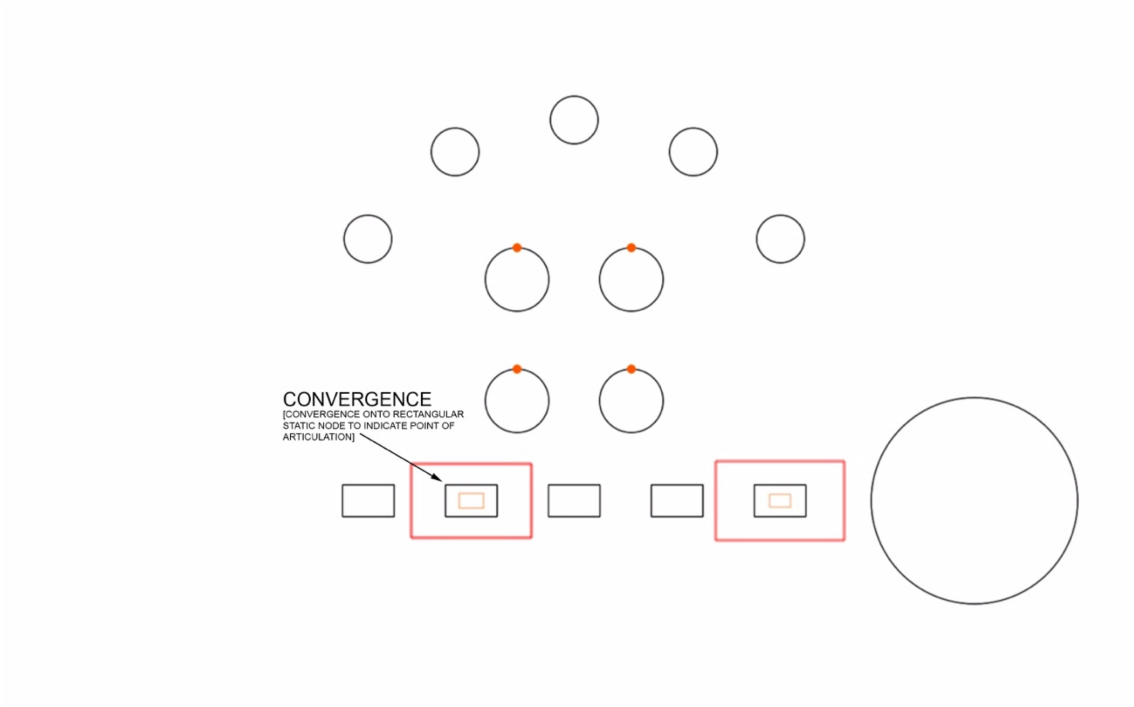

Figure 46: *Study no. 16 [NavavaN]* by Ryan Ross Smith (score detail) [341]

In addition to contact, intersection and convergence, indication can be used to shift one's focus toward a particular section of an otherwise suggestive score. In Cat Hope and Lindsay Vickery's collaborative scores *Talking Board* (2011) and *Talking Board II* (2013), "The four performers realize the work by interpreting the components of the score that are framed by a 'planchet': a circle, colour coded to correspond to each instrument, that also moves freely around the score."[342] By bringing "different elements of the score into focus",[343] the planchet provides a perceptible indicator as to which section each performer should interpret.

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[341] *Study no. 16 [NavavaN]*, Ryan Ross Smith.
[342] "The Talking Board [2011]," Lindsay Vickery, accessed February 18, 2016, http://www.lindsayvickery.com/music-2011.html.
[343] "The Talking Board II [2013]," Lindsay Vickery, accessed February 18, 2016, http://www.lindsayvickery.com/music-2013.html.

3.6 Conclusion

At the beginning of this chapter I outlined the three ideas that form the practical and theoretical basis of contemporary animated scoring practices. These three ideas and the musico-technological narrative provided the context for an examination of contemporary animated scoring practices, including a discussion of the high and low-level components of animated scores and AMN respectively. The goal of this terminological survey was to examine the existing framework, and posit suggestions for their extension, in order that contemporary animated scoring practices could be discussed with improved terminological consistency. It should be noted again that contemporary animated scoring practices are in an emergent stage, and that the practical and theoretical positions put forth in this chapter presume the field's continued emergence. To this end, I have attempted to design my terminology with extensibility in mind, and while I believe it will contribute to a unification of AMN terminology, will require amendments as new forms of AMN emerge.

In the following chapter I will first describe my creative development leading to my adoption of AMN while pursuing my MFA at Mills College, including a brief description of the primary compositional and notational themes that are present in my past and recent work. The bulk of chapter 4 will focus on several works created during my time at Rensselaer.

4. Creative Portfolio

4.1 Introduction

While my development and utilization of AMN did not begin in earnest until late-2010, certain compositional interests that are present in my current work had their genesis in my formal compositional studies that preceded my studies at Rensselaer.

While in pursuit of my Bachelor's degree in Music Composition at the University of Wisconsin-Madison in the late 1990s, I was engaged in a rigorous theoretical and practical course of study embedded in the Webernian and post-Webernian practices of set theory, serialism and integral serialism techniques respectively. Restrictive and rule-based, these compositional practices provided more than a necessary re-tuning of my ears, theretofore accustomed to the Baroque, Classical, and Romantic piano and orchestral literature. These system-based compositional practices introduced the importance of self-imposed constraints, arbitrary or otherwise, and the conceptual distillation of sound into raw sonic material. During this time, Brian Ferneyhough's *Bone Alphabet* emerged as one of several personally significant signposts, which led me to embrace the sonic and notational qualities of the New Complexity wheelhouse, while simultaneously questioning the practical realities facing the unknown composer: namely, who can, or will, play this music? This practical divide was further exacerbated by my growing interests in non-idiomatic improvisation. Still, many of my works from this time reflected a strong desire to challenge performers with densely notated, highly-prescriptive scores. These works rarely received performances, and have since been abandoned.

I was similarly taken with how chance operations enabled the discovery of musical ideas that extended beyond one's own learned baggage. Following this, I attempted to discover compositional ideas that may have otherwise not occurred to me by developing a series of graphic notational approaches. The results, however, were unsatisfying, but telling, as I came to realize that I was not interested in developing notational approaches that did not prescribe significant portions of my compositional intentions for the performer. This confirmed my feeling that the role of the composer was to make decisions, even if those decisions were based on chance or other techniques for generating content, and that the performer was responsible for the realization of these decisions.

From 2010 – 2012 I attended Mills College in Oakland, CA, ultimately earning my MFA in Electronic Music and Recording Media, and it was during the Fall semester of 2010 that I first discovered Animated Music Notation. I had been learning the programming language Processing in my spare time, and while perusing an online user forum came across the animated scores of Guðmundur Steinn Gunnarsson. Gunnarson's scores feature attack cursors scrolling from right to left across the screen, their respective points of articulation determined by their intersection with a static vertical attack line. The sonic results were of a rhythmic specificity and complexity that intrigued my musical sensibilities, and the simple, post-literate notational approach seemed to have demonstrated a successful alternative to the representation of rhythmic complexity with CPN.

Inspired by the works of Gunnarsson, I devoted the following year to the development and implementation of a wide variety of notational approaches that explored the potentials of AMN. This period of intense notational and compositional experimentation resulted in far more failures than successes, but ultimately culminated in my thesis composition *Study no. 8 [15 percussionists]*. The pieces I composed prior to *Study no. 8* explored a variety of compositional ideas, including communal intoning (*Study no. 1*), melodic deconstruction and assembly (*Study no. 2*), poly-temporality, electroacoustic synchronicity, suggestiveness, and structured improvisation (Studies 3 - 6 respectively). While these works feature notational and compositional approaches and concepts that I have continued to exploit, *Study no. 8* represents my first significant foray into the representation of rhythmic complexity with AMN, and the perceptibility of process this notational approach enabled.

The most successful of these pieces was *Study no. 8 [15 Percussionists]*, an experiment in phasing, directly inspired by Steve Reich's *Piano Phase*. However, unlike the combination of notational and textual representation of phasing, including a relatively high-level *description* of the phase process itself, it was my intention to design a low-level notational approach that accurately prescribed the phase process note for note. Due to rehearsal limitations and a lack of trained percussionists, the notational approach for *Study* *no. 8* required representational simplicity and clarity, while still preserving the prescriptive specificity of my compositional intention.

In the score, each performer's part is represented by a single aggregate modeled after the appearance and functionality of a wind-up metronome. Each aggregate contained a radial that extended from a fixed central point to an attack cursor programmed to oscillate between two nodes. Each player was instructed to follow the actions of their respective attack cursors, and each time the attack cursor made contact with either of the two nodes, the player would play the instrument that corresponded to that node (i.e. the node on the right indicated the instrument on their right, and the node on the left indicated the instrument on their left). Instrument type was determined by the node's color: Grey indicated unpitched metals, brown indicated wood, and blue indicated pitched metals.

Study no. 8 follows a somewhat conventional ABC form, and it is in the B section in particular that my work at Rensselaer has followed most deliberately. During this section, each player plays a steady pulse that is unique to all other pulses, alternating between two pieces of wood. Due to the rigidity of these autonomous pulses, the ensemble would come into unison, or near unison, at regular intervals, approximately every 23rd attack by the player with the fastest tempo. While these simultaneities provided the audience with clear musical signposts, it was the moments in between that led to my future work with AMN, and ultimately inspired the musical characteristics of *Study no. 50* (see chapter 4). During these moments, the rhythmically dense, complex gestalt created a sense of stasis or vertical time,[344] reinforced by the timbral similarities of the ensemble. These moments led me to question my approach to form, and to veer away from my own compositional baggage that was still rooted in the trappings of traditional musical practices. Specifically, the clarification of form through compositional dichotomy, including tension and release, beginnings and endings, and the soloist-ensemble dynamic. To this end, I began approaching the ensemble as iterative, a compositional and notational restriction that limited variability between performers, while anonymizing their roles. In doing so, each player is rendered an autonomous entity, a soloist surrounded by soloists, each realizing the micro-variations represented by their respective aggregates.

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[344] Jonathan D. Kramer, "New Temporalities in Music," 549.

The body of works I created at Rensselaer continued in the same spirit of exploration and discovery that drove my initial work at Mills, with each composition featuring its own unique notational approach, and each compositional concept leading toward a distinct audible instantiation. However, beginning with *Study no. 15a*, and in particular, *Study no. 31*, I began a process of refinement and repetition, leading toward an exploration of the possibilities each particular notational functionality might have beyond its initial instantiation. Similarly, the self-imposed constraint that each subsequent composition be entirely unique from its predecessors (a lost cause no doubt) began to diminish as I embraced the micro-variations within and between works, perceptibly enabled by the prescriptive notational specificity of the score, and the arbitrary processes by which these specificities would emerge.

This process of conceptual and notational repetition, refinement and distillation was not without its own practical difficulties. As performances of these works began to occur more frequently, it was not always possible to implement my own emerging biases toward conventional compositional and performance expectations. In the following chapter I will provide an in-depth description of several key works composed during my time at Rensselaer that I believe best demonstrate these emerging notational and compositional interests. A discussion of each piece will explore my compositional intentions, examine the notational approach utilized in the score, how this approach was designed to best represent my compositional intention, and a reflection on each work in performance.

My compositional practice utilizing AMN while a student at the Rensselaer Polytechnic Institute [RPI] began with *Study no. 10 [for Claviset and Electronics]* (2012), and concluded with *Study no. 50* (2016).[345] Many of the works composed between and including nos. 10 and 50 have received performances (Studies 10, 10.1, 16, 17, 21, 22, 28, 30, 31, 31.1, 34, 38, 40.3, 42, 44, 45, 46,48, 50, 51) or have been presented in workshop, lecture and classroom settings (Studies no. 15a, 24, 26, 32, 35, 37). However, it is not within the scope of this paper to include an analysis of all these works. Instead, this section

[345] Although Studies with lower numbers were composed after the completion of no. 10 (see 5.1.3), and Study no. 12 [Windmills], although revised after no. 10, was composed and performed prior.

will focus primarily on six works: *Study no. 10*, *Study no. 30*, *Study no. 0*, *Study no. 40.3 [pulseven]*, *Study no. 44 [lecture1]* and *Study no. 50*.

Before delving into these works, I will include a brief description of the technologies I have utilized to develop and present these scores. The sequential nature of my titling scheme will be addressed in order to clarify certain chronological inconsistencies, and a brief discussion of my compositional intentions will provide context for an in-depth discussion of the aforementioned works.

4.1.1 Score Development Technology

Prior to beginning my studies at Rensselaer, I created my animated scores with Processing, a high-level, java-based programming language for visualization. Processing was an ideal choice as it supports the creation of generative routines, enabling the production of persistent and evolving dynamic behaviors. In the summer of 2012 I abandoned Processing for OpenFrameworks [OF]. OF functions similarly to Processing, and many of the functions and routines I had utilized in Processing were easily ported to OF with little modification.

4.1.2 Presentation

The single-channel, global or cinema presentation model has proven to be the most practical solution for the performance situations I am most often involved with. The technical simplicity of this presentation model has become increasingly important as my work has begun to travel, and has enabled performance opportunities that may have otherwise been technologically improbable. Two of the key works that will be examined below demonstrate alternatives to this presentation model.

4.1.3 Titling Scheme

Titling my work as 'Studies' illustrates a conceptual-chunking of my compositional practice, and a sequential cataloging of my notational practice. In general, each study contains a single, often iterative notational approach, and within each approach are a set of functionalities and design elements that can be, and often are, excised in whole or in part from their initial instantiation.

It has been my intention to number these studies chronologically by completion date, and while this chronology is generally maintained, there are several inconsistencies. Some of these inconsistencies can be attributed to the absorption of notationally-similar or functionally-related sub-collections by a single "study" number. *Study no. 6*, for example, was composed in 2011, while studies 6.1 and 6.2 were both composed in 2014. Studies 6.1 and 6.2 were titled for their relevance to *Study no. 6*, namely that in each of these scores, each performer is responsible for 7 distinct sounds based on the same color palette that appears in each piece. In this sense, these three pieces' function as companion pieces to one another. Similarly, *Study no. 8.1* (December 2014), was titled as such for its relationship to *Study no. 8* (March 2012). In both pieces, the performers move through a series of phase relationships, and it is because of this compositional similarity that I consider *Study no. 8.1* to be an extension of the phasing processes identified in *Study no. 8*. The '.' indication is also utilized for works that are chronologically contiguous, so long as they share a notational or compositional basis. For example, *Study no. 40*, *40.1*, *40.2* and *40.3* are titled as such for their utilization of the radial notational approach, and compositional similarities.

4.2 Notational and Compositional Themes

4.2.1 Introduction

Since September, 2012 I have created approximately 40 compositions that are scored with AMN. Reflecting on this practice, I have identified a collection of compositional and notational themes that are generally present across these works. These themes include the use of continuous change to develop complex rhythmic relationships, the synchronization of live performers with score-triggered electronics, structural arbitrariness and micro-variation, and notational design considerations in general.

4.2.2 Continuous Change

The smooth transition of a musical parameter from state X to state Y is a continuous change. In the context of my compositional work, continuous change is most often implemented in the modification of an aggregate's local rate of change/tempo, or in cases where aggregates are not functionally autonomous, the temporal relationships between aggregates. Continuous tempo changes have been used in several works, including Studies 8, 11, 12, 22, 31, 31.1, 40, 40.1, 40.2 and 40.3, and is often used to generate complex, malleable phasing relationships between players.

4.2.3 Electroacoustic Synchronicity

Electroacoustic synchronicity describes a 1:1 temporal relationship between a human performer and an electronics component that is triggered, or *played*, by the score. *Study no. 10 [for Claviset and Electronics]* contains a system in which each performed acoustic event is simultaneously accompanied, or *prepared* by an electronic event. Each time an attack cursor (note head) crosses the attack line, the score application sends an OSC message to a Max/MSP patch running in the background (see Appendix 2, section 8.1.3). This message initiates an instance of the virtual class poly~ triggerNote, and its parameters are defined in part by the value of the incoming pitch (the pitch being that which is represented in the score). These parameters include the relationship of the synthetic pitch with the notated pitch (either unison or some other pre-defined harmonic relationship), the degree to which this pitch is detuned, relative dynamic level, and additional digital signal processes, including delay and filtering.

4.2.4 Persistency and Structural Arbitrariness

Persistent Generative Notational Prescription describes a notational method that features prescriptive notation generated in real-time during performance that will continue generating, or persist, for ostensibly any duration. The structural arbitrariness of the work is a compositional concept enabled by the persistent generation of prescriptive notation. Because the work has no composed beginning or end, it simply starts and at some point, stops, depending on some extra-musical factor beyond the compositional intention.[346] Persistent score generation can be found in the vast majority of my works, including Studies 10, 30 and 50, which are explored in detail later in this chapter. Similarly, structural arbitrariness is apparent in many of my other works, including Studies 9, 15a and 15a.1, 15b and 15b.1, 20, 31, 41, 45 and 46.

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[346] Jonathan D. Kramer, "New Temporalities in Music," 547.

4.2.5 Micro-Variation

It has been my compositional intention with many of my works to extend the concept of structural arbitrariness from a formal or global concern, to the low-level, atomic musical building blocks of the piece in order to remove any explicit sense of narrative or development, or tension and release. This is accomplished by focusing on the micro-variations between adjacent events, and limiting the range of difference to some degree bordering on imperceptible. One may hear differences, but these differences are so small that they become structurally insignificant. Micro-variation at the atomic level can enable the creation of a sonic stasis, where regardless of what may happen, nothing is accomplished in the structural or narrative sense. Jonathan Kramer's description of vertical time is the primary touchstone for this approach,[347] and has been implemented in a variety of my works, including Studies 15a and 15a.1, 15b and 15b.1, 20, 30, 31, 31.1, 33, 45 and 46.

4.2.6 Design Considerations

Musical notation, be it fixed or otherwise, must be legible to the performer, and the dynamic qualities of animated scores introduce unique hurdles for the composer seeking to maintain this legibility in order to create a specifically prescriptive representation.[348] Gerhard E. Winkler notes that the score "has to be readable in realtime", and that "the different parts of the score have to be reduced to a number of elements, which can be learned and 'trained' in advance, and which can be seized with 'one glance' immediately during a performance."[349] Thus, regardless of the inherent complexity of the composer's intention, the composer must develop a notational approach that maintains prescriptive specificity while clarifying what actions are expected of the performer. My own notational development process can be described in four steps:

Step 1: Does a notational approach already exist that is capable of representing the compositional intention? While my initial interest in animated scores was prompted by a dissatisfaction with existing notational models, I have been careful to avoid a kind of

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[347] Ibid., 547.
[348] Arthur Clay and Jason Freeman, "Preface: Virtual Scores and Real-Time Playing," 1.
[349] Gerhard E. Winkler, "The Realtime-Score. A Missing-Link in Computer-Music Performance," 2.

notational tunnel vision. Notational tunnel vision, in this case, would describe a general disregard for fixed notational approaches for no reason other than the fact that they are fixed. A particular fixed notation may very well represent the compositional intention succinctly and legibly, while circumventing the potential hurdles associated with an animated score. Considering this possibility introduces a reflexive relationship with the development of an animated notational approach: if a novel notational approach is designed and implemented in lieu of a preexisting approach, it should provide significant benefits to the representation of the compositional intention. By identifying the benefits, or necessities, of representing the compositional intention with AMN instead of a fixed, preexisting notational approach, those benefits can be exploited to further assist the representational clarity of the score, and may also lead to intriguing extensions on the original compositional intention.

Step 2: What degree of specificity is required to properly represent one's compositional intention? This consideration relates to the previous one, in that if the compositional intention does not require the real-time specific prescription of each and every event, for instance, the specific representation of these events by AMN may be unnecessary. The pitch and temporal specificity enabled by AMN in the score for *Study no. 10*, for example, is indeed necessary in that each event must be trackable by the score, in order to synchronize the electronics component with the performer. Contrarily, the time-bracket approach featured in *Study no. 28* does not require the same level of prescriptive specificity as *Study no. 10*. In *Study no. 28*, performers are instructed to play a percussive sound each time the radial attack cursor intersects with each of the two nodes. However, while the cursor is between these two nodes, the notation is less specific, indicating only the number of events that should occur within this time frame. If the score were presented with the same kind of prescriptive specificity of *Study no. 10*, it would lose the improvisatory nature that is essential to the compositional intention.

Step 3: Are there notational symbols that are better represented when combined or compounded? As Winkler notes, the reduction of elements in the score improves legibility,[350] and by compounding symbols, a note head for example, can represent not

[350] Ibid., 2.

only a particular pitch, but relative dynamic based on its size. Furthermore, the timbre, duration, playing technique, or other musical characteristics may be represented by a change in color, shape, and even traversal speed. It has been my practice to minimize the amount of notational information in the score to only include those symbols and functionalities that are essential to a successful realization. However, it is also important to consider the amount of information a single, compound symbol can legibly maintain, and that incremental changes to certain visual parameters, color and size for example, can be difficult to perceive.

Step 4: What spatial arrangement of aggregates will best facilitate legibility, and can or should this arrangement reflect performer distribution in the physical space? In the most common representation of animated scores, the score is projected in view of the performers as well as the audience. While this may be the result of practical considerations, it does provide the audience with an opportunity to see the score in action, and potentially discover correspondences between the score and the performers' actions. As Jason Freeman notes, "Many composers display the notation generated by their systems not only to the musicians but also to the audience, so that the audience can better understand the relationship between the algorithm's direct output and the musicians' interpretation of that output."[351] In lecture and workshop situations, a correspondent spatial relationship between the score and the players can be very useful for demonstration purposes, and in performance, this correspondent relationship may improve legibility by providing a floor plan or integrating the notation with the instruments (see *Study no. 30* and *Study no. 50*).

4.3 Study no. 10 [for Claviset and Electronics]

4.3.1 Introduction

Study no. 10 [for claviset and electronics] is the first piece I composed at Rensselaer, and was one of my first forays into developing a generative, persistent, and structurally arbitrary work.

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[351] Jason Freeman, "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance," 36.

4.3.2 Compositional Intention

Study no. 10 was written for Claviset[352] and score-triggered electronics. The pitch content is split into three ranges, low, middle and high, with each range roughly outlining a different scale:

Low:	F#,G,A,B,C#,D#,E (E-Minor)
Middle:	F,G,G#,A#,C,D,E (F-Minor)
High:	F#,G,A,A#,C,D#,F,G (G-Minor)

These pitch sets were selected in an attempt to destabilize an identifiable tonal center, and the functionality of each event, represented by a scrolling attack cursor, were also designed toward this end. Each time a new cursor is generated, its traversal speed, size (which denotes relative dynamic), pitch, and duration (if it is a sustained event) are randomly determined within a predefined set of ranges that will likely distribute pitches evenly over the course of a performance, as no pitch is weighted to occur more or less frequently than the others, reducing the potential for any single pitch to gain structural significance.

Still, the constraints placed on the various parameters of each attack cursor are limited to the degree that the sonic identity of the piece is maintained, while still introducing enormous combinatorial possibilities, thereby diminishing the possibility for repetition and/or stagnation (see Appendix 2, section 8.1.2).

4.3.3 Notational Approach

In the score for *Study no. 10*, a grand staff runs horizontally across the center of the screen, flanked above and below by two thin lines, with a vertical attack line located toward the left side of the score. Each event is represented by a circular attack cursor: a black cursor denotes staccato, while a white or open cursor denotes a sustained event, and will include a horizontal sustain line that extends from the center of the attack cursor toward the right side of the screen. Every cursor is connected to those adjacent to it by the *proximity web*, which are a series of thin lines designed to improve the performer's ability to track the various speeds and locations of the attack cursors. The point of articulation for each

[352] While the title states Claviset and electronics, any polyphonic keyboard instrument may be used.

performed event is denoted by the intersection of the attack cursor with the attack line. At the end of each sustain line is a vertical line that extends up or down to the flanking lines depending on which staff the attack cursor is on (treble staff will extend up, bass staff will extend down) (see Appendix 2, 8.1.1). These vertical lines terminate at an attack cursor that horizontally corresponds with the end of the sustain line, but does not prescribe any action for the performer. Rather, these attack cursors indicate a score-triggered electronic event. Similarly, each attack cursor within the grand staff is accompanied by a score-triggered electronic event (see figure 47), but unlike the attack cursors that flank the staff, these electronic events occur simultaneously with the performed events.

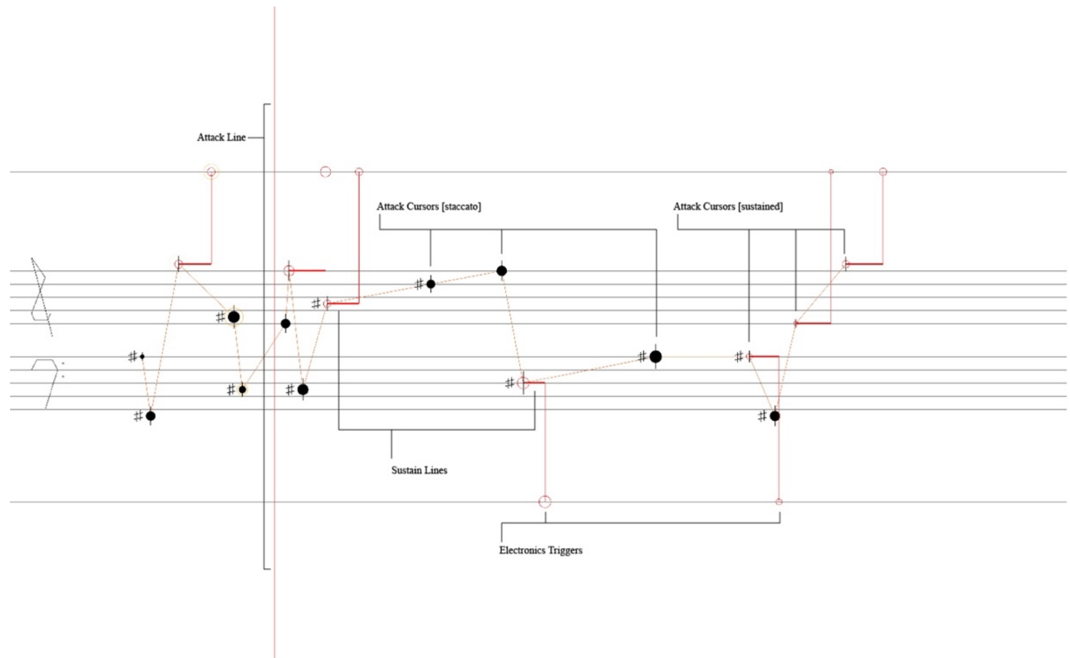

Figure 47: *Study no. 10* by Ryan Ross Smith (score detail)

The electronics events are generated by a Max/MSP patch running in the background. Every time an attack cursor crosses the attack line, an OSC message is created that contains information regarding the cursor's pitch (if performed), or position (if on one of the flanking lines). This message is then sent to the Max/MSP patch in order to trigger the corresponding electronics event (see Appendix 2, section 8.1.3).

In order for the score to produce a sense of local and global structural arbitrariness, both locally and globally, it must continue for some extended duration, requiring that the flow of attack cursors continue indefinitely, and that these cursors must avoid creating any sense of repetition. However, because the duration of a performance is ostensibly endless, it is impossible to gauge how many cursors should be generated at the beginning of the piece. In other words, no matter how many attack cursors were generated, there is still the potential that the score would run out at some point. Instead, only a small number of attack cursors are generated at the beginning of the piece, and each cursor can be *recycled* indefinitely. Each time an attack cursor extends 200 pixels beyond the left side of the screen, the parameters for that cursor are immediately redefined, the cursor is repositioned at some randomly determined point beyond the right side of the screen, and restarts its right-to-left traversal. By recycling each attack cursor, and randomly redefining its parameters each time it leaves the screen, the score will run for any duration without exhausting its notational content. After significant testing, 17 instances of ac() provided the adequate range of event density.

The notational approach for *Study no. 10* demonstrates a generative method for the representation of specifically prescribed events for extended durations, and the synchronization of human performers with a generative electronics component.

4.3.4 In Performance

I have performed *Study no. 10* on several occasions over the last four years. The first performance was held at the Old Dutch Church in Kingston, NY as part of the O+ Festival, on October 7, 2012. My performance lasted approximately 30 minutes, and audience members were invited to stay for as long or little as they liked. The following performance was held in West Hall on the Rensselaer campus in December of the same year. For this event I was able to extend my performance to approximately two hours, and as with the Kingston performance, the audience was encouraged to engage with the performance in whatever way they saw fit. In both cases, the passage of time took on an entirely unique character for me as a performer. The first 10-15 minutes felt typical; getting used to the space, becoming comfortable with the notation and its behaviors, and counting each minute as it passed. Beyond this introductory period, I quickly lost track of time, and my ability to accurately track the attack cursors rapidly improved as I achieved an intense and sustainable focus. Additional performances have been significantly shorter, and as such, did not provide adequate time to reach this particular performance mentality.

While the shorter performance of *Study no. 10* adequately represented the work's identity, the structural arbitrariness of the work was difficult to gauge in performances 10 minutes or shorter. I believe this is due in large part to the pitched nature of the work, in that regardless of my intentions to remove a sense of any tonal center, shorter performances tended to not provide enough time for the randomly selected pitch content to reach an even distribution. To this end, a minimum performance duration of 30 minutes is suggested.

Each time I have performed *Study no. 10*, I presented the score using the cinema model, and the audience's reaction to this approach is generally favorable. The most common reaction is that the aural-visual correspondence elicited the sense that one was watching a game of sorts: will he be able to play all the notes in time? In other cases, audience members simply enjoyed the ability to match what they were hearing with what they were seeing, producing a deeper sense of engagement with the work.

4.4 Study no. 30

4.4.1 Introduction

Study no. 30 was created specifically for Studio 1 at the Experimental Media and Performing Arts Center [EMPAC] in Troy, NY. Within the context of my notational practice, the presentation model for *Study no. 30* was a significant departure from my earlier works, and is also the first piece I had designed specifically for audience interaction in an installation, "non-performance" context. (see figure 48).

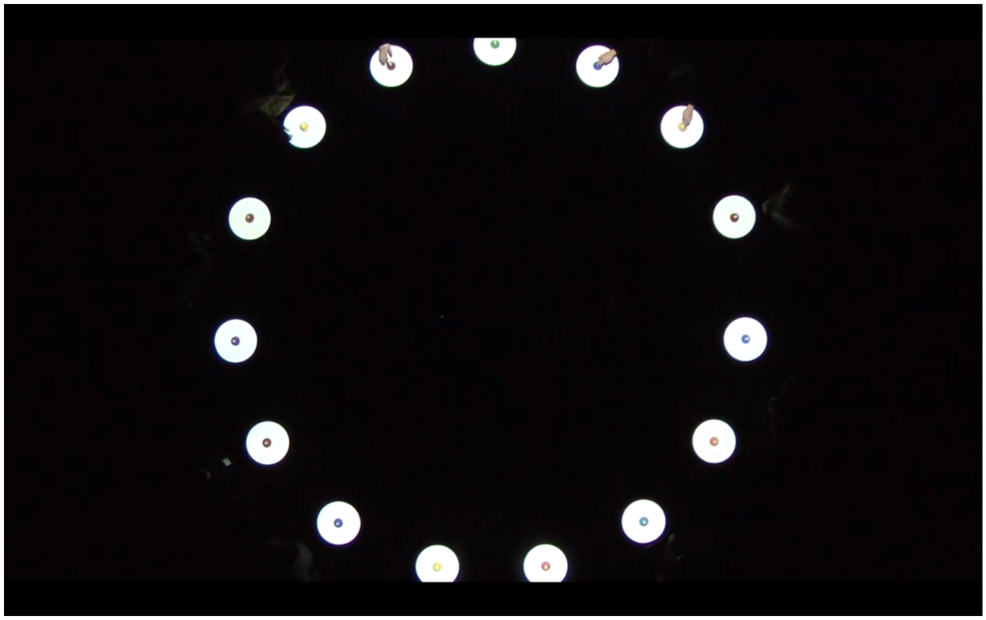

Figure 48: *Study no. 30* by Ryan Ross Smith (performance detail)

4.4.2 Compositional Intention

Like *Study no. 10*, *Study no. 30* was designed to be a persistent, generative work, one that mirrored the sonic qualities and arbitrary behaviors of wind chimes. To this end, there should be no perceptible structure, locally or globally, and the particular functionalities of the notation reflected this. Furthermore, it was my intention with *Study no. 30* to encourage audience or attendee engagement, and to substitute the traditional performance dynamic with a more inclusive (or at least less divisive) gallery setting.

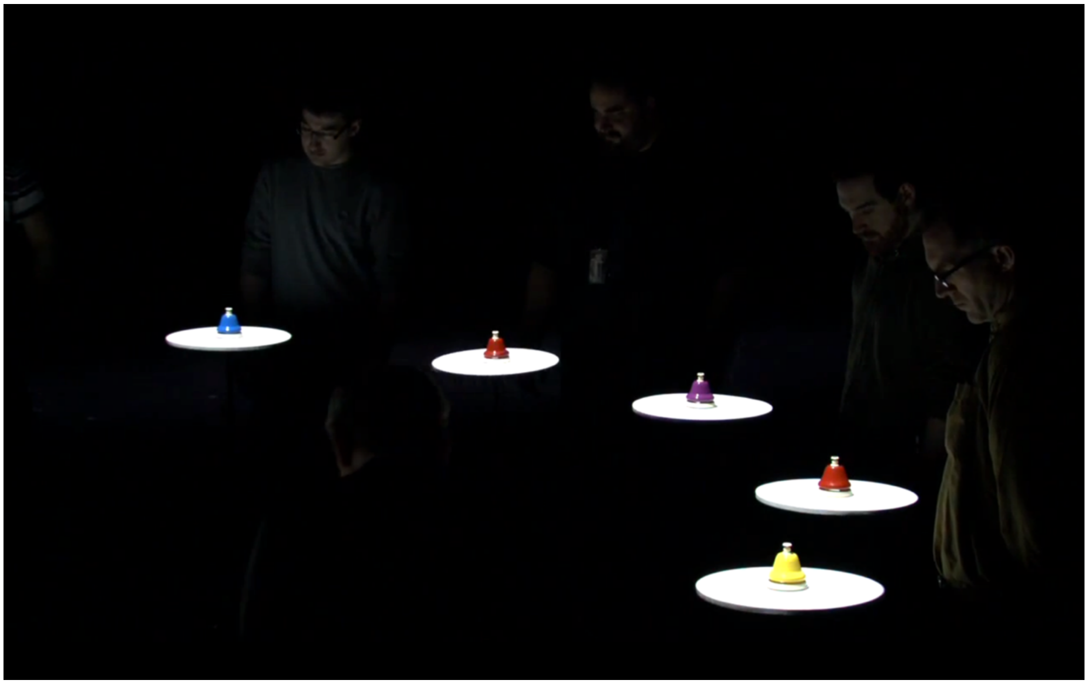

Figure 49: *Study no. 30* by Ryan Ross Smith (installation detail)

4.4.3 Materials and Instrumentation

The physical materials for *Study no. 30* included fifteen 13-inch wide circular plywood platters painted white, fifteen microphone stands, and fifteen tuned desk bells. A microphone stand adaptor was attached to the center of each platter to facilitate a stable attachment to the microphone stand. The platters and microphone stands were placed in a large circle equidistant from one another, with the center of the circle corresponding to the center of Studio 1. A single tuned desk bell was positioned at the center of each platter, and although the bells were not arranged in any particular order, they roughly outlined an A-minor/C-major scale. The lighting in Studio 1 was kept to an absolute minimum, with the edges of the room only slightly illuminated to satisfy EMPAC's fire code requirements.

4.4.4 Notational Approach

In order to ensure that the interactive qualities of *Study no. 30* would be accessible to a wide range of abilities, it was necessary to distill the notational functionality of the score to its simplest form. As Art Clay notes, "the application of real-time notation for an exhibition situation with a lay audience is clearly possible under the constraints that the notation language is easily understood and that the application provided is immediately rewarding in some way to the user."[353] One of the simplest animated notational approaches is the convergent attack ring, as it generally prescribes a single action, and this was the ideal approach to enable attendee interaction. The score was designed to project a series of convergent rings on each platter, starting at the edge of the platter, and converging on the desk bell positioned in the center. Attendees were instructed to play the bell at the moment the ring converged on the bell (see figures 50 and 51). This arrangement resulted in a strong visual correspondence between the notation and the instrument, as the convergent ring appeared to converge directly onto the bell.

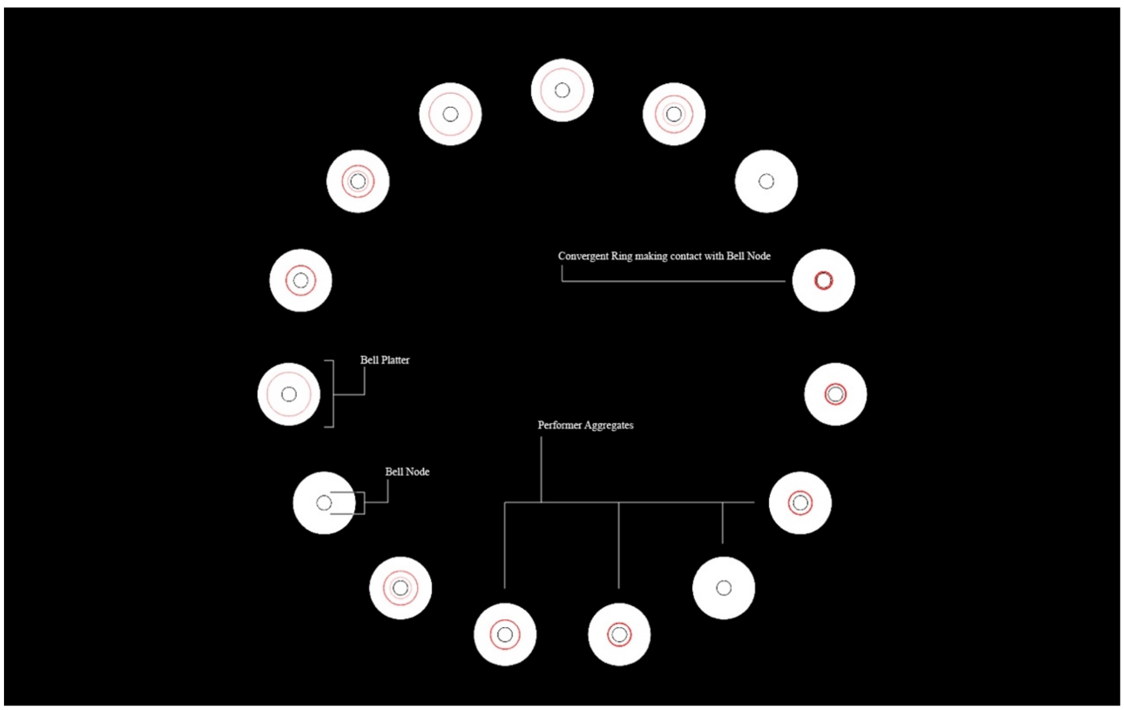

Figure 50: *Study no. 30* by Ryan Ross Smith (score diagram)

[353] Arthur Clay, "You Can Play It Too: The Virtuoso Audience," 65.

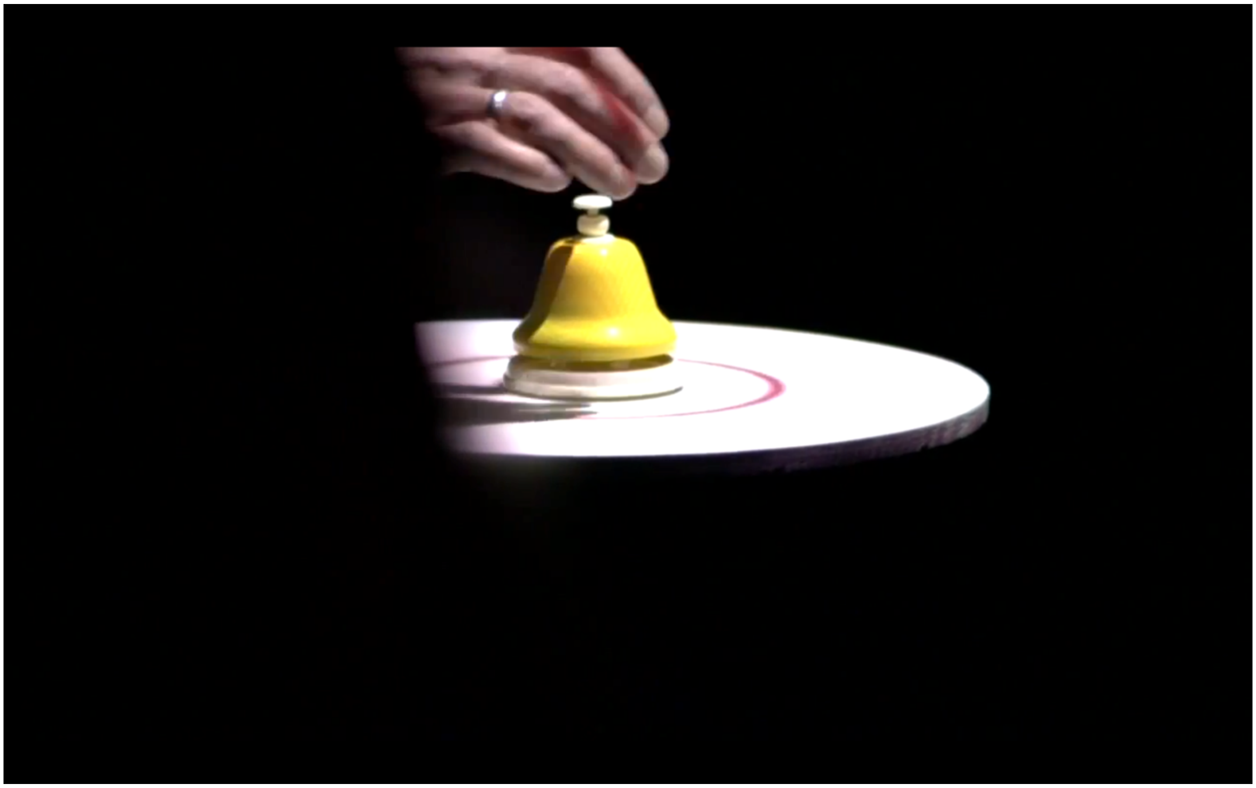

Figure 51: *Study no. 30* by Ryan Ross Smith (instrument and notation detail)

The notational behaviors for each platter were designed to be functionally autonomous from the other platters' notational behaviors on the local level, while regulated by the global functionality of the score. The duration between each attack (convergence) was randomly determined at the completion of the previous attack within a predefined temporal range that varied based on the elapsed time of the global timer. The global timer continuously ran on a two-minute loop, and the possible durations between subsequent attacks were correspondingly scaled from 1 second to 25 seconds. At the beginning of each 2-minute cycle, event density would be at its highest, as the durational range between adjacent events was at its shortest. As the cycle reached the 2-minute mark, it was likely that the event density would have thinned out significantly, as the range of potential durations between events neared 25 seconds. By delegating autonomous control to the durations between attacks to the local level, within the regulatory control of the score's global functionality, a continually evolving rhythmic gestalt emerged. The variable density of this gestalt, produced a simple and cyclical formal structure, but not so explicit as to produce a palpable sense musical direction.

4.4.5 Training Application

In order to clarify the attendees' roles, a simple application was displayed on an iPad directly outside the entry door with instructions for the correct or suggested interaction. Modelled after the score's notation, the application featured a red attack ring converging on a black node, and the attendee was instructed to tap within the black node at the moment the ring made contact. The application returned one of three results each time the screen was tapped, corresponding to the tap moment's temporal relation to the convergent ring's *actual* moment of contact. If the tap occurred within a predefined margin of error, approximately 30 milliseconds early or late, the application displayed "PERFECT," accompanied by a green screen. If the temporal location of the tap was beyond this margin of error, but within the secondary margin of 60 milliseconds, the application would display "MISS," accompanied by a red screen. If tapped beyond this secondary margin of error, no response was displayed.

4.4.6 In Performance

Study no. 30 is not the first piece I have composed in which the score is designed to run indefinitely, but it does demonstrate the first time I have had the opportunity to fully explore this possibility. Over the course of two days, *Study no. 30* ran for a total of 26 hours (13 hours each day). Because *Study no. 30* was framed as an installation, and did not require a particular performance start time or duration, it could simply exist in the space, offering the possibility for musical interaction to anyone who happened to visit.

Audience interactions with the piece took a variety of forms, from something resembling a conventional "performance" (in which groups of attendees attempted to follow the instructions indicated by the training application) to simply listening. Some interactions were deeply focused (one attendee stayed in the space by himself for nearly an hour playing a single bell), while other interactions were more playful than contemplative (running around, playing as many bells as possible as quickly as possible).

When large groups were playing simultaneously, it was possible to perceive the increasing density over each two-minute cycle. However, the sonic quality of these increases in density were not consistent between cycles, nor did they elicit a sense of musical direction or structure; rather, this variable density had a natural flow to it, much like the impact that an occasional increase in wind speed has on a set of wind chimes.

4.5 Study no. 40.3 [pulseven]

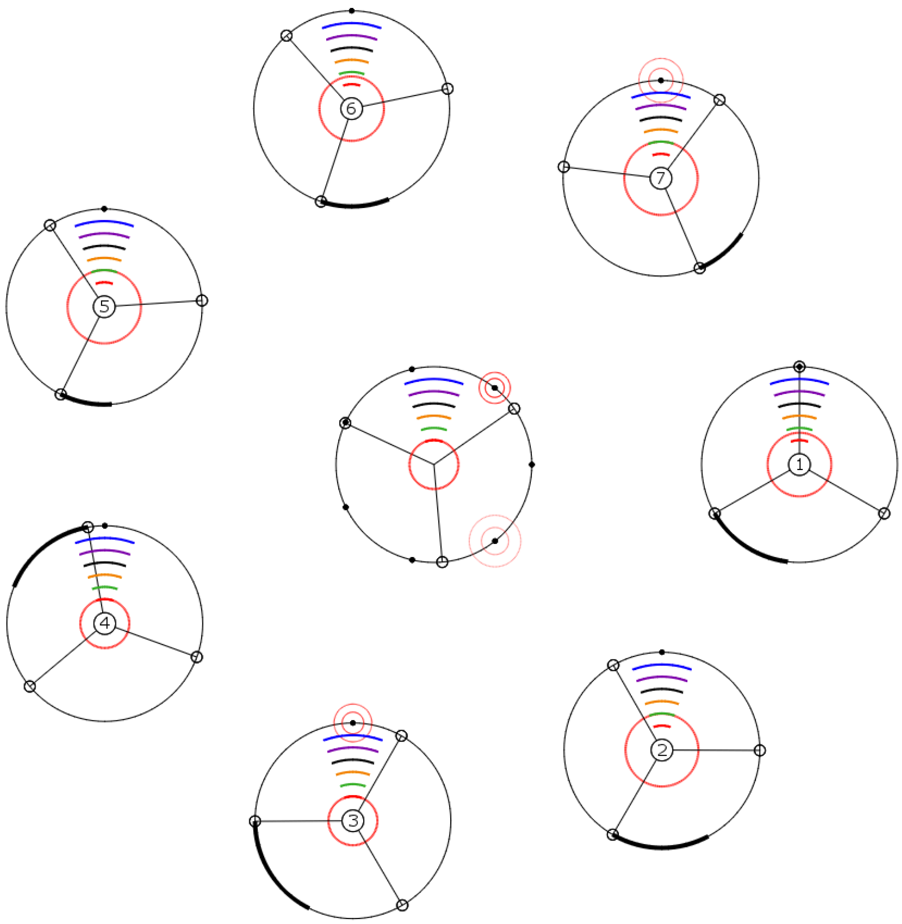

Figure 52: *Study no. 40.3 [pulseven]* by Ryan Ross Smith (score detail)

4.5.1 Introduction

The Radial AMN functionality facilitates the representation of continuously changing tempi extremely well, and has been exploited in many of my works (including Studies 11, 12, 31, 31.1, 31.3, 40, 40.1, 40.2, and 41). In the context of my creative portfolio, *Study no. 40.3* is emblematic of this approach, and demonstrative of the ease by which complex tempo relationships can be notationally represented and realized in performance with little to no formal musical training or preparation.

4.5.2 Compositional Intention

Like many of the works I have composed over the last four years, *Study no. 40.3* is designed with accessibility and portability in mind. To this end, it is not restricted to a specific ensemble or instrument type (see below). My primary compositional intention with *Study no. 40.3 [pulseven]* was to explore the kind of rhythmic complexity that emerges when multiple instances of malleable tempi are overlapped. Furthermore, I wanted to develop a notational method that enabled the coalescing of these tempi into a hocket pattern, in order to highlight the complexity of the primary rhythmic construct.

4.5.3 Instrumentation

In its current version, *Study no. 40.3* can be performed by any collection of seven pitched instruments, although the work has gone through several iterations since its original instantiation. Previous instrumental forces include piano (seven performers on a single piano), marimba (seven performers on a single marimba), percussion (unpitched and pitched), mixed ensemble (winds and strings), and vocals (with each performer speaking a single number or word). Even in its current instantiation, virtually any combination of instruments/voices will suffice.

4.5.4 Notational Approach

The score for *Study no. 40.3* features 7 *player* aggregates positioned around an 8th *ensemble* aggregate. Each player aggregate contains 3 radial attack cursors moving in clockwise motion around a central node. At the top of each aggregate is a fixed node that functions as the point of articulation. Each time an attack cursor crosses the articulation point, the player plays a short sound, and if the attack cursor is followed by a sustain arc, the sound should be sustained until the counter-clockwise edge of the arc has passed through the point of articulation. In its current instantiation (see figure 52), a series of small arcs appear above the central node. This series of arcs (or *Rainbow WiFi*), in coordination with the red circle that encapsulates the central node, determine which notes are available to performers. In this notational iteration, each performer, or the ensemble as a whole, will determine a collection of six ascending pitches prior to performance, with each pitch corresponding to one of the small arcs. The red circle then indicates which of these pitches are available for use at any given time, based on its relationship to the *Rainbow WiFi*. For instance, if the red circle is at its smallest (corresponding to the arc closest to the central node), only the lowest pitch would be available to the performer, while the red circle at its largest indicates that all six notes are available to the performer.

The central aggregate is functionally similar to the performer aggregates, but only comes into play when one or more *bridge* lines appear between the performer aggregate(s) and the 7 points of articulation (nodes) that are positioned along the edge of the aggregate (see Figure 53).

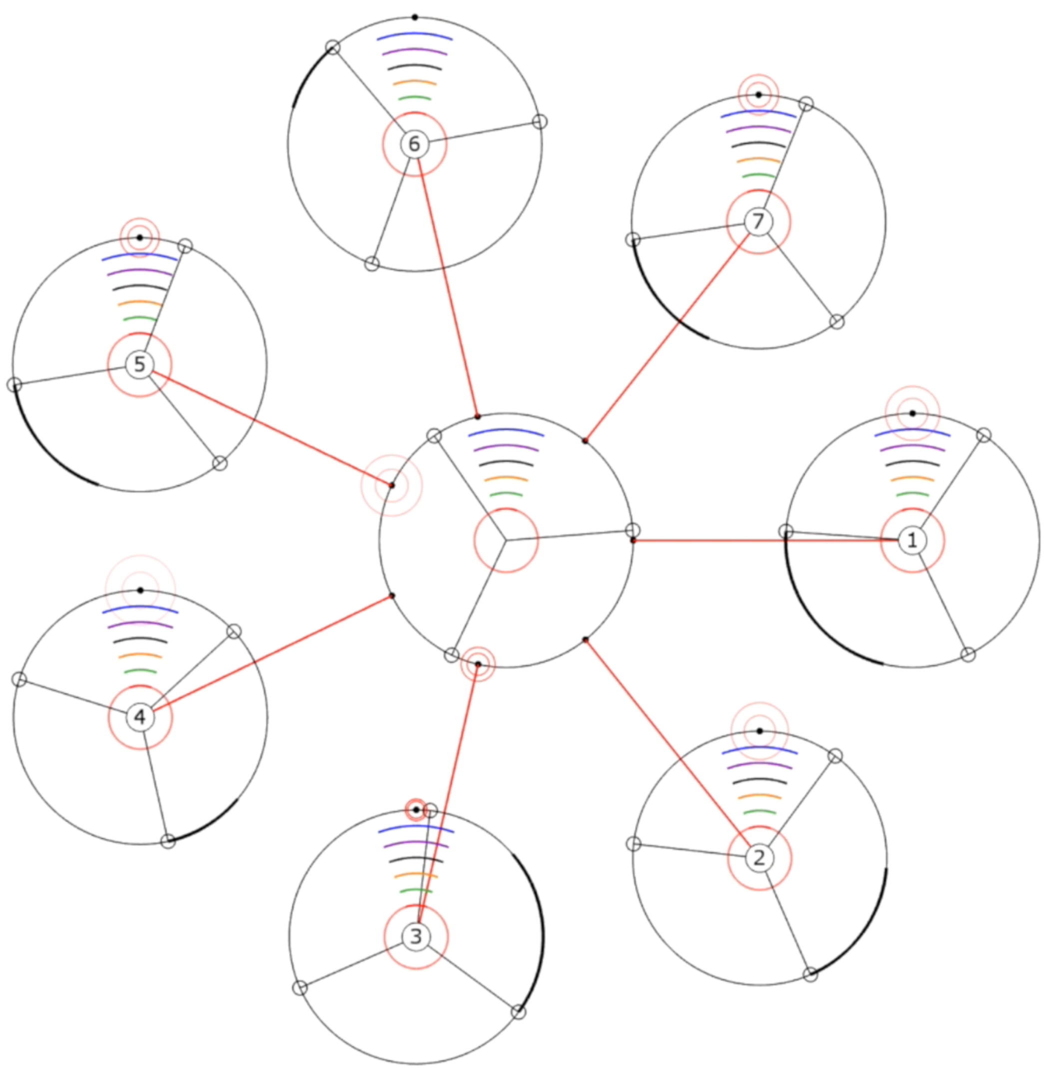

Figure 53: *Study no. 40.3 [pulseven]* by Ryan Ross Smith (score detail)

When a bridge line connects one's aggregate to the central aggregate, that player is instructed to follow the central aggregate for as long as the bridge line is visible, and to play only when the attack cursor(s) cross the point of articulation (node) that her bridge line is attached to. This aggregate was designed create hocket patterns by ensuring that when all players' bridge lines were active, no player would be playing at the same time, while constrained to the same malleable tempo. This was accomplished by spacing the attack cursors by 120°, and the articulation points by 360/7 (or approximately 51.42857142857), ensuring that no two attack cursors would make simultaneous contact with two or more nodes.

4.5.5 In Performance

Study no. 40.3 [pulseven] has been a valuable piece for demonstrating the ease by which AMN can represent complex, persistent (non)structures and layered, malleable tempi. The ease by which *Study no. 40.3* can be taught has enabled realizations (on stage or in classroom settings) by performers representing a wide range of abilities. Perhaps the most intriguing example of this occurred at Northern Illinois University in February, 2015 during a brief artist in residence period. The culmination of my time in at NIU was a concert devoted to my music performed by NIU music students, but as we neared the published start time for the concert, several scheduling disruptions limited performer availability to a single guitar player. Fortunately, I had an unfinished score for guitar and electronics that I was able to freshen up immediately before the concert, and in theory, could easily fill the rest of the concert with a performance of *Study no. 10*. As luck would have it, five minutes before the concert was supposed to begin, the percussion ensemble at NIU arrived. After collecting a variety of percussion instruments, and picking up a few instrumentalists along the way (sax and flute), we began the concert with a short open rehearsal of *Study no. 40.3*. We rehearsed for approximately two minutes before beginning the concert proper, which began with a performance of the aforementioned work for guitar, followed by an abridged version of *Study no. 10*. Upon the completion of those pieces, we assembled the ensemble, quickly revisited *Study no. 40.3*, and began performing. The first iteration was performed by a mixed ensemble that included piano, percussion, sax and flute. Next, we performed the piece on a single marimba, with each performer assigned one pitch to play throughout, followed by a performance in which each performer could choose their own pitch, and could change as often as they liked.

While I do not actively seek out performance situations of this sort, it has been encouraging to know that when they *do* occur, that works like *Study no. 40.3* are available to quickly and efficiently organize performers, and to do so without sacrificing the rhythmic specificity of my compositional intention.

4.6 Study no. 0

4.6.1 Introduction

Study no. 0 was developed during my time as a teaching assistant for Pauline Oliveros' Deep Listening course in Spring 2014. My intentions for this piece were to leverage the dynamic, visual qualities of my notational practice as a form of focused and inquisitive attention.

4.6.2 Compositional Intention

There is no specific *compositional* intention associated with *Study no. 0*. Rather, the *intention* was to develop an analog framework within which animated scores could be quickly and easily developed by virtually anyone.

4.6.3 Instrumentation

Study no. 0 can be performed by any number of players using any sound-producing device(s).

4.6.4 Notational Approach

Study no. 0 is the only example of mine included in this paper in which the score is not screen-based, nor it is meant to represent a particular compositional intention. Rather, *Study no. 0* identifies the potential that *any* dynamic object may have to indicate musical actions, and is, in a sense, the conceptual coagulate of animated scoring practices in general. To this end, *Study no. 0* does not have a score, but is simply a set of instructions that lead to the generation of a dynamic framework within which perceptible dynamic behaviors can be *framed* as prescriptive notations. An instantiation of the score for *Study no. 0* can be created by following the instructions below:

1: Identify or create a physical *frame* within which some dynamic behavior(s) can be perceptibly delineated. The frame itself must contain one static element within its boundaries that can be easily differentiated from the setting within which it is positioned. For instance, a frame may be as simple as a window, and a tree may serve as the static element. The frame must be positioned (or found) in some location where some perceptible dynamic action is likely to occur.

2: The static element must be large enough to allow the performer to perceive when the dynamic elements appear to make contact or intersect with it.

3: While there may be more than one static element, this number must be restricted to the degree that the visual interaction with dynamic elements does not become imperceptible. In other words, with too many static elements, or dynamic elements for that matter, it may become difficult to determine points of articulation and other prescribed indications.

4: The indications that result from the interaction between the static and dynamic elements should be predetermined with as much detail as possible.

5: In performance, these indications and their sonic predeterminations should be followed as closely as possible.

6: Modifications to these instructions are possible if the compositional intention calls for it, so long as the resultant notational approach is adequately prescriptive. In other words, *Study no. 0* is not designed to be *open* to the degree that it becomes a platform for improvisation, but as an extension of animated scoring practices into the conceptual space, with practical instructions for the generation of the score, and the expectation that the performer strictly adhere to the performance requirements.

4.7 The Lecture Series

4.7.1 Introduction

The *Lecture Series* emerged out of a desire to develop an alternative approach to the lecture format, and to design lectures that were instances of their topic. In other words, a lecture on AMN would not only be represented by the textual content of the lecture, but also by the method by which this content is generated, represented and realized.

4.7.2 Study no. 44 [Lecture1]

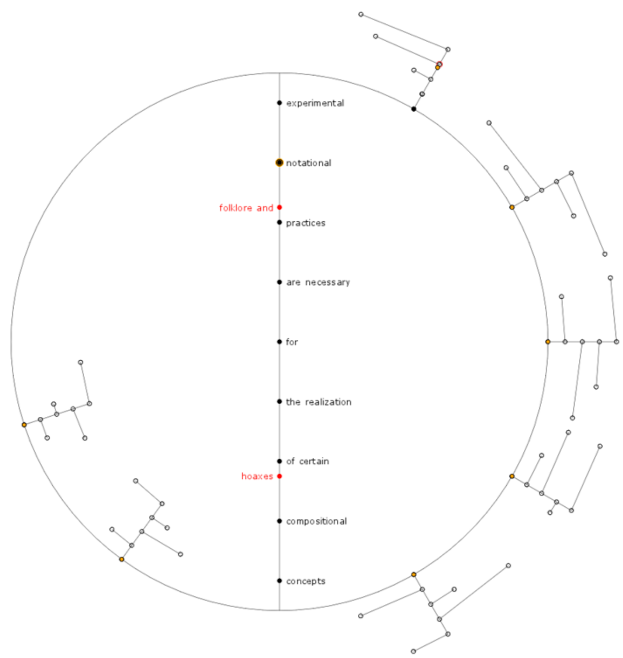

Figure 54: *Study no. 44 [Lecture1]* by Ryan Ross Smith (score detail)

4.7.2.1 Introduction

In July 2014 I was slated to deliver a 45-minute lecture entitled "The Awareness of Disappearance" at Deep Listening Art/Science: The 2nd Annual International Conference on Deep Listening, at EMPAC in Troy, NY. As a composer of electronic music created primarily with and within the computer, concerns for media obsolescence and accessibility came with the territory, while working with code to develop animated scores introduced a new set of problems, including portability and version compatibility. Additionally, my curatorial work for animatednotation.com, which relies in large part on media housed on external servers, renders their preservation and continued accessibility beyond my control. Following this, the *awareness* I intended to explore in this talk suggested one preserve one's own access to one's own work (local), while encouraging remote and sustainable public access (global). My talk would have suggested that through the consolidation of the various access points to disparate media within a single platform, one may improve accessibility and encourage preservation. Using my online curatorial work with animatednotation.com, I would have pointed out that without localized preservation, this type of consolidation will still do little to stave off the possibilities of obsolescence and/or disappearance.

However, as the conference drew near, it occurred to me that to wax poetic on the dangers of media obsolescence and disappearance to an audience of seasoned media practitioners would be unnecessary, if not a complete waste of everyone's time. Faced with an irrelevant talk, 45 minutes to fill, and little time to spare, I embraced the opportunity to create a generative lecture, transmitted via an animated score that utilized integrated electronics as sonic embellishment and disruption.

4.7.2.2 Compositional Intention

My intention with *Study no. 44* was to demonstrate an alternative approach to the lecture format that still maintained several qualities commonly found in the traditional lecture format. These included the incorporation of projected text and images to highlight key points of the lecture, the speaker positioned behind a podium or seated at a table, amplified voice, and rhetorical delivery. Extensions to the traditional lecture format included the real-time, random selection and concatenation of phrases, and sonic score *disruptions* triggered in unison with the beginning of each spoken word or phrase.

4.7.2.3 Instrumentation

Study no 44 is meant to be performed by a single speaker with slight amplification, and score-derived electronics.

4.7.2.4 Textual Content

The text contained a collection of thoughts ranging from three words to upwards of twenty, which referenced aspects of the lecture I had initially planned, and included some more general thoughts on AMN, New Music, institutional politics, the insecurities of music critics and parrots, and cutlery. The text also included phrases of an arbitrary if not humorous nature that contributed to the (in)formality of the lecture, which were particularly interesting when combined with phrases more relevant to the topic at hand.

4.7.2.5 Notational Approach

The notational approach for *Study no. 44* was designed to combine two randomly determined phrases, and to prescribe when each word or phrase should be spoken. At the center of the score is a thin vertical line. The two randomly selected phrases are displayed alongside this line, with the first phrase on the left, and the second on the right. Each word of each phrase includes a node centered on the vertical line that corresponds to the vertical position of the word or phrase. Words on the left are printed in red, while the text on the right is printed in black, and the corresponding nodes reflect this distinction. After the text is printed, an attack cursor descends from the top of the center line to the bottom, and the speaker reads each word as the attack cursor crosses that word's corresponding node. The combination of each phrase pair introduces the potential for textual content beyond the content of each phrase taken singularly. However, their horizontal displacement and coloration still clearly distinguish each phrase, allowing the audience to read each phrase in addition to the concatenated phrase coupling.

A large circle surrounds the vertical line at a diameter equal to the length of the line. As the central attack cursor descends, a secondary attack cursor rotates around this circle. The rate at which the secondary attack cursor rotates is related to the central attack cursor by a scale function, in which the descent from top to bottom is mapped to the rotation of the attack cursor from 270° to 450° (or, 12 o'clock to 6 o'clock). Along the outside of the circle is a series of node arrays; five node arrays appear on the right side of the circle, and two on the left. Beyond the *root* node of each array are eight *branch* nodes (see figure 54).

The node arrays are designed to disrupt the speaker. Each time the secondary attack cursor crosses a root node, a simple calculation randomly determines if it will continue along the circle, or move into the branches of the node array. Once the secondary attack cursor is *in* an array, a prepared piano sample is triggered every time it reaches a node. There is no *weight* to the secondary attack cursor's behaviors once it has entered a node array, and so may become *stuck* in a node array for ostensibly any duration.

4.7.2.6 In Performance

The presentation of *Study no. 44* is an instance of its topic, as the speaker's score, which is visible to the audience, *demonstrates* the functionality of an animated score while the text describes aspects of this functionality. Beyond its first instantiation at EMPAC, the notational framework of *Study no. 44* has been utilized in a paper presentation at Tenor2015: First International Conference on Technologies for Music Notation and Representation in Paris, FR, and was included as one of several notational devices in the production of *Opera3*.

4.8 Study no. 50

Figure 55: *Study no. 50* by Ryan Ross Smith (performance detail)

4.8.1 Introduction

Many of the works I composed prior to *Study no. 50* were designed to represent the compositional intention in such a way that it was clearly perceptible to the audience. These included the synchronization of the performer with score-triggered electronics, a variety of experiments in phasing and pulse-based rhythmic relationships, and in general, the perceptible correspondence between the score and its realization. Inspired in large part by the work of Steve Reich, I had been designing systems in which the audience was "able to hear the process happening throughout the sounding music."[354] While I believe these works hold some compositional merit, and that these perceptible correspondences had a valuable impact on the reception of my work, I had become increasingly dissatisfied with the influence these perceptible correspondences may have had on my compositional intentions. In some respects, many of these works were more useful as a demonstration of AMN techniques or as academic exercises than performance pieces, and perhaps there is some value in exploring the educational worth of these works. But regardless of what use value they may or may not hold, this transparency of intention, perhaps a byproduct of the academic process in general, had left me feeling compositionally dissatisfied.

4.8.2 Compositional Intention

While I approached *Study no. 50* as the piece that would put me back on an acceptable compositional trajectory, its beginnings were typical of my earlier work. In its first iteration, the rhythmic content was based on a process inspired by Brian Ferneyhough's description of *Bone Alphabet*:

> The work was composed as a succession of thirteen distinct types of musical comportment, each made up of a different number of subsections. A second stage of the compositional process involved detaching these subsections from their original context and redistributing them in a kaleidoscopic and relatively unpredictable manner.[355]

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[354] Steve Reich, *Writings on Music: 1965-2000* (New York: Oxford University Press, 2002), 34-36.
[355] "Program for Zone 4: in which momentum and position co-exist within the physicality of a musical performance," San Francisco Contemporary Music Players, accessed October 8, 2014, http://sfcmp.org/programnotes/12_Mar_SFCMP_Program_Notes.pdf.

In my initial approach, the first stage of the notational process included the determination of a single base or beat duration, randomly selected within a predetermined range. The second stage was to determine a primary tuplet depth between 1 to 13 equal divisions of the beat duration. The third stage was to divide this primary tuplet depth into two (un)equal halves, and the fourth stage, like the second, determined a secondary tuplet depth for both halves of the original primary tuplet. At the completion of these stages, two sets of tuplets would have been determined, each occupying one section of the original tuplet. The final stage determined which notes within each of the secondary tuplets are sounded, and which ones are rests. In performance, these five stages would repeat each time the performer has completed playing the two tuplets within the beat. On paper this reads like a dream come true for the defense of AMN as a prescriptive, real-time solution to the representation of complex rhythmic material, and likely, this is why I initially approached *Study no. 50* in this way. However, by basing the rhythmic characteristics of *Study no. 50* on the well-established representation of rhythm with CPN, I couldn't help but feel that the work I was creating was simply designed as a vehicle for textual exposition.

The second and final iteration of *Study no. 50* approached each event not as a member of a higher-level rhythmic value, but as a singular, autonomous entity. Rather, the duration for each event was randomly determined within a range of 500 to 1600 milliseconds at the completion of the event that immediately preceded it, with no reference to any high-level organizational principle.

By approaching each event as an autonomous entity, it was possible to generate a complex rhythmic gestalt without relying on the formality of the initial nested-tuplet approach, and allow the identity of the piece to emerge without adhering to any large-scale structural requirements.

4.8.3 Instrumentation

In order to reduce the possibility for perceptible timbral, rhythmic, or pitch-based structural articulation, the instrumentation for *Study no. 50* was limited to 42 pieces of wood (planks), 7 per player, each only slightly larger or smaller than those adjacent to it. The similarities between each plank effectively limited their perceptible distinction, although each player was permitted two sets of mallets, hard and medium, and were instructed to switch mallets as often as they pleased, so long as these changes were irregular (i.e. to avoid a structural pulsation), and that mallet usage should be evenly distributed over the course of the performance. Furthermore, each player was instructed to vary their dynamics between MP and F over the course of the performance, and similarly, to distribute this range evenly over the course of the performance. These instructions produced a narrow timbral and dynamic range with only minor perceptible changes: "Respecting self-imposed boundaries is essential because any move outside these limits would be perceived as a temporal articulation of considerable structural import and would therefore destroy the verticality of time."[356]

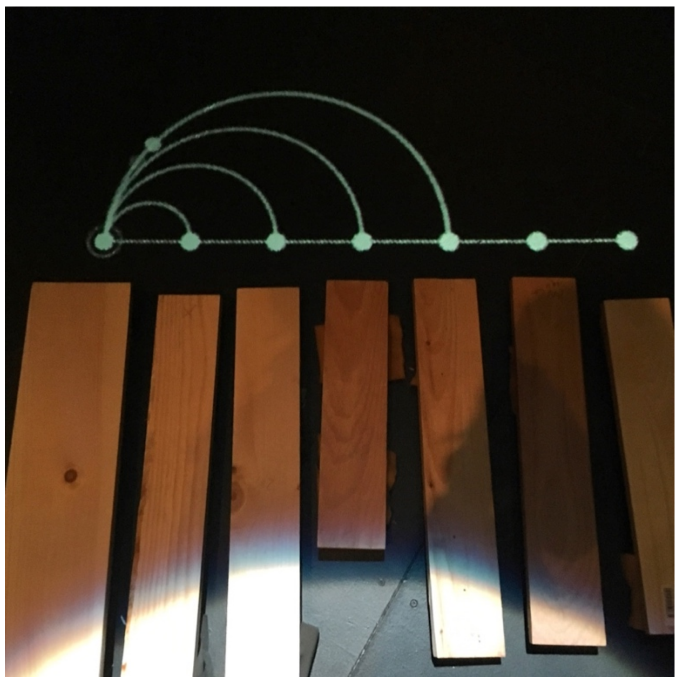

Figure 56: *Study no. 50* by Ryan Ross Smith (instrument detail)

356 Jonathan D. Kramer, "New Temporalities in Music," 549.

4.8.4 Notational Approach

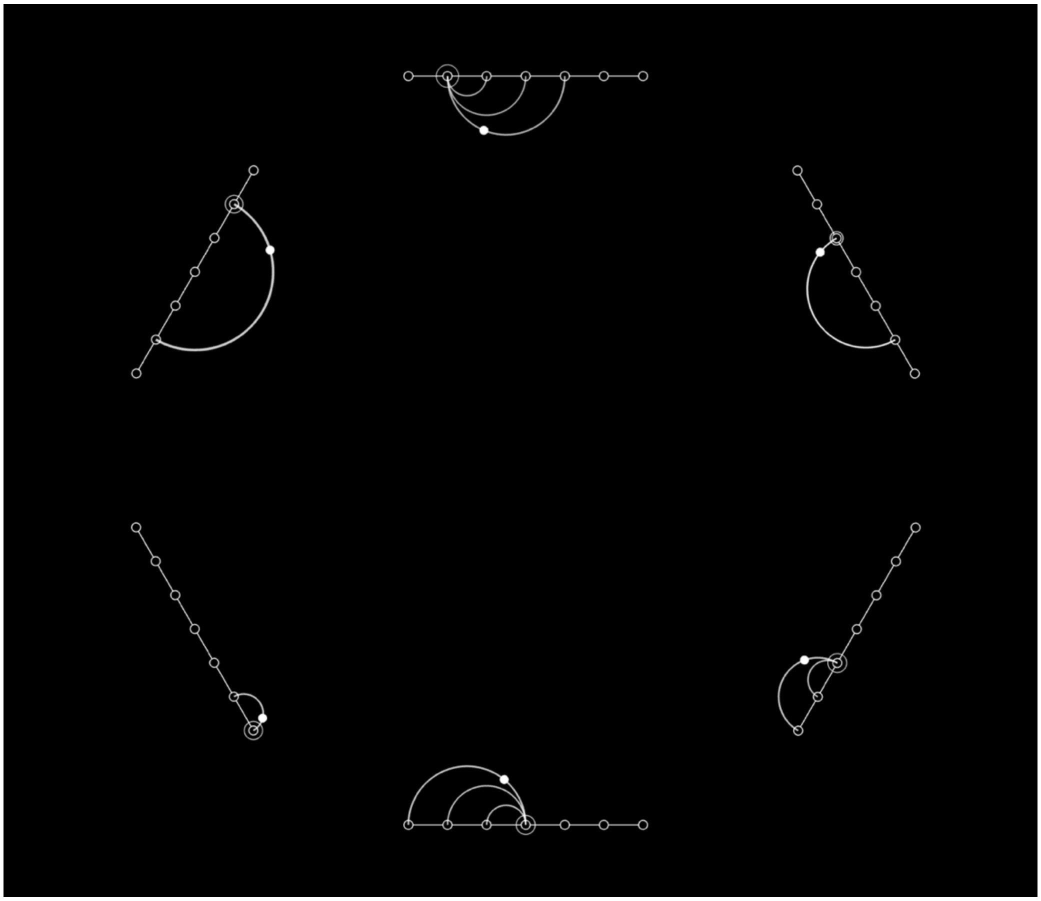

Figure 57: *Study no. 50* by Ryan Ross Smith (score detail)

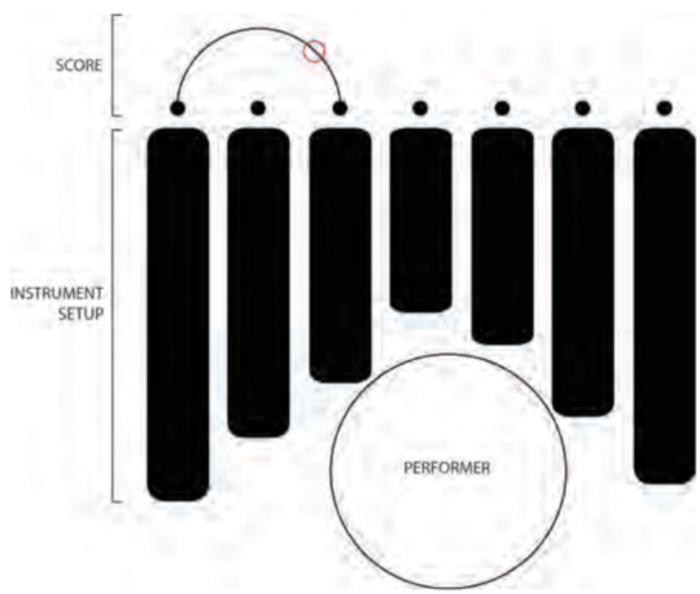

Figure 58: *Study no. 50* by Ryan Ross Smith (instrument and performer diagram)

After several notational experiments, I ultimately designed a notational approach that, like *Study no. 30*, directly corresponded to the layout of the instrument(s). At this point I had already composed several pieces that utilized the node array approach, which excels at the representation of discrete musical events with a high degree of temporal specificity, an approach that fit perfectly with the rhythmic content and instrumental layout of *Study no. 50*. Each player's aggregate contained seven nodes arranged horizontally, and in performance, these aggregates were projected onto the floor, with each piece of wood placed directly below its corresponding node. Like *Study no. 30*, the notation and instrument are merged, enhancing the score's legibility while demonstrating a unique presentation model (see figure 59).

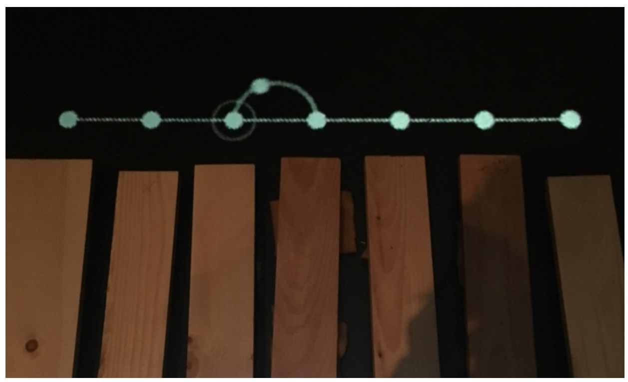

Figure 59: Study no. 50 (Instrument and notation detail)

There are four functionalities for the attack cursor, each prescribing which planks are to be played, and when they are to be played. The node that has most recently been engaged by the attack cursor is the current node, and the node that the attack cursor is moving toward is the target node. The primary notational functionality simply represents which plank to play, and when to play it, indicated by the arrival of the attack cursor at the corresponding node (see figure 60).

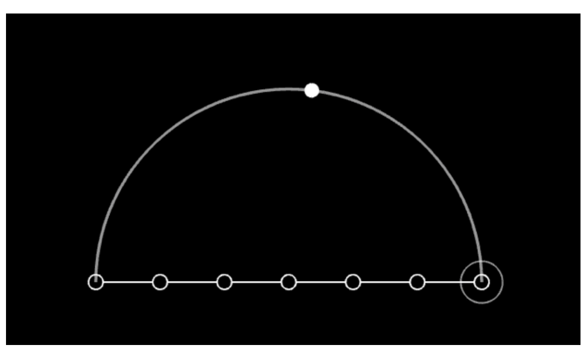

Figure 60: *Study no. 50* (Function 1: Current Node [far right] to Target Node [far left])

In figure 60, the attack cursor is en route from the rightmost node to the leftmost node. The performer will strike the plank that corresponds to the leftmost node at the moment the attack cursor makes contact with that node.

The second functionality occurs when the target node is the same as the current node. Because the attack cursor is already at the target node, the *repeat spinner* notation/functionality is utilized (see figure 61).

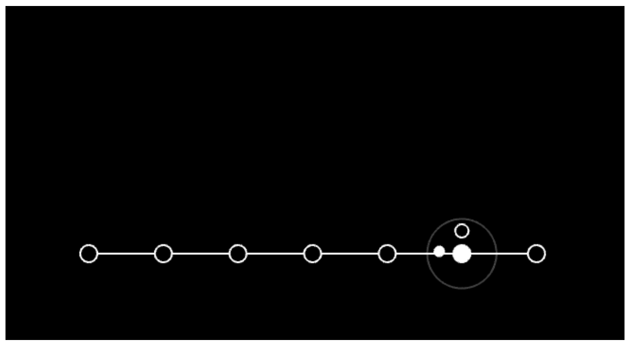

Figure 61: *Study no. 50* (Function 2: Repeat Spinner)

At the completion of the event that precedes a repeat spinner, a small node appears above the current node, followed by a radial attack cursor rotating in clockwise motion around the node. The point of articulation (repeat) is denoted by the moment the radial attack cursor makes contact with the node at 12 o'clock.

The third functionality is represented by a single arc, similar to the first functionality, but with a number displayed at the top of the arc (see figure 62).

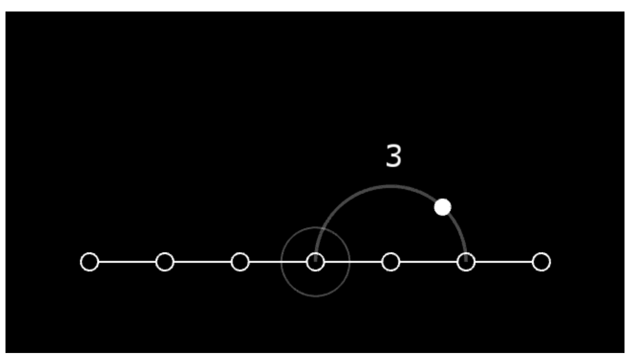

Figure 62: *Study no. 50* (Function 3: Numbered Repeats)

This number indicates that the player should repeat the current node, or target node's corresponding plank *that* number of times before the attack cursor reaches the target node. These attacks should occur within the duration it takes for the attack cursor to move from the current node to the target node, and regardless of which plank is repeated, the target node's corresponding plank should still be played upon the arrival of the attack cursor.

The fourth functionality is the flourish, in which a series of arcs extend from the current node to the target node, including every node in between (see figure 63).

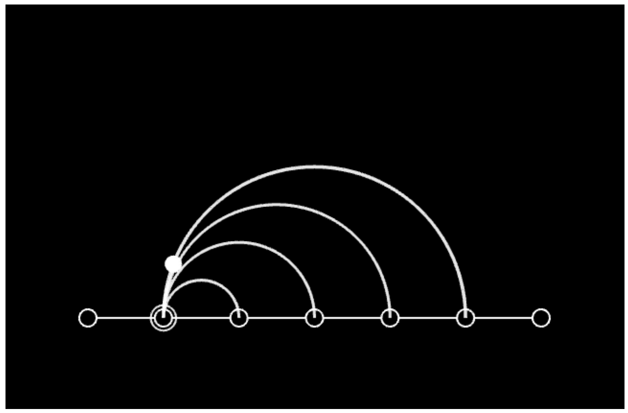

Figure 63: *Study no. 50* (Function 4: Flourish)

This notation indicates that the performer plays each plank corresponding to the nodes leading to the target node. These gestures can be played at any speed, but should be rhythmically consistent between attacks, and end as the attack cursor reaches the target node.

While the symbolic elements found within each performer's aggregate are identical, and each one contains the same functional potential, the processes within each aggregate function autonomously from the others, and are not governed by any high-level structure. The process to determine these functionalities occur at the completion of each event, and proceed as follows:

> Step 1: Determine the target node (the target node is determined randomly, and is equally weighted across all nodes, including the current node).
>
> Step 2: If the target node is the same as the current node, skip to step 6.
>
> Step 3: If the target node is immediately adjacent to the current node, choose between functions 1 and 3 (function choice is determined randomly, and is equally weighted between functions 1 and 3). If function 1 is selected, skip to step 6. If function 3 is selected, skip to step 5.

Step 4: If the target node is not the current node, and the distance between the current and target node is greater than one, choose between functions 1, 3 and 4 (function choice is determined randomly, and is equally weighted between these three functions). If function 1 or 4 is selected, skip to step 6.

Step 5: Select a number between 1 and 4.

Step 6: Determine traversal duration between 500 and 1600 milliseconds.

Step 7: Draw arc(s) or repeat spinner and activate the attack cursor.

4.8.5 In Performance

Study no. 50 was premiered at The Clark Art Institute in Williamstown, MA as part of the Williams College Department of Music's I/O Festival, and was performed by the Williams Percussion Ensemble, under the direction of Matthew Gold. The score was presented using the cinema model, projected onto a grey concrete wall using a short-throw projector in view of the audience.

The performers were seated in a semi-circle behind the projector facing the wall, with the audience spread out behind the performers. In order to facilitate a reasonable concert duration, the performance was limited to approximately 10 minutes. While this performance revealed certain deficiencies in the notational approach, specifically the speed by which the attack cursors moved, it was also encouraging to hear that no perceptible formal structure emerged; the piece simply started, and after about 10 minutes, stopped.

The performance of *Study no. 50* at EMPAC on February 5, 2016, perfectly represented the notational interests I have engaged with over the last four years, and is indicative of my shifting interest toward structural arbitrariness and non-developmental micro-variation.

The performers were arranged in a circle at the center of Studio 1, each seated with their seven planks on the floor in front of them. The score was mapped in such a way that each of the seven nodes within each aggregate appeared just beyond the end of each plank. From the performer's perspective, the attack cursor appeared to make contact with the tip of each plank, merging the notation and the instrument in both a functional and visually interesting way. Most importantly, the prescriptive clarity of this notation-instrument amalgamation perfectly represented the fundamental basis of my notational intentions: to clearly represent what to do and when to do it.

The performance lasted for 50 minutes. During the performance I alternated between my intense scrutiny of the ensemble's accuracy, and simply listening with my eyes closed. Upon viewing each player's respective interaction with the notation and their instruments, I was impressed by how well each player was able to sight read the notation with a high degree of accuracy, and that each performer was able to sustain this accuracy throughout the duration of the piece. With my eyes closed I focused more intently on the rhythmic and timbral gestalt, while attempting to clear my mind of the underlying processes that were generating the notation. The sonic result completely met my expectations of a structurally arbitrary, non-developmental concatenation of micro-variable events. It didn't take long before I had lost complete track of time, and felt as if each passing moment was of no more significance than any other. For even though *Study no. 50* is relatively dense, in a durational performance, the micro-variations between events lead one to focus on increasingly minute variations. I began to hear each passing moment as disconnected from the moments that preceded it, and independently from any that followed it.

4.9 Chapter Conclusion

In this chapter I identified *Study no. 10*, *Study no. 30*, *Study no. 0*, *Study no. 40.3*, *Study no. 44 [lecture1]* and *Study no. 50* as the six works composed during my time at Rensselaer that best demonstrate my compositional and notational work with AMN, and how the three essential ideas that form the practical and theoretical basis for contemporary animated scoring practices are manifested. To reiterate, the first essential idea is that AMN maintains the prescriptive specificity of CPN, albeit in a dynamic, real-time context. Second, the dynamic nature of an animated score displaces the traditional notion of performer interpretation from the performer to the computational processes of the score. And third, the prescriptive qualities of AMN in conjunction with the displacement of performer interpretation produces a post-literate notational approach in which performers are simply instructed what to do and when to do it, requiring little to no experience with traditional notational models.

5. Conclusion

5.1 Objectives

In this dissertation I had two primary objectives. The first was the identification of three essential ideas that formed the practical and theoretical framework for understanding contemporary animated scoring practices. First, an historical framework was developed in order to position contemporary animated scoring practices and animated music notation [AMN] as a prescriptive, post-literate, and largely digital manifestation of Western notational practices that had previously existed within various literate models, including primarily common practice notation [CPN] and graphic notation. Through the identification of a variety of antecedent devices, an historical lineage of practical usage reinforced the technological basis of AMN, thereby aligning contemporary animated scoring practices with other contemporaneous, post-literate compositional practices similarly enabled by technology. These devices include the magnetic tape recorder, the Musical Instrument Digital Interface (MIDI) communication protocol, Digital Audio Workstations (DAW), creative open-source and commercial software (Max/MSP, pD, SuperCollider, cSound), and a variety of technologies that enable musical interaction without requiring expertise with CPN or other notational approaches.

Second, the prescriptive and often controlling nature of animated scores, in conjunction with their real-time emergent qualities, demonstrates a displacement of the traditional interpretive model in favor of one based on the computational processes inherent in the generative qualities and dynamic functionalities of the animated score. This was demonstrated in part through the identification of the ephemeral, real-time qualities of animated scores, and how these qualities limit performer interaction to a constrained temporal window. The score cannot be referenced in the same way a fixed paper score can, limiting the performer's ability to engage prior to, or beyond the real time instantiation of the notation. Furthermore, the prescriptive functionalities of AMN are often extremely controlling of performer actions, instructing performers what to do and when to do it with little room left for interpretive freedom.

Third, I have demonstrated that the post-literate notational approaches found in contemporary animated scoring practices enable performer interaction across a wide range of abilities, suggesting a diminishment of the amateur-professional distinction often associated with traditional Western musical practices. The dynamic functionalities of AMN, including the use of contact and intersection as prescriptive determinants, effectively sidesteps the complex, relational symbol system of CPN. By clearly and simply prescribing what to do, and when to do it, the performer needs only to follow the notational instructions on a momentary basis. Additionally, through research into contemporary animated scoring practices and the associated written discourse, I identified and attempted to clarify terminological inconsistencies, and proposed extensions to existing high and low-level functionality and symbolic terminologies.

My second objective was to provide an analysis of the artistic work created during my time at RPI, in order to clarify how my notational and compositional intentions have developed, to position my work within the aforementioned practical and theoretical framework, and to speculate on the future of my creative practice. My analysis focused primarily on six compositions: *Study no. 10*, *Study no. 30*, *Study no. 0*, *Study no. 40.3 [pulseven]*, *Study no. 44 [lecture1]* and *Study no. 50*. For each composition I examined the appearance and functionality of the score, the generative processes of the score application, my compositional intentions for each work, and a brief discussion of each work in performance. Qualities specific to each piece were also identified, including electroacoustic synchronicity (*Study no. 10*), audience participation and persistency (*Study no. 30*), conceptual coagulation (*Study no. 0*), malleable phase relationships and hocket (*Study no. 40.3 [pulseven]*), alternatives to the traditional lecture format (*Study no. 44 [lecture1]*) and structural arbitrariness (*Study no. 50*). While many other works were composed during my time at RPI, these six works were selected as a distillation of my notational and compositional practice.

5.2 Strengths

One of the primary strengths of this research is its timeliness. The wealth of written and practical animated scoring discourse has steadily increased over the last decade, with a marked increase in activity since ca. 2010, as covered in chapter 3. Although these written and practical examples touch on nearly every aspect of contemporary animated scoring practices, this appears to be one the first large scale theoretical and practical treatment of the topic. Furthermore, while the functional analyses provided by Cat Hope, Lindsay Vickery, Gerhard E. Winkler, David Kim-Boyle, Jason Freeman and Arthur Clay represent the foundations of the high-level terminology of animated score functionality, little has been written about the low-level, atomic elements of AMN. The terminology I proposed in chapter 3 was based on analyses of both my own works, and contemporary animated scoring practices in general.

A further strength of the work presented here lies in its combination of theory and practice. As a dissertation in Electronic Arts emphasizing "practice-based research", my work can be considered as a practical representation of the three essential ideas within the more general practical and theoretical basis for contemporary animated scoring practices. Unlike a traditional musicological text, my compositional practice utilizing AMN was developed in tandem with my research into contemporary animated scoring practices, and subsequently, has had a reflexive impact on how these essential ideas were developed and manifested in the text. This has enabled me to establish a robust practical and theoretical foundation upon which both the field of practice and my creative portfolio are well represented, while embracing the emergent and open status of the field as it is at this moment in the history of Western musical practices.

One of the major contributing factors to the compositional directions I tended to favor was the representational limitations of AMN relative to CPN, and specifically, the methods of creation I was using prior to my adoption of AMN. Unlike the ostensibly endless possibilities available with patching languages like Max/MSP and pD, and the sequencing and layering power of ProTools (and other DAWs), the real time, necessarily dynamic nature of AMN immediately limits what can be adequately represented. I found that I was unable to represent compositional constructs like complex melodies, melodic and other types of phrasing, and virtuosic flourishes with the degree of prescriptive specificity that I required. But it was these very limitations that led me to focus on the compositional intentions most present in my work; namely, the creation of complex, malleable rhythmic relationships, persistency, and structural arbitrariness.

5.3 Weaknesses

The primary weaknesses of my first objective is the possibility that many existing animated scores have yet to be "discovered", and the potential downfalls of prematurely classifying an emerging field.

During my research I identified approximately 300 scores that appeared to bear some relevance to contemporary animated scoring practices. While this number was sufficient toward my development of the aforementioned practical and theoretical framework, it is certain that many relevant scores simply fell under the radar, despite my best efforts. I can only speculate on how these scores may have influenced the paper, but it is likely that as more scores emerge, they will make an impact on the evolving state of contemporary animated scoring practices.

Following this, the early identification and classification of an emerging field of practice, here demonstrated through the essential ideas, concepts and approaches may be misconstrued as more than the practical and theoretical framework this paper proposes. While I do believe that the three essential ideas provide an adequate framework for contemporary animated scoring practices in their current form, one can only speculate on how well these ideas will be generalizable across the field of practice as it continues to develop. This may be further problematized by the inclusion of my creative work in my survey and analysis of contemporary animated scoring practices, although I have, whenever possible, attempted to generalize my creative practice *within* the field, and not the other way around.

The weaknesses I have identified in my second objective reflect my compositional and notational development during the course of this research. As I have discussed throughout this dissertation, by making the score available to the audience during performance, one provides the audience with access to the otherwise mysterious relationship between the performer and the score. When I began my work with AMN, my choice to project the score was both a practical solution to an otherwise challenging technological endeavor, as well as an adherence to what I believed was the "common practice" of the time. It was only after several performances that I realized that my decision to project the score was having a positive impact on the audience's experience. Rather than look a gift horse in the mouth, I embraced these positive reactions in the packaging of my work, as the projected score appeared to improve the potential for a well-received performance; a visual seduction of sorts. With this presentation model, it was possible to explore not only the perceptibility of musical processes, as Steve Reich had suggested (and which has had valuable and lasting impact on my compositional interests),[357] but to display these notational processes as a visual counter(part/point). This model has served me fairly well over the last several years, but over time I came to feel that my own compositional intentions had begun to lean toward an exploitation of this audio-visual correspondence. This isn't to say that I consciously composed works that would best express this cross-modal experience, but it would also be untrue to say that it didn't have some (in)direct influence.

5.4 Future Work

Beyond the completion of this dissertation, it is my intention to maintain animatednotation.com [ANDC] as an online repository for works within and related to the field of contemporary animated scoring practices. Although ANDC was originally designed as a portal through which I could organize, access, and disseminate my research over the last four years, it is my hope that it will serve as a platform for future research and inquiry. While this does not solve the issues of premature classification or the potential lack of generalizability, it may, at the very least, represent a large cross-section of the field as it was in 2016, and may, in a sense, counteract the dated quality of this paper by extending beyond its fixed form into a malleable, extensible, and unfixed representation of the field as it continues to develop.

It has been my intention thus far to reduce, if not completely remove the performer's interpretive capacity, although I am curious to discover what compositional possibilities may be available with notational approaches that veer away from my stubborn ideology of representational specificity. While I have little interest in the suggestive activation of improvising performers, the dynamic framing of underdetermined notational fragments, as demonstrated by Cat Hope and Lindsay Vickery in *The Talking Board*, appears to be an encouraging direction. Similarly, the inclusion of compositional

[357] Steve Reich, *Writings on Music: 1965-2000*, 34-36.

constructs I had previously rejected for their inability to be contained by AMN may have the potential to introduce new compositional concepts following a thinning of prescriptive specificity. Certainly, a thinning of prescriptive specificity will require a heightened sense of musical responsibility on the part of the player to complete whatever musical information has been left un(der)notated. While this can be accomplished from a strictly sonic perspective, returning a degree of agency to the performer by providing interactive control over the generative capacities of the score is an area that is rife with potential, as has already been demonstrated by Jason Freeman, Art Clay, Harris Wulfson, Georg Hajdu and Gerhard E. Winkler among others.

I also intend to continue producing works that maintain my ideological perspective on notational specificity. Within this context, and beginning with *Study no. 48 [catalog]* and *Study no. 50*, I feel that my work has begun to split into two distinct compositional directions. The first maintains the inspiration I take from Reich's works and writings, and will continue to express the concept of perceptible processes, particularly in the form of malleable tempo relationships. I still believe that one of the great powers of AMN is the ability to represent time absolutely, and by doing so, can generate complex rhythmic and tempo relationships with a notational prescription that is accessible to a wide range of abilities. Contrarily, with *Study no. 48*, and especially *Study no. 50*, I feel that I have successfully begun to strip these perceptible processes away in favor of a structurally-arbitrary concatenation of micro-variable sonic atoms. The correspondence between the processes inherent in the visible notation and its sonic realization is still maintained, but these processes are perceptible only at the atomic level. Each event may lead to the next by its temporal adjacency, but ultimately do not reveal any large-scale structure or narrative.

The field of contemporary animated scoring practices is in a state of development. As these practices continue expanding into new directions of notational functionality, appearance, and compositional intentions, the sense of lively experimentation that is present in existing works will continue to influence how these new directions are manifested in practice. Thus, it seems inevitable that the works represented within this paper will come to appear dated as the field expands, due in large part to their technological basis, but more so due to the functional and visual similarities represented across the field of practice. However, I believe that the functional, visual, and compositional tendencies and similarities found in these works composed since the turn of the century represent a first wave of contemporary animated scoring practices.

This first wave is defined in part by the practical and theoretical framework developed throughout this paper. Scoring practices that populate the first wave maintain the prescriptive specificity of CPN, while rarely incorporating CPN in a functional way. The scoring practices limit performer interpretation by transferring agency to the computational or functional processes of the score, and limit performer access to a small temporal window. The performer must submit to this momentary, specifically prescribed control structure in order to adequately realize the performative expectations represented by the score. Finally, the post-literate symbol systems found in these scores often enable performer access regardless of musical training and experience. Coupled with specific prescription and the displacement of interpretive responsibility, the performer is simply instructed what to do and when to do it. The rules of performative engagement are presented clearly and succinctly, and the performer must simply mirror the score on her instrument. It is my intention to pursue a more in-depth account of this first wave of contemporary animated scoring practices upon the completion of my studies at Rensselaer.

6. References

American Composers Orchestra. "Freeman Essay." Accessed February 11, 2016. http://www.americancomposers.org/archive/2004-05-season/freeman_essay-htm/.

Animatednotation.blogspot.com. "Home Page." Accessed February 11, 2016. http://animatednotation.blogspot.com/.

Animatednotation.com. "Composers." Accessed February 11, 2016. http://animatednotation.com/.

Arsenault, Dominic. "Guitar Hero: 'Not Like Playing Guitar At All?'." Accessed February 11, 2016. http://journals.sfu.ca/loading/index.php/loading/article/view/32/29.

Attali, Jacques. *Noise*. Translated by Brian Massumi. Minneapolis: University of Minnesota Press, 1985.

Baird, Kevin. "No Clergy: A Piece for Flexible Small Ensemble Generated in Real Time Based on Audience Feedback." PhD diss., The State University of New York at Buffalo, 2005.

Barrett, G. Douglas and Michael Winter. "LiveScore: Real-Time Notation in the Music of Harris Wulfson." *Contemporary Music Review* 29:1 (2010): 55-62.

Barrett, G. Douglas, Michael Winter and Harris Wulfson. "Automatic Notation Generators." Paper presented at the 7th International Conference on New Interfaces for Musical Expression, New York, New York, June 6-10, 2007.

Beal, Amy C. "An Interview with Earle Brown." *Contemporary Music Review* 26:3 (2007): 341-356.

Bergey, R. D. "Music Timing Apparatus." United States Patent Office US002483570. Collingdale, PA, filed April 24, 1945, and issued October 4, 1949. Accessed February 12, 2016. USPTO.Gov.

Bernier, Lucas James. "The Percussion Ensemble Music of Robert Moran." DMA thesis, University of Iowa, 2012.

Bernstein, David W., ed., *The San Francisco Tape Music Center: 1960s Counterculture and the Avant-Garde*. Berkeley: University of California Press, 2008.

Brown, Earle. "Bravo Magazine." 1981. Accessed February 11, 2016. http://www.tate.org.uk/context-comment/video/performing-sculpture-earle-browns-calder-piece-tateshots.

Cage, John. *Silence: 50th Anniversary Edition*. Middletown: Wesleyan University Press, 2011.

Cage, John. *Silence*. Middletown: Wesleyan University Press, 1973.

Cage, John. *Notations*. New York City: Something Else Press, 1969.

Johncage.org. "Work detail: Concert for Piano and Orchestra" Accessed February 11, 2016. http://www.johncage.org/pp/John-Cage-Work-Detail.cfm?work_ID=48.

Cardew, Cornelius. *Scratch Music*. Cambridge: MIT Press, 1974.

Carpenter, Edwin P., and Morris S. Wright. "Key-Indicator for Musical Instruments." United States Patent Office US000347686. Brattleborough, VT, filed April 10, 1884, and issued August 17, 1886. Accessed February 12, 2016. USPTO.Gov.

Carter, Tim and Erik Levi. "The History of the Orchestra." In *The Cambridge Companion to the Orchestra*, edited by Colin Lawson, 1-20. Cambridge: Cambridge University Press, 2003.

Clay, Arthur. "You Can Play It Too: The Virtuoso Audience." *Contemporary Music Review* 29:1 (2010): 63-73. Ibook edition.

Clay, Arthur and Jason Freeman. "Preface: Virtual Scores and Real-Time Playing." *Contemporary Music Review* 29:1 (2010): 1.

Clay, Arthur and Dennis Majoe. "The Wrist-Conductor." Paper presented at the 7th International Conference on New Interfaces for Musical Expression, New York, New York, June 6-10, 2007.

Cleveland, William S. and Robert McGill. "Graphical Perception and Graphical Methods for Analyzing Scientific Data." *Science* 229:4716 (1985): 828-833.

Conduction.us. "Home." Accessed February 11, 2016. http://www.conduction.us/.

Cox, Christoph. "Every Sound You Can Imagine." Catalog Essay for Every Sound You Can Imagine, Contemporary Arts Museum Houston, Houston, TX, 2008.

Cox, Christoph. "Sonic Philosophy." *Artpulse* 16:4 (2013).

Cox, Christoph. "From Music to Sound: Being as Time in the Sonic Arts." *Sonambiente*

Berlin 2006: Klang Kunst Sound Art (2006): 214-23.

Dabbledoo Music. "Dabbledoo Music." Accessed February 16, 2016. http://www.dabbledoomusic.com/about.html.

Davies, Stephen. *Musical Works and Performances*. Oxford: Clarendon Press, 2001.

Decibelnewmusic. "The Decibel ScorePlayer." Accessed February 11, 2016. http://www.decibelnewmusic.com/decibel-scoreplayer.html.

Didkovsky, Nick. "Density Trajectory Studies: Organizing Improvised Sound." *Contemporary Music Review* 29:1 (2010): 75-80.

Donovan, Tristan. *Replay: The History of Video Games*. Lewes: Yellow Ant, 2010.

Dunn, David. "A History of Electronic Music Pioneers." Essay for the Exhibition Eigenwelt der Apparatewelt: Pioneers of Electronic Art at Ars Electronica, Linz, Austria, 1992.

Eaton, Joel and Eduardo Miranda. "Real-Time Notation using Brainwave Control." Paper presented at the Sound and Music Computing Conference, Stockholm, Sweden, 2013.

Eco, Umberto. *The Open Work*. Translated by Anna Cancogni. Cambridge: Harvard University Press, 1989.

Feldman, Jacob. "What is a Visual Object?" *TRENDS in Cognitive Sciences* 7:6 (2003): 252-256.

Ferneyhough, Brian and James Boros. "Shattering the Vessels of Received Wisdom." *Perspectives of New Music* 28:2 (1990): 6-50.

Fleischer, Richard. *Out of the Inkwell: Max Fleischer and the Animation Revolution*. Lexington: The University Press of Kentucky, 2005.

Freeman, Jason. "Extreme Sight-Reading, Mediated Expression, and Audience Participation: Real-Time Music Notation in Live Performance." *Computer Music Journal* 32:3 (2008): 25-41.

Freeman, Jason and Andrew Colella. "Tools for Real-Time Music Notation." *Contemporary Music Review* 29:1 (2010): 101-113.

Freeman, Jason. "Bringing Instrumental Musicians into Interactive Music Systems through Notation." *Leonardo Music Journal* 21 (2011): 15-16.

Gann, Kyle. “The Case Against Over-notation: A Defense and a Diatribe.” Accessed February 16, 2016. http://www.kylegann.com/notation.html.

Goehr, Lydia. *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music*. New York City: Oxford University Press, 2007.

Goodman, Nelson. *Languages of Art: An Approach to a Theory of Symbols*. New York City: The Bobbs-Merrill Company, Inc., 1968.

Gunnarsson, Gudmundur Steinn. “An Approach to Rhythm.” MA thesis, Mills College, 2007.

Hajdu, Georg. “Quintet.net – A Quintet on the Internet.” Paper presented at ICMC 2003, Singapore, September 29 – October 4, 2003.

Hajdu, Georg, Kai Niggemann, Ádám Siska and Andrea Szigetvári. “Notation in the Context of Quintet.net Projects.” *Contemporary Music Review* 29:1 (2010): 39-53.

Hope, Cat and Lindsay Vickery. “Visualising the Score: Screening Scores in Realtime Performance.” Paper presented at Diegetic Life Forms II: Creative Arts Practice and New Media Scholarship Conference and Festival, Murdoch University, Western Australia, September 3-5, 2010.

Hope, Cat and Lindsay Vickery. “Screen Scores: New Media Music Manuscripts.” Paper presented at the International Computer Music Conference, University of Huddersfield, UK, July 31 – August 5, 2011.

Horowitz, Steve. “Child of Amerika: A Musical Manifesto.” Accessed February 16, 2016. http://www.newmusicbox.org/articles/child-of-amerika-a-musical-manifesto/.

iTunes Store. “Björk: Biophilia App.” Accessed February 16, 2016. https://itunes.apple.com/us/app/bjork-biophilia/id434122935?mt=8.

Karkoschka, Erhard. *Notation in New Music*. Translated by Ruth Koenig. New York City: Praeger Publishers, 1972.

Kim-Boyle, David. “Real-time Score Generation for Extensible Open Forms.” *Contemporary Music Review* 29:1 (2010): 3-15.

Kim-Boyle, David. “Visual Design of Real-Time Screen Scores.” *Organised Sound* 19:3 (2014): 286-294.

Kramer, Jonathan D. “New Temporalities in Music.” *Critical Inquiry* 7:3 (1981): 539-556.

Kretz, Johannes. "Extending the KLANGPILOT Score Language for Real-Time Notation." *Contemporary Music Review* 29:1 (2010): 29-37.

Lopes, Filipe Cunha Monteiro. "Odaiko: Real Time Score Generator." Masters thesis, The Royal Conservatoire, The Hague, 2009.

Magnusson, Thor. "Algorithms as Scores: Coding Live Music." *Leonardo Music Journal* 21 (2011): 19-23.

Manovich, Lev. "Database as a Symbolic Form." *Convergence: The International Journal of Research into New Media Technologies* 5:2 (1999): 80-99.

McTammany, John. "Mechanical Indicator for Musicians." United States Patent Office US000422964. Worcester, MA, filed June 14, 1889, and issued March 11, 1890. Accessed February 12, 2016. USPTO.Gov.

Miller, Kiri. *Playing Along: Digital Games, YouTube, and Virtual Performance*. New York City: Oxford University Press, Inc., 2012.

More or Less. "More or Less: Realtime Composition for Computer-Controlled Soloists." Accessed February 11, 2016. http://www.essl.at/works/more_or_less.html.

Muenz, Harald. "Live Random Concepts and Sight-Reading Players: The Role of the Computer in the Era of Digested Digitalism." *Contemporary Music Review* 29:1 (2010): 81-87.

Oliveros, Pauline. *Anthology of Text Scores*, Edited by Samuel Golter and Lawton Hall. Kingston: Deep Listening Publications, 2013.

Oliveros, Pauline. *Software for People: Collected Writings 1963-80*. Baltimore: Smith Publications, 1984.

Pancake, Catherine. "Optical Scores for Improvised Music." *Leonardo Music Journal* 21 (2011): 17-18.

The Pianola Institute. "Compositions for Pianola – An Overview." Accessed February 11, 2016. http://www.pianola.org/history/history_compositions.cfm.

Reich, Steve. *Writings on Music: 1965-2000*. Edited by Paul Hillier. New York City: Oxford University Press, 2002.

Rhoadley.net. "Notation as Art." Accessed February 11, 2016. http://rhoadley.net/presentations/notation-as-art-s.pdf.

Sauer, Theresa. *Notations 21*. New York City: Mark Batty Publisher, 2008.

Seeger, Charles. *Studies in Musicology: 1935-1975*. Berkeley: University of California Press, 1977.

Smith, Ryan Ross. "An Atomic Approach to Animated Music Notation." Paper presented at TENOR 2015: First International Conference on Technologies for Music Notation and Representation, Paris, France, May 28-30, 2015.

Stanley, Thomas T. "Butch Morris and the Art of Conduction®." PhD diss., University of Maryland, College Park, 2009.

Strayer, Hope R. "From Neumes to Notes: The Evolution of Music Notation." *Musical Offerings* 4:1 (2013): 1-14. Accessed February 16, 2016. http://dx.doi.org/10.15385/jmo.2013.4.1.1.

Taruskin, Richard. *The Oxford History of Western Music: Volume 5: The Late Twentieth Century*. Oxford: Oxford University Press, 2005.

Treisman, Anne. "Features and Objects in Visual Processing." *Scientific American* 254:11 (1986): 114-125.

Ulman, Erik. "Some Thoughts on the New Complexity." *Perspectives of New Music* 32:1 (1994): 202-206.

Vickery, Lindsay. "The Limitations of Representing Sound and Notation on Screen." *Organised Sound* 19:3 (2014): 215-227.

Whitney Museum of American Art. "Musician as Interpreter: Marina Rosenfeld Speaks about Performing Christian Marclay's Screenplay." Accessed February 11, 2016. http://whitney.org/Education/EducationBlog/MarinaRosenfeldSpeaksAboutPerformingScreenplay.

Winkler, Gerhard E. "The Realtime-Score. A Missing-Link in Computer-Music Performance." Paper presented at First Sound and Music Computing Conference, SMC '04, Paris, France, 2004.

Winkler, Gerhard E. "The Real-Time-Score: Nucleus and Fluid Opus." *Contemporary Music Review* 29:1 (2010): 89-100.

Yang, Justin Wen-Lo. "Sometimes I Feel the Space Between People (Voices) in Terms of Tempos – A Work for Percussion Duo with Computer Animated Notational Interface." DMA diss., Stanford University, 2008.

7. Appendix 1: List of Works

Study no. 1

Composed: 9/2010
Instrumentation: 8 or more instrumentalists
Score Type: Radial
Presentation: Floor Projection
Duration: Open [15 minutes or more]
Software: Processing

Study no. 2

Composed: 2011/2012
Instrumentation: Vocalist, Piano and 4 Instruments
Score Type: Multiple Swiping Play Heads
Presentation: Wall Projection or Networked Monitors
Duration: Open [15 minutes or more]
Software: Processing
Performed by Mills College Contemporary Performance Ensemble, Mills College, Oakland, CA, 5.7.2014.

Study no. 3 [Canon]

Composed: 4/2012
Instrumentation: String Quartet
Score Type: Atomic Scrolling Score
Presentation: Wall Projection or Networked Monitors
Duration: 3.5 Minutes
Software: Processing
Performed by the Arditti Quartet, Mills College Masterclass, Oakland, CA, 4.14.2012.

Study no. 4 [big bear]

Composed: 11/2011
Instrumentation: Open [5 Instruments]
Score Type: Radial
Presentation: Wall Projection or Networked Monitors
Duration: 6 Minutes
Software: Processing
Performed at Mills College, Fred Frith's Composition Seminar Concert

Study no. 5 [Rainbow]

Composed: 11/2011
Instrumentation: Open [1 or more Instrumentalists and/or Vocalists]
Score Type: Suggestive
Presentation: Wall Projection or Monitors [not necessarily networked]
Duration: Open [5 Minutes or more]
Software: Processing

Performed by Drew Cecatto and Adam Tinkle at Synaesthesoria: Color and Control in Graphic Music, CPMC Theatre, UCSD, San Diego, CA, 5.20.2014.

Study no. 6 [Escalators]

Composed: 10.2011
Instrumentation: Open [5 or more Instrumentalists]
Score Type: Suggestive
Presentation: Wall Projection
Duration: 5 Minutes
Software: Processing
Performed at Slaturtid, Reykjavik, Iceland, 10.24.2012.
Performed by SuperMusique at Conservatoire de Musique de Montreal, Montreal, QC, 11.14.2013.

Study no. 6.1

Composed: 6.2014
Instrumentation: Open [4 instrumentalists]
Score Type: Swiping Playhead
Presentation: Wall Projection or Monitors [not necessarily networked]
Duration: Open [15 Minutes or more]
Software: openFrameworks

Study no. 6.2

Composed: 6/2014
Instrumentation: Open [4 instrumentalists]
Score Type: Radial Time Frames
Presentation: Wall Projection or Monitors [not necessarily networked]
Duration: Open [10 Minutes or more]
Software: openFrameworks

Study no. 7

Composed: 5/2012
Instrumentation: French Horn, Vibraphone and Score-Triggered Electronics
Score Type: Swiping Playhead
Presentation: Wall Projection or Networked Monitors
Duration: 4 minutes
Software: Processing
Performed by Rachel Trapp and Robert Lopez, Mills College, Oakland, CA, 5.2012

Study no. 8 [15 Percussionists]

Composed: 3/2012
Instrumentation: 15 Percussionists [unpitched metal, wood, pitched metal]
Score Type: Action/Tablature [Vickery]
Presentation: Wall Projection or Networked Monitors
Duration: 12 Minutes

Software: Processing [revised with openFrameworks]
Performed at Mills College, Oakland, CA, 3.8.2012.
Performed at Slaturtid, Reykjavik, Iceland, 10.24.2012.

Study no. 8.1
Composed: 12/2014
Instrumentation: Open [8 instrumentalists]
Score Type: Radial
Presentation: Wall Projection or Networked Monitors
Duration: 15 Minutes
Software: openFrameworks

Study no. 9
Composed: 6.2012
Instrumentation: Open [16 Instrumentalists]
Score Type: Malleable Node Array
Presentation: Wall Projection or Networked Monitors
Duration: Open [10 or more minutes]
Software: openFrameworks
Performed by James Saunders/Material Ensemble, Bath Spa University, Bath, UK, 11.2014. https://vimeo.com/112161023

Study no. 9.1
Composed: 6/2014
Instrumentation: Open [10 or more instrumentalists]
Score Type: Malleable Node Array
Presentation: Wall Projection or Networked Monitors
Duration: 10 Minutes
Software: openFrameworks

Study no. 10 [for claviset and electronics]
Composed 10/2012
Instrumentation: Claviset [or comparable keyboard] and Score-Triggered Electronics
Score Type: Atomic Scrolling Score
Presentation: Single Monitor
Duration: Open [20 minutes or more]
Software: openFrameworks
Performed by Ryan Ross Smith, O Positive Festival, Kingston, NY, 10.7.2012.
Performed by Ryan Ross Smith, West Hall, Rensselaer Polytechnic Institute, Troy, NY, 12.9.2012.
Performed by Ryan Ross Smith, South Oxford Space, Brooklyn, NY, 11.7.2014.
Performed by Ryan Ross Smith, Northern Illinois University while Artist in Residence, Dekalb, IL, 2.2015.
Performed by Ryan Ross Smith, West Hall, Rensselaer Polytechnic Institute, Troy, NY, 5.16.2016.

Performed by Ryan Ross Smith, Anglia Ruskin, Cambridge, UK, 5.29.2016.

Study no. 10.1
Composed: 5/2014
Instrumentation: 2 Violins, Piano, Vibraphone, Electric Bass and Score-Triggered Electronics
Score Type: Atomic Scrolling Score
Presentation: Wall Projection or Networked Monitors
Duration: Open [20 minutes or more]
Software: openFrameworks

Study no. 11 [4+4]
Composed: 2012
Instrumentation: Open [4 instrumentalists]
Score Type: Radial
Presentation: Wall Projection or Networked Monitors
Duration: 6 minutes
Software: openFrameworks

Study no. 12 [windmills]
Composed/Revised: 2012
Instrumentation: 9 Bottle Blowers [optional audience vocalization]
Score Type: Radial
Presentation: Wall Projection
Duration: Open [at least until each performer has finished one bottle]
Software: Processing [revised with openFrameworks]
Performed by Mills College graduate students, Mills College, Oakland, CA, 5.2012
Performed by audience members at the Collar City Film Festival, Vol. 1, Troy, NY, 11.3.2012.
Performed by Kirkos Ensemble and Bastard Assignments, BLOCK T Smithfield Chambers, Smithfield Square, Dublin 7, Dublin, Ireland, 7.25.2014.
Private Performance, Birmingham, UK, 4.2016.

~~*Study no. 13*~~

~~*Study no. 14*~~

Study no. 15a [for Pauline Oliveros]
Composed: Spring, 2013
Instrumentation: 15 Performers [Clapping and Vocalization]
Score Type: Convergence and Radial Time Frames
Presentation: Wall Projection or Networked Monitors
Duration: Open [10 minutes or more]
Software: openFrameworks
Performed by audience members, Northern Illinois University while Artist in

Residence, Dekalb, IL, 2.2015.

Study no. 15a.1

Composed: 2013
Instrumentation: 30 Performers [Clapping and Vocalization]
Score Type: Convergence and Radial Time Frames
Presentation: Wall Projection, Floor Projection, or Networked Monitors
Duration: Open [10 minutes or more]
Software: openFrameworks

Study no. 15b

Composed: Winter 2013
Instrumentation: Cello or Double Bass [with optional Score-Triggered Electronics]
Score Type: Convergence
Presentation: Single Monitor
Duration: Open [10 minutes or more]
Software: openFrameworks

Study no. 15b.1

Composed: Spring 2013
Instrumentation: Violin or Viola [with optional Score-Triggered Electronics]
Score Type: Convergence
Presentation: Single Monitor
Duration: Open [10 minutes or more]
Software: openFrameworks

Study no. 16 [NavavaN]

Composed for percussionist Nava Dunkelman: Winter 2013
Instrumentation: Percussion and Score-Triggered Electronics
Score Type: Convergence and Radial Time-Frames
Presentation: Single Monitor
Duration: 8 minutes
Software: openFrameworks
Performed by Nava Dunkelman, Littlefield Concert Hall, Mills College, Oakland, CA, 4.20.2013.
Performed by Matthew Curley, Middle Tennessee State University, 2.22.2015.

Study no. 16.1 [AnnA]

Composed for percussionist Anna Wray: 3/2014
Instrumentation: 4 Performers [Vibraphone, Crotales, Xylophone, Concert Bass Drum, Triangle, Oxygen Tank, Tam-Tam]
Score Type: Radial
Presentation: Wall Projection or Networked Monitors
Duration: 10 minutes
Software: openFrameworks

Performed at R.O.D. Music Hall, California Institute of the Arts, Los Angeles, CA, 3.8.2014.

Study no. 17

Composed for PLoRK: Winter 2013
Instrumentation: Laptop Ensemble [7 or more laptop performers]
Score Type: Radial and Node Arrays
Presentation: Single Monitor [per player]
Duration: Open/10+
Software: openFrameworks
Performed by PLoRK (Princeton Laptop Orchestra), Taplin Auditorium, Princeton University, Princeton, NJ, 4.24.2013.

Study no. 19

Composed: Spring 2013
Instrumentation: Brass Quintet
Score Type: Intersection, Node Array, Reverse Convergence
Presentation: Wall Projection or Networked Monitors
Duration: Approximately 15 minutes
Software: openFrameworks

Study no. 20

Composed: Spring 2013
Instrumentation: Typatune [1 or more Typatunists]
Score Type: Convergence
Presentation: Single monitor [per person]
Duration: Open [10 minutes or more]
Software: openFrameworks

Study no. 21

Composed for Duo Harpverk: Spring 2013
Instrumentation: Harp, Percussion, Vocals [2 players]
Score Type: Scrolling Score
Presentation: Wall Projection or Networked Monitors
Duration: 5 minutes
Software: openFrameworks
Performed by Duo Harpverk, Kex Hostel, Reykjavik, Iceland, 10.9.2013.

Study no. 22 [for 24]

Composed: Spring 2013
Instrumentation: 24 percussionists [pitched]
Score Type: Action/Tablature
Presentation: Wall or Floor Projection
Duration: Open [15 minutes or more]
Software: openFrameworks

Study no. 23.1 [Scrollbox (jp&kb)]

Composed for Jesper Pedersen and Katie Buckley: Summer 2013
Instrumentation: 2 vocalists
Score Type: Scrolling Score
Presentation: "ScrollBox" [Cigar box with manually rotating paper scroll]
Duration: As long as it takes
Software: openFrameworks

Study no. 24 [dance1]

Composed: Spring 2013
Personnel: 3 Dancers
Score Type: Action, Tablature
Presentation: Wall Projection or Monitors (not necessarily networked)
Duration: Open (10 minutes or more)
Software: openFrameworks
Presented in the Graduate Modern Dance Seminar, Professor Ellen Bromberg, University of Utah, Salt Lake City, Spring, 2013.

Study no. 25 [scales]

Composed: 6/2014
Instrumentation: Open [8 instrumentalists]
Score Type: Node Array
Presentation: Wall Projection or Networked Monitors
Duration: Open (10 minutes or more)
Software: openFrameworks

Study no. 26 [8x3]

Composed: Fall 2013
Instrumentation: 8 percussionists
Score Type: Scrolling Score
Presentation: Wall Projection or Networked Monitors
Duration: Open
Software: openFrameworks

Study no. 27 [up or down]

Composed: 6/2014
Instrumentation: Open
Score Type: Node Array
Performed by James Saunders/Material Ensemble, Bath Spa University, Bath, UK, 11.2014.

Study no. 28

Composed: Fall 2013
Instrumentation: Open + Percussion
Score Type: Radial Time Frames, Radial
Duration: Open

Performed by Pauline Oliveros, IONE, The Mayor of Kingston, and audience members, Deep Listening Institute, Kingston, NY, 10/2013. http://www.hudsonvalleyalmanacweekly.com/2013/10/18/iones-dream-festival-in-kingston/

Study no. 29

Generative, not animated

Study no. 30

Composed: 12/2013
Instrumentation: Tuned Desk Bells
Score Type: Convergence
Duration: Open
Performed by installation attendees, Studio 1, EMPAC, Troy, NY, 12.5-12.6.2013.
Installed and performed by Jennifer Bewerse and concert attendees, UCSD, San Diego, CA, 1.26.2015.

Study no. 31

Composed: Fall 2013.
Instrumentation: Triangles and Electronics
Score Type: Radial
Duration: Open
Performed by the Sonoma State University Percussion and Improvisation Ensemble, directed by Jennifer Wilsey, Weill Hall, Sonoma State, CA, 11.17.2013.

Study no. 31.1

Composed: Fall 2013.
Instrumentation: Triangles and Cans
Score Type: Radial
Duration: Open
Performed by Ryan Ross Smith and K. Michael Fox, West Hall, Rensselaer Polytechnic Institute, Troy, NY, December 2013.

Study no. 31.3

Composed: Fall 2013
Instrumentation: 12 Strings and winds
Score Type: Radial
Duration: 8 minutes

Study no. 32

Composed: March 2014
Instrumentation: 8 strings and winds
Score Type: Node Array
Duration: Open
Performed by graduate students during Animated Notation workshop in Zeena

Parkins' Composition Seminar, Mills College, Oakland, CA, 3.18.2014.

Study no. 33
Composed: June 2014.
Instrumentation: 5 Percussionists
Score Type: Node Array
Duration: Open

Study no. 34
Composed: June 2014.
Instrumentation: Open
Score Type: Node Array
Duration: Open

Study no. 35
Composed: Summer 2013.
Instrumentation: 50 vocalists and/or instrumentalists
Score Type: Radial Time Frame
Duration: Open
Performed by audience members, 1st Annual International Conference on Deep Listening, EMPAC, Troy, NY, 7.10.2013.

Study no. 36
Composed: June 2014.
Instrumentation: DAW
Score Type: Node Array
Duration: Open

Study no. 37
Composed: March 2014.
Instrumentation: 8 strings and winds
Score Type: Node Array
Duration: Open
Performed by graduate students during Animated Notation workshop in Zeena Parkins' Composition Seminar, Mills College, Oakland, CA, 3.18.2014.

Study no. 38 [Variations on Sol LeWitt's Variations of Incomplete Open Cubes]
Composed: March 2014.
Instrumentation: 8 instruments
Score Type: Node Array
Duration: 122 minutes
Performed at the Totally Intense Fractal Mindgaze Hut, Oakland, CA, 3.16.2014.

Study no. 39
Composed: Fall 2013.
Instrumentation: 5 performers (any instruments with the capacity for microtonal

tuning)
Score Type: Node Array
Duration: Open

Study no. 40 [pulseight]
Composed: January 2014.
Instrumentation: 8 clarinets (or open)
Score Type: Radial
Duration: Open
Performed by James Saunders/Material Ensemble, Bath Spa University, Bath, UK, 11.2014. https://vimeo.com/112161077

Study no. 40.1 [pulseighteen]
Composed: January 2014.
Instrumentation: 18 instrumentalists (open)
Score Type: Radial
Duration: Open

Study no. 40.2 [pulseighty:pitched]
Composed: January 2014.
Instrumentation: 80 instrumentalists (open)
Score Type: Radial
Duration: Open

Study no. 40.3 [pulseven]
Composed: March 2014.
Instrumentation: 7 instrumentalists (open)
Score Type: Radial
Duration: Open
Performed by the Mills College Contemporary Performance Ensemble, directed by Steed Cowart, Oakland, CA, 5.7.2014.
Performed by Students, Northern Illinois University while Artist in Residence, Dekalb, IL, 2.2015.
Performed by Wooden Cities, Studio 1, EMPAC, Troy, NY, 5.17.2015.
CCSF, San Francisco, Electronic Music Course Lecture, 8.2015.
Performed by Workshop Attendees, Animated Notation Workshop, Deane Carriage Barn, Bennington College, Bennington, VT, 9.14.2015.

Study no. 41 [rr:____]
Composed: January 2014.
Instrumentation: 9 or more instrumentalists (open)
Score Type: Radial
Duration: Open

Study no. 42
Composed: January 2014.

Instrumentation: Toy Piano
Score Type: Convergence
Duration: Open
Performed by Kristin at Mengi, Reykjavik, Iceland, 1.25.2014.
Performed by Christian Hertzog, New Music Gathering 2016, Peabody Institute, Baltimore, MD, 1.9.2016.

Study no. 43
Composed: June 2014
Instrumentation: 5 performers (open)
Score Type: Node Array
Duration: Open

Study no. 44 [Lecture1]
Composed: July 2014
Instrumentation: Voice and Electronics
Score Type: Node Array and Radial
Duration: Open
Performed by Ryan Ross Smith, 2nd Annual International Conference on Deep Listening, EMPAC, Troy, NY, 7.2014.
Performed by Ryan Ross Smith, Tenor 2015: First International Conference on Technologies for Music Notation and Representation], Paris, FR, 5.2015.
Performed by Ryan Ross Smith, Animated Notation Workshop, Deane Carriage Barn, Bennington College, Bennington, VT, 9.14.2015. http://bennington.m.bwcs-hosting.com/cal/main/showMainEnd.rdo;jsessionid=ECB05775B92D587D3138F1596B9C13A1

Study no. 45 [Lecture2: On Pi]
Composed: July 2014.
Instrumentation: 3 voices and electronics
Score Type: Convergence
Duration: Open
Performed by Ryan Ross Smith, K. Michael Fox, and Ernesto Caracamos, South Oxford Space, Brooklyn, NY, 11.7.2014.
Performed by Ryan Ross Smith and audience members, West Hall, Rensselaer Polytechnic Institute, Troy, NY, Spring 2015.

Study no. 46
Composed: December 2014.
Instrumentation: 12 vocalists
Score Type: Node Array
Duration: Open
Performed by the Cornelius Cardew Choir, Sonoma State University, Rohnert Park, CA, 4.22.2015.

Study no. 48 [catalog1]

Composed for Decibel Ensemble: Summer 2015.
Instrumentation: 6 instrumentalists (open)
Score Type: Node Array
Duration: Open
Performed by Decibel Ensemble, Anime, Perth Institute of Contemporary Arts, Perth, Australia, 9.5.2015.

Study no. 48.1 [catalog2]

Composed: Summer 2015.
Instrumentation: 2 instrumentalists (open)
Score Type: Node Array
Duration: Open
Performed by Crystal Pascucci and Mark Clifford, City Bird Gallery, New York, NY, 9.27.2015.

Study no. 48.2 [catalog3]

Composed for CTRL-Z: Fall 2015.
Instrumentation: 3 electronicists (open)
Score Type: Node Array
Duration: Open
Performed by CTRL-Z [Daniel Steffey, Nick Wang, Ryan Paige], Studio Grand, Oakland, CA, 12.17.2015.

Study no. 50

Composed: Fall 2015.
Instrumentation: 7 percussionists (wood)
Score Type: Node Array
Duration: Open
Performed by the Williams Percussion Ensemble, directed by Matthew Gold, The Clark Institute, Williamstown, MA, 1.9.2016.
Performed by the Williams Percussion Ensemble, directed by Matthew Gold, EMPAC, Troy, NY, 3.2016.

8. Appendix 2: Code Samples

8.1 Study no. 10

8.1.1 Sustain Lines and Electronic Flank Lines

```
if (extra_notes == 0) {
    ofNoFill();
    ofSetColor(255,0,0);
    ofSetLineWidth(sustain_thickness);
    ofLine(x,y,x+sus,y);
    ofNoFill();
    ofSetLineWidth(0.1);
    ofCircle(x,y,dim);

    if (y > ofGetHeight()*.5) {
        ofSetColor(255,0,0);
        ofSetLineWidth(0.1);
        ofNoFill();
        ofLine(x+sus,y,x+sus,ofGetHeight()*0.75);
        ofCircle(x+sus,ofGetHeight()*0.75,dim);

        if(x+sus <= ofGetWidth()*0.25 && eCrossedTop == false) {
            ofSetColor(255,165,0,ofMap(x+sus,ofGetWidth()*0.25,ofGetWidth()*.1,255,0));
            ofCircle(x+sus,ofGetHeight()*0.75,ofMap(x,ofGetWidth()*0.25,ofGetWidth()*0.1,dim,dim*2.5));
        };
    }

    if (y < ofGetHeight()*.5) {
        ofSetColor(255,0,0);
        ofSetLineWidth(0.1);
        ofNoFill();
        ofLine(x+sus,y,x+sus,ofGetHeight()*0.25);
        ofCircle(x+sus,ofGetHeight()*0.25,dim);


        if(x+sus <= ofGetWidth()*0.25 && eCrossedBottom == false) {
            ofSetColor(255,165,0,ofMap(x+sus,ofGetWidth()*0.25,ofGetWidth()*.1,255,0));
            ofCircle(x+sus,ofGetHeight()*0.25,ofMap(x,ofGetWidth()*0.25,ofGetWidth()*0.1,dim,dim*2.5));
        };

    }

}
```

8.1.2 Attack Cursor Reset

```
extra_notes = int(ofRandom(2));
dim = ofRandom(3,10);
crossed = false;
eN1 = ofRandom(50,150);
eN2 = ofRandom(50,150);
eN3 = ofRandom(50,150);
sus = ofRandom(50,150);
speed = ofRandom(-2,-.3);

eCrossedTop = false;
eCrossedBottom = false;
eCrossed = false;
C_NOTE = false;
CC_NOTE = false;
rDuration = ofRandom(0.005,0.03);
numRhythm = int(ofRandom(1,7));

int rhythmChoice = int(ofRandom(0,20));
if (rhythmChoice == 0) {rhythm = false;}
else {rhythm = true;}
```

8.1.3 OSC Messaging

```
for (int i=0;i<n_ac;i++) {
    if (ac[i]->x < ofGetWidth()*0.25 && ac[i]->crossed == false) {
        ofxOscMessage m;
        ofxOscMessage q;

        if (ac[i]->OSC_NOTE == i) {m.setAddress(notes[i]);}

        if (ac[i]->extra_notes == 1) {q.setAddress("/sample_trigger"); }

        sender.sendMessage(m);
        sender.sendMessage(q);

        ac[i]->crossed = true;

    }

}
```

8.1.4 Proximity Web

```
float tx[n_ac];
float ty[n_ac];
for (int i=0;i<n_ac;i++) {
    tx[i] = ac[i]->x;
    ty[i] = ac[i]->y;
}

sort(tx,tx + n_ac);

for (int i=0;i<n_ac;i++) {
    for (int j=0;j<n_ac;j++) {
        if (tx[i] == ac[j]->x) {ty[i] = ac[j]->y; }
    }
}

for (int i=0;i<n_ac-1;i++) {
    ofLine(tx[i],ty[i],tx[i+1],ty[i+1]);

}
```

8.2 Study no. 30

8.2.1 Rings Class

```
void Rings::draw() {



    ofSetLineWidth(1);
    ofFill();
    ofSetColor(255);
    ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),local_size*4);

    ofNoFill();
    ofSetColor(0);
    ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),local_size*4);


    ofFill();
    ofSetLineWidth(0.5);
    ofSetColor(255);
    ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),local_size*c_offset);

    ofNoFill();
    ofSetColor(0);
    ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),local_size*c_offset);


    if (ofGetElapsedTimeMillis() >= start && ofGetElapsedTimeMillis() < start + speed_attack) {

        ofSetColor(255,0,0,ofMap(ofGetElapsedTimeMillis(),start,start + speed_attack,0,255));
        ofSetLineWidth(ofMap(ofGetElapsedTimeMillis(),start,start + speed_attack,0,3));
        ofNoFill();
        ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),
                 ofMap(ofGetElapsedTimeMillis(),start,start+speed_attack,local_size*4,local_size*c_offset));
        trigger = false;
    }
    if (ofGetElapsedTimeMillis() >= start + speed_attack && ofGetElapsedTimeMillis() < start + speed_attack + speed_decay) {

        ofSetColor(255,0,0,ofMap(ofGetElapsedTimeMillis(),start+speed_attack,start + speed_attack + speed_decay,255,0));
        ofSetLineWidth(ofMap(ofGetElapsedTimeMillis(),start + speed_attack,start + speed_attack + speed_decay,3,0));
        ofNoFill();
        ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),
                 ofMap(ofGetElapsedTimeMillis(),start + speed_attack,start+speed_attack+speed_decay,local_size*c_offset,local_size*4));

        ofSetColor(255,0,0,ofMap(ofGetElapsedTimeMillis(),start+speed_attack,start + speed_attack + speed_decay,105,0));
        ofCircle(cos(ofDegToRad((division*num)+offset))*(global_size)+(ofGetWidth()*.5),sin(ofDegToRad((division*num)+offset))*(global_size)+(y),
                 ofMap(ofGetElapsedTimeMillis(),start + speed_attack,start+speed_attack+speed_decay,local_size*c_offset,local_size*2));

    }

    if (ofGetElapsedTimeMillis() >= start + speed_attack + speed_decay) {
        start = start + speed_attack + speed_decay + ofRandom(ofMap(fmodf(ofGetElapsedTimeMillis(),120000),0,120000,0,25000));
    }

}
```

8.3 Study no. 50

8.3.1 Attack Cursor Reset

```
if (ofGetElapsedTimeMillis() >= start + speed && restart == false) {
    attack_x = nodes_x2[next_node];
    attack_y = nodes_y2[next_node];
    temp_choice = next_node;
    current_node = temp_choice;
    dynamic_choice = int(ofRandom(3));
    next_node = int(ofRandom(num_dots));
    repeat_truth = int(ofRandom(5));
    repeats = int(ofRandom(2,5));
    multiples = int(ofRandom(4));
    speed = ofRandom(500,1600);
    start = ofGetElapsedTimeMillis();
    restart = true;
}
```

8.3.2 Repeat Spinner

```
if (current_node == i && next_node == current_node) {
    ofSetColor(255);
    attack_x = nodes_x2[i];
    attack_y = nodes_y2[i];

    ofFill();
    ofCircle(cos(ofDegToRad(ofMap(ofGetElapsedTimeMillis(),start,start+speed,270,630)))*(cursor_size*3)+(nodes_x2[i]),
             sin(ofDegToRad(ofMap(ofGetElapsedTimeMillis(),start,start+speed,270,630)))*(cursor_size*3)+(nodes_y2[i]),5);
    ofNoFill();
    ofCircle(cos(ofDegToRad(ofMap(ofGetElapsedTimeMillis(),start,start+speed,270,630)))*(cursor_size*3)+(nodes_x2[i]),
             sin(ofDegToRad(ofMap(ofGetElapsedTimeMillis(),start,start+speed,270,630)))*(cursor_size*3)+(nodes_y2[i]),5);

    ofCircle(cos(ofDegToRad(270))*(cursor_size*3)+(nodes_x2[i]),sin(ofDegToRad(270))*(cursor_size*3)+(nodes_y2[i]),7);
    }
```