

# [STUDY NO. 50] [NOTATIONAL BECOMING] [SPECULATIONS]

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## ABSTRACT

The use of animation in contemporary notational practices has become increasingly prevalent over the last ten years, due in large part to the increased compositional activities throughout Europe, the United Kingdom, and North America, and in particular Iceland and Western Australia.<sup>1</sup> The publication of several foundational texts,<sup>2</sup> and the materialization of focused scholarly meetings<sup>3</sup> and online consolidation projects<sup>4</sup> have also contributed to the expansion of this growing field of animated notational practice. The range of compositional ideas represented by these scores is vast, encompassing a wide variety of stylistic approaches and technological experimentation. While these ideas often demonstrate intriguing compositional directions, and the unique dynamic functionalities and visual characteristics of animated scores are clearly distinct from traditionally-fixed scores, it is the real-time generative processes of these scores that represent a shift in the very ontology of the musical score. In this paper I speculate on one possible framing for this ontological distinction by focusing on several attributes that, in combination, most explicitly demonstrate this distinction. These include the real-time, process-based qualities of generative animated notations, the *openness* that enables these procedural functionalities, the displacement of interpretive influence, and the *timeliness* of these processes in respect to the temporal relationship between generation, representation as notation, and sonic realization. A new work, *Study no. 50*, will be examined as a practical demonstration of these attributes, and will function as a jumping off point for a speculative discussion of the concept of *Notational Becoming*.

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<sup>1</sup> Reykjavik-based S.L.A.T.U.R. and Perth, Australia-based Decibel Ensemble.

<sup>2</sup> Contemporary Music Review, Vol. 29:1, 2010 and Leonardo Music Journal, Vol. 21, 2011.

<sup>3</sup> TENOR 2015, Paris and NIME 2014, London [Interactive Music Notation and Representation Workshop]

<sup>4</sup> animatednotation.blogspot.com & animatednotation.com.

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## 1. FRAMEWORK

### 1.1 The Animated Score

An Animated Score is any score that contains perceptibly dynamic characteristics that are essential to the symbolic representation of the compositional idea. The symbols and dynamic functionalities that populate these scores are here designated as Animated Music Notation [AMN]. The range of approaches to the design and functionality of animated scores is varied, but it is generally possible to make a broad distinction between those scores that are fixed prior to their dynamic activation, and those that generate and represent notational information in real time *as* the score is functioning. Cat Hope and Lindsay Vickery have noted that these *generative* animated scores “construct(s) components of the score in real-time,” [1] determining the local and global symbolic and functional characteristics of these components [AMN] as it is produced, and nearly simultaneous with its realization in performance. The simultaneous, real-time generation and representation of notation in generative scores are often based on “dynamic systems [that] have the role of a ‘*nucleus*’ of *relations*” that provide the foundational musical and notational content for a “*set of potentialities*” that may or may not occur in any given instantiation of the score. [2] Within a generative animated score, the *nucleus of relations* are left *open* in order to enable the continuation of these processes for the duration of the work, and the processes by which these potentialities are selected, represented as notation, and subsequently realized by the performer, occur in close temporal proximity, and generally disappear shortly thereafter.<sup>5</sup>

### 1.2 Openness

The concept of *openness* in musical works ranges from the interpretive expectations of traditionally-notated works, to the modular and malleable scores that began to emerge in the mid-20<sup>th</sup> century. Umberto Eco describes these *open works* as works designed in such a way that “considerable autonomy [is] left to the individual performer in the way he chooses to play the work.” [3] The performer is not restricted to the traditional, and often limited, mode of interpretation, but has agency to impact

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<sup>5</sup> While the following text may be applicable to animated scores that are fixed prior to their activation, this paper focuses primarily on qualities that are specific to *generative* animated scores.

the realization of a work on many levels, from its atomic characteristics to its broad formal structure. In some open works, the *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 represents an identifiable concept, preventing its dissolution into “an amorphous invitation to indiscriminate participation.” [3] These works are further regulated by their music-historical context and any relevant “notational conventions.” [4] “In order to interpret correctly the instructions in the score, the performer needs to know the notational conventions used in it and the performance practices that are assumed without being explicitly indicated. The naive performer who considers only the score and who takes it ‘literally’ would misunderstand its instructions.” [4] But even with these regulative influences, the field of possibilities may be represented by a notational form that temporarily, and perhaps intentionally, defies contextualization, and in doing so, may only provide enough information to elicit a suggestive, largely unregulated (at least regarding notational and contextual) interpretation. Without prior knowledge of a work’s potentialities, even notational forms that strictly regulate the performer’s interpretive range may not provide the *listener* with any foundation upon which to gauge the effectiveness or intrigue of the work’s openness; without a common or shared foundation, “there are no privileged points of view, and all available perspectives are equally valid and rich in potential.” [3] In other words, an open work can effectively write-out the wrong by not describing the right. The *right*, in this case, is made up of the musical *codes* that are perceptible to the listener [3], and whether or not these codes are similarly understood by the composer and the performer, so long as some code is perceptible, divergences from and within the code (drawn from the field of possibilities) will create a perceptible formal construct by its very difference. Eco describes the foundation upon which these differences can be identified as the *Ur-code*, which includes the harmonic, melodic, and rhythmic aspects of the Western musical tradition, and may also include the specific sonic characteristics of a composition and the musical context within which it exists. [4] Still, without an understanding of the music-historical context from which a particular work emerges, and an ability to perceive the code that it is based on, or diverges from, the openness of the work is aurally insignificant. In short, the work’s openness may only be intriguing at the performer level: readily available to the performer’s eyes, but meaningless to the listener’s ears.

The generative animated score is open prior to its realization, but unlike traditional notions of openness, the score’s openness is contained by, and often restricted to, the computational processes of the score. The performer still engages with the notations selected from the *field of possibilities*, but has little to no impact on the selection process itself. The notational representation of these selections is often specifically prescribed in real-time, further limiting performer intervention and diminishing the possibility for preparation. [5] Following this, the openness of generative animated scores is equally insignificant to both the performer *and* the audience. One need

not know what these potentials are, nor determine which of these potentials are selected, because neither the performer nor audience member can influence what potentialities are actualized.<sup>6</sup> Following Davies, the performer is *naïve* in this regard, as the potential for any interpretive intervention is made unavailable by the processes of the score application, and the prescriptive specificity of the AMN.

With a fixed score, its tangible rigidity necessitates some action beyond it in order to determine which possibilities, and their respective qualities, are selected in performance. These actions are generally the performer’s manual responsibility. The generative score displaces this selection/interpretation process by embedding it within the functionality of the score application. So while the score is open prior to its realization, because this realization occurs simultaneously with the emergent notational representation, the score simply indicates to the performer what to do, and when to do it, with little to no room for interpretive extrapolation. The score’s openness is effectively inaccessible.

### 1.3 Time

From the low-level relationships formed between adjacent sonic minutiae, to the high-level, formal compartmentalization of the composition, *time* is the container within which the aforementioned musical codes, and the representational results of the selection process are held. But although time contains these codes, the tendencies of these codes control the flow, shape and *size* of these containers. Jonathan D. Kramer notes that within the coded tonal system, for example, time is linear, “always in motion toward tonic resolution,” [6] subservient to the melodic and harmonic tendencies of the Western scale. When the tonic is destabilized, time finds release, and becomes increasingly multivalent: “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.” [6] This is a nondirectional, but certainly not directionless kind of time, nor is it lacking in a stable foundation or code. [3,6] Rather, the singular, magnetic qualities of the tonic are dispersed across a series of candidates that may or may not be related on a functional melodic or harmonic level. When these points of interest appear to serve some functional purpose, but their feeling of displacement within the larger structure is perceptible, the piece exists in *multiple time*. [6] As in 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.” [6] So long as this code is known,

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<sup>6</sup> Contrarily, the interactive works of Jason Freeman, Gerhard E. Winkler, Harris Wulfson and others successfully integrate audience and performer activities with the actualization of the score.

some semblance of structural clarity may still be perceptible, despite the composer's intentions to do otherwise. In all three cases, one's perception of the passage of musical time is contingent on the hierarchical relationships between a series of events in a specifically-coded Western context (or any musical context for that matter). Musical time, in these contexts, is not clock time, but is based on the relationships between events that are perceived as musically structural or "important." In these three types of musical time, the performer is, ostensibly, responsible for the perceptible, sonic expression of the composed directionality, non-directionality, and multiplicity. Contrarily, "'Moment time,' after Stockhausen's formulation of moment form," describes a music in which the ordering and qualities of the musical content are not causal. [6] 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." [6] Even with the dissolution of beginnings and endings, internal form is still perceptible, but rather than perceiving compositional form based on hierarchical tensions, "the self-containment of moments allows the listener to process them as individual entities," each a formal contributor despite a lack of relational function. [6] In a sense, each moment becomes a temporary structural tonic, defined by a local logic that extends its influence only to the beginning of the next autonomous moment. The performer still maintains some interpretive responsibility: to express the structural-autonomy of each moment. Lastly, Kramer describes *vertical time* as "a single present stretched out into an enormous duration, a potentially infinite 'now' that nonetheless feels like an instant." [6] A composition in vertical time contains any number of sonic events, but unlike the aforementioned examples, including moment time, each of these events is an anti-landmark, equal in (non)importance as the others. The even distribution of musical importance across all events effectively flattens the significance of each event, disrupting the potential for emergent hierarchies and structures. [6] More so than Kramer's other distinctions of musical time, several aspects of the generative animated score reflect the concept of vertical time. Perhaps most obvious is the capacity for the notational generation of indefinite duration. As described above, the computational processes that access and select from the field of possibilities can be designed to function autonomously from human intervention. The notational flow will continue as long as the score application is running, and because the notational flow runs uninterrupted, any performance, which is likely shorter than the potentials of an endless score, has a quality of *nowness*, as the ephemerality of the score provides no past or future temporal or structural boundaries. In addition, the visual representation of these notations demonstrate a *visual verticality*. In many animated scores, points of attack are often contained to a small, immovable visual space (scrolling score), or a dynamic object which the eye follows (swiping playhead, tablature). [1,7] The eye is *moving*, in a sense, but fixed in a correspondent relation-

ship with the behaviors of the dynamic symbol. Each instant is relegated to the necessarily controlling visual representation of the animated score, extending each sonic moment by the symbol's dynamic movement toward the next event. In order to maintain an adequate correspondence with the score, the performer is more or less *forced* into a continuous engagement with the functionality of these notations. Thus, each sonic event is visually extended by the notation as it leads the performer through a "single present" of constant movement. [6]

#### 1.4 Sound

In *Sonic Philosophy*, philosopher Christoph Cox describes sounds as "peculiarly temporal and durational, tied to the qualities they exhibit over time. If sounds are particular or individuals, then they are so not as static *objects* but as temporal *events*." [8] The temporal characteristics of sound influence not only the musical or sonic identity of the sounded, temporal event, but reflexively influence the qualities of the temporal container within which these events are framed; the quality of musical time, for instance. [6] The particular qualities of the sounded events contained within a work in vertical time, for example, will be designed to exploit the particular qualities of this container, not the other way around. In other words, extended duration and a quality of *newness* is only enabled by the sonic container. But even though these sounds are contained by the temporal framework that support its extended durational qualities, these sounds are still not *objects* distinct from the durational flow of its container. Rather, "Sound [...] affirms an ontology of flux [in] which objects are merely temporary concretions of fluid processes. This flux ontology replaces objects with events." [8] The concept of *openness* seems to mirror this ontology of flux. The possibilities inherent in an open work, for example, do not contribute to the compositional identity of the work unless they emerge during the process of its realization; there is only the potential for their momentary *concretization*, and their absence does not disrupt the identity of the work. 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 durée*)." [9] 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 cites Cage's *0'00*" as an example of emergent behaviors that, in their *becoming*, occupy a space unadorned by "musical" expectation, or as the realization of scored musical "objects." [9] The events in *0'00*" exist despite their framing by the score, and the score simply *repositions* their soundings as a *scored* event. For music, in Cox's distinction, "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." [9] In a sense, the fixed, *closed* score relegates music to a sonic reflection of an immovable object, a relationship that is maintained despite the

ephemerality of sound. Increasing the degree to which a score is left *open* loosens the structural and temporal holds on what sonic events might occur. But still, the *tangibility* of the score enables reference, repeatability, even reverence, despite the composer’s intentions to (in theory) subvert these kinds of interactions. The open qualities of the generative animated score, in tandem with the computational processes that select and represent the notational information autonomous of human interaction, demonstrate a scoring process that is much more akin to a *temporal event* than a *static object*. [8] These processes, like the realization that follows, does not *exist* in the same tangible sense as any traditional score does, open, closed or otherwise: “*Before and after the moment of performance the piece, - in the historical sense -, does not “exist”, there is nothing [...] where you can refer to.*” [2] The performer is still reading notation, but is doing so *as* it is generated. There is no fixed object, but instead a momentary reflection of the underlying, generative processes *as* notation. This uniquely temporary manifestation of these processes as notation demonstrates a clear ontological distinction between the tangible *being* of the fixed score, and the open and ephemeral notational *becoming* of the real-time, generative animated score.

## 2. STUDY NO. 50

### 2.1 Introduction

*Study no. 50* was composed in December, 2015 for the Williams College Percussion Ensemble, under the direction of Matthew Gold. *Study no. 50* was developed in tandem with the exploration of the aforementioned concepts, and its purpose here is as a practical demonstration of how these concepts informed the compositional and notational process.

### 2.2 Compositional Intentions

Prior to composing *Study no. 50*, many of my works were designed in such a way that the real-time notational processes demonstrated some perceptible musical code, including phase processes, discernable poly-temporal relationships, and hocket. While the musical results were personally satisfying, the impact of the process as a perceptible compositional factor had begun to elicit an unwelcome sense of novelty. With *Study no. 50* I endeavored to build a framework in which the generative processes that create and control the notation were functionally autonomous across all levels. In short, I wanted to reduce the possibility of emergent perceptible structures by creating a set of potential actions that were unlikely to create any local or global structural form regardless of their ordering and/or combination, and to limit the performer’s interpretive agency regarding what form these potentials might ultimately take. Following this, the score for *Study no. 50* is designed to create a consistently-inconsistent flow of events for an extended (indefinite) duration, and to evenly, although randomly, distribute these events throughout the piece. Furthermore, the selection of these events from an open field of possibilities is not governed by any high-level structures, or performer

influence. In this sense, the compositional intention and notational representation in *Study no. 50* explicitly echoes Kramer’s elucidation of *vertical time*: “The motion is so consistent that we lose any point of reference, any contact with faster or slower motion that might keep us aware of the directionality of the music. The experience is static despite the constant motion in the music.” [6]

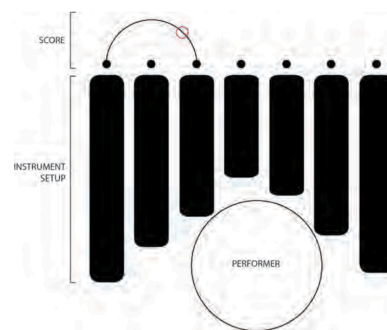
### 2.3 Instrumentation

“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.” [6]

In order to avoid the emergence of any perceptible timbral, rhythmic, or pitch-based *structural articulation*, the potential for instrumental variation is limited. The instrumentation for *Study no. 50* included 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. 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* to *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.

### 2.4 Notation

Each performer’s aggregate contains seven nodes and one attack cursor (see figure 1).



**Figure 1.** *Study no. 50* Aggregate and Performer diagram.

In figure 1, each node is represented by a small black circle, which corresponds to a single plank, represented by the black rectangles of varying lengths. Because the score is projected downward, each plank can be lined up with the corresponding node (see figure 2).

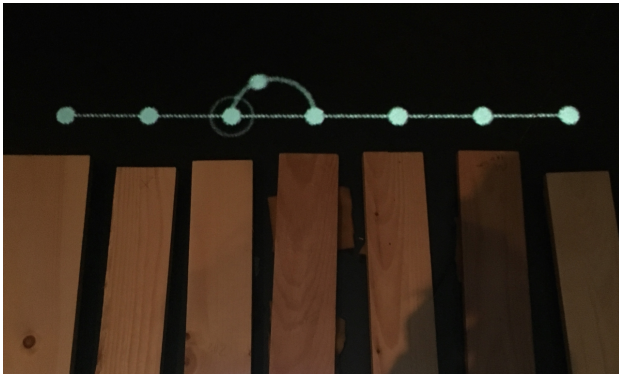


Figure 2. Performance detail.

There are four possible functionalities for the attack cursor that determine 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 3).

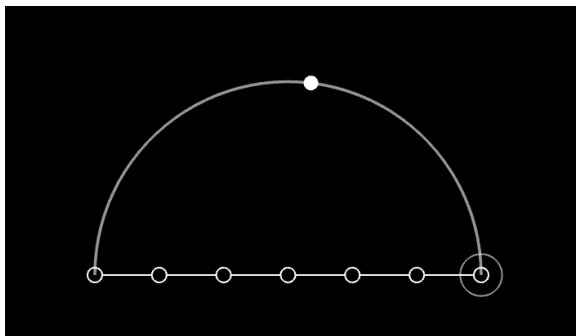


Figure 3. Function 1: Current Node [far right] to Target Node [far left].

In figure 3, 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, a notation called the *repeat spinner* is utilized (see figure 4).

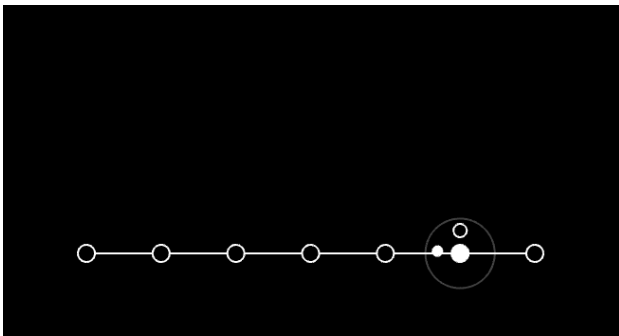


Figure 4. Function 2: Repeat Spinner.

At the completion of the event that precedes a repeat spinner, a small *attack point* appears above the current node, followed by a similarly-sized attack cursor rotating in clockwise motion around the node. The point of attack is when the rotating attack cursor makes contact with the attack point 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 5).

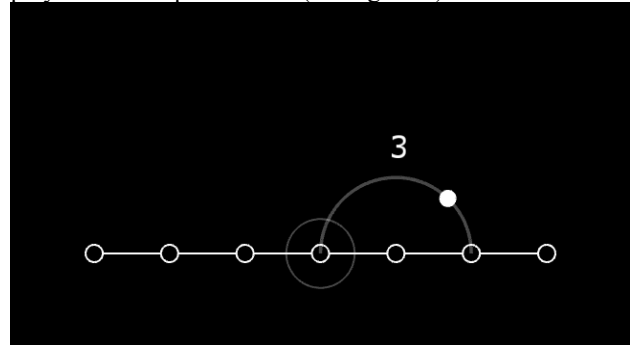


Figure 5. Function 3: Open Repeats.

This 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 the target node's corresponding plank should *not* 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, and every node in between (see figure 6).

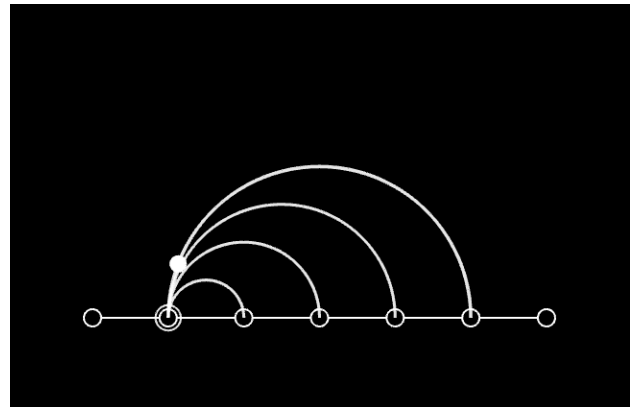


Figure 6. Function 4: Flourish.

This notation indicates that the performer play 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 should end as the attack cursor reaches the target node.

## 2.5 Notational Processes

The score for *Study no. 50* is generated in real-time from an application written with openFrameworks, and will continue to run indefinitely once executed. While the symbolic elements of each performer's aggregate are identical, and contain the same functional potential, the processes of each aggregate are autonomous from the

others, and are not governed by any high-level structure. The processes that determine the behavior's of each performer's aggregate are based on a simple set of *if-then* statements, and the particulars of these functionalities are randomly determined within a narrow range of possibilities. The functionality of the attack cursor is determined at the completion of each event (ie. the moment the attack cursor makes contact with its target node). In this sense, the potential functionality of the attack cursor is *open* until the next moment it is selected. This selection process proceeds as follows:

- 1) Determine the target node. The target node is determined randomly, and is equally weighted across all nodes, including the current node.
- 2) If the target node is the same as the current node, skip to step 6.
- 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.
- 4) If the new 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. This functionality is determined randomly, and is equally weighted between these three functions. If function 1 or 4 is selected, skip to step 6.
- 5) Select a number between 1 and 4.
- 6) Determine traversal duration.
- 7) Draw arc(s) or repeat spinner and activate the attack cursor.

Step 6, "determine traversal duration" is randomly determined within a range of 500 to 1600 milliseconds.

## 2.6 Presentation

The score for *Study no. 50* was designed to be projected onto the floor, with each node positioned directly above its corresponding plank (see figures 2 & 7). This alignment creates a direct correspondence between the notation and the instrument, facilitating legible clarity.

## 2.7 Discussion

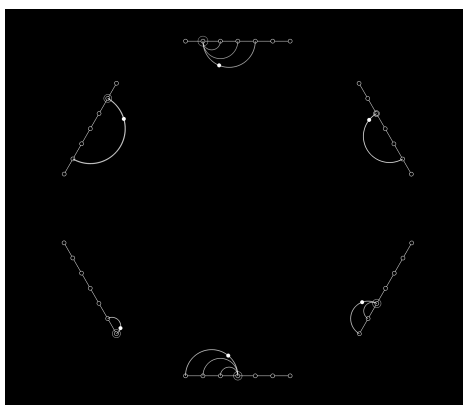


Figure 7. Study no. 50 [score detail].

As mentioned earlier, the processes that control the behaviors of the attack cursor, including the four possible functionalities, and the duration of these functionalities, represent the field of available possibilities. The random processes that select these possibilities are largely unweighted, and are determined one at a time at the completion of each event. To this end, the score for *Study no. 50* is effectively *open*, and based on the autonomous, random functionality of the selection process, and modest combinatorial possibilities, will likely generate a unique, consistently-inconsistent flow of events each time the score is activated.

This functional openness was an essential component toward the creation of a persistent, durational performance. Because a new notational function is generated at the completion of each event, and the animated music notation was designed to be sightreadable with a high degree of accuracy, a performance of *Study no. 50* can last for any duration without *running out* of notational material, while preserving the compositional identity of the work. Furthermore, the limited range of event durations, the even distribution of dynamic and timbral changes, and the general similarities between the 42 planks, creates a sustained gestalt that is devoid of any perceptible musical landmarks or structural intentions. Recalling Kramer, vertical time can be described as "a single present stretched out into an enormous duration, a potentially infinite 'now' that nonetheless feels like an instant." [6] Each *present* corresponds to the execution of each notational function, and the inconsistent, but temporally regulated concatenation of these events drastically reduces the possibility for the emergence of pulsed or structurally significant time, while maintaining a high degree of rhythmic activity, reducing the potential for structural silences.

One of the primary motivating factors for *Study no. 50* was to create a process-based work in which the process itself was perceptible only in its representation as notation. I did not want the audience to *hear* the process as it unfolds. Rather, to distinguish between the sonic realization of the score, and the visual representation of these processes as notation in their real-time becoming.

## 3. DISCUSSION

### 3.1 Notational Becoming: Speculations

The speculative concept of a *notational becoming* suggests an ontological distinction between open or closed, fixed scores, and generative animated scores. This distinction is primarily based on the location of the score's openness (including a displacement of performer agency while maintaining prescriptive notational specificity), the timeliness of these processes as temporary *concretions* of legible notation, and the unique temporality of the processes that form the compositional, notational and functional foundation of the score.

The real-time generative processes that demonstrate this notational becoming also suggest a method for the real-time production of an infinite flow of prescriptive, through-composed notation. The score becomes not the



execution of an extended-duration process regulated by performers, but the realization of notations indefinitely produced through the real time processes of the score itself. The real-time becoming process may enable distinctly durational compositional identities that can be well-maintained by the prescriptive specificity of the notation. Winkler notes that “A mixture of ‘installation’ (where one can enter, move around and go out at will) and ‘concert-situation’ (with fixed start and endtime, focused sitting and listening) seems to be the best environment for the presentation of this type of music.” [2] But there is no reason to engage with start and stop times: these notations have a continued *presence* regardless of interaction, like that of Kramer’s sculpture [6], and unlike the traditional score, when projected, the animated score maintains a unique visual presence. For although the notational content of these scores is ephemeral, the persistent notational flow maintains a notational image of the sonic qualities it represents.

Clearly, practical limitations (human biological function, live performance expectations, economic considerations) impact *actual* duration, [6] but this potential for extended duration introduces a unique compositional question: if performance duration can only be determined by practical considerations, is there a minimum durational threshold that a performance must pass in order to fully represent the compositional idea? Can the *infinite* nature of vertical time be represented in *realistic* time? Kramer notes that “Once we have entered the vertical time of the composition, we have apprehended its limits. The piece has defined for us its context; it will not step outside its boundaries.” [6] But no matter how well-defined, well controlled, and shielded from interpretive disruption the generative animated score might be, by enabling and embracing an endless durational flow as a compositional characteristic, the work, like the sculpture, is durational only to the degree that the listener decides to engage. In this sense, notational becoming represents a “ceaseless becoming and change,” [9] that is only contingent on its autonomous processes, is timely, and demonstrates a (non)structural ephemerality of notational and sonic flux.

### 3.2 Conclusions

This paper has speculated on how the open, timely, and ephemeral aspects of generative animated scores demonstrate qualities that are ontologically distinct from musical scores that are fixed prior to their performance-ready representation. I have described these qualities as a *notational becoming*, an extrapolation, if not bastardization, of Christoph Cox’s demonstration of the ontological difference between music and sound. These speculations are only temporarily concretized, and are subject to immediate revision.

### Acknowledgments

Thanks to Matthew Gold and Daniel Steffey for their valuable input.

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