Variations 10b: A Digital Realization of Cage's *Variations II*

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ABSTRACT

Beginning in the middle of the twentieth century, composers of experimental music developed a number of new notational representations, most often falling under the category of *graphical scores*. John Cage's *Variations II* is a prime example, utilizing only dots and lines as its basis. I describe an interactive version of Cage's piece, called here *Variations 10b*, where a performer can change the score and receive immediate auditory feedback as to the results of the manipulation. This stands in contrast to the process of working through the analog score, where the aural output was not coincident with movement of the dots or lines. I suggest that creating and using digital versions of these early experimental music works radically changes the process of interacting with the pieces.

Categories and Subject Descriptors: J.5 [Arts and Humanities]: Performing arts; H.5.5 [Information Interfaces and Presentation]: Sound and Music Computing—Methodologies and techniques

General Terms: Human Factors

Keywords: Experimental music, John Cage, graphical scores, performance, installation

1. GRAPHICAL SCORES, *VARIATIONS II*

Musical notation is a form of non-aural sound transmission. The marks on the page, part of their own semiotic system, enable performers to realize a time-displaced aural event. Since relative standardization of the symbols in early medieval music, the signs took the form of the notes, rests, staves, and clefs that are at least superficially familiar to most people in Western cultures. In his examination of mid-century experimental music, Michael Nyman described this traditional notation thusly: "...symbols which are read by the performer who does his best to 'reproduce' as accurately as possible the sounds the composer initially 'heard' and then stored."[6, p. 3]

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These symbols, as a system, reify choices about what musical thoughts can or cannot be expressed. The rapid emergence of experimental music[1], the forebears of which include, *inter alios*, Earle Brown, John Cage, Morton Feldman, and Christian Wolff, required radically new means of notation, the creation of unorthodox systems for representing musical thoughts previously unrepresentable. As Cornelius Cardew wrote (quoted by Nyman), "A composer who hears sounds will try to find a notation for sounds."[6, p. 3]. The neoteric sounds heard or conceived by the composer required original markings for later interpretation.

Termed *graphical scores*, composers abstracted parameters such as pitch and duration by dividing frequency and temporal spaces into levels of granularity separate from notes and quavers. Feldman's *Projections* partitioned pitch space into "high", "middle", and "low", with "bars" representing time of relative indeterminacy [6, p. 44] Earle Brown developed "time notation" in the works entitled *Folio*, where the arrangement of musical events on the page represents their temporal grouping, in a way that eschews standard metrical structure [6, pp. 48–49]. Christian Wolff, in the notation for *Duo for Pianists II*, codified the relationship between sound and time numerically, giving both the exact number of seconds as well as number of events for each "measure" [6, pp. 56–57].

In the early 1950s, Cage also developed new means of representation, including dots in a grid in *Music for Carillon I* and the word "TACET", repeated three times, in his most famous piece, *4′33″* [4, 6]. My concern in this paper is with his *Variations* series, specifically *Variations II* [2]. We find in this piece the "greatest degree of abstraction of a compositional model that Cage developed over the period from 1958 to 1961."[7, p. 11] For in *Variations II*, the notational materials are five dots and six lines; not arranged in a grid, nor compressed via a top-down structure. Rather, each line and dot appears on a piece of clear acetate; the performer arranges these dots and lines as she desires, and measures a series of musical parameters by means of the perpendicular distance from each dot to each line (see Figure 1). The parameters Cage chose represent basic qualities of sound: frequency, amplitude, timbre, duration, structure of the event, and place of event occurrence [2]. Meanings of the parameters, and the scale upon which they are projected, are up to the performer, with final decisions also decided by measurement of a "dropped perpendicular" [2].

[1]This is to be contrasted with *avant-garde* music, which in Nyman's formulation included Western European composers Pierre Boulez, Karlheinz Stockhausen, and Iannis Xenakis.

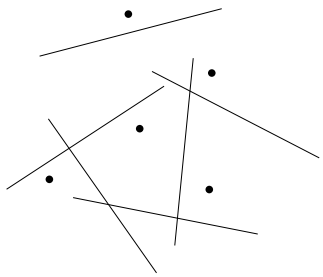

Figure 1: An example configuration of Cage's *Variations II*.

What makes *Variations II* so engaging is its ability to capture *any* musical score in existence, merely by proper arrangement of dots and lines and selection of suitable parameter scaling [7, p. 12]. This flexibility demands a deep relationship with the score, for the measurements must then be converted to another format that allows the performer to realize the score in the concert hall or recording studio. Yet we could conceive of a devoted student who masters this representation of music and is thus able to "sight-read" a score in real-time during a concert. Beyond these performance implications is the fact that the six lines define a projection of six-dimensional space, $\mathbb{R}^6$, allowing the performer to visualize and interact with an impossibly complex space of parameters by way of this projection [3].

2. DETAILS OF THE IMPLEMENTATION

One of the difficulties of producing older experimental and avant-garde music is that of realization: equipment is needed that is not readily available (such as analog signal generators), or the demands on the musician(s) are such that performance requires inordinate skill or time. Some of these issues can be mitigated through use of digital techniques; while this may not be entirely truthful to the original performance, it is often "faithful-enough" for present performances. Those who belong to "early-music" circles face the same problems: at what level do you admit that you are as loyal to the original intentions as possible? Placing these valid questions to the side, I would like to suggest that in some cases digital realizations of older experimental and avant-garde works can not only be insightful from a musicological perspective, but that nuanced understanding can come from manipulations not otherwise possible.

As an example, consider Miller Puckette, lead developer of the open-source project Pure Data (PD), who has created realizations of at least four "classic" works of computer music in PD [8]. As well, Christopher Burns produced new implementations of works by Karlheinz Stockhausen and Alvin Lucier that, through their digital source, simplify some of the necessarily-complicated electronics in the originals [1]. Both cases suggest the possibility of creating reusable sound modules for further realizations of other works.

In considering a digital realization of *Variations II*, however, the goal had nothing to do with eliminating obsolete electronics; rather, I wanted to work towards giving listeners acute insight into the ramifications of the freedom afforded by this score, as well as graphical scores in general. While *Variations II* is an older work, it is an exemplar of graphical scores and can be understood by most with a short bit of explanation.

One of the challenges in understanding the sounds of modern music is radical new representation. While even most avant-garde music is still made using the traditional, twelve-note chromatic scale, its organization in time has changed dramatically, as already mentioned. Nevertheless, the non-music-making public still has a minimal understanding of notation. So when someone comes to a performance of experimental music, they try to fit what they hear into the constrained form of traditional symbiology. But experimental music often uses these newer graphical scores, and while the liner notes (at concerts or on CDs) will make note of the conceptual underpinnings of the piece, they will often fail to explain the score and notation. I take this as my main motivation: in order to better understand how modern music is made and performed, listeners could explore, in real-time, a digital representation of a modern score. By doing so, I would hope that the hands-on knowledge would engender insights for the listener into what she hears.

The beauty of Cage's original *Variations II* is the simplicity of its design: with only six lines and five dots, and an uncomplicated framework within which the lines and dots live, the composer creates a sound-space of unexpected complexity and interdependencies. However, the digital implementation is not so simple, and here I write of the general design. *Variations 10b* consists of three parts: the graphical interface, the score creation server, and the audio output. This division of labor allows relatively simple interchange between input and output, as long as the protocol is known. I conceived of this as both a composing tool used in private, as well as a public installation. To date, the piece has been used extensively in the studio as well as exhibited at the *sound around* exhibition at the MIT Media Lab in May, 2006.

I created the graphics using Processing, an open-source Java-based dialect for quick and efficient design of artistic interfaces. An example of the interface is shown in Figure 2. Simplicity in visual design was the goal in order to mirror the original score. I attached annotations to each line, delineating the six possible musical parameters. The dots form the movable part of the interface; clicking and dragging a dot is linked to the appearance of information about that dot; that is, the current values of each of the dot's parameters, such as time of appearance in the piece, duration, frequency, occurrence (number of events) and amplitude.[2] I provided a "reset" button to randomize the positions and orientations of the lines, as well as ordering the dots at the top-left of the screen for a new re-arrangement. The "start" button sends the data to the score creation server over the Open Sound Control (OSC) protocol [10].

In contrast to Cage's formulation, I chose to make the lines fixed rather than movable. This was to focus attention on arrangements of the dots, the sound events, and thus the exploration of how the values change through movement of the event. While shifting of the lines is technically feasible, the *global* influence of the line movement makes it undesirable for my purposes. The priority is on local understanding of the event in the whole of the piece. Later versions could

[2] I do not show the value for timbre, as quantifying timbre is arbitrary and dependent on the realization chosen by the listener-composer.

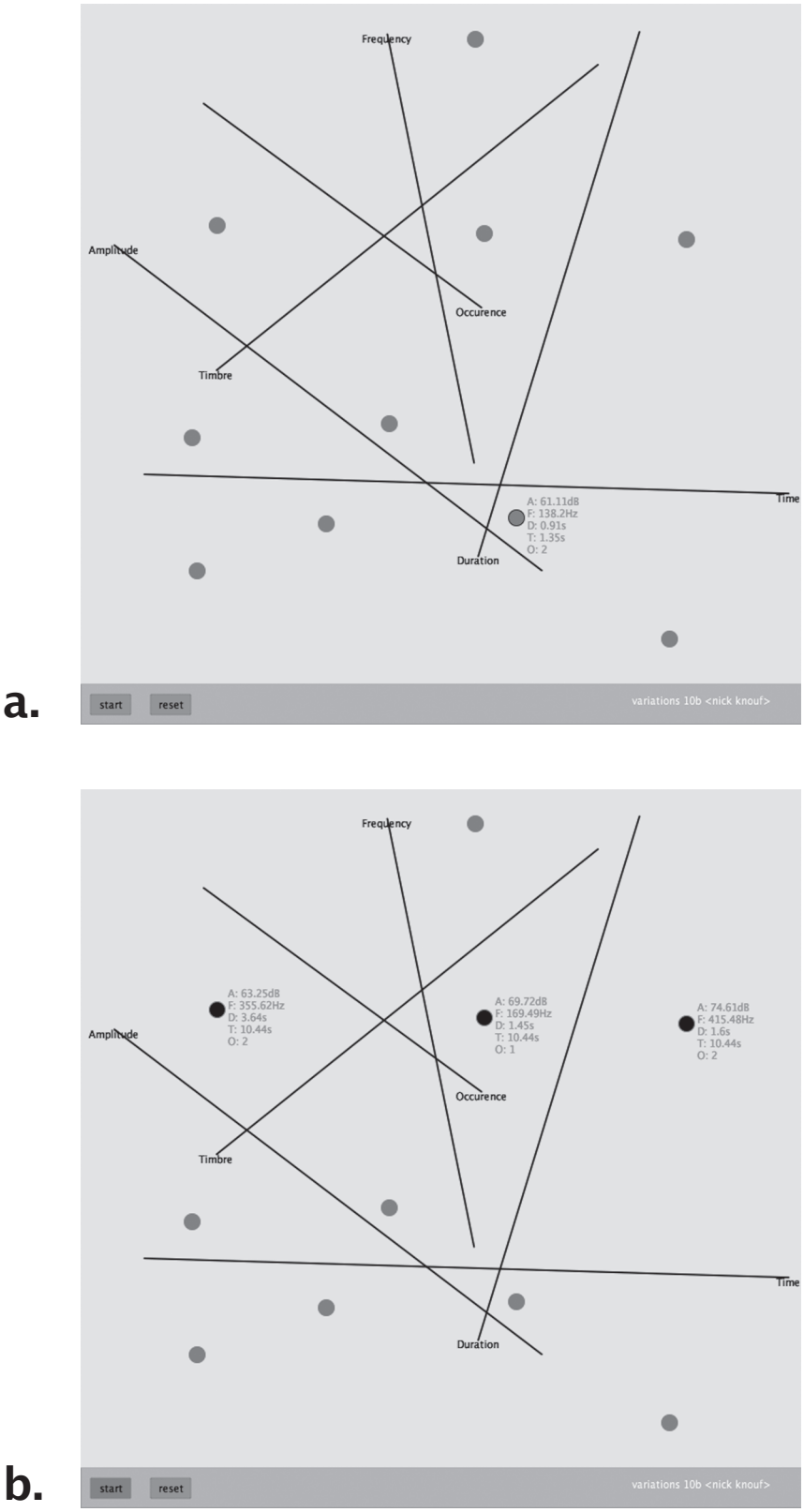

Figure 2: The *Variations 10b* interface. *a.* While clicking or dragging one of the dots, the user sees real-time feedback as to how the parameters change through movement. The "reset" button randomizes the positions of the lines and gives an ordered arrangement to the dots. The "start" button sends the data to the score creation server. *b.* During the performance of the piece, the score creation server sends commands to highlight the dots as they occur, providing secondary feedback.

implement this feature to enable fine-grained tuning of parameters that affects all events at once.

The score creation server, written in Python, listens for OSC messages and orders the events in a temporal sequence. This part of the realization is implementation-dependent; the eventual performance of the score dictates how the translation of the abstract graphical arrangements is represented. Listener-composers of *Variations 10b* can modify the scaling of parameters through a configuration file, thus determining the meaning of these parameters.

The sound of *Variations II* always depended on the performer and the choices she made as to mappings of values to sounds. For the purposes of an installation, however, I decided to make the choice of "instruments" fixed. Thus the score creation server sends the order of events to a `csound` process using a pre-determined orchestra. The order of events arrives in the form of a `csound` score file. The freedom of `csound` allows any type of sound to be made; the first installation used scanned synthesis for pedagogical reasons [9], with value ranges chosen to make the system stable. This synthesis method, however, is not fixed, and true to ethos of the piece, the choice of sound output could be determined by measurement in the interface.

I fixed the duration of the performance at thirty seconds, again to allow listener-composers the chance to have immediate and multiple interactions with the results of the composition. As with other parameters of the realization, this can be changed in the configuration file to a length more appropriate for a concert-hall performance.

While these constraints on sonic output could be said to destroy the openness of the original piece, they enable the listener-composer to concentrate on the arrangement and choice of sounds within an already-broad space of possibilities. These limitations draw the participant into the space of interest (the arrangement of dots and lines on the page) and is supported by my observation that most attendees at the exhibition were interested in hearing the results of their movements of the dots.

3. THE CHANGING PROCESS OF EXPERIMENTAL MUSIC

To end, I want to return to the earlier concerns of the paper; that is, how experimental techniques have changed the practice of Western music. *Variations II*, along with *Variations 10b*, showed how chance procedures, in a well-defined framework, can provide an intriguing space of constraints within which to explore sound. Yet the burden on the performer in traversal of this space is vastly different in the two cases. In the former, measurements had to be made using a ruler from each dot to each line; for any particular arrangement of dots and lines, this totaled thirty measurements. These values then needed to be converted into a viable scale that was meaningful for the musician in the context of her later performance. Finally, the arrangement of these events and their actualization needed to be written down in another form such that the musician could follow the ordering in the performance-event [7]. Any movement of a dot or a line required starting this process from scratch. In contrast, with *Variations 10b* the user receives immediate feedback; she can see how movement of the dot causes changes in all of the parameters at the same time, and see through her motions the projection of the six-dimensional parameter space. She can also hear an immediate realization of the piece, becoming aware of how movement of the events affects their perception in the global structure of the piece.

Therefore the process associated with the piece changes. Rather than accepting the results of chance operations, the listener-composer can modify them to her will, receiving the immediate feedback impossible in the original implementation. The time delay between sight of the score and aural output is decreased to practically nothing. She can put herself *inside* the space of the composition, placing the dots wherever she wants, rather than standing outside as a patient, detached observer of a random arrangement. Going inside enables deeper connections to the "*unintentional* differences" between repetition and variation of the sound events [5].

So perhaps we should not think about this as changes in burden; one realization is not an improvement on the other. Rather each focuses on different processes and engender access to competing aspects of the work: access to the process of measurement and study in *Variations II*; access to the process of interaction and bricolage in *Variations 10b*. I would like to suggest this as a general theme in the digital implementations of earlier conceptual and experimental works. A common thread in these pieces is the devotion the performer needed in order to realize the work. Digital versions of the pieces suggest a new relationship between the performer and the works, enabling exploration of new processes and nuances heretofore hidden by labor-intensive operations. My hope is that by living closer to the space of possibilities, digital realizations can encourage radical reinterpretations of the works.

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