

# AUTONOMY, CONTROL, AND NOTATION IN INTERACTIVE MUSIC

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## ABSTRACT

This paper proposes a conceptualization of notation for interactive musical environments. The notational approach describes the relationship between both human and non-human agents, instead of actions to be taken or sounds to be made. Of critical importance in contemporary networked culture is the degree to which technological devices and networks constrain (or control) the actions of their users. The author has developed a conception of interactivity and notational considerations which instead foreground the autonomous potential of participants and the computational systems. The author analyzes three case studies that demonstrate either a direct connection or a broader conceptual link to the described notational approach. The larger implication is a need for notational systems which do not constrain the identity of the users of interactive systems while also acknowledging and representing the agency of the systems themselves.

## 1. INTRODUCTION

In Western art music, classical composers have used notation to express the intent of their music to the performer, who then communicates this intent to the audience. The performer and composer have been trained to speak a common language that forms the heart of the score. This system prevailed over the centuries, until about the 1950's, when composers began to seek new relationships between composer and audience as mediated through notation. One such new relationship expands the scope of "performer" to include audiences – who may typically lack the training to interpret standard notation fluently. Enrolling audiences as performers, or even co-composers, is among the potential challenges facing the composer of interactive musical systems. While some forms of interactive musical systems may model themselves upon the traditions of instruments, requiring some degree of mastery, and use notation in ways familiar to common practice, others may explicitly call for performers without needing to rely on the assumption of specialized knowledge of the common practice.

This article presents one account of a particular framing of interactivity and the role notation plays within it to afford audience participation. This conception refrains from positioning the computer directly as either an instrument

or tool to be controlled, or as a proxy for a human performer. Instead, it incorporates the computer along with humans in the work as a part of a network that privileges effects from localized contextual relationships between actors.<sup>1</sup> I will then make a case for why and how notation can still function at the heart of these systems with potentially non-musically literate audiences as participants. Three case studies serve to test the validity of the theory, chosen for similarities in some of their notational concerns: Thor Magnusson's code score, the *Threnoscope*; Arthur Clay's interactive music system, *Book of Stamps*; and my own musical installation for networked mobile phones, *Parallel*. The following issues or topics will be examined in each case: the role of its symbology as passive or active; the target of the notation and assumed skill; the model for interaction in the system; the role or representation of the observer; the concepts that the notation express; and the identity of the interpreter. Using these case studies, I will argue for a unique conception of the role of notation, that represents and characterizes the relationship between users, observers, and computer agents in interactive works.

## 2. CONCEPTS AND SCOPE

### 2.1 Interactivity

Interactivity in my own composition is constrained to the domain of distributed, networked systems that foreground the computer as a compositional collaborator on the same ontological level as the human. A full account of the motivations for this constraint, rooted in ideas about Actor-Networks and the ubiquity of computers as mediating devices, is beyond the scope of this short paper [2]. While computers are human creations, their processes, upon which we increasingly rely, are ever more black boxed, fragmented, modular, distributed, and networked. Whatever computers may "be", I claim, we can't truly grasp their essence (if such a thing exists) or observe the fine details of their processes, but we can recognize our relation to them and the resulting effects at the time and in the context of their use. My creative goal as a composer is to approach the computer as an unknowable collaborator, so I strive to design interactive systems which neither seek to mimic the activities of humans directly, nor do they exist as instruments

<sup>1</sup> "Network" is used in this context not in the technological sense but rather the Actor-Network sense put forward principally by Latour, Calton, and Law. These networks are characterized by a few key properties: networks are comprised only of the actors or actants they contain and the relationships between them; these networks can be infinitely black-boxed or unpacked, or, zooming in or out does not reach an "end"; and there are no invisible components between networks – to connect disparate networks is but to zoom in or out to reveal the empirical connections. For a more exhaustive clarification, see: [1].

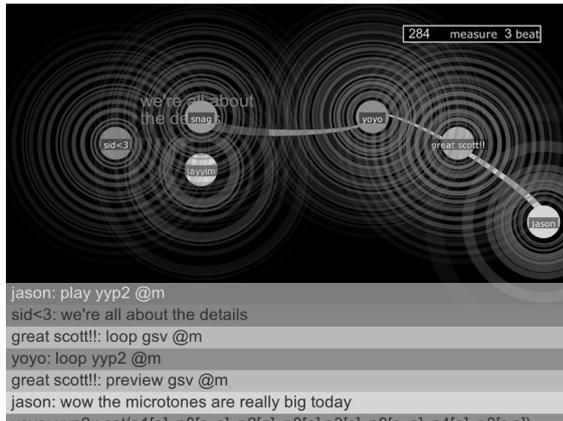


Figure 1. LOLC audience view.

to be directly controlled by the agency and intention of the human performer. To create systems that directly mimic or elevate the human perspective is to unduly limit the scope of their efficacy within the work. As George Lewis has demonstrated, these mimetic designs also make implicit assumptions about the user which can severely constrain their cultural identity as well [3].

## 2.2 Autonomy and Control

According to Felix Stalder, the Enlightenment's *reason* brought about a division of human existence into the inner and outer worlds – the outer world of appearance and social behavior, and the inner world of contemplation and formation of *personal* opinions based on logic. This new divide enabled individuality that creates a sense of autonomy, which Stalder defines generally as “the ability for people to lead their own lives according to their own plans” [4]. By extension, this would correspond to agents in interactive musical settings acting in ways that match or reflect their own contextual relationship to that musical setting. Stalder's subsequent contention is that, if the Enlightenment's *reason* did in fact create this divide, then the digital, networked age collapses it. In the “network society”, as Stalder refers to it, “in order to create sociability in the space of flows people first have to make themselves visible, that is, they have to create their representation through expressive acts of communication” [4]. What could be more social and expressive an act than interactive music-making? More importantly, in the case of a networked and interactive music setting, what would it mean to have autonomy?

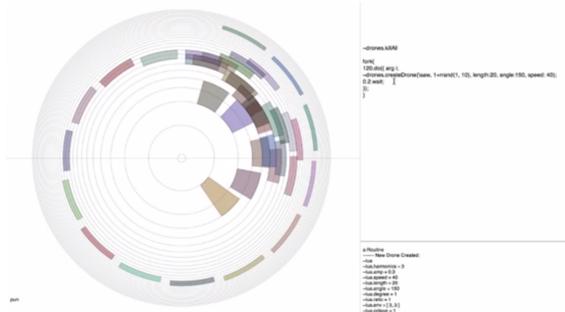
George Lewis illustrates the interactive autonomy of human and machine in performances of his improvisation machine listening system, *Voyager*. The key aspect of the *Voyager* system is that it is explicitly created with the cultural and musical identity of an African-American improviser. Further, this identity is retained throughout performance while improvising with humans [5]. The same is true of the personal identity of any human improvising with *Voyager*. The music resulting from this improvisational interaction is the conversation between the autonomous agents present. Faced with the prospect of including the general audience, ostensibly comprised of untrained musicians, this autonomy would require configurations of the

system which allow conversations to occur which did not require a priori knowledge of certain musical traditions. In some sense, the consequence of leaving these pathways closed, and creating only interactive potentials of an excessively narrow definition illustrates the darker counterpoint to autonomy, which is to say *control*. “The intellectual and musical problem endemic to structure-generating activities such as improvisation (or any other musically generative or creative activity) is that we are not always aware of the constraints that we are functioning under as we work, or why we decide upon certain actions” [5]. This is certainly true of the Anglo-centric Western musical practices that Lewis was critiquing in *Voyager*, and he notes that it is equally true of computational systems. Herein lies the abusive potential of interactive systems: Interactive systems – even those for music – that do not enable some degrees of collaborative autonomy are implicitly configured to control their users. The subtext of this control is that certain interactions are valid, while others are not. In the extreme case, this implicit control can lead to a reinforcement, if not exacerbation, of the conditions which lead to George Lewis's critique in *Voyager*.

## 2.3 Need for Notation

Beyond the traditional role of notation as a communication method between the composer and the performer, there have been a number of attempts to apply notational schema to explicitly help audience members understand the otherwise hidden processes of laptop or computer-based performance. Jason Freeman's LOLC and SGLC network music performance frameworks contain network visualization and chat feed components which are projected to aid in the audience's understanding of otherwise invisible interaction between laptop performers [6]. Likewise, Alex McLean and colleagues have documented several experiments in visualizing the code processes of live coding performances [7]. Thor Magnusson questions the ability for visualization or secondary notations to effectively capture the functionality of algorithms in meaningful ways for audiences. Instead, he posits that code itself is the best representation for the actual algorithms or blocks of code, and any visual or notational element describing them should represent their presence in the context of other algorithms or processes performed on them, as in his *Threnoscope* [8], described in section 3.

In each of these cases, the notational nature of the visualization is related closely to the way Bruce Haynes has differentiated between the descriptive score and the prescriptive score. For Haynes, the descriptive score communicates the idea of a piece to a performer who provides an interpretive realization, by contrast, the prescriptive score provides detailed instructions that, if rendered correctly, will reveal the composition at the time of performance [9]. Examples are not hard to find that seem to occupy both sides of this divide simultaneously. In the “extensible open” works of David Kim-Boyle, the score itself is realized at the time of performance and is thus inaccessible for complete a priori comprehension. At the same time, in works such as *tunings* (2006), *music for 2* (2010), and



**Figure 2.** The *Threnoscope* screen interface.

*music for 4* (2011), the scores are also designed in such a way as to elicit more interpretive responses from the graphical scores, lacking the level of formal and detailed instruction to perhaps totally qualify as a prescriptive score [10]. This point seems to be mirrored by Kim-Boyle’s own description of his “compositional strategy, whereby it becomes more useful to think of the nature of composition as being that of the design of graphical environments explored through sound” [10]. Further, these complications still arise when scores are presented for the trained performer.

In the case of scores presented for the audience’s comprehension, how does the inclusion of the presumably untrained public as receivers of the score or even potential performers further complicate the distinction or function between the prescriptive and descriptive? Or, alternatively, what is the function of the score for these audience members? The answer seems to be in many cases that they are descriptive in that they transduce and represent actions (perhaps in the form of code executed) taken at the moment they occur by performers in the work. This is the means by which the abstract computer performance, which may not otherwise resemble usual forms of musical communication, can be made a little more discernible to the viewer or participant.

The extension that I would provide, especially in the case where the audience becomes the performer, is the possibility for these representations to also represent the relationships between performers at any given moment in the work. These representations need not require specific prescriptive responses, but rather can suggest a context that may elicit a personal response from the individual user observing it. These relationships may also be created by the system and cast upon the audience/performer, proposing a momentary transformative potential within the work. From this we can imagine a notational approach that lies somewhere between the descriptive and prescriptive score – but the approach seems to drift closer to the former. The following cases analyze how three specific works demonstrate notational similarities within these considerations.

### 3. CASE STUDY 1 - THE *THRENOSCOPE*

Magnusson’s *Threnoscope* (2013) is conceived simultaneously as a notational framework and a “composed system” for live coding performance [8].<sup>2</sup> As a part of the larger

live coding practice, it functions as a constrained system which represents the code that is functioning over a period of time. Magnusson distinguishes between representing the presence of code and, as others have tried, representing the functionality of that code [8]. As he notes, “notation is a way of communicating abstract ideas to an interpreter, and in live coding that interpreter is typically a compiler called the ‘language interpreter’” [12]. So the code written by the performer, which represents processes resulting in sound or changes to sound, is interpreted by the computer and rendered into sounds and visualization. In this way, the code becomes prescriptive notation to the *Threnoscope* software. At the same time, the graphical representations of the code are displayed to the performer, any co-performers, and the audience. To these observers, the notation becomes a reference for representations of actions taken by the performer or the autonomous “machines” in the system, and the relation of each bit of running code to the others.<sup>3</sup> The system itself and the performer have the skill to respond to these representations or code, but the representational notation for the audience is an abstraction to assist in comprehension.

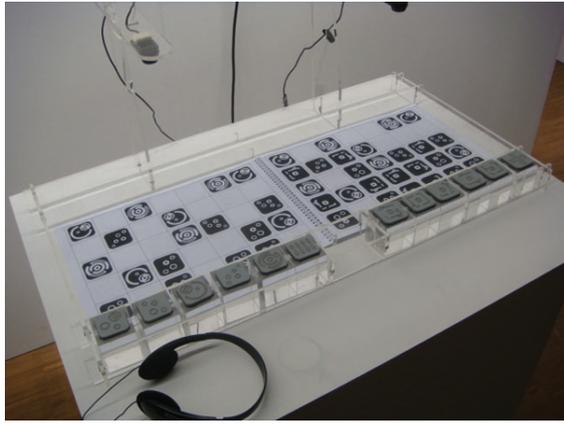
Though the notation does not explicitly “place” the observer or the performer within the score, the score creates a number of cues that can orient the observer. To some extent, observing the score’s alteration by the performer, at the time of performance, allows the audience to cognitively grasp that affordance. Though, it is also clear to the audience that they do not have the same capacity to change the score that is afforded to the performer. This creates a kind of distance between the audience and the work. Moreover, with regard to the spatialization of sound, the score’s radial design does implicitly place both the audience and the performer at the center of the circle. As the geometric representation of code moves around the plane, its sonically spatialized position in the multichannel speaker field correspondingly shifts, mapping the virtual space of the score onto the real space of the performance location.

### 4. CASE STUDY 2 - BOOK OF STAMPS

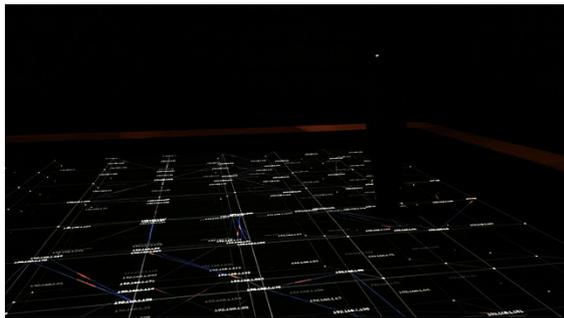
*Book of Stamps* (2009) is an interactive installation for what Arthur Clay describes as a “new audience” – the audience which has been empowered to effect meaningful change in the work, due to the composer’s efforts to “create a fluid transformation from basic passivity to intense participation” [13]. Like the *Threnoscope*, sounds are prescribed to be made by the computer, a reactive and composed system, by placing a stamp of symbolic meaning on a page within view of a computer vision camera. The computer is given some semantic understanding of the sounds associated with each stamp’s symbol. However, unlike the *Threnoscope*’s code notation, there is no performer who

<sup>2</sup> Here, Magnusson is using “composed system” to describe a system with a performance interface which is rearranged “with specific musical intent... [such that the software system embodies some aspect of the maker’s musical intent, and acts (like a score) as a vehicle for sharing musical ideas across culture.” For more discussion of this and context of the quote, see: [11].

<sup>3</sup> Magnusson uses the term “machines” to describe software agents within the system that perform actions independent of the performer’s control. An example might be the radial rotation of a “satellite” drone.



**Figure 3.** Book of Stamps.



**Figure 4.** A view of the floor projections in *Parallel* - IP addresses representing audience members appear on the grid.

shares the computer's semantic understanding of the symbols in the *Book of Stamps*. The stamps are applied by Clay's New Audience, the casual on-looker who has decided to participate. So, also like the *Threnoscope*, the primary interpreter is the computer system, but the score also acts as an abstract, representational palimpsest upon which the user may add their own contribution.

The fact that the score both maintains a record of the previously performed actions and also invites audiences to invoke additional changes leads the audience to directly identify their place as part of a group effort. However, in the absence of seeing previous actors' contributions, it could be nearly impossible to understand any rationale, intention, or motivation behind particular contributions to the score, as in: "Who put that stamp there, and why?" The one strong exception to this is Clay's own design intention behind the symbology, which is based upon collections that suggest architectural or structural relationships and forms. Clay has deliberately designed symbols that seem to imply a particular relationship to each other, where "the visitor can 'construct' building layouts in endless variation" [13]. Thus, the score does not prescribe direct action from the onlooker, but rather offers the possibility of contributing and implies a relationship between the available means of input.

## 5. CASE STUDY 3 - PARALLEL

*Parallel* (2015) is an installation-based musical piece for distributed, networked mobile phones by this author and collaborator Raven Kwok. The notational components of this piece emerge from a series of weakly-tied visualizations.<sup>4</sup> As participants, not trained performers, enter the installation space, they are allowed to connect using a iOS device with the ANMPlatform app installed. At the moment the app is connected to the network from within the application itself, an audio response is heard from loudspeakers and an IP address associated with the user's phone is added to graphical projections appearing on the floor. Further, when more than one phone is connected to the installation, data flows from one phone to another in a topology assigned by the network itself. This data flow process is also visualized by bezier curves extending between IP address nodes and strobing in the direction of the flow of data. Meanwhile, the users are allowed to manipulate an abstract interface on their iOS device, the state of which – along with incoming data from other iOS devices – determines some synthesis parameters for sound which is emitted from their mobile device itself. The ultimate effect of this network topology and interaction is that no single element has direct or complete control over the system, and all influences are assimilated into a collective system state.

From this vantage, it is perhaps possible to see how the computer and user are forced to actively reinterpret the meaning or intentions of each other, as one of the few directly causal actions in the work is the moment when the user joins the network. But the users are also forced to actively interpret their relationship to the other users present by the mediated computer network and visualizations. Together, these connections drift closer to what has been described by Werner Rammert as "framed interactivity", or a relationship which seeks to create locally and contextually coherent interaction [14]. In addition to their embodied presence within the installation setting, observers are also presented with abstract representations within the system. This provides audience members a way of grasping their invisible virtual connections to the other participants in the context of the work. Though the mobile devices they use to make the connection may have an interface with some causal influence over some elements within the work, the direct effects of that interaction have been obfuscated by distributing them elsewhere within the system. The system can produce sound even in the absence of user input. Therefore, the notation serves to privilege the relationship between actors within the system and the effects of actions as a result of those relationships, as opposed to actions or sounds themselves.

## 6. CONCLUSIONS

This article has discussed a particular framing of notation within the context of distributed and networked interactive

<sup>4</sup> I use the term "weakly-tied" here to mean that, while many different visualized forms may be related in one way or another, none of them can be considered the "parent" or "primary form". Neither can these visualizations be directly linked with a principal causal outlet for the audience. Each form presents one angle or way of viewing a particular actor or process in a complex web of influence between many actors.

musical systems. The interactivity upon which that ontology relies is defined narrowly, though the author has attempted to illustrate that the notational consequences are in fact present in other contemporary works with varying degrees of similarity. Among the main concerns of this notational schema is the concern for how each actor, human or otherwise, regards their situation within the context of the work at any moment, or even how they are to be regarded by other actors. In some ways, it functions as a bridge between certain types of compositional practice which may have one foot in each of the virtual or real worlds.

The collision or oscillation of influences between the virtual and real worlds can occur within a broader, more inclusive audience-performer hybrid. It is not hard to imagine obvious extensions to augmented, fully immersive, virtual, or video game worlds that are oriented around or inclusive of musical composition. I leave these as open questions for later exploration. To conclude, it is possible that interactive systems and the participatory audience may situate the role of notation somewhere between the descriptive and prescriptive score, or possibly somewhere new entirely.

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