Modelling Performance

Generic formal processes in live digital performance.

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Abstract—Most existing accounts of live performance concentrate on the specific features of individual works or on linking works according to commonly observed traits which allow their plausible inclusion in groups identified by authorship, style or genre. Similarly, most integration of digital technology with live performance is bespoke; an adaption of practice and enabling technology that solves only a single creative problem – that of the specific work being created.

This paper takes a different approach, which through considering practice across the range of live performance traditions contributing to contemporary digital performance activity, is able to propose a generic model of live performance which is able to account for the processes and moment to moment connections within live performance across a wide range of styles and genres. The approach is non-taxonomic, but is based on set theory and Boolean logic, the formal unfolding of a live performance is considered as the sum of individual performances generated by semi-autonomous performers. Each performer enacting a series of decisions based on their perceptions of the overall state of the performance (and each others’ activity) and a rule-set – which may be explicit or implicit.

Taking a view similar to that of Susan Broadhurst and others in seeing digital performance as an extension of existing performance traditions rather than as a completely, or mainly, new performative genre, the generic model of live performance is then extended to provide a rationale for the integration of digital technology with live performance which does not depend on specific activities or alterations of existing practice by artists or on features belonging to specific performance traditions. The application of the model in a prototype system is briefly described and some further potential implications of the model to provide a framework for analysis of existing digital performance and a template for future creative exploration are identified.

Keywords—digital performance; modelling; performance technology;

I. INTRODUCTION

The model described in this paper formed part of a project designed to develop tools for use in digital performance. The research took a generic approach to practice which, instead of concentrating on specific features of individual works or on placing works into groups identified by authorship, style or genre, attempted to identify areas of commonality across the range of digital performance practice. Through talking to artists from a range of performance-traditions contributing to contemporary digital performance activity and reviewing the tools currently used by those working in digital performance, I wanted to find out if there were any common aspects of technology use – and if there were, to identify them and develop a generic system which supported this use while leaving artists free to concentrate on those aspects of their work which differentiated it from that of others.

Alongside the qualitative analysis of interviews and the software specification and implementation, the project also required a particular understanding of how live performance worked – what its elements and functional, structural linkages were, but this understanding had to be as independent of its specific materials and individual creative devices as possible. I needed a generic model of live performance so that the proposed system could be used by as wide a range of practitioners as possible in their work.

II. SOME OBSERVATIONS ABOUT MODELLING

A model is an allegory; a representation of a meaningful ‘other’ related through a process of reduction – of scale, complexity or function. As Alan Peacock has pointed out [1], this representative aspect of models identifies them as signs, as necessarily stand-ins for something else. Further, he suggests that the ‘Language of Models’ is a complex mix of multi-layered communication codes ranging from the representational to the symbolic, from modes of signification, which are iconic and culturally indigenous, to those which are arbitrary and need to be learnt. The mechanisms of models’ significations are to be found through codes of scale, fidelity and affordance; the facilitation of use a model permits.

Models are used for many things, their representational readings support memory, imagination and play. More symbolic modes function as tools for analysis, as adjuncts to invention, and as preparations for intervention. It was this latter use-case that prompted my interest in modelling live performance. A model, particularly a functional model is a rich sign, a representation of an ontology – those aspects of the process and objects in a system that are considered sufficiently meaningful to be noted. Even more than this, a dynamic model is not just a representation of surfaces, but by demonstration, a proof that the inner workings of the modelled phenomenon have been satisfactorily understood as it reveals emergent behaviour. A model can thus reveal highly complex principles of operation while simultaneously
participating in the reductive, diminution that is the defining characteristic of all models. They 'explain' some things while not even attempting to represent others.

III. PREVIOUS APPROACHES TO MODELLING PERFORMANCE

In approaching a ‘theory’ of digital performance, some authors adopt a broadly materialist approach based on clearly identified elements while others use an approach based on theories of embodiment, cultural theory or nueraesthetics. Some accounts arise from considering a single project or series of projects, while others have a wider evidence-base where performance is delineated by genre.

In Digital Practices [2], Sue Broadhurst proposed some specific features of digital performance. After setting out the theoretical frameworks available for situating and analysing digital performance, she identified what she feels are its defining characteristics:

“An important trait of the following digital practices is the centrality of non-linguistic modes of signification… The sublime is also central to such an analysis... There is also no accentuation of the chthonic or primordial, though this is not a feature shared by all digital practices. Other aesthetic features are heterogeneity, experimentation, indeterminacy, fragmentation, a certain ‘shift-shape’ style and repetition. Also there is the free use of ‘defamiliarising’ devices, such as the juxtaposition of disparate elements, that… cause the audience to actively participate in the activity of producing meaning.” ([3] page 10)

Greg Corness [3] proposes an interesting model of improvisation with obvious implications for the integration of technology through concentrating on the qualities of (human to human) interaction and consequent event-production and decision-making within performance.

As well as these explicit accounts of performance, there are possibly an even greater number of cases where a model of live performance has underpinned a technological or creative development process, but has not been explicitly articulated; the domain’s ontology has been assumed within the functional specifications of the work, device or application being developed. Between these two positions, algorithmic approaches to creativity (particularly prevalent in the domain of musical composition by composers from a range of backgrounds including Iannis Xenakis and Brian Eno) occupy a middle-ground where the intention is to produce a structure that generates a live performance, but which, in some cases at least, also articulate and codify their creator’s epistemological views of live performance, what it is important or necessary to specify and how these specifications should be seen as relating to one another1.

In systems designed to facilitate collaborative performance, there is typically a strong emphasis on material phenomenology; an underlying model of performance as comprising strands of gestural, sonic, MIDI or visual material which, when considered by other performers (possibly with reference to a score), will influence their future individual activity. However, the ontologies of their implicit models tend to be partial; the mechanisms and principles of the decision-making about the moment-to-moment onward progress of a performance are typically assigned to the performers and are not articulated formally. A more complete formal model is the ‘KTH rule system for musical performance’ [4] which has a rule-based model and is able to predict the ways performers and a score interact to produce both the material and formal aspects of an individual performance.

Implicit models of performance may also be codified in software and hardware designed for use by individual performers (MIDI), or for the production of performance-tools (Isadora, Max) through their enumeration of data or input types or the structural and functional flexibility (or otherwise) they allow in a performance. Marc Downie, of the performance and technology ensemble Open Ended Group, has suggested [5] that some software and hardware systems can have a negative, narrowing effect on the variability of live performance, as they may channel artists to work in particular ways (and especially ways that are similar to those employed by the original designers of the systems). In a similar way, but on a smaller scale, the designers of MIDI clearly saw timbral transformation within an individual note as an unimportant part of their model of musical performance, perhaps a keyboard rather than string viewpoint.

IV. A GENERIC APPROACH TO MODELLING LIVE PERFORMANCE

A system which seeks to integrate itself in a generalised way with live performance will require a generalised model of performance itself, an idea about what can happen and how different parts of a performance may be connected. This is not to suggest that these are the only, or even the most important, questions one can ask about performance, or that they alone are in any way sufficient for a ‘Theory of Performance’. Indeed, for practitioners and audiences they might perhaps be among the least important questions, as they deliberately do not address ‘purpose’ or ‘meaning’ or ‘value’.

My goal is much more limited: looking at performance in a systemic way, can one identify classes of phenomena and the connections between them and, from this, can one identify ways in which technology can support and intervene in these operations? Underlying the proposed model is a view similar to that of Susan Broadhurst and others which considers digital performance as an extension of existing performance traditions rather than as a completely, or mainly, new performative genre. In developing a formal model of performance, I will consider digital performance as a subset of all performance activity, differentiated by the incorporation of technology with a consequent, and potentially radical, alteration to its means and articulations and creative processes, but with an underlying formal structure of

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1 This tendency is of course variable; performance-producing pieces such as Stockhausen’s Aus den sieben Tagen (1968) could perhaps be described as cultural or psychological (to the extent these differ) algorithms, but they mainly articulate more of the composer’s model of preparation for performances rather than suggest the constituent (sonic) elements of the performance.
moment-to-moment operation which is shared with non-digital performance.

In attempting to produce a generic model for this operation, a taxonomic, enumerative approach would be impossible due to the essentially heterogeneous nature of the phenomena being studied; creative acts are, by their nature, diverse and resist categorisation. Instead, my approach to modelling performance is influenced by set theory and Boolean logic.

V. A GENERIC FORMAL MODEL OF LIVE PERFORMANCE

While one cannot (and should not) attempt to enumerate the constituent elements of live performances, one can identify the set of such entities and then attempt to conduct operations on that set as a whole without trying to specify anything other than the criteria for inclusion in the set. For any sort of creative activity, those criteria are generated by the artist(s) and selection by the artist(s) is sufficient to place an element within the target set. A generic model must locate the specific taxonomy of a performance within the control of the creators of that performance.

Each individual live performance is a member of the set of live performances, which is a particular subset of the set of all creative products. I am going to suggest that the set of live performances is (at least partly) distinguished from other creative products by its members’ constituent elements being activities, by being made up to a large extent of things happening. I am also going to suggest that the ‘live’ aspect of my set’s name implies that a live performance’s constituent activities are, to some extent, produced ‘in the moment’\(^3\) and are dependent for their final performed form on conditions and dispositions at that moment within the performance as a whole. They are, to a greater or lesser extent, unpredictable until they are produced, at which point the probabilities governing the composition of their nature collapse onto the actual performed gesture, a gesture that then becomes part of the ongoing fabric of the performance. I will further formalise this by stating that these happening phenomena are a necessary condition for live performance\(^4\), but not a sufficient one; there are obviously many situations where events occur that are produced in-the-moment and that are not (generally) considered performances\(^5\).

Note that this construction is not making any assumptions about the nature of these ‘live happenings’ making up a performance. They can be in any medium, they can be quick, slow, repeating, random, numerous, rare, novel or entirely predictable. They may indeed be simply the ‘start’ and ‘end’ of a performance (John Cage’s \(4’33\)’ perhaps) or subtle and not noticeable by some or all of any audience that may be present. They may also have a variety of formal However, whatever their nature, they are not definitively shaped until they are actually performed. In improvisation, a gesture may take many forms or may not be made at all; in a conventional theatre work, a word or physical movement may be inflected in a number of ways that reflect the creative processes of actor and director. However, even after extensive rehearsal, there is always some room for variability, even for surprise. The point of my proposed description is not to rigidly define what is and is not a performance, but rather to construct a set which will include the vast majority of activity which might be considered live performance. I am not seeking to pin artists down and restrict what can be done, but rather produce a model that can accommodate and welcome the wild imaginings and interdisciplinary nature of work that seeks to apply digital technology within live performance.

Given that we are able to identify a set containing the constituent gestures and actions that make up a live performance, it is now necessary to explore the connections between these, to derive a rationale for the progress of a performance from one moment to the next. In considering the connections between live actions, I am going to propose a quality belonging to them called *significance*. For my purposes, significant activity (i.e. an activity that has the quality of significance) is that which is meaningful in determining the unfolding of a performance; it is an *event*.

An event is a discernable happening within a performance and arise as the result of *actions*. However, the relation between actions and events is complex, due to the differing characteristics of the gestures and materials of performance activity. An action can be singular (e.g. cue is given), compound; composed of an action started and then finished (e.g. a light fades) or a sequence of actions (e.g. a musical phrase is played). Some individual actions will lead to an event being generated while others will not.

In formal terms, the permitted operations on actions which could lead to an event arising are shown in table 1. In the proposed model, the capacity for using this range of relationships between actions and events is preserved.

\[^2\] Live performances also often have some elements that are not ‘happenings’; scenery, ambient qualities etc. These are not factored into the proposed model as a matter of course since they generally do not affect the moment-to-moment progress of a performance. If they did, however, the model is sufficiently general that they could be incorporated without needing to alter the model.

\[^3\] It might also be necessary (should one wish) to distinguish live performance from film or recorded performances through specifying something about the nature or origin of the activity involved, although some authors such as Auslander [6] would resist this.

\[^4\] There may well also be other creative genres that have this condition and which are to some extent contiguous with live performance.
VI. THE SIGNIFICANCE OF EVENTS

Events, however they are generated, are those actions or combinations of activity or qualities of performance-elements that identify points in a performance where its further progress becomes more fixed, where some of the potential variability of following activities is collapsed and a selective process operates. An event is a signal or gesture or a state that has implications for what happens next. While this might seem an unsatisfactorily broad definition, it is required by the generic aim of the project; it is important that the proposed model allows that the criteria for inclusion or exclusion of specific circumstances are left to those making and presenting performance. Thus, significant events might include a performer reaching the end of their material or making a particular gesture or taking up a position on stage, lights fading to blackout, a particular image being projected or the end of a section. Just as any activity becomes part of a performance through an artist including it in that performance, an activity or state becomes an event through its consideration in determining the future course of the performance. Performers follow this process many times during a performance, sometimes consciously (‘I’m going to watch the soloist here for the downbeat’, ‘I’ll start my speech as soon as the video reaches a certain point’), sometimes at an instinctual, habitual or intuitive level (‘I felt that something disjointed was needed’).

The structural or narrative determinations that are made when events occur can be highly complex and involve many terms and fine judgements. However, it is possible to build up complex logical operations from just a few basic operations and my deliberately simplified model is able to operate convincingly if the decision-making process is limited to applying a few simple binary conditional rules (e.g. ‘If the dancers finish their phrase then start playing the next section’). A binary conditional rule relates qualities of one or more events to a description (e.g. an actor says “Welcome”, the harp plays a low B or the dancer stands still) and gives a yes or no result; one is waiting, watching out (perhaps expectantly) for something and it either does or doesn’t happen. Based on this yes/no result, a performer can adopt a particular strategy for future activity which may have been decided in advance or may be ‘spontaneous’. This strategy may include the forming of gestures in particular ways; by making decisions based on the situation within the performance, the future unfolding of the performance is affected.

VII. THE PERFORMER MODEL

In my proposed generic model of performance, performers are seen as autonomous agents engaging with the performance by monitoring activity for significant events, making decisions based on pre-existing rules and what they have noted as significant and then producing or inflecting subsequent activity (see Fig. 1). The rules which frame performers’ decisions may be explicitly codified in the form of a score or script or other format, or may be based on experience, implicit rules derived from stylistically defined performance practice. Often, there may be a combination of both types of rule-sets in use.

VIII. GENERIC LIVE PERFORMANCE MODEL

The composite model presented here (Fig. 2) represents performance as a process involving the activity of one or more simplified, idealised performers. These performers are influenced by each other and by other aspects of the overall state of a performance (elapsed time, a position in a score or script etc.). They individually make decisions on further activity based on these perceptions in conjunction with a pre-existing rule-set. The process of performance is characterised by a combined, co-ordinated decision-making; the sum of performers’ actions represents the material of the performance itself.

<table>
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<tr>
<th>Table I. OPERATIONS ON ACTIONS THAT CAN LEAD TO EVENTS</th>
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![Fig. 1. An abstracted model of a performer](image-url)
The practical application of the model was tested through the development of a prototype software system, the Live Interactive Multimedia Performance Toolkit (LIMPT)\(^5\), and a domain-specific language; eMerge, for the control of performances using the system [7]. The prototype system was based on a slight modification of the real-time controller model (Fig.3).

![Client-controller architecture](image)

**Fig. 3.** Client-controller architecture

A central sever provided rule validation and storage together with an inference engine which generated activity-cues based on the state of set of variable spaces representing the sensed activity states of the performance and performers. Performance element activity sensing and cueing were provided by multiple instances of a networked client (one for each device or performer) which used an extensible plug-in architecture to allow customisable (and bespoke) sensing and cueing\(^6\). Each client instance was responsible for communicating with a participating element in a performance; a performer (a musician, a dancer, an actor…), a device (a lighting board, digital projection system, MIDI synthesiser…) or a dedicated software application (a Max program, avatar generator system, LiSa…). Different sensing and actuating affordances could be configured to suit the needs (i.e. the required input and output information formats) of the element it is supporting. The client also allowed rules (specifications of the nature and combination of significant events which should prompt specific activity) to be saved on the central server before performances during the rehearsal or devising process.

The prototype system was evaluated through use in workshop and live performance situations. Its most extended use to date has been in disDance 11054.80, a networked digital dance performance devised by Heidi Saarinen presented simultaneously in Cardiff and Singapore [8] where it successfully connected performers and audiences in both locations.

**X. FURTHER DEVELOPMENTS**

Each use of the prototype system has suggested extensions to the range of sensing and cueing capabilities clients might support.

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5 For more information, please see http://www.willcock.org/works/projects/limpt.html

6 The prototype client could sense MIDI activity (both control codes and notes), sound level, mouse and computer key activity and text input. It could generate cues as images, sounds, text and MIDI information. All communication with the central server was by XML messages to avoid bandwidth issues.
The continuing development of the system through use by a wider range of practitioners will prompt both updating of the client implementation and the development of new sensing and interfacing options and, more importantly, provide information about the applicability and validity of the underlying model presented above across different genres and performance-practices. It is only through extended use that the extent of achievement of the aim to provide a generic, non-disruptive facility for the integration of technology in live performance can be judged.

The model itself also suggests potentially fruitful new approaches to analysing performances through an examination of the significant events and subsequent decision-making that shape the overall work to reveal formal relationships within works and between separate performances which would overlay the more familiar links of genre or similarity of theme or materials.

Lastly, it is hoped that the model might support the overall goals of the original research that produced it, in stimulating and enabling creative artists to devote more of their creative energies to those radical elements of digital performance that embody the unique and characterful features of their individual artistic practice and help them to spend less time on accommodating technology which at times appears to restrict rather than inspire.

REFERENCES