The medium is the message: Composing instruments and performing mappings

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ABSTRACT

Many performers of novel musical instruments find it difficult to engage audiences beyond those in the field. Previous research points to a failure to balance complexity with usability, and a loss of transparency due to the detachment of the controller and sound generator. The issue is often exacerbated by an audience's lack of prior exposure to the instrument and its workings.

However, we argue that there is a conflict underlying many novel musical instruments in that they are intended to be both a tool for creative expression and a creative work of art in themselves, resulting in incompatible requirements. By considering the instrument, the composition and the performance together as a whole with careful consideration of the rate of learning demanded of the audience, we propose that a lack of transparency can become an asset rather than a hindrance. Our approach calls for not only controller and sound generator to be designed in sympathy with each other, but composition, performance and physical form too.

Identifying three design principles, we illustrate this approach with the Serendiptichord, a wearable instrument for dancers created by the authors.

Keywords

Performance, composed instrument, transparency, constraint.

1. INTRODUCTION

The possibilities of new computer-based musical instruments are vast. As well as the unlimited sound possibilities of software instruments, there is hope they may be made easier to learn [18] and even advance to role of co-performer [2]. However, many fail to enrol performers beyond their creators or engage audiences beyond those within the field.

Research investigating this problem often considers the experience of a potential performer. It highlights capabilities of traditional instruments that may be neglected, such as reliably reproducing an output, a diversity of musical outputs and a fine degree of control allowing performance nuances [10]. At the same time, it is hoped new instruments might be easier to learn than traditional ones, providing a quicker and steadier path of advancement [10, 18]. Some create new instruments more as an extension of their compositional practice, arguing that rather than building 'super instruments,' projects should be driven by specific compositions [3]. In this sense, composing may be seen as defining a musical space to be explored in performance [12].

Others focus on the experience of the audience. Fels et al. [6] consider the difficulty of establishing *intimacy* between audience and instrument without the commonly understood modes of performance possessed by traditional instruments. Lack of established performance practice can make it difficult to interpret (or even define) stylistic variation [7].

In this paper, we explore the difficulties that novel instruments face from the audience's point of view. By analysing performance as an act of communication we arrive at an approach to instrument creation and performance that draws upon their novelty as a strength rather than a hindrance.

2. ISSUES FACED WHEN CREATING NOVEL INSTRUMENTS

2.1 Transparency

Transparency is defined as 'the psychophysiological distance, in the minds of the player and the audience, between the input and output of a device mapping' [6, p. 109]. For example, whilst someone watching a violinist perform may not understand how each note is fingered, the connection between action and sound is intuitive and familiar through previous exposure to the violin; hence it is considered transparent. New instruments with unconventional mappings that cannot rely upon this prior knowledge are initially opaque to the audience. The challenge is then to con-

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struct instruments whose modes of use seem 'inevitable' [11] through methods such as drawing upon embodied metaphors – familiar day-to-day gestures and interactions [5].

But whilst that may *facilitate* transparency, an audience new to the instrument will still have the extra mental burden of learning how it works as well as appreciating the music it produces. Consequently, the musical content of a performance may be simplified to prevent it becoming too difficult for people to appreciate [15]. However, following this path too far risks reducing the music of a performance to a tool to facilitate the demonstration of the instrument. It reduces the appeal of returning to see another performance as, chances are, the instrument will be exactly the same and the music still simple for the sake of newcomers.

2.2 Engaging the audience

Many theories of musical appreciation focus on *expectation* (e.g. [14]). Someone listening to music is constantly and subconsciously creating a model to anticipate how it will progress. Their enjoyment depends upon both successful prediction affirming their model and a degree of surprise allowing it to develop and improve [9]. Music, in this context, becomes an act of communication, balancing the novel with the familiar. This balance is analogous to Csikszentmihalyi's theory of *flow* [4], the 'optimal experience' that can be attained when performing at the limits of one's ability. When the difficulty of a task greatly exceeds ability, anxiety follows; when ability greatly exceeds difficulty, boredom follows. But when difficulty matches ability, the person is both understanding and being challenged, allowing them to be engaged fully, improve their ability and achieve flow.

Witnessing a musician *in flow* during a performance is of course important. But the consequences of flow are also relevant when considering audience engagement. Sherry [16] identifies the difficulty of media as the degree to which it deviates from the formal convention of a familiar genre. Too much deviation can seem chaotic. It is difficult to identify any structure and frustration arises. Too little deviation and the media seems trite. Its structure has no surprises making it predictable and boring. In both cases it is a lack of *emerging structure* – improvement in our ability to predict – that hinders audience engagement. When there is just the right amount of deviation a structure steadily emerges that both affirms and expands upon our prior experience.

We may consider the workings of traditional instruments – how they are played and relate gesture to sound – as norms of musical performance. Thus, performing a novel instrument is a departure from convention, challenging the audience to understand it, to develop transparency and observe an emerging structure. The instrument is no longer just a tool to create music but is itself a part of the show.

2.3 The double bind

And herein lies the double bind of novel instruments: they seek to be both a tool to perform music and part of the musical composition itself.

The instrument as a tool

The instrument as a tool seeks to be instantly transparent. As Jordà writes, 'highly idiosyncratic instruments which are often used only by their creators may not be the best sign or strategy for a serious evolution in this field' [10, p. 326].

It has a chicken and egg problem with ubiquity. Audiences cannot appreciate the music a new instrument makes because they have not developed an understanding of how it works. But audiences will not develop this understanding because they do not appreciate its music and so do not gain exposure to it. Being consistent (i.e. predictable once the pattern is learnt) and drawing as far as possible upon embodied metaphors (i.e. formal conventions) assist it in overcoming this initial hurdle. The instrument as tool allows new forms of musical expression, and it is this new music that excites and challenges its audience and creators.

The instrument as a composition

But the instrument as part of a musical composition is an art form in itself, challenging the audience's ideas of what an instrument is, what musical performance is. It is learning about the instrument itself and how it relates to the sound it is producing that is engaging its audience. It may ground itself in formal conventions initially, but then challenge the audience to keep up as it breaks them. In particular, however, the relationship between instrument and audience *develops* throughout a performance. The audience is not just learning the developing structure of the music, but the developing structure of the instrument: its sounds, mappings and possible types of interaction.

There is clearly a conflict between these two types of instrument. Is there a middle path? Certainly, one can write a composition specifically to showcase and teach an audience about a new instrument, an approach common within the NIME community. However, when considering what drives us to build instruments and see them in performance, we believe the most exciting and unexplored direction for the future lies in pushing this latter type of instrument towards the extreme. The fact an instrument is completely novel to an audience is not a hindrance to be overcome. It is the reason we are there to see it! Each new instrument is a unique interpretation of how action connects to sound and understanding this interpretation can be as aesthetically rewarding an experience as listening to the sound itself.

3. COMPOSING INSTRUMENTS AND PERFORMING MAPPINGS

Magnusson [12] discusses 'composing an instrument' as defining and limiting the boundaries of a musical space to be traversed in performance. We expand on this idea and propose an approach to instrument creation as an art form in itself where instrument, mapping and music are an integrated part of a greater composition. On the surface, this involves the music, mapping, gesture, physical form and performance space all being constructed around and supporting the same narrative. But just as a composer will carefully consider how far each musical idea may be exposed at each point of a composition, the workings and possibilities of a novel instrument should not be revealed in an unconsidered way. The exposition of the instrument, its range of interactions and sounds, the performer's gestures, are as much a temporal art form as the music itself. The mapping is *performed*: interactions are expressively presented and developed, each coherently building on what has preceded it. The structures of each aspect of the greater composition emerge simultaneously and in sympathy with each other.

3.1 On interactive composition

Interweaving instrument and composition is, of course, not new. *Interactive composition* was proposed by Chadabe [2] as a performance process where a composition programmed generatively within a system is unleashed in performance (usually by the composer). However, this approach still regards the instrument as a somewhat static tool that allows the purely musical ideas of its creator to be expressed. Our approach considers instrument and music as mutually dependent parts of unified composition, with their relationship explored and developed within a performance. The

instrument itself becomes a temporal art form.

An instrument built around playing a specific composition may be criticised for its inability to play a diversity of pieces. Jordà argues that 'a highly sophisticated "instrument" with a low [diversity of pieces that may be played on it] may be a very good interactive composition, but should not be considered as an instrument, even if it comes bundled with a hardware controller' [10, p. 335].

There is of course a distinction missing here as to whether this 'bundled controller' is to be handed to the listener, who most likely has never seen it before, or whether it is to be used in performance on a stage by a rehearsed and experienced musician. But beyond arguing over definitions, this prescribed delimitation overlooks an important possibility: that it is precisely within such a tightly constrained domain that new ideas happen [17], new ways of using (and abusing) an instrument are found [8], and new compositions, or even new types of music, are created. In a time when musical programming languages have unleashed a bewildering amount of sonic potential, it is the constraints rather than the affordances of an instrument that characterise it [12].

3.2 Design principles

Our approach suggests the following design principles.

Principle 1. *Design for a single performance*

The main consequence of this attitude towards making new instruments is a greater focus on performance – a single performance – during the design and creation of an instrument. This not only involves letting music and instrument be mutually influential as they are created, but thinking about how they will be presented together, their combined impact on the audience, how this relates to the character and narrative of the performance. Beginning by developing the concepts and themes behind the performance is an effective way to achieve this.

Principle 2. *Consider the rate that structures emerge*

For structures to be *continually* emerging, a careful balance of affirming expectations and creating surprises is necessary to allow close consideration of the amount of learning demanded of the audience at any given moment. Thus, the workings of the instrument should develop *throughout* the performance *together* with the music. Exposing the entire instrument at the beginning and then moving on to the 'real music' not only makes maintain a coherent narrative difficult, but also demands a shift in the audience's frame of mind during the piece.

Principle 3. *It is easier to begin 'in the dark'*

Careful consideration should be given as to what information is imparted before the performance. A preceding talk or programme notes explaining how everything works may be the right decision, as having the themes within a piece of music explained prior to listening can sometimes make it easier to appreciate – but not always. An audience who have no idea what to expect, what the limits of the performance are, is a gift only those musicians with novel instruments have. It is to be exploited rather than remedied.

4. EXAMPLE: THE SERENDIPTICHORD

The Serendiptichord is a wearable instrument for dancers, the result of a collaboration between artist Di Mainstone (the second author) and sonic interaction researcher Tim Murray-Browne (the first author). Combining ideas from musical interaction with Mainstone's sculptural, 'body-centric' work, it is both instrument and the performance and narrative in which it features. We describe it here to illustrate how the above principles may be applied.

Figure 1: Heidi Buehler with the Serendiptichord in performance at the *ACM Creativity & Cognition Conference 2009*. Photo: Deirdre McCarthy

The creation of the Serendiptichord began by developing the concept behind it and the ideas it embodied: exploration, discovery, serendipity, inspiring creative movement and provoking playful behaviour (**Principle 1**). These themes informed every aspect of the instrument: its shape, the sounds it makes, how the dancer interacts with it, the way these interactions create sound, and how it is introduced in a performance (**Principle 1**). As the instrument was developed, a narrative emerged of the relationship between performer and instrument through stages of discovering the instrument, playfully exploring how it may connect to her body, becoming gradually more sinister as it begins to possess and dominate her, reaching a climax whereupon she tears it off herself, and finally a return to the innocence of before as she resists its attempts to entice her once more. The narrative not only serves to unify music, instrument and interaction: it provides a framework for the instrument to be communicated to the audience. Whilst the dancer has rehearsed extensively, her journey of discovery allows the audience to discover its facets, capabilities and personality vicariously (**Principle 2**). The Serendiptichord is not demonstrated before a performance, nor does its shape communicate how it works. Establishing transparency – the connection between audience and instrument – is part of the aesthetic experience (**Principles 2 and 3**).

The instrument is made up of a headpiece module that rests on the shoulders and extends over and in front of the head, and two hand-held modules that may be attached to the headpiece or other parts of the body (Figure 1). With an exterior of only wood and red leather, but a form inspired by the curvaceous nature of acoustic instruments, it is shaped to be elusive but enticing (**Principle 3**). Hidden inside are four wireless accelerometers. Two of these, in the left-hand module and behind the neck, use a mapping metaphor [18] of a percussive instrument with sampled sounds modelled as spheres positioned within their orientation space. They are triggered when the dancer rotates the sensors to 'hit into' the sounds, with the speed of movement mapped to the volume of the sample. This mapping is created to be *expressively* transparent: left still it is silent but the more aggressively it is moved the more aggressive its sound be-

comes. Each sample is routed through a distinct effects rack controlled by an 'intensity' parameter. The intensity of the nearest triggered sample rapidly increases when the right-hand pod is shaken and slowly decays over time. The final accelerometer controls a frequency-shifting effect applied to the master channel. Embedded within the 'trunk' of the headpiece, which swings from side-to-side, it creates the sounds most characteristic of the instrument and is the most transparent part of the mapping with its continuous connection between frequency and orientation. More detail about the mapping may be found in [13].

The narrative of a performance is divided into chapters specifying the character of the instrument, the nature of the relationship between dancer and instrument and which modules are used, as well as which samples are available to be triggered (controlled back-stage). These provide a wide scope for improvisation, but allow control over how and when different facets of the instrument are exposed, which we describe in more detail to show how **Principle 2** may be applied in practice. In a typical ten minute performance, only the box housing the instrument is visible for the first minute as the dancer creates anticipation of its contents (**Principle 3**). Once opened, just the left-hand module is revealed. We quickly realise that movement of it causes sound but it is not yet clear how they relate. The dancer emulates our limited understanding and explores this relationship. The nearly identical right-hand module follows and we might expect, as the dancer apparently does, that it behaves in a similar fashion. But our expectations are not met, and we learn that shaking it intensifies the sounds triggered by the left hand. The headpiece – perhaps the most distinctive part of the Serendiptichord – is not revealed until around a third of the way through the performance. When the nature of the entire mapping has been established, its limits are explored as the performance turns more macabre and chaotic through to a climax and recapitulation.

The Serendiptichord has been very well received by audiences with invited performances at the Barbican, the Victoria and Albert Museum and Kinetica Art Fair in London. Comments from audience members suggest part of the 'hook' of the performance is from raising the question: *is the instrument really making the sound or is it prerecorded?* It is initially unclear, and seeking the answer motivates the audience to understand the connection between interaction and sound (**Principle 3**). As the show progresses the instrument becomes more transparent, with the direct mapping of the trunk irrefutably connecting movement and sound (**Principle 2**).

5. DISCUSSION

Novel instruments created both as a tool and the artistic output of their creators suffer a conflict: simultaneously learning how they work and appreciating their full complexity can be overwhelming. It is our hope that awareness of this issue will be liberating rather than off-putting. By following the path of instrument as art form, the instrument itself becomes a part of the composition. It does not need to conform to traditional modes of learning and performing and it may be quite idiosyncratic. The model of musical appreciation discussed is of course highly simplified but it suggests that the amount of learning demanded of the listener at each moment throughout a performance is an important metric to consider – one that also arises in an information theoretic analysis of music [1]. This can be done more effectively if all of the different aspects of instrument, music and performance are composed together cohesively.

Our approach focused on audience members who have not previously seen the instrument performed. It will be of interest to develop it to include those who have. Whilst many enjoy hearing the same piece of music performed again, is the same true of composed instruments? Do following our principles make this more likely or less? Furthermore, how may principles such as these be objectively evaluated?

Finally, it should be reiterated that an instrument created around a single performance piece need not be restricted to playing only that. It is around the constraints of such a space that creativity happens. Building an instrument around the musical space implied by one composition and then exploring its limits allows those ideas to be adapted and developed into something new in a way that the blank canvas of a limitless 'super instrument' perhaps does not.

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