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Lian Loke and Toni Robertson

Interaction Design and Work Practice Laboratory [IDWoP]
Faculty of Engineering and Information Technology
University of Technology, Sydney, Broadway Campus, Building 10, Level 4, 235-253 Jones St

The Body in Design

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Lian Loke and Toni Robertson (eds)

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Faculty of Engineering and Information Technology

University of Technology, Sydney

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Designing for Conversational Interaction with Interactive Dance Works

Andrew Johnston
Creativity and Cognition Studios
School of Software
University of Technology Sydney, Australia
andrew.johnston@uts.edu.au

David Clarkson
Stalker Theatre
Carriageworks, Eveleigh NSW
david@stalker.com.au
www.stalker.com.au

ABSTRACT
In this paper we describe ongoing work, which explores the physicality of human-computer interaction in dance works. The use of physical simulations in the interface to connect with the performer's and audience's lived experience of the physical world is discussed. Drawing on past work with musicians, we argue that this approach is effective in encouraging creative, 'conversational' interactions in live performance.

Author Keywords
Dance, interaction, conversational interaction, physical modelling

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
In this paper we describe an ongoing project between the Creativity and Cognition Studios and the Sydney-based professional physical theatre company Stalker Theatre. Ultimately this will result in the creation of a large-scale outdoor dance work of around 60 minutes in duration, to be premiered in 2013.

Technically, the work involves motion capture and the use of multiple projectors. These include large scale, high-intensity projectors that will project onto buildings, sets and the dancers themselves, and a number of 'pico' projectors, which will be incorporated into costumes.

While these technical issues are significant, our principle concern (and the focus of this paper) is on the creative, interactive possibilities these technical systems provide. The question of how the actions of performers should be linked to computer generated sounds and visuals, is critical. One approach is to use the performers simply as human 'surfaces' upon which graphics, videos, etc. are projected. In this paper however, our focus is upon the interactive possibilities of the situation, and we seek to explore how dancers can be engaged in a creative, embodied dialogue with the systems that are created.

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BACKGROUND
The artistic practice and research of the first author is primarily concerned with designing creative systems which facilitate rich, complex, 'conversational' interactions in live performance. He has evolved an approach to interaction, which involves the design and construction of what might be called software 'sound sculptures'. Physical modelling techniques are used so that the sculptures, which reside only in the computer, behave like physical objects.

Physical models in creative interfaces
The first author has previously collaborated with composers and instrumentalists to create a series of works, *Partial Reflections 1, 2 and 3* and *Touching Dialogue.* These works explore notions of conversation and control in live, predominantly improvised, performance. They all have the following characteristics:

- Physical modelling techniques are used to create interactive 'sound sculptures'. These 'sculptures' do not exist in the physical world - they are software simulations – but because they apply the rules of physics they *behave* like physical objects.
- Acoustic sounds act as the source of sonic 'gestures' that act upon the sculptures. Musicians can thus poke, prod and pull the sculptures using the sounds of their instrument (clarinet, trumpet, trombone, voice, etc.).
- The sculptures are projected onto large screens visible to both the audience and performer.
- As well as responding to sounds by moving, the sculptures capture aspects of the acoustic sounds played by the musicians. As they move they produce their own sounds, which are a kind of re-synthesis (or 'echo') of the acoustic sounds mediated by the physical structure of the sculpture.

Figure 1. Screenshot from *Partial Reflections 3*, showing the simulated physical sculpture responding to sounds played on an acoustic instrument.

Physical modelling techniques have a long history in sound synthesis (Smith, 2004). Traditionally the approach has been to create high-fidelity models of the sound producing mechanisms of real-world musical instruments in order to produce more realistic synthesised sounds. One could say that rather than trying to build a violin *sound*, the idea is to create a simulated violin. If the simulation is accurate the sound it produces will be realistic.

Another, less commonly applied approach, is to use physical models as a kind of *interface layer* between the gestures of the performer and the sounds and/or visuals produced by the computer. This is the approach used in the *Partial Reflections* and *Touching Dialogue* works.

The primary reason for using physical models as a kind of intermediate mapping layer between the sounds produced acoustically by the performer and the computer generated sounds and visuals was because we were hoping to create an "instantly knowable, indefinitely masterable interface" (Levin 2000, p. 56). The musicians who participated in the design process found that the physical model interaction paradigm was intuitively understandable and controllable but provided sufficiently rich and complex audiovisual responses to allow the discovery and exploration of new musical-visual material during performance.

Physical modelling techniques have potential to create and control sounds that provide a higher degree of engagement for both performer and audience. Leman argues that there is evidence that "listening focuses on the moving source of a sound rather than on the sound itself" (Leman, 2007 p.236). In other words, when we hear music, we perceive it in terms of physical actions that we associate with such sounds. These need not necessarily be the physical actions that actually cause the sounds, but actions that we somehow associate with them based on past experiences.

He proposes a model of musical communication based on the encoding and decoding of biomechanical energy in sound. In this model, the performer realises musical goals by physically manipulating an instrument, which translates the performer's physical energy into sound. The listener, at least partially through a process of associating sounds with physical actions, makes sense of the sound. This is not to say that the listener's understanding of the music will be identical to that of the performer's, but rather that the listener will make sense of the sound in their own action-related terms. The implication is that instruments, which facilitate a more direct connection between the physical actions of performers and generated sounds, are more likely to facilitate musical communication at this gestural level.

Modes of Interaction

During 2007 and 2008 a series of user studies examining musicians' experiences with the *Partial Reflections* sound sculptures were conducted (Johnston et al, 2008, Johnston, 2009). The key issue that arose was that of *modes of interaction*.

It was observed that the musicians' interactions with the virtual instruments could be classified into three modes: instrumental, ornamental and conversational.

When approaching a virtual instrument 'instrumentally', musicians sought detailed control over all aspects of its operation. They wanted the response of the virtual instrument to be consistent and reliable so that they could guarantee that they could produce particular musical effects on demand. When interacting in this mode, musicians seemed to see the virtual instruments as extensions of their acoustic instruments. For these extensions to be effective, the link between acoustic and virtual instruments had to be clear and consistent.

When musicians used a virtual instrument as an 'ornament', they surrendered detailed control of the generated sound and visuals to the computer, allowing it to create audio-visual layers or effects that were added to their sound. A characteristic of ornamental mode is that the musicians did not actively seek to alter the behaviour or sound of the virtual instrument. Rather, they expected that it would do something that complemented or augmented their sound without requiring direction from them.

While it was not always the case, it was observed that the ornamental mode of interaction was sometimes a fall-back position when instrumental and conversational modes were unsuccessful. While some musicians were happy to sit back and allow the virtual instrument to provide a kind of background 'audiovisual wallpaper' that they could play counterpoint to, others found this frustrating, ending up in an ornamental mode of interaction only because their attempts at controlling or conversing with the virtual instrument failed.

In the conversational mode of interaction, musicians engaged in a kind of musical conversation with the virtual instrument as if it were another musician. This mode is in a sense a state where the musician rapidly shifts between instrumental and ornamental modes, seizing the initiative for a time to steer the conversation in a particular direction, then relinquishing control and allowing the virtual instrument to talk back and alter the musical trajectory in its own way. Thus each of the three modes of

interaction can be seen as points on a balance-of-power continuum (figure 2), with instrumental mode at one end (musician in control), ornamental mode at the other (virtual instrument in control) and conversational mode occupying a moving middle ground between the two.

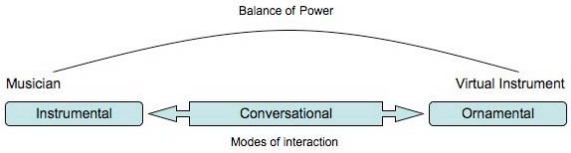

Figure2. Instruments, which support conversational interaction, facilitate a shifting balance of power between musician and virtual instrument

The implication is that virtual instruments, which seek to support conversational interaction, need also to support instrumental and ornamental modes.

CURRENT WORK

Encoded is a large-scale dance work currently in development, which will premiere in 2013. *Encoded* explores how notions of digitised space alter our perceptions of physical space. By using a combination of large and small-scale interactive projections onto building, outdoor sets and the dancers themselves, *Encoded* will blur the boundaries between physical space and digital space.

A core concern with this work is how to realise the interaction between performers and the digital elements of the environment. It would certainly be possible to simply consider the physical performance environment and the dancers' bodies simply as 'surfaces' upon which various pre-prepared images and videos could be projected but in some ways this would seem to reinforce the boundaries between the physical and the digital rather than provide an opportunity to explore them.

The approach we have been exploring is closely related to the *Partial Reflections* and *Touching Dialogue* works described above, in that a simulated physical system is used as a mediating layer between the physical gestures of performers and the visuals and sounds produced by the computer. However, rather than using a simulation based on solid objects which are linked together, *Encoded* uses simulated fluid (figure 3). The effect is hard to convey in still images - video of a recent performance can be seen at: http://vimeo.com/29471000

Our intention is that the appearance and behaviour of the software-simulated fluid will be intuitively understandable for both performers and audience, yet complex enough to facilitate conversational interactions.

Figure 3. Moving particles from the fluid simulation are projected upon the performer. The performer uses their movements to stir the fluid, which flows over and through their body.

DISCUSSION

Encoded is still in its early stages and there are a number of unresolved questions which are closely related to the themes of this workshop.

One issue is the question of the relationship between the performers and the interactive fluid. As the fluid responds directly to gestures and produces both sounds and visuals it could be seen as a kind of audio-visual instrument. To what degree should we consider the dancers to be instrumentalists? Should we attempt to facilitate direct, instrumental control over the fluid? To what degree is this necessary if we wish to encourage a kind of embodied, conversational interaction in performance? How does the behaviour of the system impact upon the embodied experience of the dancer?

Fels has described users' experiences with his *Iamascope* installation as sometimes involving what he terms a 'belonging' relationship. In this state, the person felt themselves to be an extension of the *Iamascope* – that they were in fact embodied by it - and that its movements to some degree animated their own bodies (Fels 2004).

We have observed similar responses in dancers who perform with our fluid systems, especially when fluid particles are projected onto their body. The dancer appears to be simultaneously both controlling the fluid and being animated by it. The effect is compelling and, for an interaction designer, the possibilities are definitely intriguing. This is an area for further exploration.

Just how to explore it is a question we are grappling with. Past work with musicians has led to a series of user-experience studies involving interviews and think-aloud techniques, and these approaches were helpful in exploring the relationships between the musicians and the interactive systems we had designed.

Larssen et al argue that:

"Experiential bodily knowing is felt. When becoming increasingly familiar with movement as a material for the design of technology interaction, we come to new understandings and nuances of understanding of the material." (Larssen et al, 2007 p.14)

The notion that physical movement is a material for design challenges interaction designers to become more attuned to their physicality. To date in our work this has extended only to participating in group warm-ups during workshops, and so there is considerable scope to take this further.

While we are receptive to the idea that becoming more attuned to their physicality will enhance interaction designers' connection with the dancers' craft and lead to better interactive systems, we are also mindful of the gap between the amateur and professional, in terms of ability certainly, but perhaps more importantly in the level of sophistication of domain knowledge. Composers are sometimes warned that trying to learn the instruments they compose for is counterproductive, as the level of understanding they can develop in short term 'dabbling' with the instrument is several orders of magnitude less sophisticated than that of the professional musician. We don't doubt that becoming sensitised to the physicality of the performers' craft is worthwhile, but there is a risk that it can lead us to constrain the scope of design possibilities when working with high-level performers.

CONCLUSIONS

In this paper we have presented an overview of work with musicians and dancers in which physical modelling techniques are used to attempt to create intuitively controllable audio-visual systems that facilitate conversational interactions. As our work on *Encoded* progresses we are mindful of the need for those involved in the interaction design for the project to become more attuned to their physicality. We feel that we have much to learn about how professional movers think about (and through) their bodies.

We hope this paper provides readers with some of the ideas and strategies we are applying in our creative work and research and will stimulate discussion of the relationships between physicality, embodiment and systems for creative expression.

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