Conceptualising Interaction in Live Performance: Reflections on 'Encoded'

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ABSTRACT

This paper presents a detailed examination of experiences of the creative team responsible for the direction, choreography, interaction design and performance of a dance and physical theatre work, *Encoded*. Interviews, observations and reflection on personal experience have made visible a range of different perspectives on the design, use and creative exploration of the interactive systems that were created for the work. The work itself, and in particular the use of interactive systems, was overall considered to be successful and coherent, even while participants' approaches and concerns were often markedly different. A trajectory of creative development in which exploratory improvisation and iterative design gradually became 'locked down' in preparation for final performance and touring is described.

Author Keywords

Dance; interaction; performance, physical theatre; design; evaluation

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

This paper presents a detailed examination of the experiences of a creative team including performers, director, choreographer, interaction designers, lighting designers and a composer in order to improve understanding of how interactive technologies are incorporated into live performance works. Particular attention is paid to how the individuals involved conceived of the systems, how the presence and behaviour of the systems affected the work and how the systems were appropriated and reconfigured.

ENCODED

Encoded is an hour-long dance/physical theatre work featuring four performers. The work makes extensive use of interactive systems and large and small scale projections. Technically, there are three main systems:

- A set of three 'virtual costumes', which used laser 'pico' projectors to project images and animations on performers' bodies as they moved around the performance space.
- An interactive fluid simulation system, which used infrared motion tracking to enable performers to manipulate a large-scale (approx. 15m x 10m) graphical projection in real-time.
- A projection mapping system, based on the commercial software Resolume,[1] which provides a high degree of control over the placement, arrangement and blending of both pre-rendered animations and the real-time graphics produced by the fluid simulation.

This paper will primarily focus on experiences with the interactive fluid simulation system and its use in creative development and performance.

A five-minute 'highlights' video of *Encoded* can be seen at `https://www.youtube.com/watch?v=hopxlmyVp7A`.

PAST WORK

The use of multimedia technologies in dance has a long history. Pioneer Loie Fuller (1862-1928), for example, created a sensation in 1881 with the Serpentine Dance in which coloured lights of her own design were projected on a voluminous silk costume as she danced [4]. John Cage and Merce Cunningham collaborated on *Variations V* (1965), in which dancers' movements triggered sounds played through multiple speakers placed around the performance space [14] and in the early 1970s Philippa Cullen used sophisticated analogue technologies to link performers' movements to electronic sounds [10].

Since the 1990s, digital motion tracking technology has become increasingly sophisticated and affordable, and numerous works have been created which explore their use in live performance. Landmark works include David Rokeby's Very Nervous System [23], Glow (2006) and Mortal Engine (2008) by Melbourne-based dance company Chunky Move and numerous works by Troika Ranch (USA) [11] and Palindrome

[1] `http://resolume.com/`

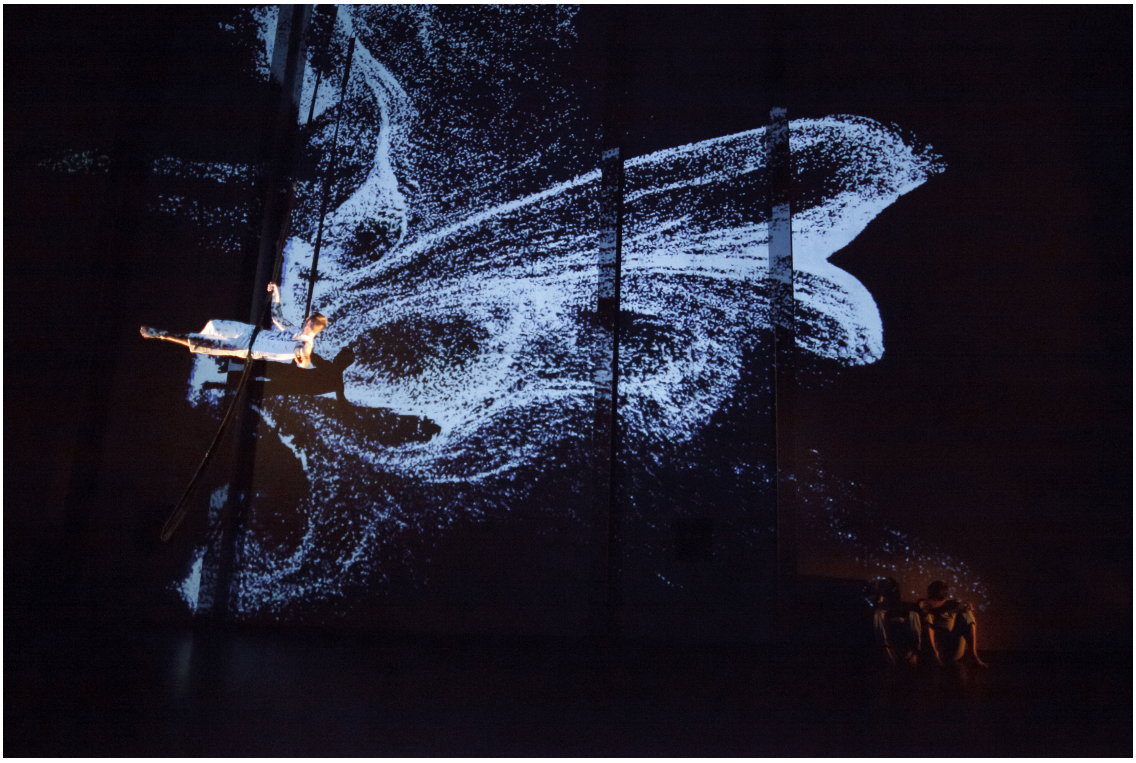

Figure 1. Performers and interactive fluid simulation in *Encoded*. (Image: Matthew Syres Photography)

(Germany) which feature sophisticated live motion tracking systems linked to computer systems that produce interactive graphics in real-time.

While there have been a number of interactive dance systems developed, particularly in recent years, research that examines the design, development and use of these kinds of systems and the impact they have on the creative work and experiences of performers is comparatively limited. Calvert et al [2] describe the impact on choreographic work of the software, *Life Forms*, developed in close collaboration with users, most notably Merce Cunningham. They show how *Life Forms* was used by choreographers partly as a way to question their habits and try new approaches.

There are also broader examinations of the creative process in dance (eg. [20]), but here the dance works do not make significant use of new technologies. On the other hand, examinations of dance works which do make use of new technologies tend to be personal reflections by the creators of the systems or critical reviews of the works themselves (eg. [21], [1], [22]). These are, of course, extremely valuable, but we observe that there is a comparative lack of case studies incorporating views from all stakeholders which examine and document the links between interaction design and creative practice in dance. There is also a lack of work which examines performance works which are developed and shown to larger and more diverse audiences. This is likely to be partly because the difficulty in touring works with high degrees of technical complexity and/or novelty means these are comparatively uncommon.

Our aim here is to present a detailed reflection on the creation and presentation of *Encoded* in order to:

- Identify and document the creative and technical strategies which were deployed;
- Reveal and examine the various ways that stakeholders conceived of the interactive systems; and
- Examine how approaches to interaction in performance changed over time.

INTERACTIVE SYSTEMS

Encoded was developed in a series of workshops over a period of nearly two years. The author was involved with the development of *Encoded* from the beginning, and worked to develop a motion-tracking interactive system based on real-time fluid simulation. The use of the fluid simulation was part of an attempt to provide interaction which was intuitively understandable but also rich and complex – an approach based on the author's past work creating systems for music performance [8, 9].

While the focus of this paper is not primarily technical, it is nonetheless important to give an overview of the basic structure of the systems developed for *Encoded*. More technical detail on the fluid simulation can be found in [7].

The virtual costumes consisted of a set of three pico projectors, two of which were attached to a specially constructed aluminium harness which was strapped to the body and third mounted on the head projecting onto a mirror which reflected back onto the face (figure 2). Each projector was connected

to an iPod Touch running a simple application which played back selected still images and videos. The iPods were controlled remotely via WiFi and Open Sound Control (OSC) [25] using TouchOSC[2] (see figure 3).

Figure 2. The virtual costume harness and projector system. (Image: Matthew Syres Photography)

The interactive fluid simulation system, the primary focus of this paper, used a camera with infra-red filter fitted (ie. a filter that blocked visible light and allowed only infra-red light through), coupled with careful infra-red lighting, to track the movement of performers in the performance space (figure 4). These movements were mapped to forces applied to a fluid simulation based on MSAFluid by Akten[3]. This allowed performers to effectively 'stir' the fluid with their movements. We created a control system using Pure Data [17] which enabled us to control a large number of the simulation's characteristics (viscosity, colours, visualisation styles, etc), provided the ability to save preset states and enabled smooth transitions between states with predetermined timings. Again, the OSC protocol and TouchOSC were used to provide a convenient control system for triggering preset fluid states.

INTERVIEWS

Interviews were conducted at two main points during the development of *Encoded*. The first series of interviews was conducted with performers and director at the conclusion of a three-week development workshop in March 2012, during which the team had experimented with a number of different versions of the fluid simulation, projection mapping and virtual costume systems. After this workshop had concluded the main building blocks of the show were in place and the director and performers had developed conceptions of the show and its creative possibilities and constraints.

A second series of interviews with all the major stakeholders was conducted in December 2012, after *Encoded* had had its premier season of five performances at CarriageWorks, a well-known performance venue in Sydney, Australia. At this point all four performers were interviewed individually, along with the director, choreographer, lighting designer, projection mapping designer and virtual costume designer. In addition, a group retrospective discussion was conducted with all stakeholders in the room. This occurred after the individual interviews were completed.

With the exception of the group retrospective, all interviews were semi-structured and focused on the individuals' experiences with the interactive systems and their approach to performing with them.

All interviews (totalling approximately 13 hours) were transcribed and analysed using grounded theory techniques [5, 6] to identify key themes and relationships. During analysis, actor-network theory [12, 13] provided a useful 'lens' for conceptualising the relationships between the technologies that were developed and the contexts within which they were developed and appropriated.

In the following sections, key themes which emerged during interviews are presented.

CONCEPTIONS OF THE INTERACTIVE SYSTEMS

While the use of interactive systems in dance has a long history, it is nonetheless true that they are still relatively uncommon and have certainly not reached the level of ubiquity of other performance technologies such as music, lighting, costume and set design. These older technologies have long and well-established traditions of use which are implicitly understood by both performers and audiences.

Interactive systems, on the other hand, do not have clearly defined contributions to make. Performers can sense that they have potential, but don't yet know where they might fit into the broader conventions of theatre and dance. In interviews, participants framed the interactive systems in several different ways at different times as they worked to understand their relationship to their own practice and to the performance as a whole. In this section we present some of the different conceptions of the interactive systems that emerged.

Contact Improvisation Partner

> "Like a form of dance that I do is called contact improvisation so it's a partner of a dance form that is also improvised and you're in contact with another person but through that point of contact there's an immense listening that through the contact you're listening and the dance begins. So it becomes a dance of one but with two bodies without verbal communication so I think, you know, the interactive systems are that. It's just finding the listening point..." (Performer)

The metaphor of contact improvisation (CI) [16, 19] is an intriguing one for interaction designers working in performance contexts. In CI, performers use physical contact as a starting point for movement improvisation. Generally, performers stay in physical contact during performance and communicate through touch as the improvisation develops.

CI is often used as a starting point to encourage exploration prior to creating set choreography. In the case of *Encoded*,

[2] `http://hexler.net/software/touchosc`
[3] `http://www.memo.tv/ofxmsafluid/`

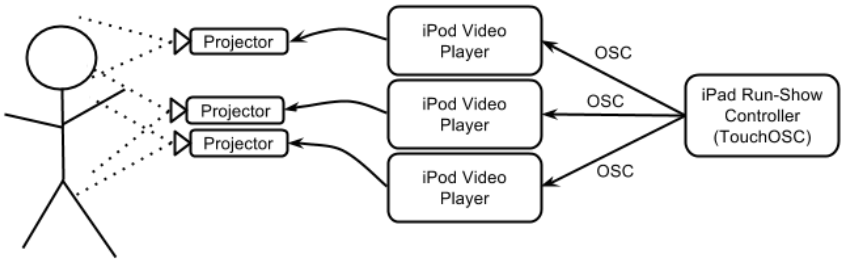

Figure 3. Overview of the interactive virtual costume system.

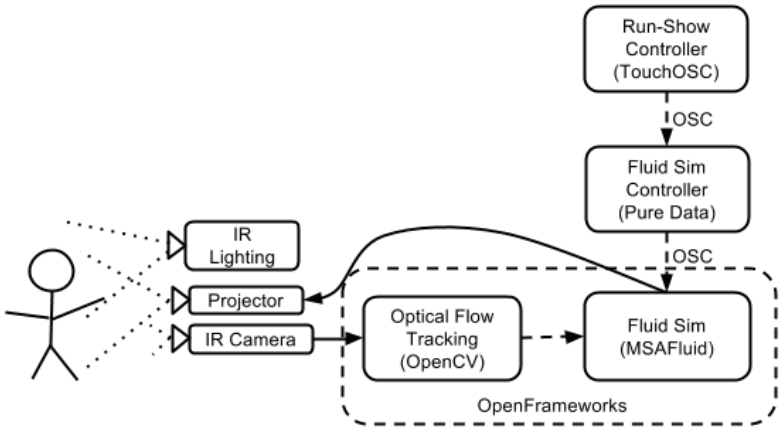

Figure 4. Overview of the interactive fluid simulation system.

CI was not consciously employed but, as the quote above illustrates, at least one performer felt there were similarities between her experiences with CI and the early stages of engagement with the interactive systems. As we will discuss later, this feeling of close connection between performer and interactive systems was not sustained throughout the full development, and did not continue to be a focus.

For designers, CI provides an interesting way of considering creative interactions. Several researcher/artists [24, 3, 15, 8] have proposed a more 'conversational' approach to interaction between improvising musicians and interactive systems in which there is:

> "...sharing of control between the musician and the virtual instrument. The balance of power is in flux, allowing the virtual instrument to 'talk back' to the musician, reflecting and transforming the sonic input in ways that move the performance in new musical directions." [8, p. 568]

We see the contact improvisation approach articulated by the performer above as an example of conversational interaction in a dance context and is something we are motivated to pursue further. Of particular interest is exploring the notion of the 'contact point' between performer and system and what this might mean for interactive systems with primarily visual outputs. Haptic feedback techniques are one obvious avenue to explore.

Interactive Mask

> "What's always interested me about this work is when I reflect back on that training and masking. Masking is one of the fundamentals of physical theatre, and we create masks, that's what we do, we either mask buildings, or we mask bodies or there's something around that. And even when we are taking the body, the movement of the body and projecting it onto a wall, in a weird way it's still a mask, because we are taking the human animation and physicality and recreating that. So in that way that's where it primarily links with the theatrical tradition." (Director)

> "The truth of what you're trying to say will emerge, and it'll emerge from subconscious... You make the work as rational as you can, but ultimately you are after the play of ingredients that you can never control in a strict sense. And so it's looking for those universal truths from the technology and the interaction and from the dancers... That is what I'm trying to tease out with this work." (Director)

The use of masks in theatre dates back to antiquity and appears to occur in all cultures [18]. Masking can have many purposes and may take many forms. At its most obvious the performer can wear a face mask of a particular archetypal character, as in commedia dell'arte, but more broadly any kind of costume can be seen as a mask, in the sense that it

to some degree conceals the identity of the wearer, and helps shape audience perceptions and performer behaviours.

In the case of *Encoded*, the quote above shows that the director was, at least at times, consciously using the various projections as masks. Most obviously this occurred with the virtual costumes, as the performers were literally masked with light as can be seen in figure 5. However, the projection mapping and interactive fluid simulation can also be seen as masks.

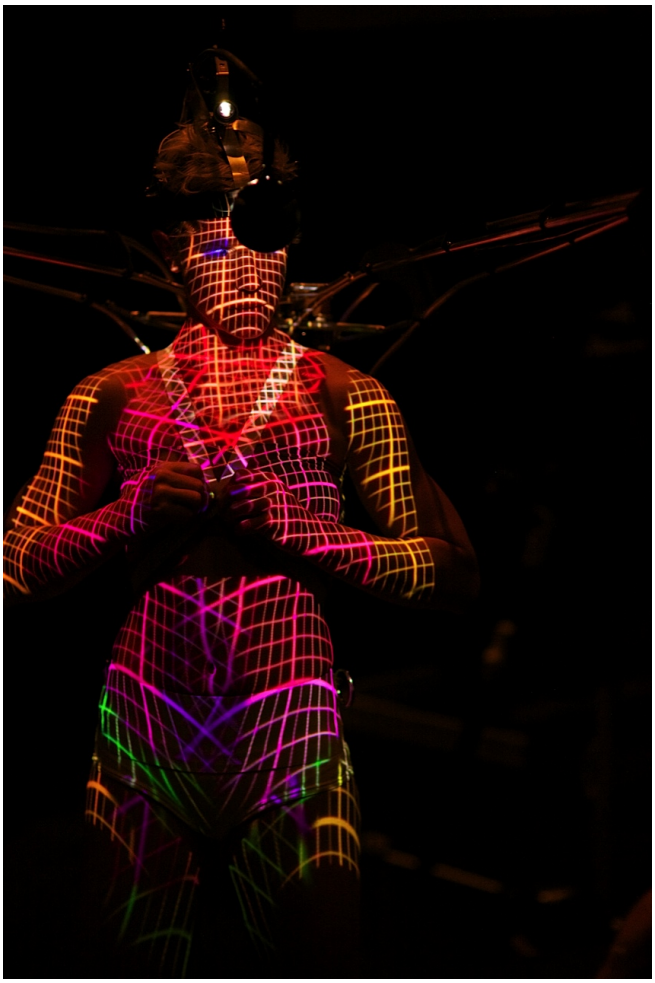

Figure 5. The virtual costume can be seen as a form of theatrical mask. (Image: Matthew Syres Photography)

> "Because when you put them on it just it changes who you are as a performer, you have [the] sense of two more limbs and that you're taking on this persona, and so I sort of give in to that." (Performer, on wearing the virtual costumes)

When a performer wears a mask, they inhabit the mask, but the mask can also possess and animate the performer. Seen as a mask, it is clear that interactive systems not only respond to movement but shape it and give it character. As interaction designers then, we do not ask only how performer movements should map to interactive system behaviour, but also how we want the behaviour of the system to shape the movements of performers. This is a symmetrical view of 'mapping' which prompts a different perspective on interaction design for performance.

If interactive systems are a kind of theatrical mask, we might ask: what are the effective interactive 'archetypes'? Commedia dell'arte features stock characters – the witty acrobat, the cowardly villain, the pompous doctor, etc. Are there interactive technologies or techniques which are becoming, or have the potential to become, the modern equivalent of stock characters in dance and physical theatre? Certainly particle systems and physical simulations are widely used in many interactive works in music, dance and interactive art. While they can be configured to have a range of different styles or characters they share a similar aesthetic. One performer described the aesthetic of the fluid simulation systems as creating a kind of 'benign universe'. This is then, perhaps, an interactive mask that yields to movement, softens and shapes it gently.

It is too early to say whether systems of this kind will become archetypes of the commedia dell'arte variety, but we can see that it is at least possible, or could feature as one strand of performance practice. At the very least we can see that conceiving of them in this way allows us to move beyond technical progress and novelty as a primary driving force in the creation and use of interactive systems in performance, and encourages greater focus on the craft of using existing interactive techniques to make a range of new works – as opposed to always creating new, bespoke systems for every work.

Movement Amplifier/Resonator

> "I think something about those spaces that is as floor dwellers we can't necessarily touch without the magic of performance to light up those spaces I think." (Performer)
>
> "So it's like a kind of echo chamber, a kind of visual echo...and resonance of what you're doing." (Choreographer)

Interactive systems which respond to performer movement can act as 'amplifiers' of that movement, in a way that is analogous to the way that using stilts or slings in physical theatre exaggerate body movements. The performer quoted above saw this as an effective way to 'enliven' the performance space, but in a way which was intimately connected with the physicality of the performers. While traditional stage lighting or pre-rendered projections can also be used in a similar way, they are not linked to performer gesture in the way that the *Encoded* interactive systems were.

For the systems to be effective in this way, the connection between performer gesture and system response needs to be clear and unambiguous. This is a technical challenge, and it is probably the case that the response of many interactive systems appears more abstract largely because of a lack of robustness and accuracy in movement tracking, rather than as a result of conscious creative decisions.

Where the technical challenge of robust tracking has been solved, the attention shifts to considering how the visual responses of the interactive system can sustain interest and

avoid becoming overly simple 'echo boxes' which merely amplify movements without also showing them in a new light to provoke audiences and/or performers to discover nuances and unexpected details.

Fragile Beast

One of the biggest fears of everyone involved with *Encoded* was that the technology would tend to dominate the humans involved in the performance. The use of the fluid simulation system as a kind of benign mask was a strategy which was effectively used to mitigate against this presumed tendency of large-scale projections.

> "One thing I really loved about the piece and the process was that it sort of allayed a fear I had in the beginning of dance and interactive technology being so much about spectacle, and I think what we achieved in this show is that it wasn't just about spectacle. It did have heart, it had calm, and it had quiet, it had subtle. ...And the feedback with people afterwards was definitely along those lines, which I was surprised about and really pleased, and thought that was really cool that you make something [that subtle] that has such big proportions." (Performer)

It is interesting to set these conceptions of the interactive and projection systems as somewhat frightening beasts that have an unfortunate tendency to megalomania against the views of the designers who create them. The *Encoded* designers had a dual view of the systems, indeed seeing them sometimes as out of control beasts, but also at other times as remarkably fragile assemblages of hardware and software components, bound together by protocols, cables and tape.

> "I hate seeing [male performer] wearing that thing. He's rude with them. They're fragile, they're really delicate devices." (Costume Designer, talking about the virtual costumes)

TRAJECTORIES OF INTERACTION & PERFORMANCE

Encoded was developed over a period of nearly two years. The development was driven by a series of workshops, typically of 2-3 weeks duration, which allowed improvisation with the interactive systems as they evolved and enabled the creation of what the director termed a 'palette' of interactive states and choreographic movements from which the final show was compiled. This palette manifested itself in later workshops as an iPad controller (using TouchOSC[4]) which contained all the effective preset states of the fluid simulation on a series of pages.

The creation of this palette and the ability for the director to control and shift between interaction states without having to call directions to the interaction designers was a significant step which heralded a transition from the looser, more improvised approach of the early workshops to the more tightly structured, choreographed final workshop which culminated in the premiere of the show.

[4] `http://hexler.net/software/touchosc`

This 'locking down' of the choreography and interactive system states was the end point of a trajectory of interaction and performance which began with shorter, playful, contact-improvisation-style workshops and smaller-scale performances. In the early workshops and showings there was considerable scope for the interaction designers to push the boundaries of their systems and respond in the moment to performer movements. The interaction designers were perhaps like improvising musicians, simultaneously contributing material and responding to the material of others.

Pushing against this free-wheeling spirit were the creative and, to some degree, commercial imperatives to 'put on a show', plus the time constraints imposed by the limited funding available to run workshops. *Encoded* received significant funding from several arts funding bodies, and with this went the expectation of creative outcomes that audiences would want to see and that could tour nationally and internationally.

> "[A major venue] have offered us this deal so if we don't do it now the show's not going to get up for another 12 months or whatever. And just purely from [the Company's] point of view... We are comparatively well funded for an ongoing company, we've got to justify that by actually doing shows regularly." (Company CEO)

Interaction designers, wishing to retain the more playful, improvised character of the earlier workshops, had to compromise and work to lock down the palette of known interactive states which were consistent and could be guaranteed to work effectively for multiple performances in many different venues. In addition, the scaling up of the projections, from a more 'person sized' 3m in width to a more 'architectural' 15m, reduced the sense of intimacy and close connection between performer gesture and visual response.

> "And necessarily that had to be kind of compromised to produce the final show, but that's a little regret... I keep on thinking, could we have still put the show on in the time we had, and had made a large scale projection that everyone likes, but also retained that intimacy and that connection that we had with some of those early workshops and the playfulness? Because with the final show it was like we are pushing a button to set the fluid into a particular state and that's it, we're not doing anything else unless something goes horribly wrong." (Interaction Designer)

Of course it is not necessary to choose between completely free improvisation and completely pre-determined performance states. Perhaps because the technology facilitates the saving of pre-set interactive system states it does to some degree encourage the locking-down of the system. The physical performers were also performing pre-set choreography but because of the 'analogue' nature of their work they retain a greater degree of control over the nuance of each individual performer.

> "And then for me the real craft comes within that set material... There's a nuance, because every live show is different – it's the play that happens within that set vocabulary. And so the question is then with what [the

interaction designers are] doing... How do we find that degree of play for you as an operator? And I think part of that challenge is because your form is so new, and that the dialogue... the language or the terminologies aren't even quite there yet for what you're alluding to. So maybe there is a way to get you what you want, but it needs teasing out." (Director)

Once performers have developed sufficient mastery of the choreography (and, of course, of their basic technique) they are able to find nuances in the material which give each individual performance a unique character. As the director alludes to in the quote above, there is certainly scope for interaction designers to retain the ability to find similar scope for finesse in live performance. Perhaps because of the complexity of the technical systems the perceived risks of this approach – at least for this iteration of the work – were, implicitly, considered to outweigh the benefits.

Given the scale of the work and the significant use of new technologies, many of those involved felt that the work would have benefited from an extra week of development time. Towards the end of development and during the performances, there were hints that performers were beginning to re-establish the more intimate connection they had with the interactive systems in the earlier workshops, but now with a focus on nuance. For several reasons though, the feeling of intimate interaction was not fully realised.

Asked whether she felt the same sense of contact improvisation between interactive system and performer in the final performances, one performer responded:

"No not at all. I think because I was so focused on doing the movements that had been set it never kind of really got there. And...most of the scenes that I was in were also with another dancer... so my first point of connection was with that person and then the projection if I got there... So it was making sure I was in time or connected with the person, and then maybe by the end I was starting to see the projections, but [I] don't feel like I really got there in the end." (Performer)

From the interviews there are two obvious factors which worked against nuanced, contact-improvsation-style interaction with the interactive systems in the final performances. The first was a simple lack of time. Developing an hour-long work in a three week workshop, especially when so much new technology was involved, was a challenge. While all performers agreed that the quality of performance was high and that overall the work was successful, it was often observed that given more time the nuances of interaction could be more fully explored.

"So the interactiveness I think did excite me and in a sense we kind of lost this, and I think it was more the timeframe that made us lose it a little bit." (Performer)

Another key inhibiting factor was a physical performance environment which was in so many ways hostile to interaction.

"Yeah it's very hard [laughs] to interact when so often the, um, abilty to see is compromised, whether it's by lights in the eyes or projectors in your face." (Performer)

From a purely practical point of view, the fact that dancers are working in a space which is lit by powerful stage lights, as well as high-power projectors, means that their vision is significantly impaired. For stage performers this of course is not uncommon. The implications for designers of interactive systems for live performance though, are significant. If there is a desire for nuanced, conversational interaction between performer and system, then it will almost certainly be necessary to present the work in non-conventional settings.

Storyboarding

"It was very different this development to other ones... Normally when we go in to make a show there's no prework done. We have an idea and we usually go and improvise and create [it] piece by piece but this time when we went in it was like [the Director] had storyboarded everything...because of all the interactive technology." (Performer)

"So what I did was I made a story board of which interactive and mapping states followed which, and I kind of made a coherent order for myself in regard [to] my initial idea of the work." (Director)

At the outset of the final, three-week workshop, the director had prepared a storyboard showing the various interactive states and projection mapping animation material. As the show took its final shape these fragments were re-ordered and adjusted. This was primarily a tool for the director to use to maintain a sense of the overall structure and direction of the show and to help communicate that structure to the rest of the team.

Based on the storyboard, the director "matched physicalities to those interactive and projection states" (Director) and added descriptions of these to the storyboard. The choreographer then used the storyboard to provide high-level structure within which he developed the detailed choreography.

"So I didn't give [the Choreographer] a hell of a lot of choreographic instruction, but I did give him landmarks, and to a certain so I was descriptive perhaps without being prescriptive." (Director)

CONCLUSION

In this paper we have presented reflections on the development of a professional dance/physical theatre work which made substantial use of interactive technologies. The work was considered successful overall, creatively and technically, and went on to tour internationally to the Netherlands and South Korea as well as around Australia. Technically, the systems that were developed were sufficiently robust and reliable to withstand the rigours of touring. The fact that they were reliable enabled the interviews and observations that we report in this paper to focus on the creative strategies that were employed and also on the different ways that stakeholders conceived of the interactive systems and their place in live performance.

The emergence of comparatively low cost of reliable tracking systems in recent years is encouraging a great deal of exploration in this area. This provides us with an excellent opportunity to examine the emerging creative and technical practices which are being developed. As this paper makes clear, the interactive systems are being conceived of in a number of different ways as people draw on past experience to make sense of them and make effective use of them in creative contexts.

The emergence of the creative vision for *Encoded* was facilitated by the director, but, like most works, it was very much an emergent, collective vision that grew out of experimentation, careful reflection and past experience. Through the interviews and reflections presented here, we have attempted to document and examine the creative processes at work and examine the mechanisms – in one specific instance – through which a new performance medium may be gradually incorporated into practice.

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