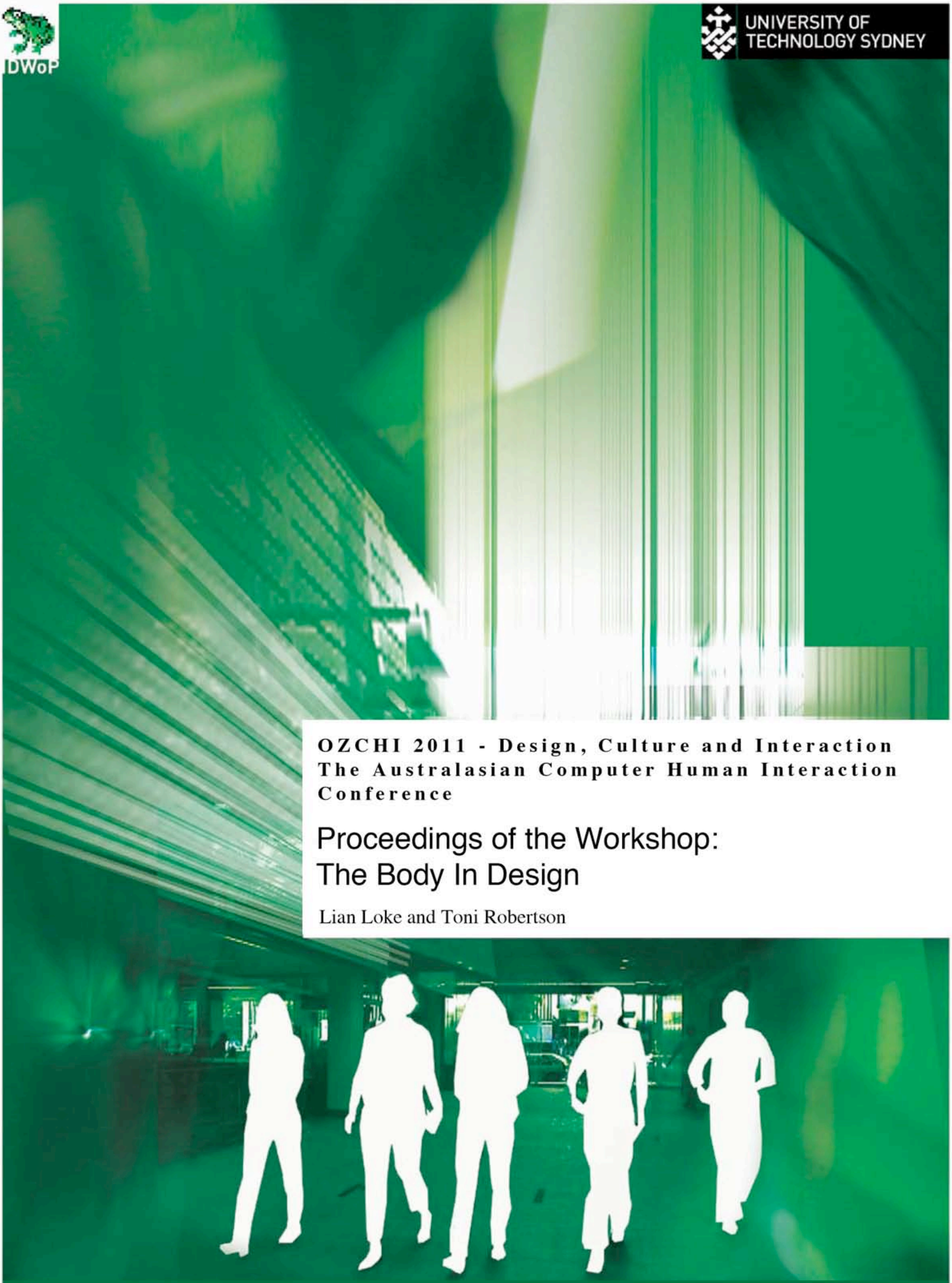

IDWoP

UNIVERSITY OF TECHNOLOGY SYDNEY

OZCHI 2011 - Design, Culture and Interaction
The Australasian Computer Human Interaction Conference

Proceedings of the Workshop: The Body In Design

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The Body in Design

Workshop at OZCHI 2011 Design, Culture and Interaction, The Australasian Computer Human Interaction Conference, November 28th, Canberra, Australia

Lian Loke and Toni Robertson (eds)

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University of Technology, Sydney

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The Workshop Call for Participation

The body remains to some degree an elusive entity in our understandings of human cognition and our evolving relations with technology. With the advent of mobile and wearable sensor technologies, the body is brought to the fore as the essential and defining site of interaction and experience. Devices hosted by and around the body, or distributed in the environment, are able to read, measure, track and provide feedback on our location, proximity, gestures, movement patterns, pulse, breathing, emotional state, gaze and so on. What and how we carry or wear and how we move through space in our daily interactions have distinct influences on our experiences of the world around us and of course, our agency to act in our everyday lives.

Digital technologies can now mediate our perceptions of our own physical and physiological processes. This mediation raises questions about our experience of our own bodies. What is the impact of these technologies on our sense of self and agency in these situations? How do they shape our (bodily) experience and what implications does this have for design?

There is a growing interest in actively working with the body in the design of interactive technologies. Design researchers are exploring the active engagement of the body and its capacity for sensing, feeling and intuiting in the process of design. This includes the experience of one's own body as a source of knowledge, inspiration and judgement, and the exploiting of tacit knowledge embedded in embodied skills. The creative potential of the body is being harnessed for design exploration, idea generation, testing and evaluation of concepts, prototypes and working systems.

This one-day workshop aims to bring together a diverse community of researchers and practitioners working on human-centred approaches to understanding the body in the design of interactive technologies. It pulls focus onto the body itself and the role of embodiment in lived experience, with a view to informing design research and practice. It will be structured around the following workshop themes:

- Theoretical and philosophical perspectives on embodiment, the body and design
- The perception and performance of the body mediated by technology
- Design approaches, methods and tools for working with the body and bodily literacy
- The role of physicality and the felt sense in interaction and design
- Other disciplines as a source of knowledge about the body relevant for design

Contents

Introduction

Welcome to the workshop "The Body in Design" being held as part of OZCHI 2011 - Design, Culture and Interaction, in Canberra, Australia on November 28th, 2011.

This is the first such workshop. Contributors come from Australia, Denmark, and the Netherlands. The papers focus on a number of different areas within the workshop theme. And reflect the broad multi and interdisciplinary backgrounds and commitments of the participants.

All papers were subjected to at least double refereeing by a panel of researchers in this and related fields. A list of reviewers is included in these workshop proceedings.

The ISBN for the proceedings is 978-0-9757948-5-2.

This workshop is the culmination of the hard work of a number of individuals - the conference committee whom we thank for choosing our workshop, the workshop committee, the referees and all the authors and delegates. We would like to thank them all for their invaluable contribution. Our special thanks go to the sponsors and supporting organizations as well as our student volunteers for their generous support.

Supporting organisations and Sponsors

The Australasian Computer Human Interaction Conference, OZCHI 2011, Canberra.

Interaction Design and Human Practice Laboratory (IDHuP), University of Technology, Sydney (UTS)

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Workshop organisers

Lian Loke and Toni Robertson, Faculty of Engineering and Information Technology, University of Technology, Sydney.

Webpage

For more details, visit our workshop web site:

http://research.it.uts.edu.au/idhup/workshops/workshop-the-body-in-design/

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Sissy: an interactive installation with a personality

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ABSTRACT

This paper describes the interactive installation Sissy (Sound-driven, Interactive, Self-conscious SYstem) at the STRP festival. The concept adheres to the design philosophy of slow technology and aims at stimulating relaxation. Sissy is made out of 700 flip dots with a black and white side and it responds to visitors' movements sensed by a camera. The white dots are coloured through the projection of animations. When people move too close to Sissy, the white dots flip to black giving the impression Sissy 'disappears'. When people take more distance the white dots, or Sissy, appear again. Observations and interviews show most of Sissy's visitors do not understand the interaction the way it was designed. The competition with other installations at a local art festival, the noise and crowded space reduce the possibilities for interaction. Most interviewees characterize Sissy as being shy, indicating she has some sort of personality, which was intentionally designed.

Author Keywords

Slow technology, STRP festival, interactive installation, interaction design, embodied interaction.

ACM Classification Keywords

H.5.2. User Interfaces and H.5.m Miscellaneous.

INTRODUCTION

It seems that in today's society we are busier, more stressed and we continuously think we run out of time. A design philosophy which fits this situation is 'fast technology', trying to make product design efficient and functional. The opposite is called 'slow technology' that can provide moments of mental rest and reflection (Hallnäs & Redström, 2001). Because it is interesting to see the actual influence of slow technology on the audience, Redström et al. (2000) assume that slow technology suits public spaces, but they did not actually confirm this. Therefore our aim was to implement an interactive installation called Sissy at an art and technology festival, STRP festival.

Embodied interaction focuses on the relation between body and interaction, and the body can be human, but can also concern the body of an object. In this paper we try to combine both. The whole human body interacts with Sissy, but Sissy itself also has a body, or at least wants the audience to think of it as having anthropomorphic features. Together this should create an experience.

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DESIGN OF SISSY

Bolter and Gromala (2003) state that the design, or medium, should explain itself to supply understanding for the user's experience of it. Examples of interactive installations include: Murmur (Rydarowski et al., 2008), Light around the edges (Winkler, 2000) and Hylozoic Grove (Beesley et al., 2010), which show an interaction between an installation and its user in terms of movement. TouchMeDare (Boerdonk et al., 2009) shows an exploratory interaction using touch and sound. Audience (rAndom International, n.d.) confronts the visitor with an interactive installation that observes you instead of you observing the installation. The Bitforms works by Daniel Rozin (n.d.) include a wooden mirror which mirrors the visitors face by a screen made out of wooden pixels. All these installations describe an interaction that asks for an exploratory attitude to find out how the installation responds to its visitors and so does Sissy. The non-interactive installation Cloud (Troika, n.d.) uses a technique that operates with flip dots for creating patterns. These flip dots supplied the inspiration for Sissy's appearance that will be explained in the next section.

Sissy is an interactive installation that responds to noise in its physical environment. The concept was created by Reitsma and Pieters who were inspired by 'slow technology'. The first generation of Sissy was inspired by Cloud's (Troika, n.d.) flip dots. Sissy was created to be used in a hotel lobby and the flip dots, which are coin-shaped elements, can flip from the black side to the white side. When using projections the white side could appear animated (see Fig. 1).

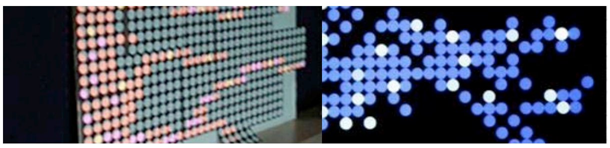

Figure 1: First generation Sissy: projection on a paper model (left) and screenshot of the animation on a PC (right).

Sissy responded to noise in the lobby and aimed to help waiting hotel guests forget about time. They could discover that Sissy's behaviour changes: when there are a lot of people in the lobby Sissy detects a lot of noise and disappears, when there is almost no one (or no sound)

Sissy re-appears. This was the idea behind Sissy but it was never implemented as such. The challenge of the project described in this paper was to transform Sissy to suit a new context: the STRP festival that tries to fuse art and technology and to work out the first generation idea into a working demonstrator.

At the festival the audience differed from hotel guests waiting in a lobby and therefore some concept changes needed to be made. One was aiming at creating a reflective activity for festival visitors by sensing the distance between Sissy and the visitor, instead of sensing noise in her environment. Sissy directly responds to the visitor's distance, aiming at drawing attention and instilling curiosity into the interactive installation's behaviour. This curiosity leading to reflection was our interpretation of slow technology. Furthermore, Sissy's shape and location was changed to suit her new behaviour, e.g. she was coming from the top of the screen instead of sideways from the corner of a hotel lobby. Fig. 2 shows the interaction scenario between a visitor and Sissy.

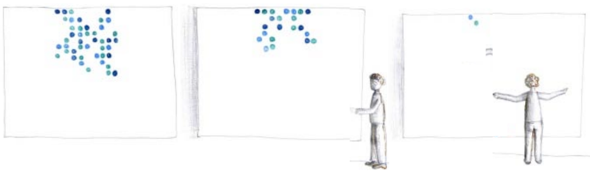

Figure 2: Interaction scenario with Sissy. Sissy feels comfortable and moves down (left). Sissy senses a visitor and moves up to create greater distance between her and her visitor (middle). Sissy moves up into the left corner because of the visitor's movement to the right (right).

We decided to make Sissy's 'body' quite large to stand out at a festival, namely 168 cm x 187 cm, and consisting of black (back side) and white (front side) coloured flip dots that can be rotated using magnetism. An algorithm on a connected PC enabled to switch direction of the magnetism for every single coil that belongs to one single dot. The projection's algorithm for the animation ran parallel to the flip dots flipping from black to white. The result is a coloured pattern that represents Sissy's appearance that is created by the projection's reflection on the white flip dots (Fig. 3).

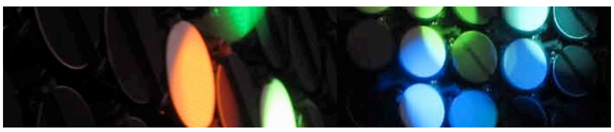

Figure 3: Close up of Sissy's new appearance on the flip dot board shows the effect of the projection on individual dots.

We wanted to find out how STRP festival visitors experienced Sissy, in the next section we explain what method we used.

The STRP festival (n.d.) is a yearly happening that aims at fusing art and technology. The focus is on a large target group: artists, die-hard engineers, high school students and even entire families. It took place from November 18th until November 28th 2010 in Eindhoven, the Netherlands. The festival attracted approximately 30,000 visitors that year. Sissy was situated in a 4m x 4m corner of an exhibition space that was part of a café. Because of several works using light effects the space was kept dark, the windows were covered and only few light sources were allowed. People passed by but also could sit down, overlooking the entire space. A camera hanging on the ceiling was programmed to be able to detect visitors' positions in the dark space using infrared lamps. Next to these lamps, hanging around the camera to enlighten the 4m x 4m detection, a projector was attached to the ceiling (Fig. 4).

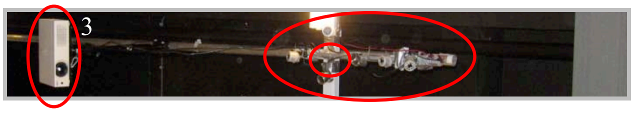

Figure 4: Infrared lamps (1), camera (2) and projector (3) hanging on the ceiling above the detection area.

The infrared lamps were used for motion detection and together with the division of the detection area into a 4m*4m grid enabled to detect peoples' movements in one of these grid areas and thus determine peoples' positions. The resulting six areas (Fig. 5) corresponded to specific behaviour of Sissy. In general Sissy will try to create a distance between itself and the visitors, e.g. moving to the right when people are on the left (area 1, 3, or 5) and vice versa (area 2, 4, or 6). Sissy will move up, when visitors move closer to her, and the distance determines with which speed. E.g. Sissy moves up quickly when people reach area 1 or 2, and quite slowly when they enter area 5 or 6. Of course the behaviour of Sissy combines moving left or right, up or down, which makes the behaviour appear complex, but still quite natural to the observer. The idea is that the audience will think Sissy is shy.

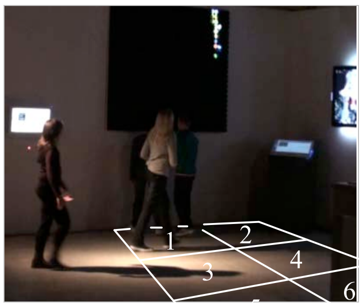

Figure 5: Indication of motion detection grid of Sissy.

After experiencing Sissy for more than one minute, in total 30 visitors were interviewed. The interviewees were mostly Dutch (27 out of 30), their ages differed between 19 and 60 years. The interviews took place near to Sissy to enable the interviewee to observe Sissy during the interview, but not interact with her. The semi structured interviews aimed to give an impression of people's vision and impression of Sissy. The interview contained three open questions and several optional continuation questions. Visitors were asked to give their general impression of Sissy's behaviour and emotion through the following semi-structured interview questions: What is your first impression? Do you think it is interesting? Could you imagine observing Sissy over a longer period of time? Could you describe Sissy's behaviour? Do you understand her behaviour? Do you recognize a specific character? Do you consider Sissy being shy? What kind of emotion does Sissy gives you? Do you feel different after visiting Sissy compared to before? Can you describe your emotion on a scale with 0 being relaxed and 10 being tense? The interviewer only asked additional questions like: 'why', 'how' and 'what' besides these ten questions during the interview. Using an affinity diagram, the interview was analyzed by means of clustering. For summarizing and abstracting the answers the following method was used. First a 'keyword' selection was made what interviewees mentioned during the interview. In some cases a 'keyword' could also be a small sentence. From these 'keywords' only those words that directly related to the corresponding question were selected. By putting them on post-its the answers became abstract. Categorizing the post-its in terms of affinity an overview of answers was created. This overview (Fig. 6) enabled to compare and to make connections between different clusters.

Figure 6: Results of interviews, clustered keywords.

Other information was gathered on all installations by the festival organization in terms of a short digital questionnaire for collecting keywords using the following questions: 1) What is your first impression? 2) What strikes you most in Sissy? 3) What dish, candy or snack does this Sissy taste like? 4) What do you consider to be the most artistic quality of Sissy? 5) What would your mother think of this work? 6) If Sissy would be a city, which city would it be? 7) How does this art work make you feel? 8) What do you find most innovative about Sissy? 9) Which word would you use to tell others about Sissy? 10) Which celebrity does this work remind you of? 11) Which theme does this art work address? 12) What innovation do you feel Sissy strongly presents?

RESULTS

All the thirty interviewees answered all ten semi-structured interview questions that resulted in 365 keywords. Interviewees were observing Sissy for at least one minute to indicate their interest before they were asked to participate the interview. Seven days of observations showed that the detection area was always occupied by at least one visitor and sometimes there were even ten people positioned in the detection area. The infrared camera recordings also showed that when visitors spent less than one minute of their attention to Sissy, they were usually just passing by and walking towards other installations. We also saw some visitors using their mobile phones to illuminate the dots and see whether this would induce behaviour.

Clustering the keywords of the interview questions about the visitors' general impressions resulted in a large group of keywords that could be summarized as visitors trying to understand the working of Sissy. Keywords included 'how does it work?', 'complex', 'I don't get it', 'flipping because of light?', and 'is it interactive?'. Another big and notable interview cluster can be summarized as 'interesting'. Descriptions of Sissy's character were: 'scared, go away, fear, happy, curious, playful', aware, unpredictable, shy and keep an eye on you. Some interviewees came up with a personification like 'butterfly', 'wind through trees' or 'a small cute animal'. In general interviewees made the assumption that 'the dots flip because of the light'. Visitors mentioned the words 'interesting' and 'fascinating' for reflecting their emotion, but described the environment as 'noisy' and 'crowded'. Nevertheless, the general score for describing their feeling resulted in an average score of 2,5 (scale 0=relaxed, 10=tensed). One interviewee even mentioned the word 'meditating' if the environment would have been more peaceful.

The digital questionnaire provided by the festival was filled out by 307 festival visitors and resulted also in keywords. The most mentioned keywords for describing the visitor's first impression of Sissy were: 'Funny', 'cool' and 'light', 'fascinating' and 'nice'. What affected visitors in Sissy was the keyword 'colour'. The candy types 'liquorice' and 'smarties' were mentioned for describing the taste of Sissy. An artistic quality of Sissy was described by the keywords 'technology' and 'tenderness'. On the question what their mother would think of Sissy visitors answered: 'funny' and 'beautiful'. The cities visitors choose for Sissy were 'New York' and 'Berlin' and 'Eindhoven'. 'Sadness' and 'slow' were keywords for describing visitors' feelings when interacting with Sissy. The most innovative aspect of Sissy was considered to be related to the 'technology'. Visitors would tell others about Sissy in terms of 'unexpected' and 'dynamic'. The celebrities that visitors thought were related to Sissy were 'Salvador Dali' and 'Warhol'. The theme visitors addressed to Sissy was 'light'. The innovation that Sissy strongly represented were described as 'solar energy', 'interaction and feeling'. Clustering all these keywords of the 12 festival questionnaire questions in terms of affinity resulted in the following clusters: 'organic', 'nice', 'light', 'fascinating', 'technology' and 'complex'.

DISCUSSION

The questions that were used for the digital questionnaire did not enable visitors to explain their rationale behind the keywords and therefore the answers were difficult to interpret. However, the first impression of visitors indicates that Sissy is experienced as being complex, both technical and behavioural. This complexity resulted in curiosity and observations showed people had spent extra time in order to understand it better. We assume that visitors' willingness to spend more time with Sissy would increase even more when Sissy would have been placed in a less distracting environment. The diversity in Sissy's characterizations reflected the diversity of Sissy's character: visitors experienced both a passive attitude described with ‘go away’ and an active attitude such as ‘curious’. The fact that the greater part of participants scored their feeling as being ‘relaxed’ in the interviews reflects the goal of slow technology but it is unclear whether visitors experienced relaxation because of Sissy or because of attending the festival in general. Misunderstanding the behaviour by explaining the movement of dots by light movement shows visitors did not notice Sissy responded to their movements. This might have been influenced by other artworks at the festival, since several other works did respond to light and therefore the visitors were expecting similar behaviours of Sissy.

Experimenting with the implementation of ‘slow technology’ in a public space shows new findings on the relation between context and ‘slow technology’. The results raise misunderstanding about the interaction that might possibly be caused by the amount of distraction. This indicates that not every environment matches the design vision of ‘slow technology’, simply because Sissy’s slow technology did not match visitors’ expectations. Sissy differed from other installations by not having spectacular interactions and obvious feedback but visitors still expected this.

It was assumed that visitors would understand that they could interact with the installation but the results show otherwise. The corner Sissy was situated in was shared with a shop and another installation resulting in a crowded area around Sissy. It was concluded that there was interference with individual interactions, which resulted in a twisted and incomprehensible interaction for the visitors. Together with the conclusions about this context we suggest a new environment for such an installation: the environment could have worked if it would have been a passage or open space but not a corner, the area needed to be big enough for better distinction of the 6 detection areas (around 6mx6m) and the distraction needed to be minimal. Examples of public spaces, but not at festivals could include: hospitals, waiting rooms, hotel lobbies or libraries.

The questionnaire showed a generally positive response of visitors to Sissy although they experienced Sissy to be complex. This could be explained by the questionnaire participants’ mentioning of Sissy’s nice aesthetics: the flipping dots in combination with the beamer projection resulted in a colourful installation that is worth looking at without understanding the interaction.

CONCLUSION

In this paper we described the design and implementation of an interactive installation at an art and technology festival. The semi-structured interviews and questionnaires about visitors’ experience of Sissy resulted in the following conclusions: Sissy’s character descriptions were categorized in three groups. Explanations contained ‘negative’ characters like: ‘scared, go away and fear’, but also ‘positive’ ones: happy, curious and playful. In-between characters were also mentioned: aware, unpredictable, shy and keep an eye on you. Visitors indicated that they felt relaxed after experiencing Sissy. Other interesting findings show the misunderstanding by the greater part of visitors of Sissy’s behaviour (disappearing when coming too close, appearing when taking more distance). The majority of the visitors spent less than one minute exploring Sissy and seemed biased by other installations that responded to light and did not notice Sissy responded to their body movement.

The questionnaire results showed the visitors had a positive opinion about Sissy in general and they considered Sissy to be alive or lively. Concluding the interview, questionnaire and observations show that we cannot define Sissy as being ‘slow technology’ since we could not confirm whether Sissy contributed to the relaxed feeling of the festival visitors, however the visitors were relaxed.

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Engaging Bodily with Video in Design

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ABSTRACT

Video is commonly used as a method for recording embodied interaction for purposes of analysis and design and has been proposed as a useful 'material' for interaction designers to engage with. But video is not a straightforward reproduction of embodied activity – in themselves video recordings 'flatten' the space of embodied interaction, they impose a perspective on unfolding action, and remove the embodied spatial and social context within which embodied interaction unfolds. This does not mean that video is not a useful medium with which to engage as part of a process of investigating and designing for embodied interaction – but crucially, it requires that as people attempting to engage with video, *designers own bodies and bodily understandings* must be engaged with and brought into play. This paper describes and reflects upon our experiences of engaging with video in two different activities as part of a larger research project investigating the design of gestural interfaces for a dental surgery context.

Author Keywords

Video, design, gesture

ACM Classification Keywords

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

INTRODUCTION

As the theme of this workshop makes clear, the body is emerging as of increasing importance to the practice and research of design in human-computer interaction (HCI) [1]. The 'embodied turn' opens many questions about how bodies are brought in to the design process. The focus of this paper is methodological: we focus on the use of video as a medium of representation of the body in a process of design. Our aim is not to simply argue for video as an appropriate format for recording people's bodily interactions or simply to propose another method for engaging with video, but to reflect (methodologically*)* on how the body was brought into design through our *own bodily engagement* with video in one design project we have been involved in. Our interest is particularly on our own bodies, gestures and movements as we engaged with video and how it was through these embodied interactions that something came to be known about the interactions of the people represented in that video.

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VIDEO IN DESIGN

Video is well suited as a recording medium for studying the detail of embodied interaction. In fields such as gesture studies [2] and interaction analysis [3] it is a standard medium for recording data. The use of video is also well established within the field of HCI, having been used as the basis for several seminal studies (e.g. [4][5]). Though usually embedded within larger design processes, video is primarily seen as a form of data, which allows analysis and re-presentation of users' situated interactions [6]. HCI research has for the most part engaged with video with an *analytic orientation*.

Running alongside this, there has also been a stream of research within HCI, which has taken more of a *design orientation* to video. In this approach, video is treated less as 'hard data' and more as a 'material for design' [7]. Examples include the use of video within collaborative activities for identifying design themes of interest [7], as part of the 'staging' of acted out future scenarios of use [8][9], and as a medium for designers to 'sketch' bodily interactions [10]. Such activities often occur within the context of collaborative design workshop situations and perhaps because of this, there is an emphasis in much of this literature on presenting and describing *methods* for d video as a design material. Less emphasis seems to be given to discussion of how video *becomes* a material for design through the embodied interactions of design process participants themselves. It is to this question that this paper is directed.

TWO EXAMPLES FROM A DESIGN PROJECT

The work presented here was carried out as part of an extended project investigating the design of gestural interfaces for a dental surgery context. The following two examples are taken from our work on this project.

Video Mirror

The 'Video Mirror' activity was a collaborative video analysis activity that we ran as part of a larger internal design workshop organized in collaboration with two other colleagues (the overall workshop is reported in [11]). Our focus here is on the Video Mirror activity itself and in particular:

- How this related to participants' getting a feel for the way gestures relate to the work of the dental surgery
- Differences we observed between video projections of gestural activity and our attempts to 'follow along'

The Video Mirror activity was used at the beginning of the workshop as a way to introduce participants to some of the findings from our earlier field studies about the work of the dentists and role of gestures in everyday interactions [12]. A specific goal of the activity was to provide participants with a bodily understanding of the findings and to ground subsequent design activities.

Figure 1: Theme card (l) and associated video clip (r)

Each participant was provided with a different 'theme card', which was an abbreviated version of the themes of interaction that had been developed from our earlier studies. Theme cards were printed on A5 sized paper and consisted of a title, a brief summary and a written description of the action on an example video clip from the field studies (Figure 1).

Figure 2: Mirroring gestures of dentists in projected video

Each participant read out their theme card for the rest of the group. Following this the example video clip for that theme was projected on a wall and the whole group was asked to watch the clip and try to mirror the action that they saw there (Figure 2). Because it is difficult to follow and mirror the interaction in a short clip upon first viewing, the clips were repeated several times with the group watching and mirroring each time until everyone felt that they had a feeling for the clip and the theme. At this point, we took a round to discuss our experiences and observations about the theme in the light of the video clip. If the participants felt it was necessary, the clip could be replayed with participants watching or mirroring the action again.

The difficulty of mirroring

A majority of the participants had participated in previous collaborative analysis activities and therefore already had some familiarity with the themes that were presented. It might be expected from this that there would not be many new insights into the themes, but this was not the case. A big surprise was how *difficult* it actually was to mirror the gestures in the clips. This seemed due to the fact that whereas we were attempting to perform gestures that we saw projected on a screen, the people who had been video recorded were performing gestures situated within a context of activity. This highlighted aspects of the context that we had not previously paid a lot of attention to in terms of the role they play in structuring the actions and gestures within the dental surgery. Specifically, we became aware of and discussed the following points:

- **Posture:** Whereas the dentists were usually sitting in low stools, and the patients were usually lying down, the workshop participants were standing. Posture has a significant effect on how it feels to perform a gesture.
- **Direction of gaze:** Whereas participants stood looking at the video screen while mimicking the actions they saw there, the people portrayed in the clips directed their gaze at the person they were talking to, towards the place where they were working, and so on. Gaze and gesture are intimately linked in interaction.
- **Instruments and artefacts:** The dentist often held instruments in his hands while working and also while gesturing to the patient. For the participants, who did not have these artefacts, it was difficult to know how precisely to make their gestures. Instruments and artefacts help shape gestures.
- **Positioning in relation to others:** When the dentist made a gesture towards another person, or passed the instruments to someone else, the location of that other person gave a direction for them to orient to. Gestures are made in relation to other people and locations.

In developing these themes we had noticed several of these themes and indeed most of the theme cards that were provided to participants made explicit mention of them. Yet they passed with little comment when first introduced. It seems that we had not really *felt* what they meant until we tried to bring our own bodies into similar kinds of gestural relationships. A pertinent factor is that our prior engagement with the video data had been more traditional analytic modes of viewing and video while making written notes and then discussing observations with colleagues. Though analytic activities also require bodily engagement, it seems relevant that the video mirror activity brought our abilities for gestural mirroring and movement *to the fore*. We want to emphasize here that it was not the verisimilitude of the videos themselves that prompted our discussion of these themes, but that the activity allowed for a bodily exploration and experience of gesture and of the difficulties associated with that.

Tracing Movements

Later in the same project, we again made use of projected video as a way of getting a feel for the movements in a dental examination. At this time, we were working through a more conventional interaction analysis of one episode of work in a dental examination based on written transcripts of activity. The video that this analysis was based on had been taken from a tripod-mounted camera positioned at the foot of the dental chair, which meant that there was a stable framing of the image from the start to the end of the examination. As an experiment, we decided to make a tracing of the recorded movements of the dentist, assistant and patient as they interacted over the course of the forty minute examination.

In order to do this, a large (approximately A0 sized) sheet of paper was taped up on a wall and the video of the examination was projected onto it. The video was played through at normal speed and the movements on the video were traced with chalk as it played. The tracing was allowed to vary between tracing the line of movement of a single part of the dentist's body (e.g. his right hand), outlining the bodies of the dentist, assistant and patient as they changed posture, and drawing the furnishings of the room that were visible on the image. The aim was simply to keep drawing or tracing the whole time. Once the tape had played through it was rewound and played again. This time tracing with a different coloured chalk. A version of the drawing that resulted is shown in Figure 3. The colours of the original drawing have been inverted in this version for legibility.

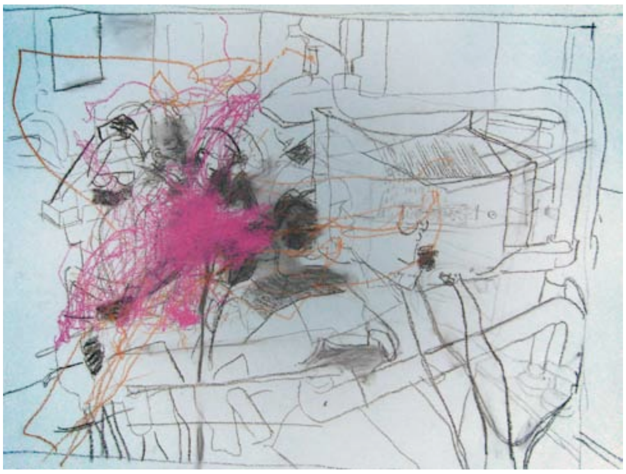

Figure 3: Tracing of dental examination movements

Traces of analysis

One way of presenting this drawing would be as a visualization of the movements of the people in the video, but this would miss the real worth of the activity. From the image above, we can see a large scribble of pink lines concentrated on an area to the left of centre. There is also a less-dense orange-line that ranges out from the same central spot, but over a larger area. Several outlines of people can also be seen, as well as the outlines of the furnishings of the room. Clearly, there is some relation between the drawing, the video that was projected, and the examination that was originally recorded, but this is not a one-to-one mapping. What we really see in the drawing are the *traces of the analyst's movements* with chalk held out to the paper, struggling to follow along with the running video.

The real worth of this activity was not in the drawing that resulted, but in the process of drawing. The drawing reflects some accumulation of temporal activity. It helps one remember while one is drawing, but it does not let us see the shape or structure of that temporal activity in the final trace. We cannot see where the line starts or ends, or whether it moved quickly or slowly, or in what direction it moved. Whereas the drawing is a flattening of forty minutes of video into a single image, the *process* of drawing took place in real time and allowed the rhythms and regularities of the analyst's own movement to be experienced as the video was followed along.

A feeling for the space

Because of a strong familiarity with the setting, the analyst had a strong feeling for how the movements in the video related to the physical layout of the surgery. As the movements of the projected video were traced, it was noticed that the movements and gestures of the dentist and assistant are located such that particular kinds of movements and gestures occur in predictable places within the surgery. The dentist moved in close behind the patient and leaned in when examining the teeth, sat straight-backed and focused on the computer when making a note, and moved to the side of the patient when explaining something about the teeth. This could be seen in the video as the tracing was being made, but the final drawing did not show it.

Figure 4: 'Movement-shapes' of the dental examination

It was therefore decided to draw another picture, which expressed the understanding of how the movements in the video fitted within the space of the surgery. This picture (Figure 4) was drawn as if looking down from the ceiling onto the middle of the dental surgery. On the left is a blue shape for the movements of the dentist and on the right side is a green shape for the movements of the assistant. In the middle is a smaller orange shape for the movements of the patient. On the assistant's side, there is a long green blob extending down the right edge. This corresponds to the bench at the back of the surgery where the assistant brings in and prepares materials for the examination. There is also a smaller blob in between this and the central area, which corresponds to where the assistant types on the keyboard. On the dentist's side, there are tendrils reaching out in different directions. These correspond to where the dentist reached to adjust the position of the bracket table and light, where he stored his instruments and where he pointed to the x-ray. The shapes of the dentist and assistant also overlap in several places. One is in the centre of the drawing, which is the area of the patient's mouth where the hands of the dentist and assistant worked when performing a scale and polish. Another is at the area behind the patient's head where the dentist and assistant passed materials back and forth.

In drawing this picture, the analyst struggled with how to indicate some of the different kinds of movements. The lines curling around the mouth and the lines reaching out to the keyboard are intended to give an impression of the way the hands were held and the quality of the movements, but for other gestures it was not clear how to do this.

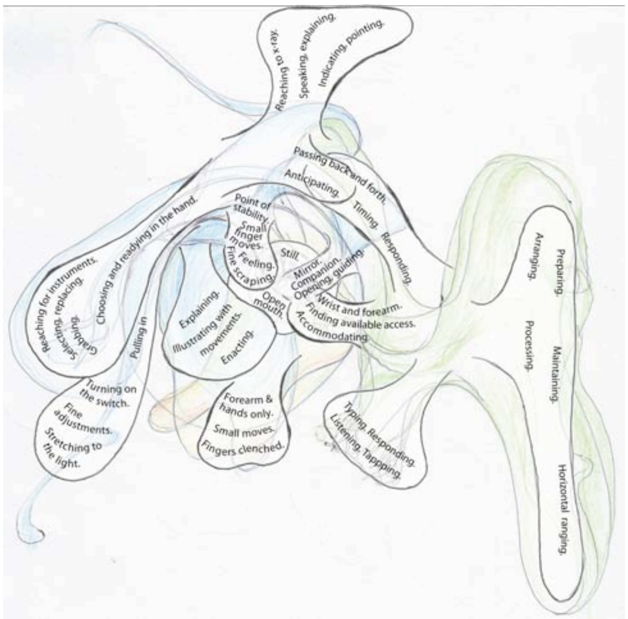

Figure 5: 'Movement-bubbles' of the dental examination

To address this, another diagram was developed which used a different way of indicating the movements. A piece of paper was laid over the movement-shapes diagram and 'movement-bubbles' were drawn indicating where the different areas of movement with words describing the quality of the movements (Figure 5).

DISCUSSION AND CONCLUSIONS

In terms of developing our design thinking in the dentist project, the activities described in this paper played an important role. In a very literal way, they helped us get a feel for the gestures and interactions of the dental surgery. This changed the way we saw the problem of gesture interface design from a question of what kind of gestures to use, to one of *what kind* of gestures to use, and *where and when* in the space of a dental examination. They are not just analytic observations, but also design moves, because they reframe relevant aspects of the setting for consideration in the design process. In reflecting on the reason that these activities were successful, it seems to us that a key ingredient is that they required our active bodily engagement and brought our own gestural abilities to the fore. This contrasts with how video is often discussed in HCI research, which is as a representation of the embodied movements *in the video*. Video is an attractive medium for recording and working with the movements of the body in design – but it needs to be brought into design through embodied engagement of design process participants. Video is a design material in this sense, and like any other material, it needs to be taken hold of and worked with.

ACKNOWLEDGMENTS

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The Experiential Design Move: an approach to reflective practice for embodied and movement based interaction

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ABSTRACT
Recent examples in the design of embodied and movement based interfaces have benefited from the use of reflection in action cycles that have their genesis within established forms of design practice such as Architecture and Industrial Design. What both of these established disciplines share are the use of sketches and models that form *artefacts supporting arguments* for a particular approach to the design problem. These are established and understood means for reflection and iteration. Designers of embodied and movement based interfaces have begun to apply this reflection in action approach, however the static representations used in Architecture and Industrial design are not sufficient to account for the temporal and experiential concerns of Interaction design and Human Computer Interaction. So the challenge, and the position of this paper, is to open a discussion on what means and tools enable a reflection on the experiential and technological challenges within Interaction Design. This paper gives an account of a recently commissioned interface prototype, the Musical Staircase, which has moved through its first design cycle of *Problem Framing*, *Design Response* and *User Evaluation* to encourage this discussion.

Author Keywords
New Musical Interfaces, Inherent Information, Public Art.

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

INTRODUCTION
The City of Melbourne Arts and Culture Branch engaged our research group in 2010 to investigate the feasibility of a Musical Staircase, in a public stairway within the City of Melbourne, to increase the public interest in the use of stairs over automated escalators. The social agenda adopted by the City of Melbourne (COM), was one of increasing the publics engagement in physical activity for the obvious health benefits. The strategy the COM adopted was to encourage this walking through *by providing a fun, interactive sound/music experience, encouraging members of the public to use these stairs in preference to an escalator*. The scope of this interactivity was to cater for the general public whilst also fostering street performers to add to the rich music and street art culture within Melbourne's streets and laneways.

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Reflective Practice, initially proposed in Schön (1983), is a means to move through solving the design problem through actions specific to its discipline. The author uses examples such as Architecture, which has a rich practice history reliant on hand sketching potential solutions to the challenges of the site and program. These paper sketches are "artefacts as arguments" for discussion and reflection. Within Industrial Design a similar discussion is developed around three-dimensional material prototypes to present arguments for design reflection. This paper presents an approach to a reflective design process for embodied and movement based interaction. This approach accounts for both the felt experience and technological challenges of this emerging design practice. The paper presents the approach in three stages. Framing the Problem, Design Response and User Evaluation.

FRAMING THE PROBLEM

Technical Precedents
The Musical Staircase was inspired by the Piano Stair at Odenplan Stockholm popularised on You Tube. The piano stair is a literal interpretation of piano keys overlayed onto an existing stairway, like a large human scale piano. The tone (white) and half tone (black) intervals are visually represented giving the readily recognisable note relationships. Another version of this interface was completed at the Southern Cross railway station in Melbourne for the 2010 Melbourne Jazz Festival. We informally evaluated the Melbourne Jazz Festival stair by using it and observing others in the critical moment of the stepping and note feedback cycle. We concluded that it was ineffective due to the lack of feedback and therefore its capability as an expressive social interface for reasons we express in the next section.

Lack of Feedback
Observing the public on the Jazz festival stair indicated little ongoing engagement. This we concluded was due to the system not providing feedback on the pressure one applied to the surface of the stair, rather it used an infra-red beam to be broken. In theory when the ankle broke this beam the sound would be triggered, however in practice there was a breakdown in the interaction loop.

This was due to the participant not always knowing that their stepping efforts produced the sound. For example if two people were stepping on the same stair at the same time it was hard to determine who was the note player, who broke the invisible beam of light first? So the *felt* perceptual information on the note being played was missing. The Odenplan system was only marginally better. Whilst it used a sensing method that measured the pressure of the foot on the stair, there was very little inherent feedback on this stepping. As a social interface both of these systems allowed only one key or note per stair width reducing the movement potential to linear up and down stepping patterns to create notes.

Interaction model to inform reflection

Contemporary approaches to tangible and embodied interaction offer some insights on the relationship between the human and machine with particular reference to the way the machine couples the users actions to its function (Ullmer and Ishii, 2000). Wensveen et al. (2004) discuss the need for satisfactory couplings between the action of the user and the function of the interface, before during and after the interaction event. These information streams are termed Inherent, Functional and Augmented. Of importance to this design project is the Inherent and Functional information. Inherent information according to Wensveen et al. (2004) relates to the action possibilities, or *feedforward*, of the interface and the perceptual motor information, *or feedback*, given through the mechanical properties of this interface. The functional information is the actual primary aim of the system; in the case of the Piano and Musical stairs this is to sound the musical notes.

Problem Statement

To overcome the feedback issues we saw in the piano stairs we focussed on two main aspects. The first was on increasing the *inherent information* and *coupling to the functional (sound) feedback* to provide the user with a greater freedom to express musical notes. The other aspect we concentrated on was the *spatial mapping* of notes to allow greater variety of note choices to increase the musical opportunity and movement styles such a system might afford. In the next section we discuss briefly how we actually respond to these aims through design.

DESIGN RESPONSE

The key aims were explored through a number of options for the arrangement of notes on a staircase in a modular "pad" like form. This pad would break the stair width into a number of notes. We also concentrated on the form and material quality this pad might take to increase its inherent information and coupling to its functional information.

Early Concepts

The modular pad was a response to the spatial mapping problem in the Piano Stairs. We needed to overcome the confusion about who played what note. This pad method allowed for dedicated notes with physical affordance and electronic sensing capability. The image at figure 1 shows an early concept for a note mapping strategy. In this approach the stair width was divided into 6 pad modules, shown as different shades of grey in the illustration. Each pad along the width is a different music sample but each pad in a straight line up the stair is a variation of the same sample. This concept aimed to encourage discovery through ensemble style playing of the samples. The samples were to be musical instruments such as drums, electric bass and synthesizer.

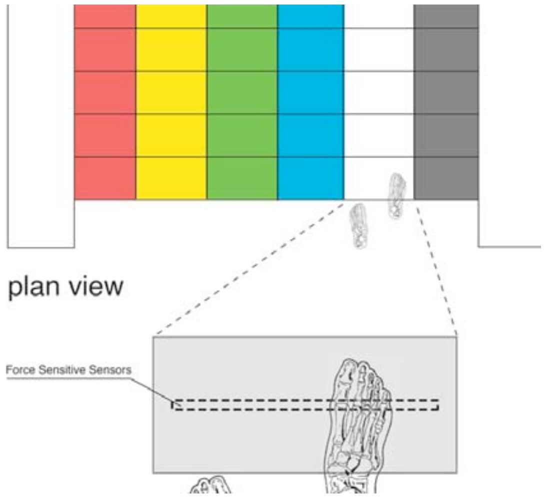

Figure 1. Linear spatial layout concept

Final Concept

We presented three different spatial mapping concepts to the COM. Figure 2 shows the concept selected for development based on these discussions. The actual notes used in the demonstration prototype are shown in dotted outline. We divided the stair into 6 modules based on the dimensions of the site selected by the COM; each module is sufficiently wide for one person to stand on.

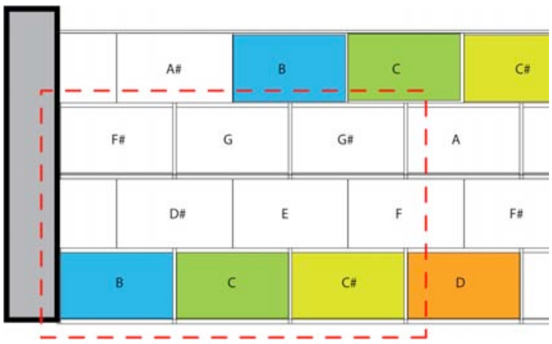

Figure 2. Musical and spatial layout as part of full stair

The spatial note mapping of the final concept was based on the CThruMusic Axis midi controller, see www.c-thru-music.com/cgi/, which has a harmonic relationship giving a semitone arrangement ascending from left to right allowing greater harmonic choice compared to the piano key approach.

Inherent Information

To improve the inherent feedback on the note being played we looked to create a compressive quality under foot, this would satisfy the felt sense of playing the note. We explored many solutions including a vibration and rocking mechanism under a moulded rubber top layer that would provide information on notes to play, through this vibration, and note pitch bend through the rocking mechanism. After discussing the constraints of the project with the COM we concluded that we had little option for multiple sensors and vibration feedback. A more conservative solution was created. This took the form of an assembly that sandwiched a single sensor, measuring pressure change, which was supported by foam between two layers of timber. The top timber layer was covered with a layer of shock absorbing rubber matting to ensure durability in public use. Our initial tests of the four-layer system with the embedded sensor generated suitable data to trigger a signal and subsequent sound through Ableton Live, the software we used for this project.

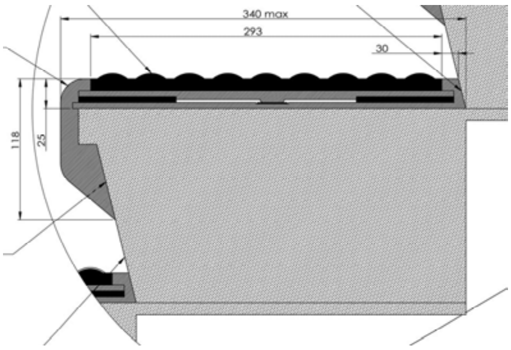

Figure 2. Drawing showing layer arrangement of stair pad

To prove the inherent and spatial qualities of this concept we constructed a demonstration prototype with 8 active pads. In constructing this prototype we realised that the microprocessors we had chosen, due to the technical constraints of the COM brief, would not be able to process large numbers of analogue values. This was a scenario likely to happen with many members of the public stepping on the pads. The only solution was to use each sensor as a digital switch; this would have implications for the note expression, which we would attempt to resolve in the sound software.

Figure 3. Image showing the 8-pad prototype.

USER EVALUATION

The Musical Stair prototype was evaluated with 18 undergraduate design students, ranging in age from 19 to 25. These students were recruited for the evaluation based on their interest in music and movement based interfaces. The evaluation was held over 2 x 3 hour sessions. The 3 hours was required to break the total number of participants into smaller groups due to space restrictions in our studio. In these smaller groups there were approximately 4 participants whose activity on the stairs was observed by 4 data collectors, plus the first author of this paper. The data was collected as both video footage and still camera photographs. After the activity a questionnaire was distributed to the students, of which 11 of the 18 participants responded.

Activity for the evaluation sessions

Our intention was for an activity that allowed for play and expression on the prototype. Previous experience with musical interfaces suggested we should provide an underlying rhythmic structure to encourage the note expression. A rhythm track was created in Ableton Live that was in 4/4 time in a four bar loop. One off beat was inserted in the second bar of this loop to create interest.

At the conclusion of the first session, the first author had a discussion with the students and reviewed the videotape. This resulted in a number of slight modifications being made to improve the activity for the following week, session 2. These included removing the offbeat from the drum track as the students indicated it was a distraction. The other modification was to remove the rubber top layer as the video footage revealed participants slipping slightly which affected their balance and confidence on the pads.

Questionnaire responses

The evaluation data discussed in this paper is based on 11 responses to the questionnaire given to the participants. The questionnaire initially determined the age and musical experience of the participants as a means to establish a context for their answers on an expressive level. The main questions determined their ranking of the experience in a four-value likert scale. These values were expressed ranging from Not really to Strongly. The questionnaire then asked the participants to express this answer as written comments in an attempt to encourage an expansion on this response. The framework in which all of the evaluation and questions were based was Wensveen et al.'s (2004) Frogger framework. The participants were familiar with this framework from other studies.

Discussion of initial results

All of the participants either play an instrument regularly or have played an instrument. So an appreciation for music making was generally understood in the group. A majority of the participants, 90%, preferred the session 2 activity setup. They articulated that this was due to the timber being more *responsive* to the result of their step and the rhythm allowing stepping in time. As a multisensory interface 72% of the participants indicated that it could be *reasonably* seen, heard and felt to enable continuous activity. However in their written comments 54% indicated their perception of a delay in the sound response contributed to a non-harmonious or unnatural interaction. In terms of the ability to express musical notes and passages 45% stated the interface was reasonable and 55% indicated it enabled a little or none at all. This question generated a high level of commentary. These comments included the beat detracting from the activity as the need to follow it hampered expression. Two participants indicated the interface should use analog force data to allow potential sound modulation and better expression. The last response relevant to this paper was based on the ascending arrangement of the note mapping. 82% of respondents indicated that the mapping allowed for a reasonable playing of a musical passage and felt the arrangement could be learnt. Criticisms included the directions of keys were hard to follow and the frustration with having to use the legs instead of fingers, given by a regular piano player.

Reflection on the design outcome

In an attempt to understand the results we return to the initial design aims of the project. These were to provide sufficient physical information to support feet moving as note play, and to extend the piano spatial mappings for greater harmonic expression. Through these results it can be concluded that the inherent or felt experience of the interface was initially over designed. The dimpled rubber cover was not needed, as the compression provided by the foam between the timber layers was sufficient for the feedback on the note play. The coupling to the sound feedback was at a sufficient latency to encourage continual interaction but it was not dynamic enough to enable expression through the feet or bodily movement. Whilst it was a compromise to use the selected micro-controllers; we now know they were central to the expressive failure of the interface, due to their signal processing limits, even with our attempts to colour the note in the sound software. As a design quality the interface needs to allow for sound expression through subtle bodily movements, we cannot be compromised by technologies that do not deliver on this aim. Future work is needed on the redesign of either the electronic sensing method, the mechanical pad design, to allow for tilt for example, or both. We will also consult literature on methods and techniques to enable dynamic expression.

In terms of the spatial mapping the results indicate that the Musical Staircase was largely successful. Comments indicated it was learnable and not too different from a piano or other chromatic mappings such as guitar fret boards.

CONCLUSIONS

This design process has been through once cycle of Framing the Problem, Design Response and User Evaluation based on the brief determined by the COM. Creating musically expressive public installations within challenging site conditions and budgets have major implications on the technologies that can be used and the interaction that can be offered. We intend to take the work further with a greater research focus on bodily movement and technologies required to leverage these for expressive interactive purposes.

Reflection on the process

Examining the precedents to the Musical Stair indicated gaps in their potential for a physically expressive experience. This shortcoming we determined was due to the lack of inherent or physical information on the act of stepping and moving to create sounds. Add to this the need for a spatial mapping that allowed for more than a linear stepping pattern.

We used this knowledge to frame our design efforts in realising the Musical Stair. The resultant prototype enabled user evaluation with an appropriate participant group. The questionnaire findings give an understanding of the general attitudes towards the Musical Staircase as enabling continuous interaction and expression. However little is yet understood about the movement quality afforded by the stair pads in terms of issues such as haptic feel and spatial affordance. To attain a finer grained understanding of these qualities will require further analysis of the video footage with particular focus on these qualities.

Returning to the idea of reflective practice for movement and embodied interaction design we can see a very different process is needed to influence good decision making than would be used for conventional disciplines such as Architecture and Industrial Design. In our view designing for embodied and movement based interaction requires,

- A robust model of the intended interaction,
- An examination of any precedents against this model to develop a sophisticated framing of the problem
- A design response through demonstration prototype
- User evaluation of this prototype

As interaction design deals in the temporal and experiential qualities of interfaces it requires user evaluation to give rich descriptions of these experiences through the usage of functioning prototypes. So to adapt Schön’s (1983) notion of reflective practice to embodied and movement based interaction the above steps need to be taken, not particularly in this order, to inform the design decisions and to reframe the subsequent iterations. We invite scrutiny on this model.

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Designing for Conversational Interaction with Interactive Dance Works

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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.

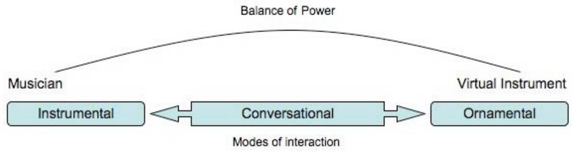

Figure2. Instruments, which support conversational interaction, facilitate a shifting balance of power between musician and virtual instrument

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.

ACKNOWLEDGMENTS

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The BrightHearts Project: A New Approach to the Management of Procedure-Related Paediatric Anxiety

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ABSTRACT

In this paper we propose a multimedia, biofeedback approach to managing pain and procedure-related anxiety experienced by children undergoing painful recurrent procedures as part of their treatment in primary care settings, based on research currently under way at the Children's Hospital at Westmead, Kids Rehab Dept. We survey existing approaches to the management of procedure-related pain and anxiety, including recent research utilising Virtual/Augmented Reality Distraction techniques, and then outline an approach that uses a biofeedback controlled interactive artwork as a focus for children to explore how they can regulate aspects of their psychophysiology (autonomic nervous system responses) through a combination of breath and attentive focus. Our research aims to assess the potential of small, portable biofeedback-based interactive artworks to mediate the perception and performance of the body in paediatric care: as experienced by children undergoing painful recurrent procedures.

AUTHOR KEYWORDS

Biofeedback, Biofeedback Assisted Relaxation Training, Paediatric, Acute, Pain, Distraction, Cognitive-Behavioural, Heart Rate, Temperature, Multimedia, Primary Care

ACM CLASSIFICATION KEYWORDS

H5.m. J.3.b Health J.5.c Fine arts, Information interfaces and presentation

INTRODUCTION

Many children with chronic conditions undergo repeated painful procedures as part of their treatment; the recurrent nature of these procedures can result in a build-up of anticipatory anxiety, causing significant distress to the children. This anxiety can exacerbate the perceived intensity of the painful stimulus, which can sometimes escalate into difficult behaviour in clinic that can also cause significant logistical delays for clinicians. Vasoconstriction caused by extreme distress can further complicate certain procedures (i.e., venipuncture for canulation). If left unaddressed - the distress, anxiety and possible trauma associated with these procedures can lead to avoidance behaviours that may stay with an individual into adulthood.

Common approaches to the management of procedure-related paediatric pain and anxiety have focussed primarily on simple distraction methods such as conversation, singing, kaleidoscopes etc. and cognitive-behavioural approaches that help children to reframe and remodel their perceptions and understandings of the situation and procedure they are undergoing, through the use of customised narratives: ("this is what I will see, do, feel, hear" etc.) and the customisation of certain details of the procedure so that children feel 'in control' -i.e. "I like to be sitting up when the tiny straw is put into my arm" the that help to familiarise and normalize the procedure, so that they no longer to feel in control of the situation.

The perceived intensity of painful stimulus is a fundamentally subjective phenomenon, modulated by our perception and attention. Anticipatory anxiety can therefore be determining factor in the level of perceived intensity of a painful procedure, and can increase the perceived intensity of the pain. With these factors in mind, there is a growing interest across clinical domains from rehabilitation to dentistry, nephrology, oncology and burns treatment in the development and use of techniques for the management of procedure related paediatric anxiety.

Cognitive-Behavioural and Distraction Methods

In modern paediatric primary care many painful procedures use Nitrous Oxide analgesia in combination with a blend of two basic approaches to the management of procedural pain and anxiety: cognitive-behavioural and distraction techniques. There are also situations where it is not safe or possible to use nitrous oxide gas - in which case a combination cognitive-behavioural and distraction techniques will be used.

Distraction techniques are the most common way of managing anxiety and perceived pain intensity experienced by children undergoing painful procedures. Distraction techniques work according the gate-control theory of pain perception developed by Mezack and Wall (1965) in which higher-order thought processes are thought to alter a person's perception of pain, due to the diversion of perceptual processing resources away from the site of noxious stimulation.

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Cognitive-behavioural approaches are used by clinical staff help children develop a sense of control over their situation, through processes of rehearsal, desensitisation and the customisation of various details of the procedure (i.e. have nitrous oxide gas whilst sitting up, only a few people in the room at start of procedure, siting in parents lap etc.). These approaches lower anxiety by a process of familiarisation and the building of trust.

Systematic Desensitization is another popular related approach - in which the anxiety provoking procedure is broken down into steps that children negotiate via increasing levels of approximation to the actual procedure. Medical Play similarly facilitates a process of familiarisation and mental remodelling - where children work with a Nurse of trained Child-Life Therapist (a.k.a. Play Therapist) and perform a version of the medical procedure on toys enabling the child to build a realistic and safe-feeling narrative and rationale for the procedure, thereby reducing anticipatory anxieties that stem largely from the child's fear of the unknown.

With the increasing ubiquity of mobile multimedia devises like portable video players, mobile phones and tablet computers (i.e., iPads), and the immediate sense of connection that most children demonstrate with these devices, there is now understandably, considerable interest in the use of these recreational and entertainment technologies as Distraction tools for managing paediatric pain and procedure related anxieties.

Figure 1. Prototype BrightHearts iPad app in use - combining multimedia distraction and biofeedback assisted relaxation training (Photo Julia Charles).

Malloy and Milling's (2010) systematic review of eleven comparative studies on Immersive Virtual / Augmented Reality distraction, revealed these methods to be effective for reducing experimental pain, as well as the discomfort associated with burn injury care, with studies focussed on needle-related pain providing less consistent findings. They suggest that VR distraction may be a useful tool for clinicians working with a variety of pain problems.

Compared to research on Augmented and Virtual Reality Distraction methods, Biofeedback Assisted Relaxation Training (BART) remains a relatively under-explored set of approaches for paediatric acute pain and anxiety management (as distinct from the many studies focusing on its use in the treatment migraines, headaches and specific psychological problems such as Generalized Anxiety, Panic and Posttraumatic Stress disorders).

BIOFEEDBACK TRAINING: A DEFINITION

Biofeedback training is method by which individuals learn to voluntarily sense and then control some aspect of the physiology, utilizing electronic or electromechanical instruments to measure, process and display information back ('feedback') in such a way that subjects can eventually learn to sense and then influence the behaviour being observed, usually via auditory and/or visual displays. The objective of biofeedback training is to help people develop a greater awareness and voluntary control over physiological processes - first by way of the external displays, and then via internal psychological cue (Schwartz and Olsen, 1995). Biofeedback is not a process of electro-mechanical coercion in which people are 'shocked' or 'brainwashed' into shape - nothing is 'done to' the trainee in the sense of conventional medical treatment – and its effectiveness relies to a large extent on the motivation of the subject to interact with the biofeedback display (i.e. 'play the game').

Biofeedback training supports a philosophy of self-regulation and empowerment that has significance beyond the immediate rehabilitation of the specific functions being trained. Skills gained in the regulation of specific body functions i.e. heart rate, temperature, brainwave activity, muscle control etc. often generalise into an increased sense of self-efficacy - an inner conviction that the individual can make a positive difference to their experience and situation. Such beliefs can in turn generalise into more active mastery over psycho-social problems (Davies, 2003).

We hypothesize that these affirming beliefs and self-representations may have a positive impact on how subjects perceive and manage their experience of procedural pain.

Biofeedback training in paediatric healthcare

While the efficacy of biofeedback for the management of acute pain and anxiety associated with painful procedures has not been established - there is some evidence to support its efficacy in the management of paediatric headache, recurrent abdominal pain, constipation, burns self-catheterization procedures and functional dyspepsia related to duodenal eosinophilia.

Gil et al. (1988) evaluated the effectiveness of a package of biofeedback and behavioural techniques designed to reduce a child's distress associated with learning self-catheterization. The findings suggest that distress associated with medical procedure such as self-catheterization can be reduced by breaking a complex procedure into discrete steps…and that EMG biofeedback can help the child to relax during each step. This case provides an example of biofeedback as an attention-management tool used as part of a larger systematic desensitisation approach.

Schurman et al. (2010) have evaluated the effectiveness of biofeedback assisted relaxation training (BART) for paediatric abdominal pain in children aged 8–17 years over the course of approximately 1 year. Children receiving standardized medical care (SMC) and BART evidenced better pain outcomes (steeper decline in pain intensity and duration, steeper rate of clinical improvement) than children receiving SMC alone. Findings from this study also indicated that both SMC and SMC+BART interventions can yield improved outcomes on many psychological and social variables, in addition to pain and functioning variables. The authors note that the basic education provided as part of the initial clinic evaluation process may have been sufficient to reduce anxiety in the group of children assigned to receive SMC only and promote effectiveness of medication in the body, although effects sizes indicate a possible stronger effect for children receiving multifaceted treatment.

PROPOSAL: MULTIMEDIA BIOFEEDBACK DISTRACTION – A HYBRID APPROACH

We propose a new hybrid approach that combines visually rich, multimedia 'distraction' with cognitive-behavioural training processes in the form of a biofeedback-based interactive artwork. The aim is to encourage children to explore and learn how to voluntarily influence their autonomic responses by way of heart rate variability and skin temperature biofeedback displays.

Similar to the way that Gil et all (1980) used Biofeedback as part of a larger processes of Systematic Desensitization, this proposal uses biofeedback assisted relaxation training (BART) as part of a Cognitive Behavioural process that focuses on supporting the child to reframe how they respond to an anxiety-provoking situation, whilst at the same time diverting attention away from their procedure-related anxieties.

Our approach builds on previous practice-based creative arts research work undertaken by one of the authors, based around two biofeedback controlled interactive artworks: *Cardiomorphologies* (Khut, 2005) and *The Heart Library Project* (Khut, 2009), that utilised heart and breath rate biofeedback to control interactive sound and video projections: large scale, richly layered visuals that audiences where invited to interact with through a combination of breathing and emotional focus (memories, imagined situations). Accounts of audience members who have interacted with these systems (recorded using video-cued retrospective recall) revealed a consistent focus on themes of agency, self-efficacy, and questions embodiment, intimacy, mortality and psycho-physiological interaction (Khut, 2006, Khut and Muller, 2005, Muller et al., 2006).

Figure 2. Prototype app. with pulse sensor on finger

We are proposing a way of using biofeedback assisted relaxation training that is not presented to children as a 'treatment' for their anxiety, but rather as an interactive art 'game' in which they are invited to explore with their carers and/or members of the clinical team, ways that they influence the appearance of the work, through relaxation. It differs from other multimedia distraction approaches (i.e. Virtual/Augmented Reality and Tablet games (i.e., iPad) in that it is actively involving the children in processes of reflection on and experimentation with their own autonomic nervous system responses.

We hypothesize that this approach could combine some of the immediate benefits of interactive multimedia distraction techniques with the longer-term improvements in psychological and social variables previously noted by Schurman (2010).

Challenges and Misconceptions

Studies into the application of Biofeedback Assisted Relaxation Training (BART) for the management of procedure-related pain anxiety have been few in number. Despite significant improvements in research methodology and growing body of research over the past thirty years, research and implementation of biofeedback training in primary health care settings in general remain extremely limited.

Some factors influencing this situation include: the pseudoscientific claims made by many 'New Age' proponents and distributors of biofeedback equipment; the methodological weaknesses of many studies; the considerable time, space and additional attention required normally required for the training of subjects in the use of these systems (i.e. EMG muscle-tension biofeedback).

Another challenge for this proposal is the tendency to perceive biofeedback as a 'tech fix' - based on the aforementioned misconception of that something is 'being done to' the biofeedback subject, as if the equipment itself was somehow controlling the behaviour, independent of the child and the instruction and motivation provided by the trainer/facilitator. Schurman et al. (2010) in their study of BART treatment for paediatric headaches have remarked on the positive benefits of person-to-person education processes irrespective of specific modalities use (standard medical care vs. biofeedback) - this highlights to the continuing importance of inter-personal exchange in the acquisition of pain and procedure-related anxiety management and coping skills.

In relation to the pseudoscientific status of biofeedback training within mainstream primary care, its important to differentiate marketing claims from actual peer reviewed research publications.

The use of EMG (muscle relaxation) and skin temperature (hand warming) biofeedback in the treatment of paediatric and adult headaches has been extensively researched. A systematic review of biofeedback treatments for migraine by Nestoriuc and Martin (2006) published by the International Association for the Study of Pain, identified eighty-six outcome studies, fifty-six of which they were able to include in their review, from they concluded that biofeedback was affective evidence-based behavioural treatment that significantly and substantially reduces the pain and psychological symptoms of migraine patients within the scope of only eleven sessions.

Cost factors need to be weighed against the type of technology required: not all biofeedback training modalities require sophisticated amplifiers and software analysis systems – simple thermometer devices have been used for hand-warming/cooling biofeedback treatment of headaches.

Until recently the cost associated with professional biofeedback systems, together with the time-consuming nature of conventional biofeedback relaxation training methods and the space required do this work in, have been significant and legitimate barriers to prospective researchers working in primary care. As the cost of computer technologies continue to decline it is inevitable that rich, multimedia-enhanced biofeedback functionalities will soon be able to be embedded in common mobile phone and tablet devices. Technical requirements for BART need to be considered within the context for which they will be used. *Peripheral* biofeedback training modalities (i.e. heart rate pulse-plethysmography, temperature sensors, galvanic skin Response sensors etc.) are much simpler technically (and therefore cheaper to produce) than more complex EMG, ECG or EEG (brainwave) biofeedback systems. Considered within the context of BART based procedure-related anxiety management focus considered in this paper – these simpler peripheral modalities may be all that is required to obtain a basic real-time measure of autonomic nervous system activity (fight-flight, rest-digest responses).

CONCLUSIONS

A biofeedback-based approach utilising 'immersive multimedia' biofeedback displays in the form on an interactive art mobile 'app', could combine benefits of AR/VR Distraction approaches with cognitive-behavioural training approaches that emphasise the development of coping skills, that may have the benefit of generalising to a broader sense of mastery over subjective impulses and self-efficacy via the learning-by-doing approach exemplified by biofeedback training.

An important design question that has yet to be fully addressed is what constitutes 'immersive' multimedia, compared to AR/VR - what makes for an a particularly 'immersive' display on a mobile device such as a mobile phone or tablet device (i.e., iPad), and how does this immersion compare with the immersion someone feels when they are enjoying a good novel, or playing a mobile computer game.

We are still in the preliminary stages of this research, collecting interview data with children who undergo painful recurrent procedures, and the clinicians who work with them; observing clinical practices and situations, and prototyping interface concepts and visualisation systems for the biofeedback displays. Our aim is to develop a device and method for its use, based on close examination of user experiences and procedure contexts. A systematic review of literature on biofeedback for pain and procedure related anxiety, and methodologies used and recommended in related studies (i.e. BART for headaches, abdominal pain and non-procedural anxiety problems, VR/AR Distraction methods etc. will also be undertaken in early 2012. We anticipate Pilot Tests with selected children and clinics will take place in early 2012, and a Clinical Trial to measure and assess the efficacy of this system in clinical settings is scheduled for the second half of that year.

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Multiplicity through connectivity: investigating body-technology-space couplings in participatory activities

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ABSTRACT
We report on a participatory design workshop, which consisted of diverse activities in which participants explored the concept of "connectedness" in various ways. The aim of the workshop was to facilitate multiplicity as a generative strategy to be used in early phases of design. In this position paper, we focus on the machine-mediated performance session of the workshop, in which participants extensively used their bodies to explore ways to couple with technological tools, their partners and the space. The aim of the performance session was to facilitate multiplicity in couplings between body, technology and space. We analysed the activities according to a coding scheme involving Laban's effort categories. We explain how the various forms of connection between bodies and different technological tools were constructed in each activity. We discuss how connectivity of technology can be used to support multiplicity in design.

Author Keywords
Multiplicity, connectivity, participatory design

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

INTRODUCTION
In our research study, we aim to support the multiplicity and richness involved in human agency in order to generate inspiring ideas and open up possibilities in the early phases of design. To this end, we conducted a participatory design workshop, which was part of a series of participatory design workshops (Kocaballi et al., 2010) organized to bring together diverse activities facilitating multiplicity. The focus of workshop was upon concept of connectedness and the multiple ways of performing connections between humans and between humans and technologies. We considered connectedness to be a suitable concept for our explorative process as it enables us to focus on relations between the entities rather than on the entities themselves.

There is a growing body of research built upon embodied and relational perspectives (Boehner et al., 2005; Dourish, 2001; Gaver et al., 2003; Wei, 2007) in the domain of interaction design. These studies embrace a relational view of human agency and augment its multiplicity, richness and relational nature. For example, Wei (2007) explores interaction, gesture and agency through what he calls performative phenomenological experiments as tools for philosophical inquiry. In Wei's TGarden project, a media-rich responsive space, actors-spectators improvise gestures with specially designed costumes equipped with sensors. Similarly, we undertook performative phenomenological experiments in the form of participatory design workshops.

In this paper, we report on our workshop with two interaction designers. Our focus is upon the machine-mediated performance session, in which the workshop participants extensively used their bodies to explore ways of coupling with technological tools, their partners and the space.

PARTICIPATORY DESIGN WORKSHOP
Participatory design workshops, with their emphasis on negotiation, diversity and co-construction of meaning (Muller, 2003), provided us with a suitable play platform. Our participatory design workshop involved two 22-year-old female interaction designers, who were close friends and had worked together before. The workshop consisted of four sessions lasting approximately 4 hours in total: a silence session, a physical sensitivity session, a rich-poster session and finally a performance session. In addition to participants discussing their experience after each session, there was a separate reflection session at the end that allowed participants to reflect on their overall experience. We selected the activities in the sessions according to their capacities to facilitate what Law (2004) refers to as multiple ways of knowing.

In the silence session, participants were asked to close their eyes and concentrate on the existence of their own and their partner's body and space. This session aimed to increase the participants' awareness of themselves and of others' selves.

In the physical sensitivity session, participants performed physical exercises encouraging interaction through body movements. These exercises were structured to help participants to understand and analyse elements and qualities of the space, and take these qualities up, or allow these qualities to come through their bodies.

In the rich-poster session, participants made a collage of pictures, texts and objects on an A0-paper sheet. The aims of this session were to understand what "connectedness" meant to participants, to increase their awareness of the

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concept and to see different forms of connection on a shared medium.

In the final machine-mediated performance session, participants performed five short activities using three technological devices: two wearable devices with tilt and distance sensing capabilities and one webcam with image processing capability. The aim was to explore different forms of connection with other bodies and space through technologies, which allowed participants to create various sound effects through their body movements. Participants played with the technological tools and experimented in different ways to communicate with their partners and co-compose sound effects.

The machine-mediated performance session

We used different sensing technologies to facilitate various connections between bodies, technology and space. The session consisted of five short activities using five sound-generating technological devices: two Wii-motes, two rangefinder devices and a webcam. These devices represent three different ways of coupling between human, technology and space. Wii-motes generate sound effects based on movement in vertical and horizontal dimensions: the rangefinder devices produce sounds based on the changes in the distance within 70cm range. The webcam detects motion and triggers musical notes according to the place of motion in space. Each device differs in its particular way of capturing body movement. While the Wii-motes sense the movement of human body fairly independently of other bodies and the space using measurements in vertical and horizontal axes, the rangefinder devices sense the movement of the body in relation to other bodies or entities in space using a directional distance measurement. Finally, the webcam senses all of the motion within its field of view producing sounds from the movements of all of the bodies in space. While the Wii-motes and the rangefinder devices need to be attached to the body, the webcam can be placed somewhere in the space detached from the bodies. We also provided the participants with various straps allowing them to attach the devices to any parts of their bodies. The multiplicity in capacities of technological tools and ways of coupling with the technologies allowed participants to explore and perform various connections through their movements and sound effects.

In addition to using different sensing technologies, we played with the degree of coupling between the wearable devices (i.e. Wii-motes and rangefinder devices) that was encoded in the software. When two devices are coupled, the sound producing system gets sensing data from each device and combines them to produce a single sound effect. Thus, participants using the coupled devices do not have a total control over the generated sound effects. They have to coordinate their movements to shape sound composition. However, when the devices are decoupled, each device produces a separate sound effect independent from the other device. A different sound effect is assigned to each device.

Participants used decoupled Wii-motes, coupled Wii-motes, decoupled rangefinders, coupled rangefinders and finally webcam in each activity respectively. We were interested in whether a pre-set connection or coupling between devices facilitates more collaboration and creative engagements between participants. Each activity lasted about 3 minutes. Participants had a chance to play with the devices and select the sound effects before each activity.

Analysis methodology

All activities were video-recorded for retrospective analysis. We segmented the video sequences according to the different body-technology-space arrangements. There were various arrangements during a session but not all of them allowed participants to create a connection, in which they were able to coordinate their movements and co-compose sound effects. After watching the video sequences multiple times, we concluded that the arrangements that lasted less than 3 seconds did not involve a connection between participants and could be considered as connection attempts only. Thus, our video segments included the arrangements that lasted 3 or more seconds. We analysed video segments by using a coding scheme, which included ten codes: form of body-technology-space arrangement, connection strategy, duration of connection, mobility of participants, proximity of participants, movement qualities of two participants, technologies, mapping strategy and finally the sound effect (see Table 1). We used Laban's effort categories (Laban, 1971) to describe movement qualities of participants. Laban's effort categories are useful for describing the temporal and dynamic qualities of human movement. There are four categories, each of which had two polar values: i) Space: Direct/Indirect; ii) Weight: Strong/Light; iii) Time: Sudden/Sustained; and (iv) Flow: Bound/Free. When coding the segments, we also consulted our transcriptions of the reflection sessions of activities. This allowed us to better read the connection.

RESULTS

Activity 1 using decoupled Wii-motes

There were seven different connections constructed in the activity. The average duration of a connection was 14 seconds. The most prominent result was the same qualities of movement for both participants for all

Arrangement	Connection via	Duration	Mobility	Proximity	Movements-P1	Movements-P2	Devices	Mapping	Sound
	Movement strategy of making similar movement patterns.	00:26-36, 8sec	2Ps St	2Ps close	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2Ps 2Ecs	Devices decoupled	Electronic Screaming, gun shot, discrete sound

Table 1. The coding scheme for analysis of connections between 2 Participants (Ps) and 2 Rangefinders (RF).

connections in the activity. The qualities of movements were mostly strong in weight and always bounded in flow. However, the qualities varied in time and space. The participants constructed the connections by talking, observing and using the strategy of making similar movements and mimicking. Three of the seven connections were constructed by verbal communications such as "*we are all robots*" and "*let's do the similar, up!*" The participants preferred to be in face-to-face position and maintain eye contact. They said that although they did the same movements, they could not get the similar sound effects. They expected similar responses from the devices but the responses were different. The different types of sound effects and the mapping algorithm caused the differences between devices' responses. However, this did not cause any problems in constructing the connections but definitely changed the characteristic of the connections. After the first two connections, the participants did not use the straps.

Activity 2 using coupled Wii-motes
Participants found it hard to coordinate their movements and figure out the mapping algorithm employed. There were four different forms of connections but, in fact, they were parts or phases of one main connection, which was based on the participants' idea of creating an effect of a slowly gathering storm. They said that having a theme for the activity helped them to coordinate their movements and hence create a connection. Their movement qualities according to the Laban's categories were always varied and did not show any common patterns. The only common pattern was the bounded flow of their movements. Although the participants could not achieve the desired storm effect, they systematically experimented different possibilities of connections using verbal communication and strong eye contact. The average duration of a connection was 8 seconds.

Activity 3 using decoupled rangefinders
This activity was the most fruitful one in terms of the variety of connections. Participants performed 14 different connections most of which was over 10 seconds. They used verbal communication only three times for coordinating their movements: the body language and eye contacts were sufficient. Their main coordination strategies were doing the similar or opposite movements. Their movements had the same qualities in eight activities. All qualities of movements varied across the different connections except the quality of flow, which was again bounded for all connections. One participant said that her device's sound effect was not as powerful as her partner's so she decided to use it as a background rhythm and made repetitive movements. Another participant maintained that the limited sensing capacity of the devices made them more explorative. The longest connection, 35 seconds, was performed in this activity.

Activity 4 using webcam
The webcam activity resulted in 12 different forms of

connections, which were radically different from the previous activities in terms of positioning of bodies and movement qualities. The webcam allowed participants to use their full body in many different axes. They did aerobic movements and even a headstand. Their movements were usually sustained in time and indirect in space. For the first time, the flow of their movement was free for some connections. They used many different parts of the space and did not need to be close to their partners in space. The participants liked the flexibility in creating sound effects and 'tool-less' freedom of interaction. The average duration of a connection was 13 seconds.

DISCUSSION

When the participants were using Wii-motes, they decided to create harmonic sounds and movements. They systematically tried many different combinations of movements, e.g., doing the same movement at the same time; doing the opposite movements at the same time and doing movements at different speeds. The capabilities of Wii-motes did not invite participants to make movements involving multiple bodies at the same time.

The rangefinder devices had a limited range of sensing. However, the distance was a special kind of measurement that required the existence of two things to be in a particular physical arrangement. This characteristic of the devices invited participants to experiment, that is, to try various ways of creating spaces in between the different parts of a single body, in between the different bodies and in between the bodies and other things in the space. So, although the device had a very limited sensing range, there was a broad variety in interactions and connections.

The webcam's motion detection capability supported the use of full body movements in many axes in many different ways. The movements of participants were free in flow only in this activity. Since the camera detected any motion in its field of view, it was hard for the participants to recognize the effects of their own movements, which is a critical requirement for creating and sustaining a connection between human and technology. However, the participants dealt creatively with the difficulty of recognizing their own effects. For example, one participant became stationary and made repetitive movements while the other participant walked in and out of the camera's field of view making sweeping arm movements in many axes. In this way, each participant was able to observe her movements' contribution to the sound effect.

Coupled vs. decoupled
The strategy of coupling the wearable devices did not work well for supporting more collaboration and creative engagements between participants. The participants did try to collaborate with their partners more when using the decoupled devices but the pre-defined relation between the devices limited the participant's expressive capacity. They usually looked for a very direct one-to-one mapping between their movements and sound effects. However, the combined controls made it extremely hard for them to get the desired sound effects by using their own movements. The participants found the control of the coupled devices boring as they were not able to access to the whole set of musical notes. One participant said that "*the combined one might be more interesting but we*

should not compromise our own capacities". In general, coupling the devices might be suitable for free-play but if there is task-oriented activity, it can be frustrating and be perceived as an obstacle. One important point about using coupled devices is that the researchers should provide the participants with sufficient time to learn and experiment the coupled capabilities of devices. In our case, the duration of three minutes was not sufficient for participants to develop a common understanding of working principles of devices.

Multiplicity through connectivity

The connectivity can be defined as an entity's ability to make connections. Based on the usage patterns of technological devices in the activities, the connectivity of the devices can be sorted from the highest to the lowest as follows: the webcam, the rangefinders and the Wii-motes (see Figure 1). The webcam with its ability to capture any motion in space allowed participants to use any parts of their bodies to create sound and, hence, make a connection. It provided the participants with the highest possibility of making connections. Similarly, the rangefinder devices with their ability to capture distance between any two points provided the participants with endless opportunities to create sound. In contrast, the Wii-motes invited participants to use them in a very specific way. In order to use their full capacity, one needs to hold them by his/her hands otherwise one's capacity to generate sound effects diminishes radically. For this reason, participants almost always preferred to use them by their hands and did not use the straps provided to them.

The webcam and rangefinders with their high degrees of connectivity facilitated the creation of many different connections whereas the Wii-motes with the low degrees of connectivity could only support the construction of a few connections. This finding suggests a positive relation between connectivity and multiplicity: increasing the connectivity of a device may prove useful for increasing multiplicity. However, the quality of connections can be also as important as the multiplicity of connections. For example, the low granularity of the webcam's sensing capacity could not capture the rich variation of human movements in different connections. This indifference to the variations affected the participants' sense of connection. In many cases, although they felt a connection, it was a very weak one for them to maintain their interest in longer periods of time. This was not a problem for our study since we aimed to obtain as many different forms of connections as possible. However, a few long-lasting connections might be more insightful for different studies. Here, the types and aims of the projects are the main factor for making a selection between the multiplicity of connections and the quality of connections.

The machine-mediated performance session was successful in terms of supporting multiplicity in connections. The high level goal of workshop was to integrate what we refer to as Agency Sensitive Design (ASD) qualities into design process. There are six ASD design qualities: relationality, visibility, multiplicity, configurability, duality, and accountability. For an extended presentation of ASD approach and its qualities, please see Kocaballi et al. (2011).

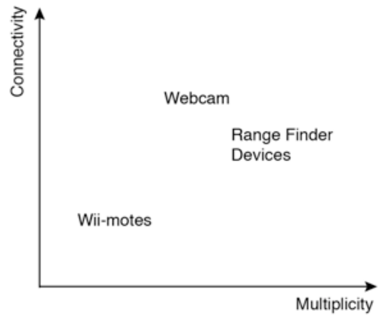

Figure 1.Three devices, connectivity, and multiplicity

Each workshop session embodied at least one ASD quality. We aimed to integrate qualities of multiplicity and configurability into the machine-mediated performance session. While the quality of multiplicity was effectively supported, the quality of configurability could not be supported. We attempted to support configurability by making compact wearable devices that were attachable to different parts of the bodies by using various straps. However, the participants did not use the straps and held the devices by their hands only. The lack of expressive capacity in many of the configurations rendered those configurations useless or not preferable. This finding suggests that the difference between the expressive capacities of alternative configurations should not be very high in order to support configurability.

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Shaping and Understanding Audience Bodily Experience

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ABSTRACT

We are exploring new possibilities for bodily-based aesthetic experiences, by bringing together participatory art practices, human-computer interaction, new media and the Bodyweather performance methodology. In the development of a prototype participatory live art installation, *Speechless*, we placed audience bodily experience as the subject of the artwork. Internal physiological processes of breathing and heartbeat were made audible through breath- and pulse-sensing digital soundscapes. We were particularly interested in the role of the embodied imagination and its transformative capacity on the felt experience of the body. The recounts of audience testing provide preliminary insights into how people experienced their bodies in new ways through participation in the artwork.

Author Keywords
Audience, body, felt experience, imagination, interactive art, sensors, sound

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

INTRODUCTION
We are exploring new possibilities for bodily-based aesthetic experiences, by bringing together participatory art practices, human-computer interaction (HCI), new media and the Bodyweather performance methodology. In the kinds of artistic contexts we are envisaging, audience participation is crucial and audience experience of their own bodies becomes a central component of the work. The application of digital technologies can externalize and amplify qualities of bodily experience in ways not possible before, such as internal physiological processes of breathing and heartbeat (e.g., Schiphorst and Andersen, 2004; Khut, 2006).

Many contemporary artists are currently working with audience experience and participation as important elements of their practice, particularly in the realm of interactive art. Participatory art practices share with interactive art the premise that the artwork is brought into being – or completed – only with the interaction or participation of people (Winkler, 2000; Bishop, 2006; O'Reilly, 2009). There is growing interest in applying established methods from HCI to these novel artistic contexts in order to understand the audience experience of the interactive artwork (e.g., Höök et al., 2003; Khut & Muller, 2005; Bilda et al., 2006; Khut, 2006; Muller et al., 2006)

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Methods for accessing and evaluating user experience such as think-aloud protocols, co-discovery, recounts, video-cued recall, interviews and questionnaires can provide artists and researchers with valuable insights into the audience experience. These methods can be applied in an iterative process of making and evaluating, so that understandings of audience experience are folded back into the developing work. A tension exists for artists as authors of a work and the audience interpretation of the work. How the evaluation data is used to influence the final work may be approached differently by artists and by interaction designers, depending on what values are driving the development. Höök et al. (2003) raise concerns about directly applying traditional HCI evaluation methodologies to artworks; what is considered good research practice in a field that traditionally values objectivity may not fit well with the more subjective stance of the world of art. They describe how they adapted existing HCI evaluation techniques to suit artists' concerns, with a particular focus on fine-tuning and improving the interaction design aspects of the interactive artwork. In our project, we were interested to find out how audience responded to the work and if it generated responses of a poetic and somatic nature.

Bilda et al. (2006) developed a coding scheme to analyse audience experience of interactive artworks, containing the seven categories of physical, purpose, state, object, perceptual, conceptual and recall. The categories of state and perceptual are the most relevant to our interests. *State* covers the person's felt, emotional state, the use of their physical senses, as well as the activities that they are engrossed in during the interaction. *Perceptual* deals with the perception of sound, image and the relations between them. However, it does not acknowledge how the perception of external events impacts on the perception of self and the experience of the feeling state of one's body.

We conducted research into understanding and designing for body-focused interactions in an artistic context, extending the research conducted in the Thinking Through The Body project (Loke et al., 2011). We were interested in how people could experience their bodies and sense of self in new ways, by drawing their attention to internal processes and sensations, amplified and externalized through the use of digital technologies. We were also interested in how we could potentially shape this bodily focus through the use of the embodied imagination. We turned to the Bodyweather performance methodology for inspiration, as it works with the concept of transforming the body through imagery (McAuley, 2003).

SPEECHLESS

The project brought together four artists/researchers with backgrounds in dance performance making, new media arts, human-computer interaction and costume design. It involved the making of a prototype participatory live art installation, *Speechless*, with audience bodily experience as the subject of the artwork.

In this artwork the perception and performance of one's own bodily processes is brought into sharp focus. We experimented with techniques for transforming a sense of self through the embodied imagination, aiming for participants to be simultaneously deeply present in their body and potentially experiencing a sense of embodiment beyond human. One specific technique from Bodyweather works with placing imagery in the body or placing the body in imagery extending beyond the body. The concept of *scaling* imagery through the embodied imagination became useful in this context.

We came together for two intensive residencies, over a six month period. The aim of the second residency was to produce the prototype installation, *Speechless*, which could be tested with audience. The installation consisted of a series of experiential body-focused stations, each one providing a different yet related experience of one's body. At three of the four stations (Lung, Heart and Spine), audience participants were invited to experiment with varying sensations of weight, touch, constriction, compression, breathing and heartbeat. At the Lung and Heart Stations, the participant's breathing and heartbeat were amplified through breath- and pulse-sensing digital soundscapes. The Spine Station used no technology. The fourth station (Recall) invited audience to reflect on their experiences of the previous three stations.

The Lung Station

At the Lung Station, participants explored their breathing with a breath-sensing soundscape combined with constrictive body-straps fastened around the body from the chest down to the ankles (Figure 6). The breath sensor apparatus consisted of a chest strap with the breath sensor incorporated, attached just below the armpits. The synthesized sounds responded to the rise and fall of the participant's breathing. We wanted to use sound to evoke a deep, monumental scale, and to grow from something that could be perceived as small and intimate to large scale. The sound ranged from breath-like to ocean waves.

At each station, an artist acts as a guide and leads the participant through a scripted trajectory. This decision to include the artist in the actual work enabled us to prompt the participant in the use of their embodied imagination in a way that was sensitive to where they were in the temporal structure of the work. About three-quarters of the way through, we explicitly suggest to the participant an image of the Whale Body that scales their sense of self outside beyond their physical skin. "Now we'd like to invite you to re-scale, and imagine your whole body as a whale lung that is filling the entire space".

Figure 6. The Lung Station offered an experience of breath and constriction

The Heart Station

At the Heart Station, participants were invited to experiment with sensations of weight and compression (Figure 7). Participants selected objects to be placed on their body by the guide whilst listening to a soundscape controlled by their pulse. They lay down on a bed, with the tray of objects nearby. The pulse sensor was attached to the participant's index finger with a Velcro strap and placed on the surface of the bed.

Figure 7. The Heart Station offered an experience of heartbeat, weight and compression

The soundscape starts with a pulsing sound and shifts to progressively more turbulent pre-recorded textures: deep resonant and chaotic soundscapes evoking the rush of fluids, immersed in reverberation effects designed to evoke placement within a monumental, cathedral-like interior.

Again the guide offers the participant a transformative image, "Now we'd like to invite you to imagine your whole body as a whale heart that is filling the entire space – imagine the sides of your heart touching the skin of the building. Imagine the weight and volume of your heart." We invite the participant to scale their sense of self beyond their physical skin. And then to rescale back to human dimensions towards the end of the experience, "Now come back to the scale of the human heart and remember the feeling and the sound of your pulse."

AUDIENCE TESTING

We invited six people to participate in our audience testing. We wanted a range of body types and people with an interest in the kind of work we were doing. The participants had backgrounds in architecture, dance, film, new media, production and performance. There were four women and two men. Each participant was scheduled to arrive at a set time to ensure an even flow of people throughout the installation. Information sheets and ethics consent forms were available in the waiting area, prior to entering the installation space. Each participant was met by one of the artists and guided through the installation. Video documentation of the artwork is at http://vimeo.com/25535870.

We recorded participants verbally recounting their experience of the installation at the Recall Station and invited them to provide written feedback in response to a set of questions (see Table 1).

Table 1. Feedback Form questions

Q1 What were the pivotal moments in your experience of each work (Lung Station – standing and being bound, Heart Station – lying on bed with objects, Spine Station – lying down back to back)?
Q2 What factors contributed to, or detracted from, the experiential flow in each work?
Q3 Were there specific stations that could be shorter or longer in duration? If you could change some of the timings or transitions, what would you make longer or shorter?
Q4 Did any of these stations give you a different experience of your body? If so, what influenced that experience?
Q5 Choose 3 words that vividly describe your experience.

DATA ANALYSIS

For this paper the focus is on audience bodily experience: how people experienced their body during the encounter and what factors played a role in influencing that experience. The data is analysed from a number of analytic lenses: the relationship between the embodied imagination and felt sensation; the influence of objects and costume; and the sonically mediated experience of physiological processes of breathing and heartbeat. We will limit our discussion here to the reports from the two stations incorporating explicit use of the Whale Body metaphor and digital technologies – the Lung Station and the Heart Station. The results of the analysis are discussed in the following sections.

Lens 1: The relationship between the embodied imagination and felt sensation

The interest here is on the relationship between imagination and its experiential effect on the body. The term 'embodied imagination' refers to the intertwining of our imaginative capacities and the felt experience of the body. It brings to the foreground the understanding that our mind and body are fundamentally connected in creative and transformative ways. In this project, we were specifically looking at the use of imagery to transform one's perception and experience of self and the world. This lens includes the use and influence of language on how people experience and imagine their bodies.

A distinction is made between *associative* images that are understood mentally and *transformative* images that are deeply felt in the body. In the audience recounts, we identified associative images whenever a person used language such as "it reminded me of …" or "it brought up memories". For example, P4 describes how her experience of the Lung Station (the constriction of the straps and the attention to breath) reminded her of a conversation with a pregnant friend and the friend's description of carrying the child inside being like "her body the membrane between universes". Here the image is a reference, an association. The image itself is not necessarily *felt* in the body in a transformative sense. An example of a transformative image is given by P1 where he describes his feeling state at the Recall Station, "It feels like a whole body space. I'm inside someone's body, I'm having that … sensation now, we're just … inside the whole body." And, "The whale imagery sent me the feeling like I'm inside a whale."

P3 provides an interesting example of the transition from thinking mentally about an image to actually feeling the image in the body. She comments that the straps fastened along the length of her body "assisted with actually being able to *imagine* myself as a whole body […] It made me *feel* like I was one piece" (our emphasis).

Observations made by participants pointed to the paradox of being physically restricted in some way yet invited to expand their bodily sense through their imagination, particularly with the Whale Body metaphor. The following quotes from participants are testament to this.

"Oppositions. Bound physically. Lying with stones or another body but focusing on vastness like Whale Lung."

"To think of the body as a whale was interesting as the size of the creature opened up my body and mind to think of a new scale."

The Whale Body metaphor operated for some participants as a meta-image for the entire experience in the space.

Lens 2: The influence of objects and costume

In the Lung Station, the constrictive straps played a major role in how people perceived their bodies and the process of breathing.

"The binding, however, shifted my focus to the operation of breathing; the shifting volumes of oxygen; taking my sensibility, paradoxically, deeper within and expansively outward." This example illustrates P5's experience of the act of breathing shifting from a sense of the breath flowing in and out to a spatial sense of breathing and the expansion and contraction of the lungs and body. P3 describes the effect of the binding as conveying the essence of a single lung.

In the Heart Station, the experience of the stones on the body yielded some interesting insights. "Rocks replaced/became body parts. Imagined/experience of womb, weight of baby." The weight and pressure of the variously sized stones on the torso, belly, neck or face of the participant caused them to merge their sense of self with the objects and to imagine the objects as other kinds of entities and qualities. The transformative image is reinterpreted here with the example of P1's experience of the stones becoming part of his body. The physical boundary of the body, usually associated with the skin, is dissolved in the experiential merging of external objects with the body.

P3 talked about the stones making her feel more alive, "The weight of the objects made me more aware of my inner workings, under the skin, making me feel each organ being put to work under the pressure". For P5, the internal qualities of the body were brought to the fore – a recognition that the body is mostly fluid. "The placing of the large weight was an astonishing moment; one where you are made actively aware of the fluidic nature of the body and its organs: against solidity, the corpus ebbs and flows". However, both P2 and P4 were doubtful of how the placement of the stones on the body seemed to change the pulse.

Lens 3: The sonically mediated experience of physiological processes of breathing and heartbeat

In the Lung Station, the participant's breathing patterns are made highly audible through the soundscape. Most people spent some time attending to and playing with their breathing as reflected by the changing sonic feedback generated in response to the data from the sensors. As P2 reports, "The sound made me aware of my breathing and I felt greater power as I felt I was breathing under water". P1 wanted to play with and challenge the relationship. P3 raised the question of how true the sonic feedback was to her breathing in terms of timings. P4 noticed that the emptying of the lungs and the expansion had different sounds. For P3, the sound promoted her capacity to take on the transformative image of the Whale Body and also to imagine herself in the deep sea.

Few comments were made for the Heart Station, apart from the mention of being able to hear variations of the heartbeat and wondering what the relationship was between the placement of stones on the body and the pulse.

In closing the discussion of the analysis, Table 2 contains the set of three (or more) words offered by participants in response to question 5 on the Feedback Form. The words summarise and suggest the character of the participant experience.

Table 2. Three words to vividly describe the experience

(Sub)merged, Isolated, Peaceful resignation
Water, Meditation, Body
Internal, Aware, Mammal, Exploration
Cosmos, Animal, Relationship
Expansive (physically), Exploratory (Internally), Connective (between mind + operations, conditions + possibilities of the body)
Physical, Immersive, Gentle

CONCLUSION

In the development of *Speechless*, we aimed to create the conditions for an immersive and reflective encounter (with self), by providing space and time for people to let go of everyday concerns and discover the poetic and transformative possibilities of paying attention to the state of one's body, its physiological processes and the felt sensations that colour our lived experience. The analysis of the audience recollections of their experience within the prototype installation suggested that it was effective in bringing people to a sharper awareness of their bodily experience and evoking interesting and poetic re-interpretations of their physiological processes.

Further work is needed on relevant theories pertaining to embodied cognition, the role of the imagination in shaping bodily experience and methods for accessing and evaluating audience experience.

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Spooning in the Kitchen

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ABSTRACT
Cooking together is an important part of everyday life. In cooking with others we share not only the experience of creating the meal, but a social event in which people enhance their relationships through shared stories, relating daily happenings and discovering new ideas about food preparation from each other. Cooking together in the kitchen also involves bodily negotiation, where we position ourselves in order to share techniques, show progress in cooking, demonstrate what the food should look like at many points in the recipe, and share the sociality of the activity. If we then want to introduce technology into this situation, to support either the cooking activity, the social activity or both, it is important that we design this technology to fit with the physicality of both the kitchen, and the cooks. Our method for understanding the bodily experience of the cooking activity involved a digital ethnography on a set of YouTube videos of people cooking together in their kitchens. From an analysis of F-formations of social encounters in the kitchen, we were able to identify the "spooning" configuration – a close-up view over the cooks shoulder as an important part of the human-food interaction.

Author Keywords
Cooking together, the body in the kitchen.

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

INTRODUCTION

Cooking together is an important part of our lives. We cook with friends, families, colleagues and strangers to share not only the experience of creating a meal, but as a social event where we enhance our relationships with others through shared stories, relating daily happenings and discovering new ideas about food preparation from each other. Recently, the kitchen has become a focus for HCI research into understanding the role that technology currently plays with regard to the cooking activity and what roles it might play in the future (Grimes & Harper, 2008).

From a methodological point of view, we want to understand the shared cooking experience for the purpose of generating design ideas for technological augmentation of kitchen spaces. This involves understanding not only how artefacts and kitchen spaces shape the movements of an individual while cooking, but also how the presence of others, sharing the cooking experience, influence the kinds of physical interactions that happen. In using YouTube as our data source, we are able to focus on peoples interactions with co-present others, with physical space, with cooking artefacts, as well as the remote audience (via the camera).

Our first research agenda is to gather understanding of the human-food interaction to inform technology and interaction design providing people with the experience of cooking with family, friends and others who are geographically distributed using their respective kitchens as a single, digitally "blended" cooking space. Our manifesto is that people involved in this shared remote cooking activity should experience essential, "as if I was there", aspects of the cooking activity. This then supports distant friends and relatives sharing their everyday activities, using the cooking activity to set the conversational context, with close ones who are living away. This is important for maintaining these close tie relationships (Nardi et al, 2004).

BACKGROUND

Inspired by smart domestic environment projects (e.g. Georgia Tech Aware Home[1], MIT House_n[2], Washington State University CASAS Smart Home[3]) and in particular smart kitchen projects (e.g. CounterIntelligence[4], CounterActive[5]), especially collaborative cook (deRuna et al., 2010), our design focus is on adding value to a shared domestic experience, using technology to bring people together in a social context. We take the approach that kitchens are "sites where meaning is produced, as well as meals" (Bell & Kaye, 2002) to create a blended interactive kitchen space for geographically distributed people together in a shared virtual place for socializing while cooking.

An important challenge for HCI researchers interested in the design of new domestic technologies is to observe and

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[1] http://awarehome.imtc.gatech.edu/

[2] http://architecture.mit.edu/house_n/

[3] http://architecture.mit.edu/house_n/

[4] http://www.media.mit.edu/ci/

[5] http://www.media.mit.edu/pia/counteractive/

make sense of people's daily practices, so that these practices can meaningfully inform design and seed innovation (Bell & Kay, 2002). Understanding the human-food interaction is important so that our designs do not seem irrelevant to people or constrain them from performing their everyday activities in the ways that they want to. Our first task in this research project therefore, is to understand what it is that people do and how they do it when cooking together in their own kitchens. We want to get a sense of how people move around kitchen spaces during the activity of cooking together, both in respect to co-present others, and also how they physically orient to the "person in the camera". This is why the YouTube videos are an appropriate data source for this human-centred approach to understanding the body in the design of interactive technologies for the kitchen.

In the domestic research context, traditional HCI methods of "understanding users" such as direct observation, interview and questionnaires are not always possible, desirable, or even effective in gathering information about peoples activities in their own homes. As the design of domestic technologies becomes more prevalent in HCI, an assortment of techniques for dealing with "understanding users" in these kinds of private situations is emerging. Examples include: cultural probes to understand close-tie relationships (Kjeldskov et al., 2005); video cameras placed in rooms to understanding communications in families (Crabtree & Rodden, 2004) and functional systems installed over extended periods of time to access lived routines of the home (Sellen et al, 2006). In the spirit of these explorations, we take a similar approach with emphasis on opening up spaces for informal analyses, chance observations and serendipitous design inspirations.

As the movie "Kitchen Stories" (Hamer, 2003) so charmingly illustrates, it is not ideal, or even logistically possible, to sit in an observation chair in the corner of people's kitchens to observe their cooking behaviors. The movie shows, and Crabtree and Rodden (2004) confirm, that although the home is relatively easy to access, direct observation disrupts the ordinary flow of household activities and can cause people to alter their ordinary behavior. Instead we use YouTube videos to access to how conversations in the kitchen unfold, how people interact with each other, with the food, and with the physical artifacts and spaces of the kitchen environment when cooking together in a form of digital ethnography (Dicks et al., 2005). YouTube is becoming a useful resource for different types of qualitative research projects, to study its use in asynchronous video computer-mediated communication (Harley & Fitzpatrick, 2009), as a performance stage (Blythe & Cairns, 2010), and in building online communities (Rotman & Preece, 2010). In terms of gaining access to peoples "kitchen stories" YouTube provides an excellent insight into how people choose to digitally share with others the activity of "cooking together".

How the physical aspects of cooking spaces contribute to shaping the kinds of activities and experiences people have when cooking together is an important aspect of this study. As well as the natural proxemics (Hall, 1966) involved in the activity of cooking together in a kitchen space the introduction of technology into this situation creates new "interaction proxemics" (O'Hara et al., 2011) of collocated people in respect to the cameras and display artifacts, as well as the virtual presence of remote participants. In the original notion of proxemics the different spatial distances are given numeric values. *Intimate* distance is 0-45cm and reserved for lovers, family and close friends. *Personal* distance is 45-120cm and usually used with strangers in everyday situations. *Social* distance is 120-360cm and encompasses things like work and business meetings. *Public* distance is anything beyond 120cm, where any sense of personal involvement with the other actor is lost. The very activity of cooking can influence the general ways in which human interaction is spatially organized in the cooking space. Having to work side-by-side at a kitchen bench influences the way that two people communicate as opposed to working at opposite sides of a kitchen island. Facing a video camera during the interaction adds yet another level of complexity, not only to the collocated communication, but also in respect to field of view of the camera, as this affects the viewers perceived distance from the cook.

The F-formation (facing formation) system is a conceptual tool that can be used to analyse physical spaces in terms of how they support social interactions and by extension, their potential augmentation with technology (Kendon, 1990; Marshall et al., 2011). This spatial-orientational system, explains how people arrange themselves spatially in different kinds of focused interactions, to support their conversations. Just as space can generate and structure the activities of those who inhabit it, there is also an interaction between spatial structures and the different kinds of social activities that are enacted within them. These F-formations can therefore be used to explore the influence of physical space on social interactions.

In Kendon's (1990) system of the F-formation individuals have a spaced called a *transactional segment*. This is the space in which people focus their attention and manipulate artefacts. This space is defined in relationship to their lower body, so turning their head sideways directs their gaze out of it, and the segment changes in size depending on the kind of activity that people are doing. The F-formation is formed when the transactional segments of two or more people overlap and create a shared inner space, where the main activity occurs, called the *o-space*. There is also a *p-space*, the area occupied by the people and their personal artefacts (i.e. handbags, briefcases, cooking implements). Kendon identifies the following spatial patterns: *L-shaped* (standing perpendicular), *vis-à-vis* (facing) and *side-by-side* (formed by two people); *circular*, *rectangular*, *semi-circular,* and *linear* (for groups of three or more). We use F-formations to identify spatial patterns of people, kitchen design and camera locations that support social interaction while cooking together over a distance.

OUR STUDY

In their kitchen manifesto, Bell and Kaye (2002) advocate a kitchen/technology relationship that draws on and learns from the rich cultural history of the kitchen as a place for living and above all, a focus on those who experience the space, rather than the resident technologies.

In our approach, we studied a set of videos published on YouTube to understand particular nuances of the activity of people cooking together. We used qualitative content analysis on a set of 169 YouTube videos comprising the search results for the keyword phrase "cooking together" on 15 November 2010, sorted by relevance (see Figure 1). Several of the resulting videos were clearly not related to the research area of people cooking together but were poems, music clips or gaming videos with misleading keywords. These were discarded from the analysis process as well as any duplicates, leaving a final set of 61 videos to be analyzed in depth.

Figure 1. Sample scene from "Cooking Together" video

From this analysis the following set of categories were induced: *video production, cook expertise, relationship of cooks, genre, content, intended audience, skill level, location, background story, mood, food role, people role, motivation*. This was then used to make a content map of the videos based on their attributes within these categories. From this content map, six main types of videos were identified: *family life; family cooking; celebrities cooking; amateur cooking show; professional cooking show; documentary; educational video and advertising*. A representative video from each of these groupings was then "transcribed" in detail, using a map form similar to Kendon's diagramming technique for recording F-formations at a birthday party (p. 228). On the map we recorded patterns of physical movement and bodily relationships of the cooks to each other and to the "remote person" (in respect to the camera view). Each frame was time stamped with the video time count and recorded a newly established position of individuals and the position of the camera and field of view. The cooks were shown as ovals with two lines extending to show their *transactional segment*, making visible where they intersect to create an *o-space*. Paths of movement through spaces and focal artefacts were also documented. Showing the virtual position of the imagined viewer made it possible to identify their participation in F-formations.

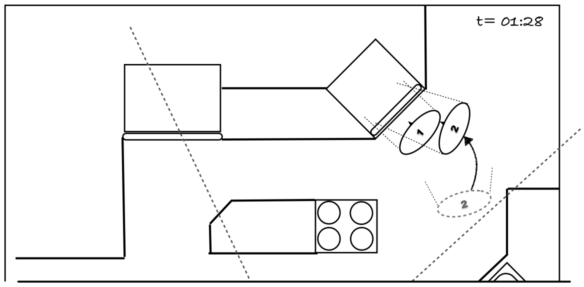

Figure 2. F-formation Map of YouTube video: 57

These maps were then used to identify the following: the F-formation system between collocated cooks; the F-formation system between the viewer (the camera) and the cooks; and the perceived distance between the viewer and the person in focus using the distance classifications from Hall (1966). These identifications where then studied in respect to activities being performed by the cooks, the positions of the cooks in respect to each other and the position of the camera in respect to the activity in focus and the cooks. Identifying F-formations highlighted situations where an *o-space* was formed by participants' *transactional segments* (including the viewer) and any focal artifacts (i.e. the food being prepared, the kitchen utensils) located in that o-space. The proxemic coding was used to correlate the intimacy or otherwise of the bodily interactions between cooks (including the "virtual" viewer).

FINDINGS

Our analysis focused on the location and composition of F-formations (Kendon, 1990) in the kitchen between people cooking together and a "virtual" viewer. Focusing the digital ethnography on F-formations allowed us to identify situations when interaction with the camera, the cooking partner, and/or both, supported inclusion in the social encounter for all. That is, when an F-formation exhibited an *o-space* formed by all participants' transactional segments (cooks and viewers). In both cases the transactional segments intersected on the activity being performed and hence an F-formation system was created and maintained for the duration of this activity. The formation of the *o-space* confirmed the viewer's participation in the activity of cooking together. In any digitally "blended" cooking space, that is the kind of experience that should be supported using technology.

Using the spatial maps of the human-food interaction helped us to identify a new kind of spatial pattern, not previously classified by Kendon (1990), that formed an important part of the cooking interaction when wanting to include others in the activity. We called this F-formation *spooning*. From the videos it can be seen that *spooning* is an important part of showing and sharing progress during a cooking activity. It is also an *intimate* interaction, in respect to Hall's (1966) proxemics. People come from behind a person, both to assist in an activity being performed by the front person (e.g., how to chop food in a particular way, how to add an ingredient) and to see what a person is doing with a particular artefact or piece of food from the perspective of the front person (e.g., stirring a pot, putting something in the oven). This is particularly poignant when you are the viewer to the interaction through the camera, as you really feel connected to the cooking activity when the video is taken over the shoulder of the cook.

DESIGN IMPLICATIONS

Being able to map out whether a space provides adequate opportunities for social interactions is a good starting point from which to consider what kind of technology interventions can transform a space (Marshall et al, 2011). In designing camera positions in a digital kitchen it seems that it would not support an feeling of involvement in the activity to simply have a camera that focuses on the stove top from directly above (as in the CounterActive kitchen). An important part of the interaction is our (the remote persons) view over the shoulder of the person we are cooking with – both the angle of view, and some capture in the periphery of parts of that person to indicate their presence. This personal relationship adds to the social aspects of the interaction missing from some of the recent digital kitchen designs surveyed in the literature. Most digital kitchen designs that we have seen simply place cameras in locations that could be said to be providing "a clear view of the cooking artefact". In our project, it is more about shared experience of an ongoing conversation around food preparation and daily encounters than it is about clear views and detailed ingredient lists.

Our concern in this study was in understanding, through our particular form of digital ethnography, how people cook together in respect to geometric properties and configurations of the spaces they are cooking in, how they involve artifacts and others in the interaction and their communication behaviors both with others collocated in the space and their perceived YouTube "audience". An important part of the understanding gained was how they turned a physical kitchen space into a place for experiencing cooking and commensality through their physical movement and bodily orientations to people on "the other side of the camera".

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Augmenting the Analysis of Social and Physical Interactions

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ABSTRACT

Social and physical interactions are embedded in settings which are not only material but also social, cultural and historical, and studies of use require a focus on the social construction of meaning [0]. Therefore, in order to position our understanding of sociophysical interactions within the context of wider culture production we adopted a dual pronged methodological approach that uses the ethnomethodology informed technique of 'Interaction Analysis' in the form of video data analysis to design *for the body* from data generated *by the body* itself. We then augment Interaction Analysis with lenses from cultural theory to provide insights into not only *what* the users in the study were doing, but also *why* they were doing it in terms of the cultural forces that underpinned their behavior. The process of augmenting Interaction Analysis with Cultural Theory resulted in a surprisingly holistic framework for exploring sociophysical interactions.

INTRODUCTION

This paper presents insights generated from a study investigating the opportunity between tangible interactions offered by mobile/embedded technologies and social engagement offered by social technologies, which we label *sociophysical* interactions. The study investigated the potential for the Microsoft Kinect for Xbox 360 to enhance socio-physical interactions in a cross generational context. Five families interacted with the Kinect over a three week period.

The focus of this paper is on the issues surrounding methodological approaches for understanding the user needs and consequent design possibilities for systems that facilitate socio-physical interactions. We found that an unexpectedly holistic picture of socio-physical interaction is produced when ethno-methodology and cultural theory are used in conjunction with each other.

We conclude that as HCI continues to embrace critically and theoretically informed approaches to the design of new technology, an increasingly politicized design space will emerge. To ensure that ideological agendas do not overshadow genuine user needs ethnomethodological approaches take on a new relevance, not only as a means for understanding users, but to provide a counter balance to the new culturally situated accounts of user behavior.

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SOCIOPHYSICAL INTERACTIONS

There is a growing body of work within HCI that examines socio-physical interactions. Dourish [0], among others, highlighted the separation between the social and the physical typical in the analysis of interactive systems. Drawing upon the work of many in the field, including the phenomenological research of Robertson [0, 0], he called for a research program in embodied interaction that used its foundations in the philosophy of phenomenology to map connections between the tangible and social computing.

Dourish [0] argues that the design of these technologies should not be driven by the definition of tasks and their requirements, or the development of standalone applications, or the pursuit of technology solutions for their own sake. Instead the goal is the design of technologies that support, mediate and enable human interaction, with a focus on ubiquity, tangibility, and particularly, shared awareness, intimacy and emotions. Furthermore, interaction is always, by definition, embodied interaction both in the sense of its always being dependent on bodily capacities, such as movement, language and thought and its embeddedness in a physical world where our bodies and the world we are in are made of the same 'stuff'.

Mueller et al. [0] also describe a growing focus on interactions that place the human body at the center of the experience, and builds on this in their development of exertion technologies. One of the benefits of such systems is not only enhanced physical well being, but also greater opportunity for maintaining social interactions. Despite these advances in the field, Hornecker [0] notes the research community "lacks concepts for analyzing and understanding the social aspects of tangible interaction and design knowledge on how to design so as to support social interaction and collaboration" (p.439).

SITUATING METHODOLOGICAL APPROACHES

Particular insights about use of technology can be generated from ethnomethodological perspective, which are grounded in "the detailed and observable practices, which make up the incarnate production of ordinary social facts [0]". Historically, the use of ethnomethodology *in Computer Supported Cooperative Work* arose from analysis of workplace settings. The focus on the studies of people's everyday interactions in a variety of settings, not only work.

Recently, a growing body of critically informed HCI approaches argue that analysis of everyday technologies requires rethinking and readapting these methodologies – or risking making all of our life like work [0]. These culturally grounded approaches offer researchers and designers cultural interpretations of action and critiques of the design process.

The research presented here explores these two methodological approaches by investigating the potential to reconcile the two approaches in order to better understand user needs and design implications for systems that facilitate socio-physical interactions.

AUGMENTING THE ANALYSIS OF SOCIO-PHYSICAL INTERACTIONS

The study investigated the use of the Kinect for Xbox 360 to enhance socio-physical interactions in intergenerational families. Five intergenerational families used the Kinect gaming system over a three-week period. The participants were instructed to film their interaction during the game play session and two follow up interviews with the participants were conducted.

The researchers analyzed the video data to understand how participants co-operate and collaborate in their activities. This approach was informed by Jordan and Henderson's account of 'Interaction Analysis' [0].

Cultural theory was also used to examine the video data and interview transcripts to critically analyze not only what the users in the study were doing, but also why they were doing it in terms of what cultural forces underpinned their behavior.

The next section will describe the defining features of each approach. We will then examine the application of these two approaches to understanding sociophysical interactions.

Interaction Analysis

Interaction Analysis is consistent with ethnomethodological approaches [0]. Interaction analysis stresses the need to keep the analysis free from analytical categories. It is through the course of multiple replayings of the video data with a multi-disciplinary group that the emerging themes start to appear.

The strength of Interaction Analysis is that it deals with the actual details of technologically mediated interactions and allows technology developers to see exactly how existing technology fits (or doesn't fit) into current practice. Interaction Analysis also exposes the practical reasoning activities of participants themselves in a way that avoids them having to remember, justify or even know what they did. This effectively indicates how people think and make sense of technology they are using, moment by moment, in the performance of some task.

The importance of situating the exploration of a human activity in the context in which it will occur is important. However, a strictly ethnomethodological approach focuses on the exchanges of interaction in situ and rejects theoretically informed lenses through which to analyze the data [0]. Even though much of ethnography in HCI is not strictly ethnomethodological, the role of the researcher is more often one of a fieldworker analyzing what is seen as naturally occurring, rather than as a cultural facilitator and interpreter.

While these ethnographic insights are valuable, the approach is not without its limitations. Nardi [0] points to the failure of observational and interview data to deal with social structures, institutions and cultural values. Sengers also notes the shortcomings in approaches that fail to integrate cultural and historical analysis. A major research challenge is the development of methodologies that use cultural theory to analyze the cultural context of everyday life and to develop appropriate computer science technologies and methodologies [0].

Cultural Theory

A growing body of critically informed HCI research illustrates that cultural theory is relevant beyond theoretical analysis and social commentary and has the potential to extend beyond passive criticism of what it is observing, to the active re-contextualization of design and design approaches [0, 0].

Cultural theory helps us understand users' needs and desires; it sheds light on why people are likely to adopt one trend but not another and helps indicate which cultural influences are shaping society at any given time. It points out things like why our love for the iPod extends beyond its functionality as an MP3 player and includes our collective embrace of its distinctive white headphone cords. So although design practice has ways of understanding technological features—and of eliciting user needs—cultural theory helps to illustrate the symbolic value of technological artifacts, which is often at least as important to their adoption and use as their instrumental functions. This makes it a viable way for a designer of technologies to reason and explore new products or services [0].

Unlike ethnomethodology, which urges the researcher to resist the role of cultural facilitator, the application of cultural theory to HCI requires the researcher to embrace the role. As Barzdell notes:

> You, the critic, are constructing meaning. By examining these relationships you're not decoding or finding what is empirically there (social sciences are much better suited to this goal). Instead, you are

offering a new way to see or think about something; you are developing the very concepts that you and others later on (including social scientists) will use to understand and evaluate a phenomenon in a new light. [0]

Reconciling the Two Approaches

It is evident that these are two very different approaches. As a result mutual criticism between the two disciplines has emerged.

Ethnomethodologists lament "the wholesale importation of cultural theory (via media studies and so on) into the field of HCI. Indeed, the signature of these new 'reflexive' ethnographies increasingly gaining exposure within CHI. This brings in other cultural 'standpoints' that provide existential conditions for reflexive critiques of dominant discourses" [0].

Crabtree argues that the problem with critically informed approaches is that their inherent need to deconstruct all that they it encounter results in findings that meet the agenda of the researcher. The needs of the user become peripheral in the quest to fulfill this agenda. It is for this reason that new approaches, while alluring, fail to provide sufficiently detailed social analyses to ground design in what people do [0]

Most significantly, the rejection of theory by ethnomethodology continues to act as a metaphorical red flag for those wishing to adopt more culturally situated HCI approaches. These debates are becoming increasing evident during conference presentations, and are played out regularly in HCI blogs.

Having discussed the divergent characteristics of the two approaches, we will now explore the possibility for the two methodologies to combine together in a complimentary manner. The next sections will illustrate how the two approaches can coexist, by examining the application of these two approaches.

The cultural theory perspective

Recent interpretations of critically informed HCI has seen agendas such as Feminism shape analytical lenses [0]. When applied to the data from the user study this meant a feminist critique was used to better understand the way in which gender is constructed and the role that technology plays in shaping notions of 'the body'.

Focusing on this issue drew attention to the way in which three of the mothers in the families participating in the study were reluctant to reveal their age. Rather than attempting to gather information about their age in order to keep with preconceived ideas of what our data *should* look like, this indicated the potential to recognize and reshape our research questions so they are more in keeping with cultural mores and taboos. Thus, rather than seeing the lack of data about specific age as being problematic, this indicated an opportunity to identify and address an important methodological challenge.

In addition to indicating the need to rethink the way in which we approach the question of age, the reoccurring reluctance to reveal age also tells us something about the female's relationship with her own body. For example, one of the women who did not wish to disclose her age also reported than when it was her turn to engage with the Kinect in front of other people she felt embarrassed and conspicuous, and a pregnant participant felt that it heightened awareness of her condition.

From a cultural theory point of view the data tells us about the complex and unique relationships that women have with their changing bodies and the need for design approaches that are sensitive enough to allow for this.

The Interaction Analysis perspective

When comparing the two approaches, what is immediately evident is that the ethno methodological approach told us virtually nothing about gender. This is not because ethnomethodology set out to ignore power structures relating to gender completely, but rather that it would only flag them if it were found to emerge from the users' interactions. The lack of gender related insights could mainly be attributed to the way in which ethnomethodology resists drawing on performed; thus distancing notions of the domestic space as being one that is zoned according to gender.

An exception to this is that when the interview data was included in the analysis the issues regarding the women's reluctance to reveal age did arise. But this type of data is secondary in the Interaction Analysis approach and there was nothing in the actual video data itself to suggest gender related concerns were at work.

We must then ask ourselves, was the issue of gender in the interview transcripts merely an extension of the researcher's own background in cultural theory – what Crabtree would call an example of the researcher implanting their own theoretical concerns in place of those of the user's concerns? Or does it indicate the importance of extending ethnomethodological notions of what constitutes data so that previously secondary sources such as interview data become included as primary sources?

CONCLUSION

One of the characteristics of HCI is that it has remained a relatively un-politicized space. The third wave of critically informed design methodologies we are now heading into will bring about change, one of which is the emergence of new politicized HCI design space. For example, the introduction of Feminist HCI will mean we forever lose the previous HCI construction of the 'user' as genderless beings. So although these theories will bring many benefits to the design of new technologies, the culturally loaded nature of these discourses will change the landscape of HCI as for example, as increasing awareness of gender pushes out an ambiguity towards it. The importance of this ambiguity should not be underestimated.

Ethnomethodology, however, could provide equilibrium when combined with critically informed accounts of user behavior in order to provide a balance to the design process. In this way the tension between the two disciplines can be recontextualized so they form a holistic 21st Century HCI approach to the design of emerging fields such as sociophysical interaction.

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